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Source Term Estimates for DOE Spent Nuclear Fuels
Volume I

January 2004

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Source Term Estimates
DOE Spent Nuclear Fuels
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SUMMARY

Spent nuclear fuel owned by the U.S. Department of Energy (DOE) includes diverse fuels from various experimental, research, and production reactors. These fuels currently reside at several DOE sites, universities, and foreign research reactor sites. In accordance with the Record of Decision, Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs (May 1995), all DOE spent nuclear fuel will be consolidated at the Hanford Site, the Savannah River Site, and the Idaho National Engineering and Environmental Laboratory for storage until final disposition at the national repository, which is currently under development.

Safe storage, transportation, and ultimate disposal of these spent nuclear fuels will require safety analyses to support design and licensing of the necessary equipment and facilities. These safety analyses will require radionuclide inventories to represent the radioactive source term that must be accommodated during handling, storage, and disposition of these fuels.

This report provides the results and summarizes the analytical processes employed to estimate the radiological inventories associated with DOE-owned spent nuclear fuels. Based on these estimates, the heat loading and photon emission spectrum for each spent nuclear fuel are also provided.

Subsequent to the original March 2003 issue of this report, the National Spent Nuclear Fuel Program Spent Fuel Database has been updated to Version 5.0.1. This revision incorporates information from Version 5.0.1 of the Spent Fuel Database. The net impact of the changes on the total estimated radionuclide inventory was an ~2% decrease for the bounding case and an ~14% decrease for the nominal case. An assessment of the impacts concluded that these changes are not expected to impact the repository licensing basis. A comprehensive list and discussion of the changes are documented in EDF-036, "DOE/SNF-REP-078 Revision 1 Impact Assessment."

ACKNOWLEDGMENTS

This analysis summarizes information for U.S. Department of Energy (DOE) spent nuclear fuels that currently reside, or will be consolidated, at one of three DOE sites prior to final disposition. During development of this report, valuable information and suggestions were provided by personnel at each of these sites as well as the Yucca Mountain Project. The following individuals have been particularly helpful.

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FIGURE

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ACRONYMS

BOL	beginning-of-life
DOE	U.S. Department of Energy
EOL	end-of-life
FIS	Fuel Information Sheet
LA	license application
MCNP	Monte Carlo N-Particle
NSNFP	National Spent Nuclear Fuel Program
PSO	Program Support Organization
SFD	Spent Fuel Database
SNF	spent nuclear fuel

Source Term Estimates for DOE Spent Nuclear Fuels

1. PURPOSE

This report provides the results and summarizes the analytical processes employed to estimate the radiological source terms for spent nuclear fuels (SNFs) owned by the U.S. Department of Energy (DOE). Based on the source term estimates, the heat loading and photon spectrum for each SNF are also provided. The results of this analysis will provide isotopic information with a consistent and documented basis for all DOE-owned SNF intended for repository disposal. This information will facilitate analyses that support safe storage, handling, transportation, and eventual disposition of these fuels. The results of this report are adequate to be used for preclosure and postclosure safety analysis at Yucca Mountain.

2. BACKGROUND

In accordance with the Record of Decision for Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs,[1] DOE SNF will be consolidated at the Hanford Site, the Savannah River Site, and the Idaho National Engineering and Environmental Laboratory. Each storage site is responsible for the safe handling, storage, and final disposition of the DOE SNF in its custody. The National Spent Nuclear Fuel Program (NSNFP) consolidates SNF information from each site and makes it available to support DOE planning and scoping activities as well as design and licensing efforts to enable final repository disposal of DOE SNF.

DOE is responsible for storage and final disposition of nuclear fuel that spans several decades of nuclear research and defense-related material production. To support nuclear nonproliferation objectives, DOE has also taken custody of many foreign research reactor fuels. The SNF presently in DOE custody consists of many different fuel types. Although historical data, such as fuel fabrication, operations, and storage records, are incomplete or questionable for some of these fuels, these fuels have been safely handled and stored for many years at DOE storage facilities.

The fuel information currently available at the DOE storage sites is often determined by the records requirements and the intended disposition path at the time the fuel was placed into storage. These requirements and disposition paths were often unique to each site and evolved over time. As a result, the availability and completeness of the radionuclide inventories and associated documentation varies considerably for DOE SNFs. If directly relied on to demonstrate compliance with repository licensing criteria, much of the available historical information for these fuels will not meet current quality assurance requirements without additional characterization. Costly characterization of these fuels can be avoided by employing a credible means to obtain a conservative source term estimate for use in repository design, analyses, and licensing activities.

A process for creating a conservative estimate of these SNF source terms was developed by a team of experts representing each of the DOE SNF storage sites. The process relies on precalculated results that provide radionuclide inventories for typical SNFs at a range of decay times. These results are used as templates that are scaled to estimate radionuclide inventories for other similar fuels. The templates were generated using ORIGEN-based calculational techniques described in DOE/SNF/REP-055,[2] which includes discussion and references to relevant experimental data and validation studies. Additional validation studies[3,4,5,6] have been performed that further demonstrate the validity of the model and underlying codes.

To estimate an SNF source term, an appropriate template is selected to model the production of activation products and transuranics by matching the reactor moderator, fuel cladding and compound, and beginning-of-life (BOL) enrichment. Precalculated radionuclide inventories are extracted from the appropriate template for the desired decay period and then scaled to account for differences in fuel mass and specific burnup. By modeling various combinations of reactor moderator, fuel enrichment, fuel compound, and fuel cladding, templates have been developed to reasonably model a broad range of DOE SNFs.

The template methodology enables a source term estimate to be completed for virtually any DOE SNF for decay dates up to 100 years following reactor shutdown. This process, which was introduced in DOE/SNF/REP-059[7] and further refined in this report, uses available information, conservative assumptions, and similarity principles to estimate SNF radiological inventories. A similar approach that is employed on a more limited scale to estimate radionuclide inventories needed to support shipment and acceptance of foreign research reactor fuels is documented in Reference 8.

By employing the template methodology to estimate DOE SNF radionuclide inventories, needless expense and personnel exposure associated with characterization are avoided. The scope of this report includes all DOE-owned SNF destined for the repository except for navy SNF. The Navy will provide source term information separately. Sodium-bonded SNF that is projected to be treated is not included in this report.

3. QUALITY ASSURANCE

The radionuclide inventory estimates presented here have been developed to support preclosure and postclosure licensing and design considerations at the proposed Monitored Geologic Repository near Yucca Mountain, Nevada.

Preliminary dose calculations and scoping studies have indicated that repository performance is relatively insensitive to the form and composition of DOE SNFs. There are three reasons for this. First, DOE SNFs comprise a relatively small fraction (~3% by MTHM) of the total SNF that will be placed in the repository. Second, DOE SNFs are primarily from research, test, and production reactors that are typically low burnup fuels and are thus less likely to have high concentrations of radionuclides. Third, the DOE standard canister serves as an engineered barrier that provides additional confinement.

A recent study concluded that the DOE SNF standard canister and the canister handling equipment and facilities could be designed such that an accident resulting in a breach (i.e., any release) is not a credible event.[9] The Yucca Mountain Project strategy that demonstrates that a preclosure release from a DOE standard canister is not credible is outlined in Reference 10. Nonetheless, preliminary dose calculations that assume a breach, even though a breach is not credible, have shown that radiological doses remain well below the regulatory limit.[11] Similarly, even though analyses show that a postclosure release from DOE SNFs is not expected during the 10,000-year regulatory period, calculations again indicate that doses would remain well below the regulatory limit.[12] Because of these relatively large margins of safety, additional fuel characterization is not justified, and existing DOE SNF information is considered sufficient for demonstrating compliance with repository preclosure and postclosure safety requirements.

The NSNFP procedures applied to this activity implement DOE/RW-0333P, Revision 13, "Quality Assurance Requirements and Description,"[13] and are part of the NSNFP QA program. The NSNFP QA Program has been assessed and accepted by representatives of Office of Quality Assurance within the Office of Civilian Radioactive Waste Management for the work scope of the NSNFP. The NSNFP work scope extends to the work represented in this report. The NSNFP work scope is generally described by DOE, Memorandum of Agreement for Acceptance of Department of Energy Spent Nuclear Fuel and High Level Radioactive Waste, Revision 1, between the Assistant Secretary for DOE-EM, Washington, D. C., and the Director of DOE-RW, Washington D.C. This document is also known as the Comprehensive Memorandum of Agreement.

NSNFP procedure PSO 3.03, "Engineering Analyses," requires the validation of models used in NSNFP engineering analyses to ensure that processes, systems, and phenomena are represented to an appropriate level of detail based on the intended use of the results.[14] The estimates provided here rely on two models. First, the templates are created by modeling nuclear reactor fuel depletion using MCNP-ORIGEN2 Coupled Utility Program Code (MOCUP). Detailed discussion of these codes and associated validation is given in Reference 3. Additional studies that further validate the models and calculational techniques used to generate the templates and demonstrate the applicability of this methodology to a wide variety of DOE SNF are included with References 3, 4, 5, 6, and 15. Second, the template methodology scales precalculated radionuclide inventories from one fuel to model other similar fuels. This methodology was developed by a team of experts representing the Idaho National Engineering and Environmental Laboratory, the Hanford Site, the Savannah River Site, and the Yucca Mountain Project and has been formally documented and reviewed in DOE/SNF/REP-059 (see Reference 7).

The templates and associated logic used to determine scaling factors and calculate the source term estimates were originally codified using software routines and macros within Excel 2000 in accordance with NSNFP procedure PSO 19.01, "Software Control."[16] These software routines and macros were uniquely identified and have been independently verified to produce correct results. This was achieved by:

1. Including on the output sheet a comparison of the ratio of heavy metal mass estimated using the methodology to that currently residing in the NSNFP Spent Fuel Database (SFD). These ratios, which provide an indication of the reliability of the estimate, remain near unity for fuels when not using the "Worst Case" template. This ratio exceeds 1 (often by large amounts) when the Worst Case template is used, which is to be expected based on the very conservative construction of this template.

2. Reviewing results to ensure the calculated results correctly implemented the logic described in this report (by a designated technical reviewer who sampled several of the output sheets).

3. Independently checking implementation of the logic employed for the estimates (Figure 1) by comparing results obtained from a different programmer using a different program (Microsoft Access) to independently implement the same logic.[17]

Subsequently, the template methodology for estimating radionuclide inventories has been incorporated directly into the NSNFP SFD. SFD Version 5.0.1 has recently been released to provide a consistent basis for DOE SNF information that supports repository license application. The radionuclide inventories provided here are those generated by SFD Version 5.0.1, which has been checked against the original Excel workbook to verify that the methodology documented in the previous revision to this report is reproduced by the SFD.[18]

Based on the considerations outlined above, the estimates presented here are considered to be adequate to support dose calculations for postclosure analyses as well as preclosure beyond design basis events analyses. If used for analyses that support conclusions beyond these purposes, responsibility for specifying applicable standards and for determining adequacy resides with the user. This report includes references and documentation intended to facilitate any such subsequent determinations of adequacy.

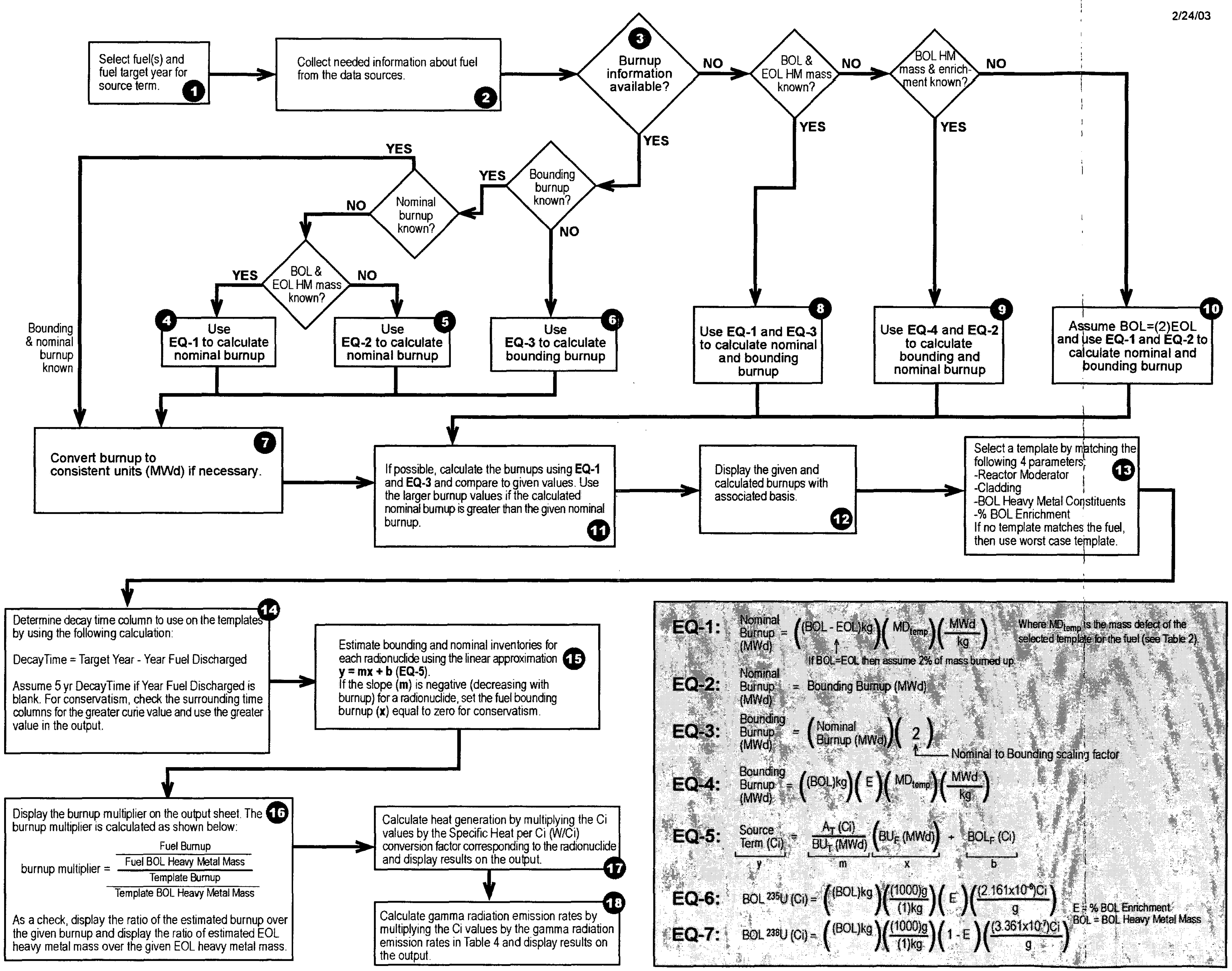

Figure 1. Logic flow for calculating Fuel Radionuclide Inventory Worksheet Output.

4. REQUIREMENTS AND CONSTRAINTS

In accordance with the analysis plan, Update Source Term Estimate Using Released LA Version of SFD, dated September 16, 2003, this report and the supporting analysis were performed in accordance with NSNFP procedures PSO 3.03, PSO 3.04, and PSO 19.02 (see References 14, 19, and 20).

5. INPUT

The input relied on to estimate the radionuclide inventories resides in the NSNFP SFD. These inputs include the precalculated templates and the fuel properties relied on to select an appropriate template and to calculate the scaling factor. These are discussed in Sections 5.1 and 5.2, respectively.

5.1 Precalculated Templates

A template contains precalculated (i.e., ORIGEN output) radionuclide inventories at each of 10 specified decay periods, ranging from 5 to 100 years following irradiation. Templates include 145 radionuclides that typically account for over 99.9% of the total curie inventory.

The source term estimates rely on the availability and proper selection of a template that reasonably models the production and destruction of radionuclides (as a function of burnup) within the fuel being estimated. The source term is strongly dependent on the neutron energy spectrum and the fuel composition. The reactor moderator is a key factor in determining the neutron energy spectrum. Fuel composition can be reasonably well characterized by the fuel compound (i.e., uranium, uranium-thorium, uranium-plutonium), BOL enrichment, and cladding. These four parameters (i.e., reactor moderator and fuel compound, enrichment, and cladding) serve as the basis for identifying a template that reasonably models the fuel whose source term is to be estimated. Reference 7 suggests that most DOE SNFs can be accommodated by 28 templates, each representing potential combinations of these parameters. In order to help conservatively estimate source terms for fuels that do not fit well within one of the 28 suggested templates or when sufficient information is not available to determine the appropriate template, a bounding or "Worst Case" template is used.

A hypothetical template was developed with the intention of bounding the actual source term for virtually any conceivable SNF. It was produced by using ORIGEN to model a hypothetical fuel with properties (reactor and fuel parameters, and cross-section libraries) that maximize the production of actinides and activation products. To help ensure that this template would conservatively estimate source terms when linearly scaled to account for different burnups, the burnup on this template fuel was adjusted to maximize the curies per MWd (for key radionuclides). This template is included in Appendix A as the Hypothetical Fuel template. To further ensure conservatism, the resulting radionuclide inventories were then normalized to a per MWd/kg basis and, for each radionuclide, were compared to the corresponding normalized value from each of the other templates, and the highest was retained. The net result, included in Appendix A as Worst Case (Template 29), contains for each radionuclide a normalized curie content equal to the highest of all the templates including the Hypothetical template. The Hypothetical template was used in the analysis only as a step in deriving the Worst Case template.

The 1980 version of ORIGEN2 was used for the generation of all templates (see Reference 21). Newer versions of ORIGEN exist, but the 1980 version was used to be consistent with preceding work and validation studies. The numerical solution methodology (matrix exponential method) used in the ORIGEN code did not change from the 1980 to 1991 code versions. The differences in the versions lie in the updated data libraries. The differences in the libraries mainly pertain to updated half-life data for radionuclides. These differences were scrutinized, and it was determined that these differences did not have a significant effect on the result of this analysis.

Using the techniques outlined in Reference 2, 15 of the 28 templates proposed in Reference 7 have been developed and are used in this analysis. The ORIGEN inputs used to generate these 15 templates are documented in Reference 22. These 15 templates are sufficient to address 99.9% (by heavy metal mass) of the DOE spent fuels (95% of the SFD records). The Worst Case template was employed to conservatively estimate source terms for the remaining DOE SNFs. The 15 completed templates, along with the worst case template, are included in Appendix A along with a crosswalk table that shows how the 29 proposed templates are represented by the 16 templates used.

5.2 Fuel Properties

The reactor moderator, the fuel cladding, the fuel compound, and BOL enrichment are used to select an appropriate template. The fuel quantity and burnup are used to determine the proper scaling of the template results. If necessary, the nominal and bounding burnups are conservatively estimated as described in Section 6. The fuel removal or reactor shutdown date is used to account for decay time. If not known, the fuel storage, shipment, or any other date that confirms that the fuel is out of the core may be used.

Fuel-specific information needed to select a template and to calculate the scaling factor was confirmed and collected using a Fuel Information Sheet (FIS). An FIS was prepared for each fuel record in the NSNFP SFD.[a] The FISs were prepopulated with the available information from the SFD and provided to each of the three SNF custodial sites (Hanford, Savannah River, and the Idaho National Engineering and Environmental Laboratory) to review and make any necessary changes and to provide the basis (i.e., references or rationale) for the information included.[23] Sites were also asked to provide, when available, existing source term information for each fuel. Site responses were indicated in References 24, 25, 26, and 27. The SFD was then updated to address any new information provided by the sites.

As noted previously, complete information is not available for many DOE SNFs. In the absence of information needed to select a template or to calculate scaling factors, assumptions that tend to predict higher radionuclide concentrations (i.e., err toward a more conservative result) were used. Table 1 suggests assumptions that are expected to provide conservative results when substituted for missing information. One or more of these parameters may also be used in lieu of known information when such a substitution allows selection of a template other than the Worst Case template. When matching a fuel record to a template, the order of importance of the four criteria is typically: 1-reactor moderator, 2-fuel type, 3-cladding, and 4-enrichment.

a. The Spent Fuel Database (SFD) is owned by the U.S. Department of Energy Office of Environmental Management (DOE-EM) and is maintained by the National Spent Nuclear Fuel Program (NSNFP). The SFD contains records for all DOE-owned or managed SNF including nuclear fuel at non-DOE-owned domestic research reactors and foreign research reactors. Because the SFD is used by several organizations, including the DOE sites, Headquarters, and Yucca Mountain Project personnel who need information about SNFs, the SFD records were chosen as the basis for performing the source term estimates. Information used to create records in the SFD was obtained from the sites where the SNF is in storage or use. Sources for this information came from the best available documentation and include fuel fabrication records, Appendix A data supplied by the irradiating reactor, and other technical documents. The sites where the SNF is in storage or use have reviewed the data in the SFD and have updated fuel information where appropriate. The data are checked regularly against Nuclear Materials Safeguards and Security records and Material Control and Accountability records. The SFD is controlled in accordance with NSNFP procedure PSO 19.02, "Management of the Spent Fuel Database."

Table 1. Conservative assumptions.

Unknown Parameter	Conservative Assumption	Basis
Cladding	If cladding is unknown, assume it is stainless steel.	Stainless steel is more conducive to the production of activation products than other typical cladding materials (e.g., aluminum, zirconium, graphite).
Fuel compound	If end-of-life (EOL) plutonium exceeds 1% by weight, assume a mixed oxide fuel. If thorium is present at EOL, assume a U-Th oxide fuel. Otherwise, assume a uranium fuel.	Because the majority of spent nuclear fuels (SNFs) are uranium fuels, this is assumed unless information provides evidence of other fuel compounds.
BOL enrichment	Assume the initial fissile mass equals the fissile mass depleted (i.e., 100% depletion). If needed, the initial uranium inventory may be estimated as the EOL heavy metal mass plus the initial fissile mass.	Estimates the lowest possible enrichment (i.e., will underpredict the actual enrichment) and thus maximizes heavy metals available for transmutation. These correlations assume uranium fuels. Uranium fuels compose the majority of DOE SNFs. These correlations also provide reasonable approximations for other fuel types.
Moderator	Heavy water.	Heavy water moderation produces a soft neutron spectrum that is generally more conducive to transmutation of heavy metals.
Reactor shutdown or fuel removal date	Date for fuel shipping, storage, or any other activity that confirms the fuel was no longer in the reactor.	Use of a later date will produce a conservative result for all radionuclides of interest except Neptunium-237 and Americium-241 because, for a period, they may increase rather than decrease with decay time.

6. ANALYSIS

The analytical method employed is based on the template methodology described in Reference 7. An appropriate template is selected by matching the fuel compound, BOL enrichment, cladding material, and the reactor moderator to those of a precalculated template fuel with a specified mass and burnup. By matching these parameters, the template fuel provides a reasonable model for the generation of activation products, actinides, and fission products that can be scaled to account for burnup. The template provides radionuclide inventories for 145 radionuclides at 10 decay times ranging from 5 to 100 years.

After identifying an appropriate template, the SNF radionuclide inventory is estimated by scaling the template results to account for differences in burnup. The scaling factor accounts for the ratio of the absolute burnup (given in MWd) of the SNF to the absolute burnup of the template fuel. Absolute burnup differences result from differences in both the mass and the specific burnup (given in MWd/MTIHM) of the SNF relative to the template. It is, therefore, useful to consider the scaling factor as the product of a mass multiplier (M_M) and a burnup multiplier (M_{BU})

where

$$M_M = \frac{(\text{Mass of Fuel}(\text{kg}))}{(\text{Mass of Template}(\text{kg}))} = \text{mass multiplier}$$

$$M_{BU} = \frac{(\text{Burnup of Fuel}(\text{MWd}) / \text{Mass of Fuel}(\text{kg}))}{(\text{Burnup of Template}(\text{MWd}) / \text{Mass of Template}(\text{kg}))} = \text{burnup multiplier}$$

$$\text{scaling factor} = M_M * M_{BU} = \frac{(\text{Burnup of Fuel}(\text{MWd}))}{(\text{Burnup of Template}(\text{MWd}))}$$

Although these two component multipliers combine to produce a single scaling factor, each contributes differently to the uncertainty in the resulting estimate.

All radionuclide inventories scale linearly with the mass multiplier. Fission products also scale linearly with the burnup multiplier. However, because the buildup and depletion of actinides and activation products is not a true linear function of burnup, error may be introduced when linearly scaling these radionuclides to account for differences in specific burnup. To aid in assessing the impacts of this error, the Fuel Radionuclide Inventory Worksheets (the output of this analysis) include information to show the contribution of the burnup multiplier to the overall scaling factor (in the "Checks" block at the bottom of the page under Burnup Multiplier).

Figure 1 shows the equations and associated logic used to prepare a source term estimate for each DOE SNF intended for repository disposal. The analytical approach uses available information and, in the absence of needed information, conservative assumptions in the estimate. The inputs are gathered as explained in Blocks 1 and 2. Blocks 3 through 12 show the logic for using the available information to obtain nominal and bounding burnups that will be used to scale the template results. Blocks 13 through 15 show how applicable template results are selected and scaled to obtain the source term estimate. Blocks 16 through 18 show how other output information is calculated.

The following provides more detailed information for each of the blocks shown in Figure 1. The NSNFP SFD was used with a number of imbedded software routines and macros in order to facilitate management of the input information, assumptions, and calculations.

Block 1: The fuels whose source term is to be estimated and the date for the desired source term estimate are specified. The date is used in Block 14 to determine the elapsed decay time to the date of the source term prediction. For the analyses documented herein, a source term estimate is provided for each DOE SNF record in the SFD (marked to go to a repository) for the years 2010 and 2030. These years correspond to the projected dates for beginning and completion of shipment of DOE SNF to the repository.

Block 2: For each SNF, available information is obtained from the LA version of the SFD. This information includes the fuel name and SFD identification number (SNF ID#), reactor moderator, fuel cladding, BOL fuel enrichment, fuel compound, BOL heavy metal mass, burnup, and decay time as well as the number and type of canisters expected for this fuel. For the purposes of this document, the heavy metal mass is defined as the sum of the masses of all plutonium, uranium, and thorium isotopes.

Block 3: The nominal and bounding burnup (MWd) of the SNF being estimated are used to determine the nominal and bounding burnup multipliers. If only one of the burnups (bounding or nominal) is known, it is used directly, and the other is estimated as shown in Blocks 4, 5, or 6. If neither the nominal nor the bounding burnup is available, they are estimated as shown in Blocks 8, 9, or 10.

Burnup(s) Available in SFD—Blocks 4 Through 7

Block 4: If the bounding burnup is given but the nominal is not, and the change in heavy metal mass is known, the nominal burnup is calculated directly by assuming that the change in heavy metal mass resulted from fission (Equation 1 in Figure 1). Equation 1 multiplies the change in heavy metal mass by a mass defect factor (specific to the template that will be used for the fuel). The mass defect for each template, Md_{temp}, is defined as the template burnup divided by the change in heavy metal mass. The values for MD_{temp} calculated from the templates and used in Equation 1 are shown in Table 2.

Block 5: If the bounding burnup is given but the nominal is not, and if the change in heavy metal is not known, the nominal burnup is conservatively estimated to be the same as the bounding burnup. This obtains the maximum attainable nominal burnup by presuming there was no power peaking (i.e., flat power distribution) within the reactor core. The conservatism of this assumption has a positive correlation with the actual peak to average power distribution within the reactor.

Table 2. Mass defect values for each template.

Template	MD_{temp} (MWd/kg)	Template	MD_{temp} (MWd/kg)
3 (FFTF)	998.1412	12 (ATR)	947.0194
5 (FERMI)	881.8022	15 (Pathfinder)	944.6476
6 (FSV)	945.7257	21 (LWBR)	973.1629
7 (N-Reactor)	1054.9570	24 (PWR)	950.9527
8 (HFBR High E)	921.1030	26 (TRIGA Al)	954.5186
9 (HFBR Med E)	950.4648	27 (TRIGA FLIP)	950.4202
10 (HFBR Low E)	954.7123	28 (TRIGA SS)	954.6073
11 (HFBR Zr)	958.5533	29 (Worst Case)	950.3525[a]

a. A default value was used for template 29 (Worst Case) because it is a very conservative nonphysical fuel. The default value comes from the following formula: 950.3525 MWd/kg = $(1.854 \times 10^{-24}$ MWd/Mev)(200 Mev/atom)$(6.023 \times 10^{23}$ atom/235 g)(1000 g/kg).

Block 6: If the nominal burnup is given but the bounding is not, the bounding burnup is conservatively assumed to be twice the nominal burnup because (1) radial power peaking factors in a typical nuclear reactor core rarely exceed a factor of two and (2) axial peaking is not a factor because the DOE SNF canister contains the full length of the fuel. The conservatism of this assumption has an inverse correlation to the peak to average power distribution within the reactor.

Block 7: The equations used in the estimate are based on absolute burnup using units of MWd. Consequently, if burnups are given per unit fuel (i.e., specific burnup), they are converted to absolute burnups by multiplying by the appropriate quantity of fuel. If specific burnups are given as MWd per MTIHM but initial heavy metal mass is not given, the absolute burnup is calculated by substituting the following relationship into Equation 1 and solving for the absolute burnup:

$$BOL(kg) = [Burnup(MWd)/ Burnup_S(MWd/MTIHM)]*(1000\ kg/MTIHM)$$

Where $Burnup_S$ is the known specific burnup.

In the event that the BOL and EOL heavy metal mass in the SFD are equal (indicating very low burnup), it is conservatively assumed that 2% of the heavy metal mass was depleted.

No Burnups Given in SFD—Blocks 8 Through 10

Block 8: If the change in heavy metal mass is known, the nominal burnup is calculated directly by assuming that the change in heavy metal mass resulted from fission (see explanation in Block 4). The bounding burnup is then conservatively assumed to be twice the nominal burnup. The basis for this assumption is explained in Block 6. In some cases, the given EOL and BOL heavy metal masses are equal, which indicates very little burnup. However, all fuels intended for repository disposal are conservatively assumed to have some burnup. Consequently, a burnup of 2% of the initial heavy metal mass is assumed in the event that the given BOL and EOL heavy metal masses are the same.

Block 9: If EOL heavy metal mass is not known but BOL heavy metal mass and enrichment are known, 100% burnup of all available fissile material is conservatively assumed. Available fissile material is estimated as the BOL heavy metal mass times the percent enrichment. The conservatism of this assumption is inversely correlated to the actual burnup of the fuel. For fertile fuels, nonconservatism could be introduced to the extent that fissile isotopes are produced during reactor operation.

Block 10: The minimum information needed to estimate burnup (using this methodology) is the EOL heavy metal mass, which is available for virtually all DOE SNFs. If burnup, loss of initial heavy metal mass, or initial fissile mass is unknown, the BOL heavy metal mass is assumed to be twice the EOL heavy metal mass. Having assumed the BOL heavy metal mass to be twice the EOL heavy metal mass, the burnup is calculated directly by assuming that the change in heavy metal mass resulted from fission (see explanation in Block 4). Because of the conservatism introduced by this assumption (described below), this calculated burnup is used for both the bounding and the nominal.

Block 11: If burnup information and both BOL and EOL heavy metal mass are available directly, a consistency check is performed to ensure that the reported nominal burnup is conservative relative to that calculated based on the heavy metal depleted (i.e., Equation 1). If the calculated nominal burnup is greater than that provided, it is used in the estimate for conservatism. When this occurs, the bounding burnup estimate (i.e., twice the calculated nominal burnup) is also used if it is greater than the bounding burnup given.

Block 12: To facilitate evaluation of the estimate, the output sheet displays the bounding and the nominal burnups given along with the calculated and estimated values for the same. The bases of the calculated and estimated values are also displayed with the output.

Block 13: An appropriate template is selected based on four properties: the reactor moderator, the fuel type, BOL enrichment, and cladding. These four properties were selected because they are the primary factors for modeling production of activation products and actinides, and also because they are either available or can be conservatively estimated for DOE SNFs. When possible, a template is selected that matches all four of these parameters. If one or more of these parameters is not known, a conservative assumption (see Table 1) may be applied. If a template matching all four parameters is not available, an alternative template may be selected in accordance with the template selection guide (see Appendix A), an alternative template may be manually selected, or the Worst Case template may be used. The Worst Case template was derived in order to conservatively estimate virtually any fuel. The four template-selection parameters are displayed for both the fuel being estimated and the template fuel in Section III of the Fuel Radionuclide Inventory Worksheet along with justification for the template selection if there is a mismatch on any of these four parameters.

Block 14: The precalculated template results include inventories (curies) for 145 radionuclides at each of 10 decay times (5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years). The number of years between the desired date of the estimated source term and the date the SNF irradiation activities ended (i.e., reactor shutdown or fuel removal from the core) determines the decay time used in the estimate. The desired source term date is an input. For conservatism, the 5-year decay period is selected if no information is available to identify the fuel decay period.

When the desired decay time falls in the interval between two of the precalculated intervals, the higher of the two surrounding values is selected for each radionuclide. For example, if the desired decay period is 13 years, the inventory at both the 10 and 15-year decay periods is considered for each radionuclide, and the higher of the two inventories is selected. This provides conservatism even for radionuclides whose inventory may be building up rather than being depleted with time. The template radionuclide inventories at the selected decay time are displayed on the Fuel Radionuclide Inventory Worksheet.

Block 15: Most SNF radionuclide inventories can be estimated simply by scaling the precalculated template result by the ratio of the SNF burnup to the template fuel burnup. However, in order to properly account for radionuclides that have nonzero initial values and are depleted rather than produced by increasing burnup, the calculations retain the general form of the linear correlation:

$$Y_i = m_i x + b_i$$

where

Y_i = the estimated inventory (curies) for radionuclide_i

m_i = slope of the buildup ($\Delta Ci/\Delta MWd$) and is determined for each radionuclide from the precalculated template inventory

Note: When the BOL inventory is zero (i.e., $b_i = 0$), which is the case for most radionuclides of interest, the slope reduces to the precalculated template value at the desired decay period divided by the template burnup, $m_i = Ci_{i,t}/BU_t$.

x = burnup of the fuel being estimated

Note: Both a nominal and a bounding burnup are used in order to estimate nominal and bounding radionuclide inventories. For radionuclides whose inventory decreases with burnup (i.e., m is negative), the bounding burnup is set to zero because the maximum concentration of these radionuclides occurs prior to irradiation.

b_i = initial inventory of $radionuclide_i$ for the fuel being estimated. If the initial inventory is not available for the fuel being estimated (or for uranium fuels cannot be calculated using Equations 6 and 7 of Figure 1), it is approximated by scaling the initial inventory of the template fuel by the ration of the BOL heavy metal mass of the fuel being estimated to that of the template fuel. When a fuel's BOL heavy metal mass is not known, it is estimated by adding the heavy metal depleted (computed by using the fuel burnup and the mass defect from the selected template) to the EOL heavy metal mass. For radionuclides of interest other than Am-241, U-233, U-235, U-238, Th-232, Pu-238, Pu-239, Pu-240, Pu-241, and Pu-242; the BOL inventory, b, is set to zero. Consequently, the estimate reduces to Y = mx, where $m = Ci_t/BU_t$ and $x = BU_f$. This can be reformulated as $Ci_f = Ci_t*(BU_f/BU_t)$, where (BU_f/BU_t) is the factor used to scale the template radionuclide inventories to obtain an estimate of the fuel radionuclide inventories.

Note: Special consideration is taken for Am-243 in one spent fuel record. For SNF ID-776 (americium targets), a known initial value of 9.5712 Ci = (48 g)(0.1994 Ci/g) of Am-243 is entered to account for this special case.

The resulting estimates, Y_i, for 45 key radionuclides are displayed on the Fuel Radionuclide Inventory Worksheet (see Section 7). To facilitate checking the calculations, each of the above factors is displayed on the Fuel Radionuclide Inventory Worksheet along with the basis for the burnup used and any identified issues or discrepancies.

Block 16: The absolute burnup (i.e., MWd) of the fuel being estimated is the product of its specific burnup (i.e., MWd/MTHM) and its mass. Because the buildup and depletion of actinides and activation product is not a linear function of burnup, error is introduced when scaling to account for differences in specific burnup. Hence, to aid the analyst in assessing any resulting uncertainty in the estimate, the ratio of the specific burnup of the SNF being estimated to the specific burnup of the template fuel (i.e., the burnup multiplier) is displayed with the output. To further aid the analyst in assessing uncertainty associated with the input data and template selection, the ratio of the estimated burnups (see explanation in Block 11) to the given burnups is displayed. The ratio of the estimated EOL heavy metal mass to the EOL heavy metal mass given in the SFD is also displayed. The estimated EOL heavy metal mass is calculated by multiplying the curies of heavy metal (uranium, plutonium, and thorium) in the nominal estimate by the appropriate grams to curies conversion factors (see Table 3).

Block 17: Based on the estimated radionuclide inventories, the decay heat production is also calculated and displayed on the worksheet. The total decay heat produced is calculated by summing the decay heat from each of the 145 radionuclides. The decay heat from each of the radionuclides is calculated by multiplying the estimated curies of each radionuclide by its respective curies to watts conversion factor (see Table 4).

Block 18: Based on the radionuclide inventories estimated using the bounding burnup values, the photon emission rates for each of 18 specified energy groups are also summed over each of the

Table 3. Specific activity of heavy metals.

	Half-Life[a] (Years)	Atomic Weight[b]	Specific Activity[c]	
			Ci/g	g/Ci
Am241	4.322E+02	241.0568229	3.431E+00	2.914E-01
Am243	7.380E+03	243.0613727	1.993E-01	5.018E+00
Pu236	2.851E+00	236.0460481	5.312E+02	1.882E-03
Pu237	1.248E-01	237.0484038	1.208E+04	8.278E-05
Pu238	8.774E+01	238.0495534	1.712E+01	5.843E-02
Pu239	2.406E+04	239.0521565	6.215E-02	1.609E+01
Pu240	6.537E+03	240.0538075	2.278E-01	4.390E+00
Pu241	1.440E+01	241.0568453	1.030E+02	9.709E-03
Pu242	3.869E+05	242.0587368	3.817E-03	2.620E+02
Pu244	8.261E+07	244.064198	1.773E-05	5.640E+04
Th227	5.124E-02	227.027699	3.073E+04	3.254E-05
Th228	1.913E+00	228.0287313	8.195E+02	1.220E-03
Th229	7.339E+03	229.031755	2.127E-01	4.702E+00
Th230	7.700E+04	230.0331266	2.018E-02	4.955E+01
Th231	2.911E-03	231.0362971	5.315E+05	1.881E-06
Th232	1.405E+10	232.0380504	1.097E-07	9.120E+06
Th234	6.597E-02	234.043595	2.315E+04	4.319E-05
U232	7.200E+01	232.0371463	2.140E+01	4.673E-02
U233	1.585E+05	233.039628	9.678E-03	1.033E+02
U234	2.445E+05	234.0409456	6.247E-03	1.601E+02
U235	7.038E+08	235.0439231	2.161E-06	4.627E+05
U236	2.341E+07	236.0455619	6.468E-05	1.546E+04
U237	1.848E-02	237.048724	8.161E+04	1.225E-05
U238	4.468E+09	238.0507826	3.361E-07	2.975E+06

a. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

b. J. S. Coursey, D. J. Schwab, and R. A. Dragoset, Atomic Weights and Isotopic Compositions (Version 2.3.1), [Online, 2001], Available: http://physics.nist.gov/Comp (January 17, 2003), National Institute of Standards and Technology, Gaithersburg, Maryland.

c. Specific Activity = Ci/g = $(3.575 \times 10^5)/[(A)(T)]$

where A = atomic weight, T = half-life in years.

Table 4. Conversion factors for curies to watts and photon emission rates.

Photon Energy Group No.			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Lower Photon Energy Group Limit (MeV)			0.0100	0.0200	0.0300	0.0450	0.0700	0.1000	0.1500	0.3000	0.4500	0.7000	1.0000	1.5000	2.0000	2.5000	3.0000	4.0000	6.0000	8.0000
Upper Photon Energy Group Limit (MeV)			0.0200	0.0300	0.0450	0.0700	0.1000	0.1500	0.3000	0.4500	0.7000	1.0000	1.5000	2.0000	2.5000	3.0000	4.0000	6.0000	8.0000	14.0000
Mean Photon Energy (MeV)			0.0150	0.0250	0.0375	0.0575	0.0850	0.1250	0.2250	0.3750	0.5750	0.8500	1.2500	1.7500	2.2500	2.7500	3.5000	5.0000	7.0000	11.0000
	Half-Life (years)	Heat Gen. (W/Ci)	Photons/sec/Ci																	
AC227	2.177E+01	4.842E-04	2.942E+08	2.405E+06	3.811E+04	2.882E+06	1.913E+07	7.252E+06	6.364E+06	2.738E+05	0.000E+00	1.706E+00	9.694E-01	4.847E-01	2.438E-01	1.221E-01	8.991E-02	2.679E-02	1.735E-03	1.095E-04
AG110	7.795E-07	7.183E-03	2.590E+10	5.698E+09	3.774E+09	5.587E+09	3.530E+09	2.405E+09	3.504E+09	1.713E+09	2.905E+09	3.774E+08	1.658E+08	3.415E+07	3.363E+06	4.773E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG110M	6.841E-01	1.670E-02	1.284E+09	4.477E+08	1.273E+08	1.558E+08	7.548E+07	7.659E+07	1.010E+08	1.695E+09	4.884E+10	5.883E+10	1.188E+10	4.588E+09	3.437E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG111	2.040E-02	2.240E-03	7.733E+09	1.621E+09	9.953E+08	1.373E+09	8.214E+08	4.699E+08	9.657E+08	2.165E+09	3.996E+07	4.662E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM241	4.322E+02	3.322E-02	8.177E+09	9.361E+08	7.659E+07	1.376E+10	9.028E+06	8.621E+06	4.810E+05	4.662E+05	2.557E+05	7.511E+04	7.067E+01	3.537E+01	1.776E+01	8.917E+00	6.549E+00	1.957E+00	1.280E-01	8.177E-03
AM242	1.827E-03	1.162E-03	2.390E+10	5.402E+08	3.589E+08	4.292E+08	1.806E+09	2.886E+09	9.694E+07	1.228E+07	3.319E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM242M	1.520E+02	3.951E-04	1.635E+10	2.416E+03	0.000E+00	7.474E+07	1.806E+07	1.976E+07	8.214E+06	0.000E+00	0.000E+00	2.490E+01	1.166E+01	5.698E+00	3.293E+00	1.906E+00	1.706E+00	7.289E-01	8.325E-02	9.546E-03
AM243	7.380E+03	3.214E-02	8.621E+09	0.000E+00	2.405E+09	4.551E+06	2.157E+10	2.457E+08	6.623E+05	0.000E+00	5.402E+05	1.510E+02	8.288E+01	4.144E+01	2.128E+01	1.095E+01	8.399E+00	2.749E+00	2.187E-01	1.865E-02
BA136M	9.760E-09	1.210E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	4.851E-06	3.926E-03	1.754E+08	0.000E+00	2.409E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.811E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA140	3.502E-02	2.790E-03	9.509E+09	7.585E+09	1.314E+09	1.084E+09	5.994E+08	4.329E+08	1.883E+09	2.856E+09	6.919E+09	4.699E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BE10	1.600E+06	1.201E-03	4.181E+09	7.955E+08	4.884E+08	6.327E+08	3.189E+08	1.684E+08	1.295E+08	1.214E+07	7.252E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BI211	4.050E-06	3.989E-02	3.774E+08	5.587E+03	3.400E+03	4.329E+03	7.881E+08	1.125E+03	1.169E+03	4.218E+09	8.325E-01	1.232E+02	6.993E+01	3.511E+01	1.761E+01	8.843E+00	6.512E+00	1.935E+00	1.254E-01	7.918E-03
BI212	1.151E-04	1.700E-02	9.620E+09	1.380E+09	1.336E+09	1.317E+09	8.880E+08	5.365E+08	8.991E+08	3.674E+08	2.745E+08	4.847E+09	3.297E+08	1.251E+09	1.077E+01	3.182E+00	2.342E+00	6.956E-01	4.514E-02	2.853E-03
C14	5.729E+03	2.933E-04	8.658E+08	1.225E+08	5.883E+07	4.625E+07	7.585E+06	5.550E+05	3.297E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113	0.000E+00	0.000E+00	1.909E+09	3.282E+08	1.865E+08	2.094E+08	8.177E+07	3.101E+07	9.546E+06	3.774E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	1.459E+01	1.683E-03	3.996E+09	7.585E+08	4.662E+08	5.957E+08	3.001E+08	1.587E+08	1.247E+08	1.310E+07	1.528E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	1.221E-01	3.728E-03	1.336E+10	2.797E+09	1.828E+09	2.616E+09	1.573E+09	1.014E+09	1.317E+09	5.143E+08	2.708E+08	5.772E+08	2.568E+08	4.292E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	8.901E-02	1.464E-03	3.574E+09	5.698E+08	6.549E+09	4.255E+08	2.005E+08	2.076E+10	6.475E+07	4.514E+06	3.774E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	1.049E+11	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.101E+02	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
CE144	7.783E-01	6.632E-04	1.980E+09	2.738E+08	3.996E+09	2.301E+08	9.176E+08	4.292E+09	6.253E+06	9.361E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CL36	3.010E+05	1.462E-03	5.143E+09	1.010E+09	6.290E+08	8.399E+08	4.477E+08	2.520E+08	2.338E+08	3.959E+07	1.203E+07	1.184E+01	2.054E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CM242	4.468E-01	1.162E-03	6.031E+09	0.000E+00	1.413E+07	0.000E+00	0.000E+00	7.548E+05	3.848E+05	0.000E+00	9.694E+04	2.061E+04	6.068E+03	2.387E+03	1.384E+03	7.992E+02	7.178E+02	3.071E+02	3.526E+01	4.070E+00
CM243	2.850E+01	3.670E-02	3.238E+10	0.000E+00	5.291E+07	1.672E+08	6.216E+09	1.092E+10	1.191E+10	2.094E+07	0.000E+00	1.232E+02	6.993E+01	3.511E+01	1.761E+01	8.843E+00	6.512E+00	1.935E+00	1.254E-01	7.918E-03
CM244	1.811E+01	3.498E-02	5.550E+09	0.000E+00	1.099E+07	0.000E+00	0.000E+00	0.000E+00	3.186E+05	0.000E+00	0.000E+00	2.050E+05	9.546E+04	4.662E+04	2.701E+04	1.565E+04	1.410E+04	6.031E+03	6.956E+02	7.992E+01
CM245	8.499E+03	3.317E-02	3.219E+10	0.000E+00	4.292E+07	0.000E+00	6.179E+09	1.328E+10	1.887E+09	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
CM246	4.731E+03	3.273E-02	4.921E+09	0.000E+00	1.232E+07	0.000E+00	0.000E+00	0.000E+00	6.179E+07	0.000E+00	0.000E+00	3.959E+07	1.846E+07	9.028E+06	5.254E+06	3.038E+06	2.731E+06	1.169E+06	1.351E+05	1.554E+04
CM247	1.560E+07	3.196E-02	5.661E+09	0.000E+00	0.000E+00	3.411E+07	5.402E+08	1.306E+09	2.512E+09	3.115E+10	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
CO60	5.270E+00	1.542E-02	1.961E+09	3.389E+08	1.935E+08	2.183E+08	8.584E+07	3.297E+07	1.084E+07	3.041E+06	1.746E+05	2.764E+06	7.400E+10	0.000E+00	3.922E+05	1.214E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR51	7.586E-02	2.140E-04	4.144E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.093E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	2.062E+00	1.018E-02	3.360E+09	6.364E+08	6.327E+08	5.069E+08	2.612E+08	1.425E+08	1.306E+08	2.176E+07	4.699E+10	3.263E+10	2.157E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS135	2.300E+06	3.337E-04	1.069E+09	1.617E+08	8.325E+07	7.659E+07	1.950E+07	3.774E+06	1.743E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS136	3.587E-02	1.364E-02	2.583E+09	3.700E+08	5.772E+09	5.624E+09	2.475E+09	1.754E+08	1.317E+10	1.591E+10	3.448E+08	3.552E+10	3.197E+10	3.737E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	3.000E+01	1.105E-03	3.659E+09	6.919E+08	4.218E+08	5.365E+08	2.675E+08	1.402E+08	1.114E+08	1.669E+07	3.134E+06	2.068E+05	7.881E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU152	1.360E+01	7.582E-03	3.700E+09	1.043E+08	2.346E+10	4.440E+09	5.143E+07	1.029E+10	3.363E+09	1.173E+10	1.410E+09	1.265E+10	1.846E+10	9.324E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	8.600E+00	8.946E-03	6.771E+09	9.990E+08	9.213E+09	2.472E+09	4.736E+08	1.506E+10	3.112E+09	4.958E+08	3.504E+09	1.761E+10	1.950E+10	5.846E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU155	4.959E+00	7.273E-04	2.671E+09	2.427E+08	7.770E+09	2.342E+09	1.169E+10	6.438E+09	2.372E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU156	4.157E-02	1.032E-02	9.657E+09	1.758E+09	5.587E+09	2.468E+09	4.403E+09	6.327E+08	1.117E+09	4.921E+08	4.181E+09	8.510E+09	1.580E+10	3.541E+09	5.846E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 4. (continued).

Photon Energy Group No.			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Lower Photon Energy Group Limit (MeV)			0.0100	0.0200	0.0300	0.0450	0.0700	0.1000	0.1500	0.3000	0.4500	0.7000	1.0000	1.5000	2.0000	2.5000	3.0000	4.0000	6.0000	8.0000
Upper Photon Energy Group Limit (MeV)			0.0200	0.0300	0.0450	0.0700	0.1000	0.1500	0.3000	0.4500	0.7000	1.0000	1.5000	2.0000	2.5000	3.0000	4.0000	6.0000	8.0000	14.0000
Mean Photon Energy (MeV)			0.0150	0.0250	0.0375	0.0575	0.0850	0.1250	0.2250	0.3750	0.5750	0.8500	1.2500	1.7500	2.2500	2.7500	3.5000	5.0000	7.0000	11.0000
	Half-Life (years)	Heat Gen. (W/Ci)	Photons/sec/Ci																	
FE55	2.600E+00	1.375E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE59	1.232E-01	9.324E-03	2.427E+09	4.366E+08	2.564E+08	3.067E+08	1.362E+08	6.253E+07	3.648E+07	2.394E+06	3.589E+05	6.216E+04	5.550E+03	5.994E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FR223	4.145E-05	2.597E-03	2.387E+10	1.728E+09	9.398E+08	1.265E+10	6.142E+09	9.583E+08	2.468E+09	4.292E+08	2.986E+07	3.078E+08	1.069E+02	2.113E-03	1.058E-03	5.328E-04	3.922E-04	1.166E-04	7.548E-06	4.773E-07
GD153	6.626E-01	8.619E-04	5.217E+09	0.000E+00	3.959E+10	8.473E+09	1.265E+10	6.438E+09	1.273E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
H3	1.235E+01	3.366E-05	1.362E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	1.570E+07	4.625E-04	1.954E+09	2.516E+10	7.363E+09	3.164E+07	4.403E+06	2.398E+05	2.683E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I131	2.201E-02	3.396E-03	3.996E+09	2.461E+09	7.548E+08	5.846E+08	1.210E+09	1.558E+08	3.060E+09	2.938E+10	3.186E+09	5.661E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	2.278E-06	4.591E-03	1.691E+10	3.848E+09	2.364E+09	3.434E+09	2.105E+09	1.391E+09	1.887E+09	8.103E+08	3.922E+08	9.842E+07	9.916E+07	4.699E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	1.356E-01	1.410E-03	6.438E+08	1.339E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	4.810E+09	0.000E+00	1.580E+09	1.365E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	4.905E-04	1.994E-03	4.144E+08	1.240E+10	1.092E+06	1.476E+06	8.103E+05	4.736E+05	4.847E+05	1.550E+10	5.106E+05	4.551E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR85	1.072E+01	1.497E-03	5.476E+09	1.073E+09	6.697E+08	8.954E+08	4.773E+08	2.708E+08	2.549E+08	4.440E+07	1.447E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	4.588E-03	1.676E-02	1.206E+10	2.501E+09	2.172E+09	2.346E+09	1.380E+09	1.132E+09	1.513E+09	7.659E+09	1.365E+10	1.539E+10	5.032E+06	3.226E+10	3.389E+08	1.228E+09	1.010E+07	0.000E+00	0.000E+00	0.000E+00
MN54	8.556E-01	4.979E-03	5.106E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.633E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO93	3.498E+03	9.344E-05	3.959E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB93M	1.360E+01	1.771E-04	6.993E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB94	2.030E+04	1.019E-02	3.086E+09	5.698E+08	3.419E+08	4.218E+08	1.987E+08	9.657E+07	5.994E+07	2.845E+06	1.676E-05	6.845E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB95	9.624E-02	4.795E-03	7.770E+08	1.062E+08	5.032E+07	3.885E+07	6.364E+06	4.995E+05	1.565E+02	0.000E+00	0.000E+00	3.334E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB95M	9.880E-03	1.389E-03	2.749E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.006E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND144	2.099E+15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.101E+02	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
ND147	3.028E-02	2.413E-03	6.623E+09	9.879E+08	1.817E+10	8.214E+08	1.151E+10	3.922E+08	6.697E+08	1.584E+09	5.032E+09	1.332E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI59	8.000E+04	6.366E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI63	9.200E+01	3.971E-04	2.046E+08	1.247E+07	2.527E+06	2.557E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP237	2.140E+06	3.056E-02	2.905E+10	4.255E+09	0.000E+00	2.771E+08	7.474E+09	8.473E+08	4.144E+08	1.043E+06	8.880E+05	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
PA231	3.277E+04	3.013E-02	2.139E+10	3.848E+09	1.036E+08	1.595E+08	7.215E+07	2.646E+07	9.435E+08	2.720E+09	1.254E+06	1.240E+02	7.030E+01	3.534E+01	1.772E+01	8.880E+00	6.549E+00	1.954E+00	1.273E-01	8.103E-03
PA233	7.393E-02	2.270E-03	2.638E+10	2.609E+08	1.362E+08	1.280E+08	1.169E+10	2.572E+09	4.070E+08	1.476E+10	7.733E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PA234	7.643E-04	1.436E-02	6.845E+10	2.120E+09	1.369E+09	3.141E+09	2.028E+10	1.310E+10	1.243E+10	2.997E+09	1.728E+10	5.254E+10	5.698E+09	2.494E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PA234M	2.225E-06	4.943E-03	3.641E+10	7.733E+09	5.106E+09	7.437E+09	4.699E+09	3.075E+09	4.218E+09	1.869E+09	9.546E+08	3.996E+08	2.664E+08	3.534E+07	3.167E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PB210	2.230E+01	2.317E-04	9.768E+09	2.065E+06	3.737E+05	1.214E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PB211	6.864E-05	2.996E-03	1.010E+10	2.057E+09	1.328E+09	1.883E+09	1.277E+09	6.845E+08	8.658E+08	2.094E+09	1.088E+08	1.306E+09	4.218E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PB212	1.214E-03	1.904E-03	8.251E+09	3.596E+08	2.072E+08	2.394E+08	1.269E+10	2.475E+08	1.754E+10	1.018E+09	8.695E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD107	6.496E+06	5.929E-05	6.031E+07	3.622E+05	5.217E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	1.770E+01	2.550E-04	2.779E+09	0.000E+00	2.801E+10	2.812E+08	6.882E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM147	2.623E+00	3.588E-04	1.199E+09	1.869E+08	9.842E+07	9.509E+07	2.712E+07	7.437E+06	5.180E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	1.470E-02	7.698E-03	3.186E+10	6.771E+09	4.514E+09	6.475E+09	3.996E+09	2.631E+09	3.600E+09	1.587E+09	9.509E+09	5.217E+09	9.694E+09	8.177E+06	5.846E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148M	1.131E-01	1.268E-02	6.401E+09	1.095E+09	4.107E+09	1.254E+09	2.372E+09	2.031E+08	6.290E+09	1.106E+10	7.807E+10	1.765E+10	6.031E+09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PO212	9.506E-15	5.300E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.101E+02	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
PO215	5.640E-11	4.465E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.101E+02	1.732E+07	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
PO216	4.753E-09	4.093E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.101E+02	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03

Table 4. (continued).

Photon Energy Group No.			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Lower Photon Energy Group Limit (MeV)			0.0100	0.0200	0.0300	0.0450	0.0700	0.1000	0.1500	0.3000	0.4500	0.7000	1.0000	1.5000	2.0000	2.5000	3.0000	4.0000	6.0000	8.0000
Upper Photon Energy Group Limit (MeV)			0.0200	0.0300	0.0450	0.0700	0.1000	0.1500	0.3000	0.4500	0.7000	1.0000	1.5000	2.0000	2.5000	3.0000	4.0000	6.0000	8.0000	14.0000
Mean Photon Energy (MeV)			0.0150	0.0250	0.0375	0.0575	0.0850	0.1250	0.2250	0.3750	0.5750	0.8500	1.2500	1.7500	2.2500	2.7500	3.5000	5.0000	7.0000	11.0000
	Half-Life (years)	Heat Gen. (W/Ci)	Photons/sec/Ci																	
PR143	3.714E-02	1.863E-03	6.882E+09	1.376E+09	8.732E+08	1.191E+09	6.623E+08	3.922E+08	4.181E+08	1.032E+08	1.661E+07	1.906E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	3.286E-05	7.350E-03	2.657E+10	5.772E+09	3.848E+09	5.735E+09	3.637E+09	2.483E+09	3.626E+09	1.791E+09	1.724E+09	3.922E+08	3.115E+08	3.615E+07	2.816E+08	2.523E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144M	1.369E-05	3.421E-04	2.054E+09	9.435E+02	1.106E+10	3.001E+07	5.217E+02	3.356E+02	4.292E+02	1.617E+02	2.690E+07	2.128E+07	8.325E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU236	2.851E+00	3.481E-02	6.660E+09	0.000E+00	0.000E+00	2.113E+07	0.000E+00	3.885E+06	1.795E+05	0.000E+00	1.924E+05	2.453E+02	1.269E+02	6.290E+01	3.371E+01	1.817E+01	1.487E+01	5.513E+00	5.402E-01	5.550E-02
PU237	1.248E-01	9.606E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	1.025E-02	0.000E+00	0.000E+00	4.070E-03	2.316E-03	1.162E-03	5.846E-04	2.923E-04	2.150E-04	6.401E-05	4.144E-06	2.620E-07
PU238	8.774E+01	3.315E-02	5.809E+09	0.000E+00	1.672E+07	0.000E+00	3.215E+06	0.000E+00	2.560E+05	0.000E+00	0.000E+00	1.806E+04	7.363E+02	9.879E+01	5.476E+01	3.027E+01	2.575E+01	1.021E+01	1.077E+00	1.173E-01
PU239	2.406E+04	3.082E-02	2.113E+09	0.000E+00	2.309E+06	7.807E+06	7.844E+05	3.123E+06	4.440E+05	2.361E+06	8.695E+04	7.918E+03	8.806E+01	3.537E+01	1.776E+01	8.917E+00	6.549E+00	1.961E+00	1.280E-01	8.214E-03
PU240	6.537E+03	3.113E-02	5.550E+09	0.000E+00	0.000E+00	1.310E+07	0.000E+00	2.161E+06	1.328E+05	0.000E+00	6.956E+03	7.955E+03	3.608E+03	1.765E+03	1.021E+03	5.920E+02	5.291E+02	2.264E+02	2.597E+01	2.982E+00
PU241	1.440E+01	3.101E-05	2.812E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	7.585E-05	0.000E+00	0.000E+00	3.027E-05	1.721E-05	8.621E-06	4.329E-06	2.172E-06	1.595E-06	4.736E-07	3.078E-08	1.946E-09
PU242	3.869E+05	2.954E-02	4.366E+09	0.000E+00	1.517E+07	0.000E+00	0.000E+00	2.272E+06	1.425E+06	0.000E+00	0.000E+00	8.436E+05	3.922E+05	1.920E+05	1.114E+05	6.475E+04	5.809E+04	2.490E+04	2.868E+03	3.300E+02
PU244	8.261E+07	2.900E-02	3.922E+09	0.000E+00	1.058E+07	0.000E+00	0.000E+00	0.000E+00	2.838E+08	0.000E+00	0.000E+00	1.824E+08	8.510E+07	4.144E+07	2.409E+07	1.395E+07	1.254E+07	5.402E+06	6.216E+05	7.141E+04
RA223	3.130E-02	3.561E-02	1.058E+10	0.000E+00	3.119E+04	0.000E+00	1.898E+10	1.854E+09	7.844E+09	3.138E+09	9.324E+07	1.084E+06	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
RA224	1.002E-02	3.431E-02	1.695E+08	0.000E+00	0.000E+00	0.000E+00	1.580E+08	0.000E+00	1.550E+09	1.617E+06	2.930E+06	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
RA226	1.600E+03	2.887E-02	3.482E+08	0.000E+00	0.000E+00	0.000E+00	2.287E+08	0.000E+00	1.006E+09	2.794E+05	2.357E+05	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
RA228	6.700E+00	7.706E-05	4.292E+07	5.513E+05	6.512E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB87	4.696E+10	8.358E-04	1.580E+09	2.616E+08	1.447E+08	1.539E+08	5.365E+07	1.728E+07	3.271E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH103M	1.067E-04	2.302E-04	4.033E+08	2.338E+09	2.745E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	9.475E-07	9.592E-03	3.097E+10	6.808E+09	4.551E+09	6.808E+09	4.366E+09	3.012E+09	4.477E+09	2.383E+09	1.243E+10	7.437E+08	9.472E+08	1.765E+08	5.439E+07	7.955E+06	1.040E+06	0.000E+00	0.000E+00	0.000E+00
RN219	1.255E-07	4.149E-02	4.144E+08	0.000E+00	0.000E+00	0.000E+00	6.179E+08	4.995E+07	4.440E+09	2.657E+09	2.409E+07	9.435E+05	1.876E+05	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
RN220	1.762E-06	3.797E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.101E+02	0.000E+00	2.475E+07	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
RU103	1.075E-01	3.345E-03	1.439E+09	5.069E+08	1.310E+08	2.708E+08	5.365E+07	2.616E+07	1.450E+08	1.476E+08	3.134E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	1.008E+00	5.947E-05	1.476E+08	2.035E+06	2.819E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB124	1.648E-01	1.328E-02	8.362E+09	1.843E+09	1.136E+09	1.573E+09	9.287E+08	5.920E+08	7.696E+08	7.030E+08	4.144E+10	5.957E+09	3.452E+09	1.769E+10	2.035E+09	1.487E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	2.770E+00	3.127E-03	2.453E+09	1.565E+10	4.292E+09	2.083E+08	9.324E+07	1.621E+08	2.250E+09	1.336E+10	1.717E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB126	3.394E-02	1.848E-02	5.957E+09	1.665E+09	8.362E+08	1.036E+09	5.846E+08	4.847E+08	4.403E+09	3.604E+10	1.121E+11	2.816E+10	1.606E+09	8.177E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB126M	3.612E-05	1.274E-02	1.132E+10	2.801E+09	1.621E+09	2.227E+09	1.351E+09	8.806E+08	1.166E+09	3.552E+10	7.437E+10	5.661E+08	8.695E+08	4.551E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE79	6.496E+04	2.489E-04	1.014E+09	1.499E+08	7.474E+07	6.290E+07	1.180E+07	1.040E+06	2.831E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	9.310E-01	5.527E-04	4.995E+09	0.000E+00	5.550E+10	5.032E+09	0.000E+00	5.365E+05	0.000E+00	0.000E+00	8.880E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM147	1.070E+11	1.369E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	3.101E+02	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
SM151	8.999E+01	1.172E-04	2.812E+08	2.875E+07	4.958E+06	9.583E+05	8.621E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	6.708E-01	5.168E-04	1.521E+09	1.621E+10	0.000E+00	2.535E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN121M	4.997E+01	2.004E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN123	3.536E-01	3.124E-03	1.166E+10	2.416E+09	1.569E+09	2.227E+09	1.317E+09	8.399E+08	1.051E+09	3.848E+08	1.391E+08	1.976E+07	2.050E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN125	2.639E-02	6.627E-03	1.795E+10	3.848E+09	2.546E+09	3.737E+09	2.313E+09	1.547E+09	2.220E+09	1.524E+09	9.620E+08	3.630E+09	5.032E+09	9.620E+07	7.881E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	1.000E+05	1.247E-03	3.600E+09	1.465E+10	4.218E+08	4.218E+09	1.758E+10	4.070E+07	1.528E+07	6.660E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR89	1.383E-01	3.457E-03	1.302E+10	2.720E+09	1.772E+09	2.535E+09	1.517E+09	9.731E+08	1.251E+09	4.773E+08	1.869E+08	3.774E+07	2.427E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR90	2.912E+01	1.161E-03	8.473E+09	1.617E+09	9.916E+08	1.284E+09	6.512E+08	3.463E+08	2.738E+08	2.701E+07	1.369E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB160	1.980E-01	8.145E-03	6.993E+09	8.547E+08	5.291E+08	7.030E+09	5.365E+09	1.991E+08	1.650E+10	9.361E+08	2.805E+08	2.668E+10	1.117E+10	7.326E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Table 4. (continued).

Photon Energy Group No.			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Lower Photon Energy Group Limit (MeV)			**0.0100**	**0.0200**	**0.0300**	**0.0450**	**0.0700**	**0.1000**	**0.1500**	**0.3000**	**0.4500**	**0.7000**	**1.0000**	**1.5000**	**2.0000**	**2.5000**	**3.0000**	**4.0000**	**6.0000**	**8.0000**
Upper Photon Energy Group Limit (MeV)			**0.0200**	**0.0300**	**0.0450**	**0.0700**	**0.1000**	**0.1500**	**0.3000**	**0.4500**	**0.7000**	**1.0000**	**1.5000**	**2.0000**	**2.5000**	**3.0000**	**4.0000**	**6.0000**	**8.0000**	**14.0000**
Mean Photon Energy (MeV)			**0.0150**	**0.0250**	**0.0375**	**0.0575**	**0.0850**	**0.1250**	**0.2250**	**0.3750**	**0.5750**	**0.8500**	**1.2500**	**1.7500**	**2.2500**	**2.7500**	**3.5000**	**5.0000**	**7.0000**	**11.0000**
	Half-Life (years)	Heat Gen. (W/Ci)	Photons/sec/Ci																	
TC99	2.130E+05	5.014E-04	3.423E+09	5.772E+08	3.226E+08	3.515E+08	1.288E+08	4.477E+07	1.073E+07	1.943E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE123M	3.277E-01	1.457E-03	1.221E+09	1.632E+10	2.782E+09	0.000E+00	3.341E+07	0.000E+00	2.198E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE125M	1.588E-01	8.405E-04	2.105E+09	3.811E+10	8.843E+09	0.000E+00	0.000E+00	9.139E+07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE127	1.067E-03	1.350E-03	4.847E+09	9.361E+08	5.809E+08	7.770E+08	4.033E+08	2.246E+08	2.331E+08	4.884E+08	1.565E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE127M	2.984E-01	5.380E-04	1.018E+09	1.203E+10	2.050E+09	5.180E+06	3.341E+07	1.613E+05	1.550E+05	2.919E+04	1.587E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129	1.323E-04	3.573E-03	1.240E+10	8.806E+09	1.547E+09	2.194E+09	1.299E+09	8.251E+08	1.569E+09	3.959E+08	2.805E+09	1.232E+08	2.235E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129M	9.199E-02	1.754E-03	2.220E+09	9.768E+09	1.820E+09	2.971E+08	1.776E+08	1.610E+08	1.469E+08	5.587E+07	1.447E+09	2.964E+08	1.358E+07	1.117E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TH227	5.124E-02	3.651E-02	1.883E+10	1.069E+08	1.839E+08	3.004E+09	3.511E+09	4.366E+08	1.114E+10	2.124E+09	1.846E+06	6.253E+06	1.517E+04	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
TH228	1.913E+00	3.269E-02	4.292E+09	0.000E+00	0.000E+00	0.000E+00	4.366E+08	4.366E+07	1.284E+08	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
TH229	7.339E+03	3.060E-02	4.033E+10	1.502E+07	3.774E+09	2.194E+08	2.198E+10	2.749E+09	3.996E+09	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
TH230	7.700E+04	2.831E-02	3.885E+09	0.000E+00	0.000E+00	1.658E+08	0.000E+00	1.917E+07	7.548E+06	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.769E+01	8.880E+00	6.512E+00	1.943E+00	1.258E-01	7.955E-03
TH231	2.911E-03	5.610E-04	1.802E+09	5.883E+09	1.695E+08	3.471E+08	3.411E+09	2.375E+08	8.288E+07	1.092E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TH232	1.405E+10	2.420E-02	3.012E+09	0.000E+00	0.000E+00	5.698E+07	0.000E+00	1.602E+07	3.101E+02	0.000E+00	0.000E+00	1.236E+02	7.030E+01	3.522E+01	1.765E+01	8.843E+00	6.512E+00	1.939E+00	1.258E-01	7.955E-03
TH234	6.597E-02	4.054E-04	6.401E+09	2.294E+08	1.088E+08	1.698E+09	2.320E+09	9.102E+07	9.472E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	7.966E-06	9.034E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL207	9.069E-06	2.937E-03	1.092E+10	2.253E+09	1.458E+09	2.065E+09	1.214E+09	7.696E+08	9.509E+08	3.363E+08	1.154E+08	1.088E+08	7.067E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL208	5.837E-06	2.353E-02	1.358E+10	2.594E+09	1.687E+09	2.409E+09	3.811E+09	9.250E+08	4.773E+09	4.551E+08	3.959E+10	5.291E+09	1.576E+08	7.585E+05	0.000E+00	3.511E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U232	7.200E+01	3.210E-02	6.031E+09	0.000E+00	0.000E+00	7.807E+07	0.000E+00	2.864E+07	1.691E+06	1.099E+06	6.438E+03	1.236E+02	7.030E+01	3.526E+01	1.769E+01	8.880E+00	6.512E+00	1.946E+00	1.262E-01	7.992E-03
U233	1.585E+05	2.907E-02	3.030E+09	7.733E+06	3.700E+07	7.326E+06	1.565E+07	1.291E+07	1.550E+07	5.920E+06	3.637E+04	1.236E+02	7.030E+01	3.526E+01	1.769E+01	8.880E+00	6.512E+00	1.946E+00	1.265E-01	8.029E-03
U234	2.445E+05	2.880E-02	5.032E+09	0.000E+00	0.000E+00	4.033E+07	0.000E+00	1.432E+07	3.123E+02	0.000E+00	1.684E+04	1.092E+03	7.104E+01	3.556E+01	1.787E+01	8.991E+00	6.623E+00	1.987E+00	1.310E-01	8.547E-03
U235	7.038E+08	2.619E-02	2.213E+10	0.000E+00	3.378E+07	6.586E+06	2.886E+09	5.698E+09	2.017E+10	5.032E+07	2.475E+06	3.374E+05	2.542E+02	1.251E+02	6.993E+01	3.922E+01	3.371E+01	1.362E+01	1.469E+00	1.624E-01
U236	2.341E+07	2.708E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	6.327E+06	5.920E+02	0.000E+00	0.000E+00	3.060E+02	1.550E+02	7.659E+01	4.181E+01	2.283E+01	1.906E+01	7.326E+00	7.474E-01	7.918E-02
U237	1.848E-02	1.893E-03	3.090E+10	1.147E+09	1.628E+08	1.450E+10	6.734E+09	1.173E+10	8.843E+09	5.217E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U238	4.468E+09	2.536E-02	4.218E+09	0.000E+00	0.000E+00	2.231E+07	0.000E+00	0.000E+00	1.210E+05	0.000E+00	0.000E+00	7.770E+04	3.615E+04	1.769E+04	1.025E+04	5.957E+03	5.328E+03	2.290E+03	2.638E+02	3.034E+01
XE131M	3.258E-02	9.620E-04	1.273E+09	1.939E+10	3.386E+09	0.000E+00	0.000E+00	0.000E+00	5.291E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	1.436E-02	1.071E-03	3.034E+09	3.608E+08	1.480E+10	2.375E+08	1.325E+10	3.885E+07	3.056E+07	2.412E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y90	7.301E-03	5.543E-03	4.181E+10	8.954E+09	5.920E+09	8.695E+09	5.439E+09	3.637E+09	5.106E+09	2.353E+09	1.251E+09	3.885E+08	1.284E+08	1.003E+07	1.103E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y91	1.602E-01	3.592E-03	1.343E+10	2.816E+09	1.839E+09	2.631E+09	1.580E+09	1.018E+09	1.317E+09	5.143E+08	2.068E+08	3.774E+07	1.106E+08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN65	6.677E-01	3.505E-03	1.188E+10	3.737E+07	2.442E+07	3.489E+07	2.083E+07	1.332E+07	1.680E+07	7.104E+06	9.620E+08	1.258E+06	1.676E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR93	1.530E+06	1.162E-04	2.442E+08	1.573E+07	3.056E+06	2.338E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR95	1.752E-01	5.066E-03	2.412E+09	4.292E+08	2.520E+08	2.986E+08	1.291E+08	5.661E+07	2.731E+07	1.106E+06	1.269E+05	3.215E+10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

radionuclides and displayed on the worksheet. The conversion factors used for each of the 18 energy groups for each radionuclide are shown in Table 4. The data in Tables 3 and 4 are from the ORIGEN2 library files (see Reference 21) and includes the bremstrahlung effects associated with UO_2. Because of space constraints, only the average values are shown on the output sheets, but the values shown correspond to a range (as shown in Table 4). The inventory of each radionuclide (Ci) is multiplied by its respective photon/sec/Ci value in Table 4 to get a photon/sec value. These values are then summed across all isotopes for each energy group and displayed on the output sheet.

7. RESULTS

For each fuel, the results of the estimate are presented on a Fuel Radionuclide Inventory Worksheet. Appendixes C and D provide Fuel Radionuclide Inventory Worksheets for the years 2010 and 2030 for each DOE SNF record in the SFD. These dates, respectively, represent the estimated timeframes for packaging and shipment of fuels to the repository and for completion of emplacement of fuels in the repository. The results include a nominal and bounding source term estimate along with the associated heat generation rates and photon emission spectra. Appendix B provides an index by fuel name that supplies the SNF ID number, Total System Performance Assessment category, design basis event category, and page number for the 2010 and 2030 source term estimates. Appendix C also includes tables summarizing the total DOE SNF radionuclide inventory, broken down by canister type and design basis event group.[28,29] Appendix D also includes tables summarizing the total DOE SNF radionuclide inventory, broken down by type and Total System Performance Assessment group (see Reference 29).

To facilitate checking and to aid the analyst in determining the uncertainty associated with the estimate, the worksheet displays all input used within the estimate, including any assumptions that were necessary in order to compensate for lack of information. Each Fuel Radionuclide Worksheet contains three sections. Section I includes header information that identifies and provides key information for both the fuel being estimated and the template used in the estimate.

Section II shows for each of the 45 radionuclides of interest the factors used in the linear estimate (Y = mx+b) where m represents the change in curies relative to the change in burnup; x is the burnup; b is the initial curie content; and Y is the resulting estimate. Although estimates are performed for each of the 145 radionuclides in the precalculated template, the Fuel Radionuclide Worksheet displays only the 45 shown in Table 5. These 45 radionuclides include those identified as important for Total System Performance Assessment and preclosure safety analysis. The remaining 100 radionuclides are also estimated. The sum of the curies from the remaining radionuclides is also displayed on the Fuel Radionuclide Worksheet.

Section III includes subsections for Template Selection Summary, Burnup Summary, and Checks. The Template Selection Summary subsection provides the information relied on to select an appropriate template (i.e., the reactor moderator, the fuel cladding, the fuel compound, and the fuel enrichment). A table is provided that identifies these parameters as given for the fuel along with those of the template selected and the basis for any differences.

The Burnup Summary subsection provides a table that identifies both the given (i.e., burnup values in the SFD) and estimated burnup. For conservatism, the larger of the given and estimated is used for the estimates given in Section II. The table also contains a basis section that documents the source and the method used to estimate the burnup. The basis section may include one or more of the following messages.

> ***Nominal burnup calculated from the heavy metal mass destroyed.*** This message indicates that the nominal burnup was calculated by converting the fission energy for the heavy metal atoms fissioned to MWd. In other words, the nominal burnup was calculated using Equation 1 of Figure 1. (See discussion of Blocks 4 and 8 in Section 6 of this report.)
>
> ***Nominal burnup set equal to bounding burnup.*** This message indicates that information is not available to support an estimation of the nominal burnup, but the bounding burnup was either provided or estimated. In this case, the nominal burnup is conservatively assumed to be the same as the bounding burnup. (See discussion of Blocks 5 and 9 in Section 6 of this report.)

Table 5. List of radionuclides shown on output.

Radionuclides	Total System Performance Assessment (TSPA)[a] Dose Contribution: Up to 1×10^4 yr [c]	Total System Performance Assessment (TSPA)[a] Dose Contribution: $> 1 \times 10^4$ to 10^8 yr [c]	Preclosure Safety Analysis (PSA)[b]
AC227	0.95	0.95	X
AM241	0.95		X
AM242M			X
AM243	0.95	0.95	X
C14	0.95	0.95	
CL36	0.99	0.95	
CM243			X
CM244	0.99		X
CO60			X
CS134			X
CS135	0.95	0.95	
CS137	0.95		X
EU154			X
EU155			X
FE55			X
H3			X
I129	0.95	0.95	X
KR85			X
NP237	0.95	0.95	X
PA231	0.95	0.95	X
PB210	0.99	0.95	
PM147			X
PU238	0.95		X
PU239	0.95	0.95	X
PU240	0.95	0.95	X
PU241	0.99		X
PU242	0.99	0.95	X
RA226	0.95 (EPA)	0.95 (EPA)	
RA228	EPA	EPA	
RU106			X
SE79		0.95	
SN126	0.99	0.95	
SR90	0.95		X
TC99	0.95	0.95	
TH229	0.95	0.95	X
TH230		0.95	
TH232	0.99	0.95	X
TL208[d]			
U232	0.95		X
U233	0.95	0.95	X
U234	0.95	0.95	X
U235	0.99	0.99	
U236	0.99	0.95	X
U238	0.95	0.95	X
Y90			X

a. Office of Civilian Radioactive Waste Management, "Radionuclide Screening," ANL-WIS-MD-000006 Rev. 01, August 2002, Tables 10 and 11. MOL.20020923.0177.

b. Office of Civilian Radioactive Waste Management, "Significant Radionuclides Determination," CAL-WHS-SE-000002 Rev. 00, July 2001, Table 5. MOL.20010905.0143.

c. 0.95 = For postclosure analysis, the doses from the radionuclide total to 0.95 fraction
0.99 = For postclosure analysis, the additional doses from the radionuclide totals to 0.99 fraction
EPA = Additional isotopes required by EPA 10CFR197.30 and 10CFR63.331 for ground water protection standard.

d. Thallium-208 is shown on the list, because it is the dominant contributor to Group 14 of the photon emission spectra out to 100 years.

***Nominal (or bounding)Burnup taken from SFD and converted to MWd using BOL = XX.xxx kg** (where XX.xxx is the estimated BOL heavy metal mass).* This message indicates that the BOL heavy metal mass was estimated from the fuel's specific burnup (MWd/MTIHM) and the EOL heavy metal as described in the discussion of Block 7 in Section 6 of this report. Using this estimated BOL value, the given specific burnup was then converted to an absolute burnup (i.e., MWd).

Bounding burnup assumed to be twice nominal burnup. This message indicates that information is not available to support an estimation of the bounding burnup but the nominal burnup was either provided or estimated. In this case, the bounding burnup was conservatively assumed to be twice the nominal burnup. In other words, the bounding burnup was estimated using Equation 3 of Figure 1. (See discussion of Blocks 6 and 8 in Section 6 of this report).

Bounding burnup estimated using BOL heavy metal and enrichment. This message indicates that the bounding burnup was conservatively estimated by assuming 100% depletion of the initial fissile inventory. This allows burnup estimates to proceed in the event that only BOL information is available. In other words, the bounding burnup was conservatively estimated using Equation 4 of Figure 1. (See discussion of Block 9 in Section 6 of this report.)

Nominal burnup assumed 2% of BOL Heavy Metal mass. This message indicates that the BOL and EOL heavy metal masses were equal, and therefore, nominal burnup was conservatively estimated by assuming 2% burnup of the initial heavy metal mass. (See discussion of Block 8 in Section 6 of this report.)

Nominal (or Bounding) burnup taken directly from SFD (converted to MWd). This message indicates that the burnup was given (from SFD) in MWd/MTIHM and was converted to MWd using BOL heavy metal mass. (See discussion of Block 7 in Section 6 of this report.)

Bounding burnup estimated by assuming BOL heavy metal mass was twice EOL. This message indicates that the nominal burnup was calculated using Equation 1 of Figure 1 after assuming that half the original heavy metal mass has fissioned. The estimate assumes that BOL heavy metal mass was twice the EOL heavy metal mass, which is equivalent to assuming that the heavy metal destroyed is equal to the heavy metal remaining. This is a conservative assumption for virtually all DOE SNF (see discussion included in Appendix E) and allows burnup estimates to proceed in the event that only EOL information is available. Because of the conservatism of this assumption, the bounding burnup is set equal to the nominal burnup when it is estimated by assuming that BOL heavy metal was twice the EOL heavy metal.

The Checks subsection provides the burnup multiplier and, when possible, the ratios of the estimated (i.e., calculated nominal and bounding) burnups and the estimated EOL heavy metal mass with those provided from the SFD. The burnup multiplier is the ratio of the specific burnup (i.e., burnup per MTIHM) of the fuel being estimated over the specific burnup of the template fuel. A burnup multiplier indicates the portion of the linear scaling that accounts for differences in specific burnup. For example, a burnup multiplier of 1 indicates that any scaling accounts for a different mass of fuel with the same specific burnup. As noted previously, error is not introduced when scaling to account for different masses of fuel. Scaling to account for different specific burnups, however, introduces error when estimating inventories of actinides and activation products. The burnup multiplier provides an indication of both the magnitude and the direction of the potential error associated with this linear approximation. The magnitude of this error is a function of the nonlinearity of the buildup of each radionuclide with respect to burnup (reference) and the magnitude of the scaling factor. The direction of this error is determined by whether the curvature of the radionuclide buildup is positive or negative and whether the burnup multiplier is more or less than one.

When the heavy metal masses at BOL and EOL are provided, the nominal burnup is back-calculated from the depleted heavy metal mass. This calculated nominal value as well as the estimated bounding value is compared against the burnups (nominal and bounding) given in the SFD. This ratio gives an indication of the integrity (i.e., internal self-consistency) of the input data.

Similarly, the heavy metal masses in the estimated radionuclide inventory are summed and compared to the EOL heavy metal mass given in the SFD. The ratio between the estimated and the given EOL heavy metal mass of the fuel is another cross-check that may alert the analyst of potential uncertainty associated with the data or the estimate. If the ratio of the estimated EOL over the given EOL is 1 (or close to 1), then the estimated EOL radionuclide inventories for the fuel's heavy metal constituents are consistent with SFD values. SFD EOL heavy metal values have been cross-checked against Nuclear Materials Safeguards and Security records and Material Control and Accountability records. A deviation in this heavy metal mass ratio is an indication that the heavy metal loadings of the template are not consistent with those of the fuel. For example, because the construction of the Worst Case template maximizes the EOL value of all radionuclides, the EOL heavy metals are artificially inflated often to nearly 600 times the actual values. Table 6 shows the distribution of the predicted heavy metal mass relative to the heavy metal mass values in the SFD for each of the fuels. As illustrated by the table, the heavy metal mass ratios are quite good with the exception of those fuels whose radionuclide inventories were estimated using the Worst Case template and for some of the HWCTR and CANDU fuels estimated using an HFBR template. As a result, the total estimated EOL heavy metal for all DOE SNF in the 2030 nominal burnup case is about 2,469 MTHM while the total EOL heavy metal for all DOE SNFs included in this analysis is about 2,406 MTHM.

Table 6. Distribution of predicted versus SFD heavy metal mass ratios.

		Template Used		
EOL/EOL Range	No. of SNF Records	HFBR	Worst Case	Other
0.7–0.9	4			4
0.9–1.1	509	37		472
1.1–2	13		2	11
2–3	16	15	1	
3–10	1		1	
10–20	1		1	
30–40	4		4	
40–100	1		1	
100–200	1		1	
590–610	18		18	

Each fuel record identifies the type and estimated number of canisters that will be needed for the fuel associated with the record. The radionuclide content of a canister is estimated simply by dividing the inventories shown on the worksheet by the number of canisters. The cumulative number of DOE SNF canisters is projected to be approximately 3,500. This projection includes the standardized canisters required for high integrity cans. As explained in Appendix F, there are numerous uncertainties that could significantly affect the number of DOE SNF canisters that are ultimately used. For analyses that rely on either the total number of DOE SNF canisters or on the content of an individual canister, a range of 2,500 to 5,000 DOE SNF canisters should be considered to account for these uncertainties and to assess the importance of the canister count. Appendix F also reports the number of standardized canisters of each size required for each DOE SNF group.

8. UNCERTAINTY AND ERROR

This report provides the results and summarizes the analytical processes employed to estimate the radiological inventories associated with DOE-owned SNF. The accuracy of the estimates is affected both by the accuracy of the input data relied on as well as the simplifications introduced by the methodology itself. A brief discussion of the overall accuracy of the estimates is given below. A more thorough discussion of each of these uncertainties and of the conservative nature of the methods used to account for missing or questionable input information is given in Appendix E.

Sources of uncertainty in the template methodology include those associated with the ORIGEN calculations used to generate the templates, the ORIGEN input used in the template calculations, and those associated with selecting and scaling a template. The uncertainty associated with scaling a template can be further broken down into (a) uncertainty associated with the burnup of the fuel being estimated and (b) uncertainty associated with using the linear scaling to account for the difference in burnup between the template fuel and the fuel being estimated. The contribution of each of these uncertainties depends on the radionuclide being estimated, and the quality and availability of the information used to select and scale a template. Hence, based on the radionuclide of interest and the fuel being estimated, one of 16 different uncertainty ranges may apply. Table 7 shows the combined standard deviation for each of the 16 potential paths along with the percentage of the total estimated curie inventory associated with each path. A weighted standard deviation is also shown in order to estimate the net uncertainty contribution from each path on the total estimated curie from all DOE SNFs.

Table 7. Overall standard deviations.

Case #	Template Fuel	Radionuclide	Template Selection Basis	Burnup Basis	Standard Deviation		% of Ci	Standard Deviation (weighted)	
					lower	upper		lower	upper
1	yes	fission product	NA–Template Fuel	SFD Information	-6.12%	6.12%	50.40%	-3.09%	3.09%
2	yes	fission product	NA–Template Fuel	Assumed BOL=2*EOL	-49.63%	6.12%	0.00%	0.00%	0.00%
3	yes	non fission product	NA–Template Fuel	SFD Information	-33.91%	55.00%	4.48%	-1.52%	2.46%
4	yes	non fission product	NA–Template Fuel	Assumed BOL=2*EOL	-59.79%	55.00%	0.00%	0.00%	0.00%
5	no	fission product	SFD Information	SFD Information	-25.62%	50.31%	15.96%	-4.09%	8.03%
6	no	fission product	SFD Information	Assumed BOL=2*EOL	-55.51%	50.31%	0.00%	0.00%	0.00%
7	no	fission product	Table 1 assumptions	SFD Information	-13.69%	25.62%	5.88%	-0.81%	1.51%
8	no	fission product	Table 1 assumptions	Assumed BOL=2*EOL	-51.12%	25.62%	5.88%	-3.01%	1.51%
9	no	fission product	worst case template	SFD Information	-45.35%	7.50%	4.20%	-1.90%	0.32%
10	no	fission product	worst case template	Assumed BOL=2*EOL	-66.94%	7.50%	1.68%	-1.12%	0.13%
11	no	non-fission product	SFD Information	SFD Information	-40.93%	73.65%	1.12%	-0.46%	0.82%
12	no	non-fission product	SFD Information	Assumed BOL=2*EOL	-64.03%	73.65%	0.00%	0.00%	0.00%
13	no	non-fission product	Table 1 assumptions	SFD Information	-34.73%	59.58%	2.72%	-0.94%	1.62%
14	no	non-fission product	Table 1 assumptions	Assumed BOL=2*EOL	-60.26%	59.58%	1.12%	-0.67%	0.67%
15	no	non-fission product	worst case template	SFD Information	-55.45%	21.79%	5.44%	-3.02%	1.19%
16	no	non-fission product	worst case template	Assumed BOL=2*EOL	-74.16%	21.79%	1.12%	-0.83%	0.24%
							100.00%	-0.2146	0.2158

Lastly, for analyses in which the source term per canister or the total number of DOE SNF canisters is important, the uncertainty associated with the projected canister count must be taken into consideration. Although the canister count is estimated at approximately 3,500 (including the standardized canisters required for high integrity cans), a potential range of 2,500 to 5,000 canisters should be considered in order to account for uncertainty and to assess the importance of the canister count. The bases for this uncertainty and a summary of the number of standardized canisters of each size required for each DOE SNF group is included in Appendix F and further discussed in Reference 28.

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CONTENTS

Appendix A

Template Selection Guide and Templates

Appendix A

Template Selection Guide and Templates

On the following page a table is provided listing each of the templates as outlined in report DOE/SNF/REP-059. The templates that were not completed have a TBD (to be determined) in the Page Number column and have a crosswalk to an acceptable completed template. An appropriate template is selected based on the reactor moderator, the fuel compound, BOL enrichment, and cladding. When possible, a template is selected that matches all four of these parameters. If one or more of these parameters is not known, a conservative assumption may be applied. If a template matching all four parameters is not available, an alternative template may be applied in accordance with the template selection guide. When matching a fuel record to a template, the order of importance of the four criteria is: 1–reactor moderator, 2–fuel type, 3–cladding, and 4–enrichment.

Following the template table is a detailed writeup of each of the completed templates. (The page numbers of each template are shown in the template table.) Some templates use 365.25 days per year for the decay calculations, and some templates use 365 days per year. This should produce a very minimal error in the output.

Templates and Template Selection Guide

Reactor Type (moderator)	Fuel Clad	BOL Enrichment	BOL Heavy Metal Constituents	Template No.	Template Fuel	Alternate Template No. [a]	Page No.
Fast	Stainless Steel	60 to 100%	Pu and U	1	TBD[b]	3	TBD[b]
Fast	Stainless Steel	30 to 100%	U	2	TBD	5	TBD
Fast	Stainless Steel	10 to 30%	Pu and U	3	FFTF	NA	A-5
Fast	Stainless Steel	0 to 5%	U	4	TBD	5	TBD
Fast	Zirconium	10 to 40%	U	5	Fermi	NA	A-20
Graphite	Graphite	60 to 100%	Th and U	6	Ft. St. Vrain	NA	A-39
Graphite	Zirconium	0 to 5%	U	7	N-Reactor	NA	A-51
Heavy Water	Aluminum	40 to 100%	U	8	HFBR	NA	A-64
Heavy Water	Aluminum	10 to 20%	U	9	Modified HFBR	NA	A-74
Heavy Water	Stainless Steel	0 to 5%	U	10	Modified HFBR	NA	A-84
Heavy Water	Zirconium	0 to 5%	U	11	Modified HFBR	NA	A-96
Light Water	Aluminum	60 to 100%	U	12	ATR	NA	A-108
Light Water	Aluminum	40 to 60%	U	13	TBD	12	TBD
Light Water	Aluminum	10 to 20%	U	14	TBD	12	TBD
Light Water	Stainless Steel	60 to 100%	U	15	Pathfinder	NA	A-121
Light Water	Stainless Steel	60 to 100%	Th and U	16	TBD	21	TBD
Light Water	Unclad	40 to 60%	U	17	TBD	15	TBD
Light Water	Stainless Steel	10 to 20%	U	18	TBD	15	TBD
Light Water	Stainless Steel	5 to 10%	Th and U	19	TBD	21	TBD
Light Water	Stainless Steel	0 to 5%	U	20	TBD	15	TBD
Light Water	Zirconium	60 to 100%	Th and U	21	LWBR	NA	A-134
Light Water	Zirconium	60 to 100%	U	22	TBD	15	TBD
Light Water	Zirconium	5 to 20%	U	23	TBD	24	TBD
Light Water	Zirconium	0 to 5%	U	24	PWR	NA	A-151
Light Water	Zirconium	0 to 5%	Pu and U	25	TBD	29	TBD
LW/U-Zrx[c]	Aluminum	10 to 20%	U	26	TRIGA-Al	NA	A-162
LW/U-Zrx[c]	Stainless Steel	60 to 100%	U	27	TRIGA-FLIP	NA	A-174
LW/U-Zrx[c]	Stainless Steel	10 to 20%	U	28	TRIGA-SS	NA	A-187
	Inconel and Stainless Steel		U-Pu-Th		Hypothetical	NA	A-200
All Else	Composite[d]	Composite[d]	Composite[d]	29	Worst Case	NA	A-211

a. This column specifies the available template that was used in this analysis.

b. The templates with a TBD designation were not completed due to time and funding constraints.

c. Light water and uranium-zirconium-hydride (LW/U-Zrx) moderated reactor.

d. This template does not represent any real or postulated fuel. It includes the maximum normalized (per MWd per kg) radionuclide content for each radionuclide from each of the other templates.

Template 3

Fuel-Specific Source Term Calculations
Fast Flux Test Facility (FFTF) Fuel

Introduction

The Fast Flux Test Facility (FFTF) spent nuclear fuel (SNF) currently resides at the U.S. Department of Energy (DOE) Hanford Site. The total FFTF SNF inventory represents approximately 0.25% of the total uranium mass in the DOE SNF inventory.

The radionuclide inventory or source term used for the FFTF template is based on a radionuclide inventory calculated by the Hanford site personnel (References 1 and 2). The Hanford calculation represents a relatively comprehensive list of radionuclides; however, the reported inventory does not provide activity estimates for all of the radionuclides identified in the "Guide for Estimating DOE Spent Nuclear Fuel Source Terms" (Reference 3). In order to provide these additional radionuclide activity estimates, a complementary FFTF fuel assembly depletion calculation was performed by the Idaho National Engineering and Environmental Laboratory (INEEL) National SNF Program personnel.

The INEEL complementary calculation was designed to use the same input data as the Hanford calculation and match the reported Hanford radionuclide activities. Matching activities provided the verification basis for using the INEEL calculated additional radionuclides in the template inventory here. The INEEL FFTF fuel assembly depletion calculation used the same input data, namely burnup (152,230 MWd/MTHM), assembly heavy metal isotopic masses, assembly structural masses, assembly geometry, and FFTF reactor data.

In order to reproduce the Hanford calculation, the INEEL calculational methodology (Reference 4) was invoked to generate beginning-of-life (BOL) FFTF fuel assembly neutron cross sections and perform the depletion calculation. Good agreement was obtained between the Hanford and INEEL depletion calculation results. As a consequence, the additional radionuclide activity estimates were taken directly from the INEEL output and used to supplement the Hanford data as needed.

Fast Flux Test Facility

The FFTF was a 400-MW(th), liquid sodium-cooled, fast flux test reactor, which is owned by DOE and located on the Hanford Site. The FFTF mission was to provide testing capability for US advanced reactor programs and the production of medical radioisotopes. In 1993, the FFTF was ordered into a safe shutdown condition, and in 2002 the FFTF was ordered to be permanently shut down and defueled. During its 10-year operation, the FFTF irradiated a wide variety of fuels, including the FFTF driver fuel, potential driver fuels, and related advanced fuel systems.

Fast Flux Test Facility Fuel Assembly Data

An FFTF driver assembly is 144 inches long and is a hexagonal bundle of 217 wire-wrapped fuel pins, encased in a stainless steel duct. Figures 1 and 2 show an FFTF standard driver fuel assembly with the major features and dimensions identified.

The FFTF fuel is a mixed oxide (MOX) of uranium and plutonium oxides. The uranium enrichment is 0.2% U-235 (or depleted uranium), and the plutonium enrichment is 86% Pu-239. The plutonium heavy metal mass fraction is 29% Pu/[U+Pu]. Over the course of the FFTF operation, there were four different types of driver assemblies. These assemblies differed in fissile load, but maintained the same basic physical geometry. Of these four assemblies, the assembly with the highest plutonium content (Type 4.1) was chosen for the Hanford high burnup depletion calculation.

The cladding and duct material for the driver assembly are 316 stainless steel (SS-316). The depletion calculations were performed using material masses that encompass only the active 36-in. (91.44-cm) long core region. Hence, the structural material, the small Inconel or depleted uranium spacers, and the SS-316 end fixtures were ignored because of the relatively low neutron fluence and minimal expected activation in these regions above and below the fuel column.

Selected FFTF standard driver fuel assembly design characteristics are listed below:

Fuel Bundle:	Hexagonal array of 217 wire-wrapped pins
Fuel Pin Pitch:	Triangular, 0.726-cm pin-to-pin centers
Fuel Pellet Diameter:	0.494 cm
Fuel Material:	Mixed U/Pu oxide
U Enrichment:	0.2% U-235 BOL (depleted uranium)
Pu Enrichment:	86% Pu-239 BOL
Pellet Density [%TD]:	90.4
Smeared Density [%TD]:	85.5
Oxygen/Metal Atom Ratio:	1.96
Active Fuel Length:	91.44 cm
Fuel Pin Length:	237.5 cm
Assembly Length:	365.8 cm
Cladding Outer Diameter:	5.84 mm
Cladding Thickness:	0.38 mm
Cladding Material:	Stainless Steel 316 (SS-316)
Pellet-Cladding Gap Thickness:	0.14 mm (diametral)
Wire Diameter:	1.422 mm
Wire/Duct Material:	SS-316
Coolant :	Liquid Sodium
Average Coolant Density:	0.846 g/cc (443.5°C)

Fast Flux Test Facility Assembly Fuel Compositions/Masses

Table 1 lists the Hanford-supplied FFTF fuel assembly compositions/masses that include the heavy metal uranium and plutonium isotopic masses in a single assembly. In addition, the oxygen in the MOX fuel is given along with the total SS-316 structural mass for a single assembly. These data are part of the ORIGEN input data and are used in both the Hanford and INEEL activation/depletion calculations. Note: These masses differ slightly from the descriptive text in Reference 2.

Fast Flux Test Facility Assembly Structural Constituents and Impurities

Table 2 lists the major SS-316 constituent elements and impurities needed for the activation calculation. Column 1 lists both the major constituents and impurity elements in the SS-316. Column 2 is the Hanford-supplied element weight percents for the major constituents. These Column 2 data are used in both the Hanford and INEEL calculations. The Column 3 data are the impurity concentrations in ppm per Reference 5. The INEEL calculation in addition includes these impurity data in the activation calculation.

Burnup

The burnup chosen for this template is 152,230 MWd/MTHM as specified by the Hanford calculation (Reference 2). This encompasses all the spent FFTF driver fuel assemblies as well as the Test Driver fuel assemblies. The 275 Test Driver fuel assemblies are basically the same in terms of geometry and heavy metal loading as the standard driver assemblies, with the exception of minor variations in the SS-316 cladding composition (such as titanium additions to the generic SS-316 cladding alloy). Most of the standard driver assemblies have burnups in the range of 70,000 to 90,000 MWd/MTHM. Only three FFTF experiments exceeded the 150,000-MWd/MTHM burnup value. For calculational purposes here, the FFTF fuel assembly burnup is assumed to be continuous over 928 equivalent full power days (EFPDs) at an assembly power of 5.4 MW.

The relatively high burnup (152,230 MWd/MTIHM) is conservative for the buildup of fission products, activation products, and minor actinides in the source term and nonconservative with regard to criticality safety and fissile isotope concentrations, in particular Pu-239.

Cross Sections

The Hanford calculations used here were performed in 1991. An independent review of the calculations was performed in 1999 by Hanford personnel. The Hanford reviewers were familiar with both the FFTF and the ORIGEN code (Reference 6). The calculations were found to be consistent and correct based on available information. However, the available ORIGEN output does not specifically list the cross sections used in the calculations, and therefore, they are not independently verifiable.

The corresponding INEEL depletion calculation generated BOL cross sections based on the FFTF data given above and the methodology described in Reference 4. These neutron cross sections were used in the INEEL burnup or depletion calculation for the generation of activity estimates for the additional radionuclides required for the single FFTF fuel assembly source template inventory. Cross sections for 37 actinides were updated in a standard ORIGEN2 liquid metal fast reactor library. The FFTF specific cross sections take into account neutron flux spectral and spatial characteristics of the FFTF and assembly geometry and materials.

An explicit triangular pitch unit cell model with reflective boundary conditions was developed for the MCNP4B computer code (Reference 7) to represent an FFTF fuel assembly. This model was used to calculate the volume-averaged fluxes and reaction rates for the 37 actinides. These data were then converted into 1-group cross sections for use in the ORIGEN2 depletion or activation calculation.

Burnup Calculation

Table 3 summarizes the power or exposure history used in the INEEL burnup or source term calculations for a single FFTF fuel assembly. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years. These decay or cooling times correspond to the specified time periods in Reference 3. The radionuclides and their corresponding activities included in the Hanford calculations are incorporated directly into the template. The Hanford-provided radionuclide inventory is given only for decay times of 5, 10, 20, 50, and 100 years. Therefore, interpolation of these data were required in order to provide estimates for the other five decay dates. The INEEL calculation was used to supplement the Hanford data by providing activity estimates for the radionuclides not reported in Reference 2. The radionuclides/activities reported in Reference 2 and the interpolated values are designated separately in the table as are the INEEL-generated radionuclides/activities.

The goal for the FFTF template was to use the Hanford-provided data where possible and not try to reproduce these data. The simplest means of interpolation was the linear interpolation in order to fill in the other missing decay time vectors not supplied by Hanford. With the exception of a few low concentration daughter decay products, the relatively long-lived 41 radionuclides decay in a nice smooth exponential fashion. Linear interpolation is a reasonable approach to estimating the intermediate time vector activities. Any error introduced from linear interpolation results in an estimated activity that is greater than the actual value. This is in line with the basic template philosophy of erring conservatively.

The Hanford depletion calculation used the ORIGEN2 code to calculate the radionuclide concentrations that follow in the attached template. The source terms are for a single 217 pin FFTF MOX assembly. Masses of material, burnup, and power level are as indicated above. Radionuclide activities in the template are presented as a function of decay time after shutdown.

Similarly, the INEEL depletion calculation also used the ORIGEN2 computer code to calculate radionuclide inventory for a single FFTF fuel assembly. The fuel element masses and impurities (graphite, uranium, and thorium), neutron cross sections, burnup, power history, and power level as discussed above are input data for the ORIGEN2 calculation.

References

1. K. H. Bergsman, "Hanford Spent Fuel Inventory Baseline," WHC-SD-SNF-TI-001, 1994.

2. R. L. Symons, "Radiation Source Term for the Fuel Irradiated to 150 MWd/kg Burnup," RLS-91-010, 1991.

3. National Spent Nuclear Fuel Program, *Guide for Estimating DOE Spent Nuclear Fuel Source Terms*, DOE/SNF/REP-059, July 2000.

4. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

5. J. C. Evans et al., *Long-Lived Activation Products in Reactor Materials*, NUREG/CR-3474, Prepared for the U.S. Nuclear Regulatory Commission by Battelle, Pacific Northwest Laboratory, Richland, WA, August 1984.

6. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

7. "MCNP4B: Monte Carlo N-Particle Transport Code System," contributed by the Transport Methods Group, Los Alamos National Laboratory and distributed by the Radiation and Safety Information Computational Center as code package CCC-660, April 1997.

Table 1. FFTF driver fuel isotopic constituents and masses in a single assembly.

Isotope/Element	Mass (g)	Heavy Metal Mass Fraction
Pu-239	8382.9	0.254660
Pu-240	1162.5	0.035316
Pu-241	115.4	0.003504
Pu-242	18.5	0.000563
Total Pu	9679.3	0.294042
Am-241	18.5	0.000561
U-235	49.5	0.001504
U-238	23170.8	0.703892
Total U	23220.3	0.705396
Total heavy metal	32918.1	1.000000
Oxygen	4347.6	
SS-316	21327.8	
Total	58593.5	

Table 2. FFTF SS-316 structural material constituent and impurity concentrations.

Constituent or Impurity	SS-316 Cladding Concentration (wt%)	SS-316 Cladding Concentration (Ref. 5) (ppm)
H		
Li		0.18
Be		
B	0.002	
C	0.06	
N	0.01	
O		
F		
Na		6
Mg		
Al	0.05	
Si	0.75	
P	0.04	
S	0.01	
Cl		
K		3
Ca		14
Sc		
Ti		200
V	0.04	
Cr	18.00	
Mn	2.00	
Fe	61.848	
Co	0.05	
Ni	14.00	
Cu	0.04	
Zn		71
Ga		60
As	0.03	
Se		9
Br		2
Rb		
Sr		0.23
Y		5
Zr		6

Table 2. (continued).

Constituent or Impurity	SS-316 Cladding Concentration (wt%)	SS-316 Cladding Concentration (Ref. 5) (ppm)
Nb	0.05	
Mo	3.00	
Ag		5
Cd		
In		
Sn		
Sb		13
Cs		
Ba		
La		0.2
Ce		
Pr		
Nd		
Sm		0.2
Eu		0.07
Gd		
Tb		9
Dy		
Ho		1
Er		
Tm		
Yb		2
Lu		0.8
Hf		
Ta	0.02	
W		218
Tl		
Pb		30
Bi		
Th		
U		5

Table 3. Assumed power and decay history for the FFTF fuel assembly used in the INEEL template depletion calculation.

Duration (days)	Cumulative Duration (days)	Time-Averaged Power (MW_{th})
928	928	5.4
1826.25	2754.25	0.0
1826.25	4580.50	0.0
1826.25	6406.75	0.0
1826.25	8233.00	0.0
1826.25	10059.25	0.0
3652.5	13711.75	0.0
5478.75	19190.50	0.0
5478.75	24669.25	0.0
5478.75	30148.00	0.0
7305.00	37453.00	0.0

The ten dates with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year decay times in accordance with the template format.

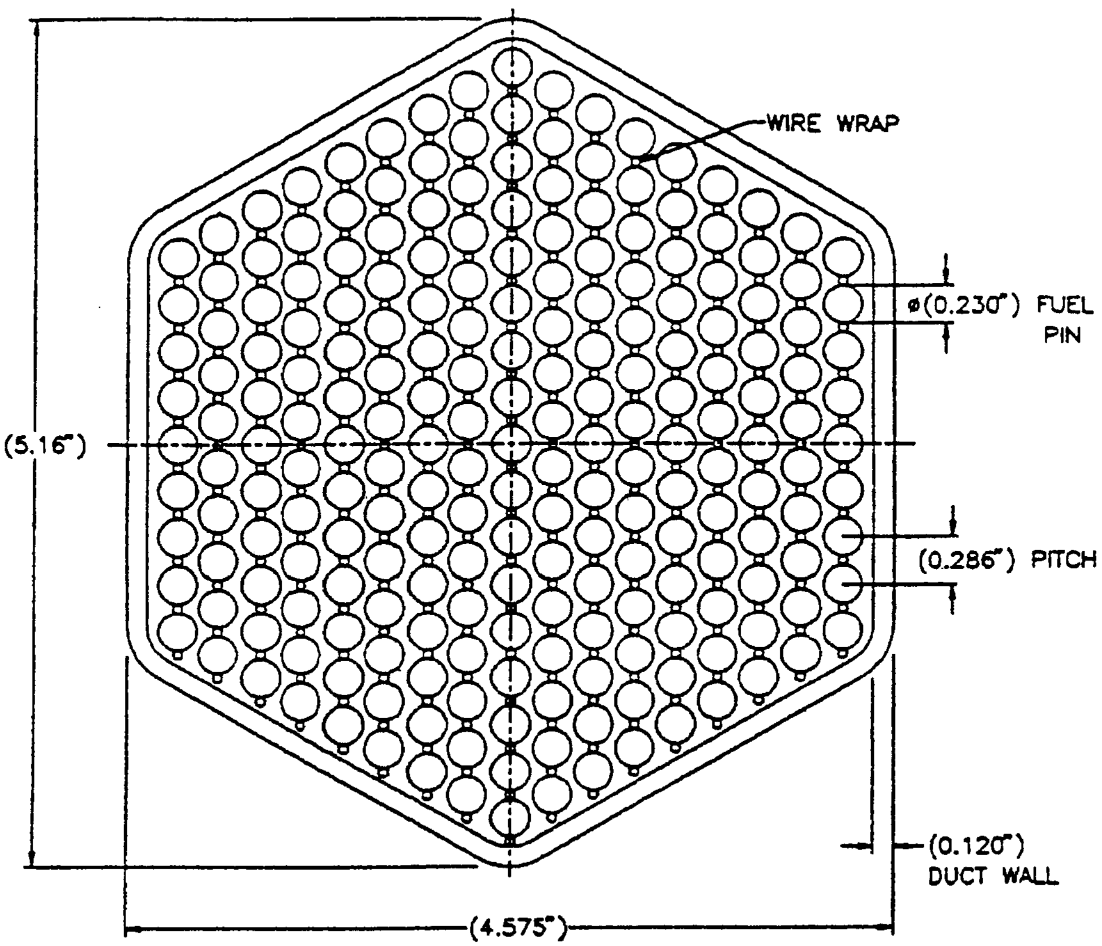

Figure 1. Fast Flux Test Facility fuel pin bundle cross section.

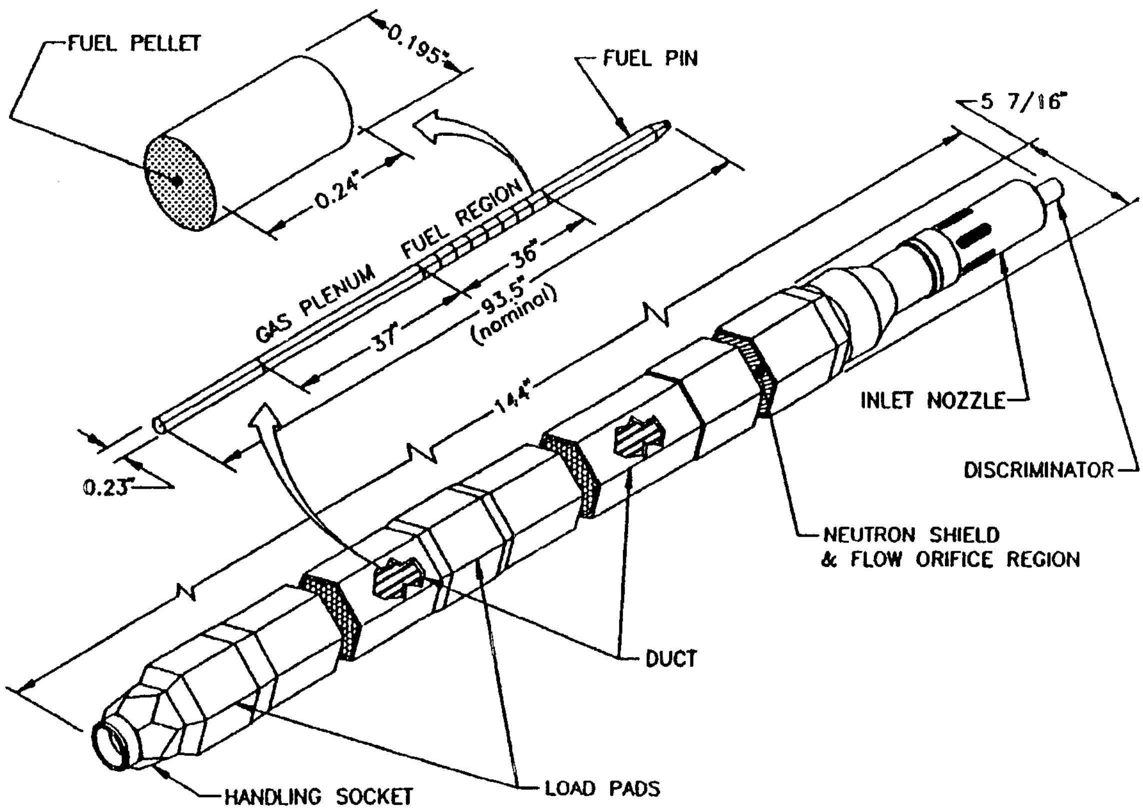

Figure 2. Fast Flux Test Facility standard driver fuel assembly.

Fast Flux Test Facility Element

Stainless Steel Cladding, MOX Fuel

Coolant:	Liquid Sodium
Fuel Meat:	MOX
Clad:	Stainless Steel 316
Burnup:	152,230.0 MWd/MTHM
Burnup:	5,011.2 MWd/single assembly (high burnup)
Basis of Calculation:	Single fuel assembly
BOL U-235:	49.5 grams U-235 per assembly
BOL U-238:	23,170.8 grams U-238 per assembly
BOL Total U per Assembly:	23,220.3 grams U per assembly
BOL Pu-239	8,382.9 grams Pu-239 per assembly
BOL Pu-240	1,162.5 grams Pu-240 per assembly
BOL Pu-241	115.4 grams Pu-241 per assembly
BOL Pu-242	18.5 grams Pu-242 per assembly
BOL Am-241	18.5 grams Am-241 per assembly
BOL Total Pu/Am per Assembly	9,697.8 grams Pu/Am per assembly
BOL U Enrichment	0.2% U-235
BOL Pu Enrichment:	86.4% Pu-239

DECAY TIMES (years out of core)

(Activities* in Ci/assembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
AC227	8.726E-10	2.297E-09	4.321E-09	6.883E-09	9.928E-09	1.729E-08	3.098E-08	4.729E-08	6.579E-08	9.343E-08
AG110	1.505E-01	9.491E-04	5.988E-06	3.778E-08	2.383E-10	9.486E-15	2.382E-21	5.982E-28	1.502E-34	2.379E-43
AG110M	1.131E+01	7.136E-02	4.502E-04	2.840E-06	1.792E-08	7.132E-13	1.791E-19	4.497E-26	1.129E-32	1.789E-41
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM241	**2.150E+02**	**3.190E+02**	*3.905E+02*	**4.620E+02**	*4.880E+02*	*5.400E+02*	**6.180E+02**	*6.186E+02*	*6.192E+02*	**6.200E+02**
AM242	**1.100E+01**	**1.070E+01**	*1.050E+01*	**1.030E+01**	*1.007E+01*	*9.620E+00*	**8.940E+00**	*8.394E+00*	*7.848E+00*	**7.120E+00**
AM242M	**1.100E+01**	**1.080E+01**	*1.055E+01*	**1.030E+01**	*1.008E+01*	*9.645E+00*	**8.990E+00**	*8.441E+00*	*7.892E+00*	**7.160E+00**
AM243	5.397E-01	5.394E-01	5.392E-01	5.389E-01	5.387E-01	5.382E-01	5.374E-01	5.366E-01	5.359E-01	5.349E-01
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	**1.250E+04**	**1.120E+04**	*1.003E+04*	**8.850E+03**	*8.113E+03*	*6.638E+03*	**4.425E+03**	*3.516E+03*	*2.606E+03*	**1.394E+03**
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BE10	1.382E-06	1.382E-06	1.382E-06	1.382E-06	1.382E-06	1.382E-06	1.382E-06	1.382E-06	1.382E-06	1.382E-06
BI211	8.729E-10	2.298E-09	4.326E-09	6.892E-09	9.941E-09	1.730E-08	3.101E-08	4.734E-08	6.586E-08	9.351E-08
BI212	4.124E-03	6.614E-03	7.349E-03	7.354E-03	7.119E-03	6.504E-03	5.632E-03	4.875E-03	4.220E-03	3.484E-03
C14	**1.310E-01**	**1.310E-01**	*1.310E-01*	**1.310E-01**	*1.308E-01*	*1.305E-01*	**1.300E-01**	*1.300E-01*	*1.300E-01*	**1.300E-01**

DECAY TIMES (years out of core)

(Activities* in Ci/assembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	1.378E+01	1.087E+01	8.569E+00	6.757E+00	5.328E+00	3.313E+00	1.625E+00	7.966E-01	3.906E-01	1.510E-01
CD115M	2.210E-10	1.039E-22	4.884E-35	2.296E-47	1.080E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	2.920E-12	3.596E-29	4.429E-46	5.455E-63	6.718E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	3.496E-06	3.496E-06	3.496E-06	3.496E-06	3.496E-06	3.496E-06	3.496E-06	3.496E-06	3.496E-06	3.496E-06
CE144	**1.510E+03**	**1.760E+01**	*8.801E+00*	**2.380E-03**	*1.983E-03*	*1.190E-03*	**5.930E-15**	*4.151E-15*	*2.372E-15*	**2.710E-34**
CL36	1.716E-06	1.716E-06	1.716E-06	1.716E-06	1.716E-06	1.716E-06	1.716E-06	1.716E-06	1.716E-06	1.716E-06
CM242	**1.160E+01**	**8.880E+00**	*8.680E+00*	**8.480E+00**	*8.300E+00*	*7.940E+00*	**7.400E+00**	*6.947E+00*	*6.494E+00*	**5.890E+00**
CM243	4.224E+00	3.741E+00	3.312E+00	2.933E+00	2.597E+00	2.036E+00	1.414E+00	9.818E-01	6.817E-01	4.191E-01
CM244	**2.160E+01**	**1.780E+01**	*1.500E+01*	**1.220E+01**	*1.081E+01*	*8.030E+00*	**3.860E+00**	*2.873E+00*	*1.885E+00*	**5.690E-01**
CM245	8.881E-03	8.877E-03	8.873E-03	8.870E-03	8.866E-03	8.859E-03	8.848E-03	8.837E-03	8.826E-03	8.812E-03
CM246	4.769E-04	4.765E-04	4.762E-04	4.758E-04	4.755E-04	4.748E-04	4.737E-04	4.727E-04	4.717E-04	4.703E-04
CM247	3.033E-09	3.033E-09	3.033E-09	3.033E-09	3.033E-09	3.033E-09	3.033E-09	3.033E-09	3.033E-09	3.033E-09
CO60	**2.430E+02**	**1.260E+02**	*7.985E+01*	**3.370E+01**	*2.819E+01*	*1.718E+01*	**6.520E-01**	*4.567E-01*	*2.613E-01*	**9.080E-04**
CR51	5.593E-17	8.069E-37	1.164E-56	1.679E-76	2.423E-96	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	**2.410E+03**	**4.490E+02**	*2.323E+02*	**1.560E+01**	*1.300E+01*	*7.800E+00*	**6.490E-04**	*4.543E-04*	*2.596E-04*	**3.260E-11**
CS135	2.390E-01	2.390E-01	2.390E-01	2.390E-01	2.390E-01	2.390E-01	2.390E-01	2.390E-01	2.390E-01	2.390E-01
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	**1.320E+04**	**1.180E+04**	*1.058E+04*	**9.360E+03**	*8.580E+03*	*7.019E+03*	**4.678E+03**	*3.717E+03*	*2.755E+03*	**1.473E+03**
EU152	5.655E+00	4.383E+00	3.397E+00	2.633E+00	2.040E+00	1.226E+00	5.707E-01	2.657E-01	1.237E-01	4.463E-02
EU154	**4.980E+02**	**3.330E+02**	*2.410E+02*	**1.490E+02**	*1.264E+02*	*8.110E+01*	**1.320E+01**	*9.311E+00*	*5.421E+00*	**2.350E-01**
EU155	**1.110E+03**	**5.500E+02**	*3.430E+02*	**1.360E+02**	*1.137E+02*	*6.903E+01*	**2.053E+00**	*1.438E+00*	*8.223E-01*	**1.890E-03**
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE55	**2.080E+02**	**5.480E+01**	*2.931E+01*	**3.810E+00**	*3.175E+00*	*1.906E+00*	**1.280E-03**	*8.960E-04*	*5.120E-04*	**2.080E-09**
FE59	7.510E-11	4.559E-23	2.767E-35	1.680E-47	1.020E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FR223	1.204E-11	3.169E-11	5.964E-11	9.499E-11	1.370E-10	2.385E-10	4.275E-10	6.526E-10	9.079E-10	1.289E-09
GD153	1.082E-01	5.791E-04	3.098E-06	1.658E-08	8.870E-11	2.539E-15	3.890E-22	5.959E-29	9.129E-36	7.483E-45
H3	**7.550E+01**	**5.700E+01**	*4.475E+01*	**3.250E+01**	*2.809E+01*	*1.927E+01*	**6.040E+00**	*4.338E+00*	*2.635E+00*	**3.650E-01**
I129	**6.460E-03**	**6.460E-03**	*6.460E-03*	**6.460E-03**	*6.460E-03*	*6.460E-03*	**6.460E-03**	*6.460E-03*	*6.460E-03*	**6.460E-03**
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	5.629E-12	4.440E-23	3.502E-34	2.762E-45	2.178E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	5.882E-12	4.639E-23	3.659E-34	2.886E-45	2.276E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	1.553E-14	7.301E-27	3.433E-39	1.614E-51	7.587E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR85	**6.450E+02**	**4.670E+02**	*3.555E+02*	**2.440E+02**	*2.092E+02*	*1.396E+02*	**3.510E+01**	*2.499E+01*	*1.487E+01*	**1.390E+00**

DECAY TIMES (years out of core)

(Activities* in Ci/assembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
MN54	**1.690E+02**	**2.930E+00**	*1.465E+00*	**8.890E-04**	*7.408E-04*	*4.445E-04*	**2.480E-14**	*1.736E-14*	*9.920E-15*	**6.330E-32**
MO93	2.980E-02	2.977E-02	2.974E-02	2.971E-02	2.968E-02	2.962E-02	2.953E-02	2.945E-02	2.936E-02	2.924E-02
NB93M	5.116E-02	8.077E-02	1.037E-01	1.215E-01	1.353E-01	1.543E-01	1.695E-01	1.766E-01	1.799E-01	1.817E-01
NB94	1.384E-01	1.384E-01	1.384E-01	1.384E-01	1.383E-01	1.383E-01	1.382E-01	1.381E-01	1.381E-01	1.380E-01
NB95	1.176E-03	3.005E-12	7.682E-21	1.964E-29	5.019E-38	3.279E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB95M	3.929E-06	1.004E-14	2.567E-23	6.561E-32	1.677E-40	1.096E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND144	1.410E-10	1.416E-10	1.416E-10	1.416E-10	1.416E-10	1.416E-10	1.416E-10	1.416E-10	1.416E-10	1.416E-10
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI59	1.115E+00	1.115E+00	1.115E+00	1.115E+00	1.115E+00	1.115E+00	1.114E+00	1.114E+00	1.114E+00	1.114E+00
NI63	**2.090E+01**	**2.010E+01**	*1.940E+01*	**1.870E+01**	*1.807E+01*	*1.680E+01*	**1.490E+01**	*1.349E+01*	*1.208E+01*	**1.020E+01**
NP237	**1.160E-02**	**1.210E-02**	*1.270E-02*	**1.330E-02**	*1.422E-02*	*1.605E-02*	**1.880E-02**	*2.186E-02*	*2.492E-02*	**2.900E-02**
PA231	7.779E-09	1.320E-08	1.879E-08	2.454E-08	3.047E-08	4.281E-08	6.258E-08	8.385E-08	1.066E-07	1.393E-07
PA233	9.701E-03	1.012E-02	1.068E-02	1.136E-02	1.212E-02	1.384E-02	1.668E-02	1.965E-02	2.266E-02	2.662E-02
PA234	9.062E-06	9.062E-06	9.062E-06	9.062E-06	9.062E-06	9.062E-06	9.062E-06	9.062E-06	9.062E-06	9.062E-06
PA234M	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03
PB210	1.110E-09	9.814E-10	9.566E-10	1.111E-09	1.540E-09	3.685E-09	1.213E-08	3.041E-08	6.267E-08	1.345E-07
PB211	8.729E-10	2.298E-09	4.326E-09	6.892E-09	9.941E-09	1.730E-08	3.101E-08	4.734E-08	6.586E-08	9.351E-08
PB212	4.124E-03	6.614E-03	7.349E-03	7.354E-03	7.119E-03	6.504E-03	5.632E-03	4.875E-03	4.220E-03	3.484E-03
PD107	3.263E-02	3.263E-02	3.263E-02	3.263E-02	3.263E-02	3.263E-02	3.263E-02	3.263E-02	3.263E-02	3.263E-02
PM145	2.559E-06	2.134E-06	1.755E-06	1.443E-06	1.186E-06	8.020E-07	4.458E-07	2.477E-07	1.377E-07	6.292E-08
PM147	**8.270E+03**	**2.210E+03**	*1.184E+03*	**1.570E+02**	*1.308E+02*	*7.853E+01*	**5.670E-02**	*3.969E-02*	*2.268E-02*	**1.040E-07**
PM148	7.326E-11	3.568E-24	1.737E-37	8.461E-51	4.121E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148M	1.301E-09	6.334E-23	3.085E-36	1.502E-49	7.316E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PO212	2.642E-03	4.238E-03	4.708E-03	4.712E-03	4.561E-03	4.167E-03	3.609E-03	3.123E-03	2.704E-03	2.232E-03
PO215	8.729E-10	2.298E-09	4.326E-09	6.892E-09	9.941E-09	1.730E-08	3.101E-08	4.734E-08	6.586E-08	9.351E-08
PO216	4.124E-03	6.614E-03	7.349E-03	7.354E-03	7.119E-03	6.504E-03	5.632E-03	4.875E-03	4.220E-03	3.484E-03
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	**1.510E+03**	**1.760E+01**	*8.801E+00*	**2.380E-03**	*1.983E-03*	*1.190E-03*	**5.930E-15**	*4.151E-15*	*2.372E-15*	**2.710E-34**
PR144M	**1.810E+01**	**2.110E-01**	*1.055E-01*	**2.860E-05**	*2.383E-05*	*1.430E-05*	**7.110E-17**	*4.977E-17*	*2.844E-17*	**3.250E-36**
PU236	5.526E-02	1.639E-02	4.859E-03	1.441E-03	4.276E-04	3.794E-05	1.358E-06	4.038E-07	3.789E-07	3.782E-07
PU237	2.949E-12	2.592E-24	2.278E-36	2.002E-48	1.760E-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	**1.550E+02**	**1.490E+02**	*1.435E+02*	**1.380E+02**	*1.169E+02*	*7.455E+01*	**1.110E+01**	*3.081E+01*	*5.052E+01*	**7.680E+01**
PU239	**3.430E+02**	**3.430E+02**	*3.430E+02*	**3.430E+02**	*3.430E+02*	*3.430E+02*	**3.430E+02**	*3.427E+02*	*3.424E+02*	**3.420E+02**
PU240	**3.690E+02**	**3.690E+02**	*3.690E+02*	**3.690E+02**	*3.688E+02*	*3.685E+02*	**3.680E+02**	*3.674E+02*	*3.668E+02*	**3.660E+02**

DECAY TIMES (years out of core)

(Activities* in Ci/assembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
PU242	**1.260E-01**	**1.260E-01**	*1.260E-01*	**1.260E-01**	*1.262E-01*	*1.265E-01*	**1.270E-01**	*1.270E-01*	*1.270E-01*	**1.270E-01**
PU244	5.621E-09	5.621E-09	5.621E-09	5.621E-09	5.621E-09	5.621E-09	5.621E-09	5.621E-09	5.621E-09	5.621E-09
RA223	8.729E-10	2.298E-09	4.326E-09	6.892E-09	9.941E-09	1.730E-08	3.101E-08	4.734E-08	6.586E-08	9.351E-08
RA224	4.124E-03	6.614E-03	7.349E-03	7.354E-03	7.119E-03	6.504E-03	5.632E-03	4.875E-03	4.220E-03	3.484E-03
RA226	6.989E-11	4.202E-10	1.283E-09	2.880E-09	5.427E-09	1.418E-08	3.935E-08	8.319E-08	1.500E-07	2.812E-07
RA228	3.162E-14	9.100E-14	1.736E-13	2.754E-13	3.941E-13	6.770E-13	1.207E-12	1.858E-12	2.630E-12	3.845E-12
RB87	1.853E-06	1.853E-06	1.853E-06	1.853E-06	1.853E-06	1.853E-06	1.853E-06	1.853E-06	1.853E-06	1.853E-06
RH103M	2.761E-09	2.793E-23	2.826E-37	2.859E-51	2.892E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	**4.550E+03**	**1.460E+02**	*7.308E+01*	**1.510E-01**	*1.258E-01*	*7.550E-02*	**1.660E-10**	*1.162E-10*	*6.640E-11*	**1.940E-25**
RN219	8.729E-10	2.298E-09	4.326E-09	6.892E-09	9.941E-09	1.730E-08	3.101E-08	4.734E-08	6.586E-08	9.351E-08
RN220	4.124E-03	6.614E-03	7.349E-03	7.354E-03	7.119E-03	6.504E-03	5.632E-03	4.875E-03	4.220E-03	3.484E-03
RU103	3.063E-09	3.098E-23	3.134E-37	3.171E-51	3.208E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	**4.550E+03**	**1.460E+02**	*7.308E+01*	**1.510E-01**	*1.258E-01*	*7.550E-02*	**1.660E-10**	*1.162E-10*	*6.640E-11*	**1.940E-25**
SB124	3.254E-07	2.398E-16	1.767E-25	1.302E-34	9.590E-44	5.206E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	**1.160E+03**	**3.310E+02**	*1.791E+02*	**2.710E+01**	*2.259E+01*	*1.356E+01*	**1.490E-02**	*1.043E-02*	*5.960E-03*	**5.470E-08**
SB126	3.081E-02	3.081E-02	3.081E-02	3.081E-02	3.081E-02	3.080E-02	3.080E-02	3.080E-02	3.079E-02	3.079E-02
SB126M	2.201E-01	2.201E-01	2.201E-01	2.201E-01	2.200E-01	2.200E-01	2.200E-01	2.200E-01	2.200E-01	2.199E-01
SE79	**5.080E-02**	**5.080E-02**	*5.080E-02*	**5.080E-02**	*5.078E-02*	*5.075E-02*	**5.070E-02**	*5.070E-02*	*5.070E-02*	**5.070E-02**
SM145	6.827E-07	1.650E-08	3.989E-10	9.641E-12	2.330E-13	1.361E-16	1.923E-21	2.715E-26	3.834E-31	1.309E-37
SM147	8.211E-07	9.674E-07	1.006E-06	1.017E-06	1.020E-06	1.021E-06	1.021E-06	1.021E-06	1.021E-06	1.021E-06
SM151	**5.060E+02**	**4.870E+02**	*4.690E+02*	**4.510E+02**	*4.355E+02*	*4.045E+02*	**3.580E+02**	*3.238E+02*	*2.896E+02*	**2.440E+02**
SN119M	3.524E-01	2.011E-03	1.147E-05	6.545E-08	3.734E-10	1.216E-14	2.258E-21	4.195E-28	7.791E-35	8.258E-44
SN121M	1.625E-01	1.516E-01	1.415E-01	1.320E-01	1.231E-01	1.072E-01	8.706E-02	7.071E-02	5.743E-02	4.351E-02
SN123	5.659E-02	3.138E-06	1.740E-10	9.644E-15	5.347E-19	1.643E-27	2.800E-40	4.772E-53	8.131E-66	7.681E-83
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	2.201E-01	2.201E-01	2.201E-01	2.201E-01	2.200E-01	2.200E-01	2.200E-01	2.200E-01	2.200E-01	2.199E-01
SR89	1.068E-06	1.386E-17	1.799E-28	2.335E-39	3.031E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR90	**4.820E+03**	**4.280E+03**	*3.825E+03*	**3.370E+03**	*3.083E+03*	*2.510E+03*	**1.650E+03**	*1.306E+03*	*9.618E+02*	**5.030E+02**
TB160	1.971E-05	4.914E-13	1.225E-20	3.051E-28	7.602E-36	4.721E-51	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC99	1.975E+00	1.975E+00	1.975E+00	1.975E+00	1.975E+00	1.975E+00	1.975E+00	1.975E+00	1.974E+00	1.974E+00
TE123M	1.210E-04	3.083E-09	7.856E-14	2.003E-18	5.103E-23	3.314E-32	5.486E-46	9.082E-60	1.504E-73	6.342E-92
TE125M	**2.820E+02**	**8.070E+01**	*4.366E+01*	**6.610E+00**	*5.509E+00*	*3.307E+00*	**3.630E-03**	*2.541E-03*	*1.452E-03*	**1.340E-08**
TE127	3.032E-02	2.743E-07	2.482E-12	2.246E-17	2.032E-22	1.664E-32	1.233E-47	9.134E-63	6.767E-78	4.537E-98
TE127M	3.095E-02	2.801E-07	2.534E-12	2.293E-17	2.075E-22	1.699E-32	1.259E-47	9.325E-63	6.909E-78	4.632E-98

DECAY TIMES (years out of core)
(Activities* in Ci/assembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TE129M	3.892E-13	1.691E-29	7.349E-46	3.193E-62	1.387E-78	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TH227	8.608E-10	2.267E-09	4.266E-09	6.797E-09	9.804E-09	1.706E-08	3.058E-08	4.668E-08	6.495E-08	9.223E-08
TH228	4.124E-03	6.611E-03	7.343E-03	7.348E-03	7.113E-03	6.503E-03	5.632E-03	4.875E-03	4.220E-03	3.484E-03
TH229	7.254E-09	7.479E-09	7.808E-09	8.247E-09	8.804E-09	1.030E-08	1.364E-08	1.852E-08	2.522E-08	3.746E-08
TH230	7.875E-08	2.630E-07	5.523E-07	9.432E-07	1.432E-06	2.690E-06	5.232E-06	8.490E-06	1.239E-05	1.849E-05
TH231	5.042E-05	5.201E-05	5.360E-05	5.519E-05	5.678E-05	5.995E-05	6.471E-05	6.947E-05	7.423E-05	8.057E-05
TH232	1.203E-13	2.298E-13	3.528E-13	4.891E-13	6.388E-13	9.783E-13	1.588E-12	2.317E-12	3.166E-12	4.484E-12
TH234	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03	6.971E-03
TL206	5.435E-16	5.435E-16	5.435E-16	5.435E-16	5.435E-16	5.435E-16	5.435E-16	5.435E-16	5.435E-16	5.435E-16
TL207	8.704E-10	2.292E-09	4.314E-09	6.873E-09	9.914E-09	1.725E-08	3.092E-08	4.720E-08	6.568E-08	9.325E-08
TL208	1.482E-03	2.376E-03	2.640E-03	2.642E-03	2.558E-03	2.337E-03	2.024E-03	1.752E-03	1.516E-03	1.252E-03
U232	6.177E-03	7.383E-03	7.479E-03	7.259E-03	6.957E-03	6.333E-03	5.483E-03	4.745E-03	4.107E-03	3.388E-03
U233	3.736E-07	5.899E-07	8.169E-07	1.058E-06	1.314E-06	1.880E-06	2.879E-06	4.070E-06	5.456E-06	7.610E-06
U234	2.898E-03	5.275E-03	7.570E-03	9.786E-03	1.193E-02	1.599E-02	2.157E-02	2.661E-02	3.115E-02	3.652E-02
U235	**5.270E-05**	**5.440E-05**	*5.615E-05*	**5.790E-05**	*5.958E-05*	*6.295E-05*	**6.800E-05**	*7.307E-05*	*7.814E-05*	**8.490E-05**
U236	4.170E-04	4.713E-04	5.255E-04	5.798E-04	6.340E-04	7.423E-04	9.045E-04	1.066E-03	1.228E-03	1.443E-03
U237	3.612E-03	2.839E-03	2.232E-03	1.754E-03	1.379E-03	8.522E-04	4.139E-04	2.011E-04	9.767E-05	3.729E-05
U238	**6.890E-03**	**6.890E-03**	*6.890E-03*	**6.890E-03**	*6.890E-03*	*6.890E-03*	**6.890E-03**	*6.890E-03*	*6.890E-03*	**6.890E-03**
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y90	**4.820E+03**	**4.280E+03**	*3.825E+03*	**3.370E+03**	*3.083E+03*	*2.510E+03*	**1.650E+03**	*1.306E+03*	*9.618E+02*	**5.030E+02**
Y91	4.549E-05	1.826E-14	7.329E-24	2.942E-33	1.181E-42	1.903E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN65	1.011E-02	5.627E-05	3.132E-07	1.744E-09	9.709E-12	3.010E-16	5.194E-23	8.963E-30	1.547E-36	1.486E-45
ZR93	1.924E-01	1.924E-01	1.924E-01	1.924E-01	1.924E-01	1.924E-01	1.924E-01	1.924E-01	1.924E-01	1.924E-01
ZR95	5.296E-04	1.354E-12	3.460E-21	8.844E-30	2.261E-38	1.477E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
Bold text denotes data supplied by Hanford.
Italicized text denotes data interpolated from the Hanford data.

Template 5

Fuel-Specific Source Term Calculations FERMI Subassembly Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term template for a single FERMI spent nuclear fuel subassembly. This single subassembly source term uses a core average burnup based on the 101 driver subassemblies from Core A-2. The data sources for the analysis are documented herein, and the INEEL calculational methodology is described in Reference 1.

FERMI Reactor History

Over the lifetime of the FERMI liquid metal fast breeder reactor (LMFBR), two separate cores were operated. These two cores are designated as Cores A-1 and A-2. Both cores contained fuel subassemblies of similar design and uranium loading, but each core had a slightly different number of total driver subassemblies. Core A-1 operated from August 23, 1963, to October 6, 1966, and accumulated a total core burnup of approximately 636.7 MWD. Core A-2 operated from September 23, 1970, to December 2, 1971, and accumulated a total core burnup of approximately 5,926.0 MWD, or more than nine times that of Core A-1.

From the INEEL inventory record data (Reference 2), there are 104 driver fuel subassemblies of low burnup and 101 subassemblies with a relatively higher burnup currently stored at the INEEL. These data suggest that the 104 subassemblies are from Core A-1 and the 101 higher burnup subassemblies are from Core A-2.

FERMI Reactor Data

The FERMI reactor core and fuel elements are described in some detail in Reference 3. Data from this reference has been used to develop reactor physics models needed to develop neutron cross sections for the fuel depletion and radionuclide inventory analysis.

The FERMI subassemblies consist of a stainless steel can containing a 12-×-12 array of rods. The 2.646 × 2.454 × 34.594-in. steel can has a 0.096-in. thick wall. Inside the can, the 12-×-12 array consists of 140 fuel pins and 4 corner pins (stainless steel). The fuel pin meat is a uranium-molybdenum (U-Mo) metal rod with 10 wt% molybdenum metal. The fuel pin clad is zircaloy and is bonded to the fuel meat. The fuel meat and pin diameters are 0.148 in. and 0.158 in., respectively. The uranium metal is medium enriched at 25.6 wt% U-235 at beginning-of-life (BOL). The pin pitch within the subassembly is 0.2 in., and the subassembly pitch in the core is approximately 2.693 in.

The following data provide specific fuel element dimensions, materials, densities, enrichment, etc., which are typical for a FERMI driver subassembly. The BOL data below were used in the fuel depletion calculation for the FERMI subassembly source term generation.

Fuel subassembly:	12-×-12 array of fuel pins in stainless steel can
No. of Rods:	140 fuel rods, 4 stainless steel corner pins
Fuel Rod Meat:	Uranium/molybdenum metal alloy
Fuel Meat Density:	17.32 g/cc (10 wt% Mo)
Fuel Rod Meat Diameter:	0.148 in.
Fuel Rod Meat Length:	30.5 in.
Uranium Enrichment:	25.6 wt % U-235
Heavy Metal Loading per rod:	34.33 g/rod U-235/rod (BOL)
	99.77 g/rod U-238/rod (BOL)
	134.10 g/rod TOTAL U

Heavy Metal Loading per subassembly:

4,806.144	g/rod U-235/subassembly (BOL)
13,967.856	g/rod U-238/subassembly (BOL)
18,774.000	g/subassembly TOTAL U

Molybdenum Metal Loading:	14.90 g/rod Mo (BOL)
Molybdenum Metal Loading:	2,086.00 g/subassembly Mo (BOL)
Clad:	Zircaloy
Clad Outer Diameter:	0.158 in.
Clad Pin Length:	32.06 in.
Clad Density:	6.44 g/cc
Clad Thickness:	0.005 in.
Total Zircaloy Mass:	1,138.48 g/subassembly
Can Dimensions:	2.646 × 2.454 × 34.594 in.
	0.96-in. wall thickness
Can Material:	Stainless Steel 304
Steel Density:	7.92 g/cc
Can Steel Mass:	4,382.89 g/subassembly
Steel Corner Pins (4) Mass:	325.35 g/subassembly
Total Steel Mass:	4,708.24 g/subassembly
Coolant:	Liquid metal sodium
Coolant Temperature:	800°F
Coolant Density:	0.85 g/cc

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for the material components in a single FERMI subassembly. In addition, for the ORIGEN2 (Reference 4) depletion calculation, conservative and detailed impurity concentrations were added for the zircaloy clad (References 6 and 7) and the stainless steel 304 can/corner pins (References 8, 9, and 10). Table 1 lists the impurities and corresponding concentrations used in the calculations.

Burnup

The core burnup sustained by the Core A-2 subassemblies was chosen for this template. The Core A-2 burnup was substantially higher than Core A-1. The Core A-2 subassemblies accumulated a total core burnup of approximately 5,926.0 MWD or an average subassembly burnup of approximately 58.67 MWD per subassembly for the 101 subassemblies in this core. This subassembly average burnup translates into a 1.4% U-235 depletion, or a 3,125.1 MWD/MTU per subassembly. This burnup is conservative with respect to the buildup of fission products, activation products, and minor actinides in the source term, but nonconservative with regard to criticality safety, in particular U-235 and U-238 end-of-life concentrations.

The Core A-2 power history profile is based on Reference 5. Table 2 gives the accumulated days over which Core A-2 operated along with the corresponding accumulated burnup in megawatt-days and the reactor thermal power in megawatts (MW_{th}) for the 101 core subassemblies. In Table 2 that there are many time periods in which the reactor power is zero; these represent reactor shutdowns. Also, the single, average-burnup FERMI subassembly burnup is based on 1/101 of the total reactor power and forms the basis the FERMI template.

Cross-Section Development

The neutron cross sections used in the burnup or depletion calculation for the source term generation of a single average-burnup FERMI subassembly are based on the methodology described in Reference 3. Cross sections from a standard ORIGEN2 LMFBR library were updated once using BOL cross sections specifically developed to account for the unique FERMI neutron flux spatial and spectral characteristics to ensure accurate calculation of the fission product and actinide production as a function of burnup.

In order to calculate the BOL FERMI neutron cross sections, an explicit FERMI 1/8-core model was developed with reflective boundary conditions on the radial surfaces. The reflective surfaces created the transport effect of a full core. Figures 1 and 2 show cross sectional views of the MCNP computer model (Reference 11).

FERMI Subassembly Exposure History

Table 2 summarizes the FERMI total core power or exposure history. In the actual depletion calculation for the single, average-burnup FERMI subassembly, 1/101st of the total core power was used as the subassembly power output in the burnup or source term calculations. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years.

Burnup Calculation

The ORIGEN2 computer code was used to perform the depletion or burnup calculation for a single FERMI subassembly. The fuel subassembly masses and impurities, neutron cross sections, burnup, power history, and power level as discussed above are input data for the ORIGEN2 calculation. The ORIGEN2 output or radionuclide concentrations are given as a function of time in the attached template table representing a single average-burnup FERMI subassembly.

The 145 radionuclides listed in the template represent greater than 99.99% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

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Table 1. Zircaloy and stainless steel 304 material constituent and impurity concentrations.

Constituent or Impurity	Zircaloy Concentration (wt%)	Stainless Steel Concentration (ppm)
H	0.002497	
Li		0.13
Be		
B	0.00005	
C	0.026968	0.08 wt%
N	0.00799	525
O	0.094887	
Na		37
Mg		
Al	0.007491	200
Si	0.011986	1.00 wt%
P	0.009988	
S	0.003496	
Cl		130
K		3
Ca		19
Sc		0.03
Ti	0.004994	600
V	0.004994	690
Cr	0.124851	18.40 wt%
Mn	0.004994	1.53 wt%
Fe	0.224731	68.99 wt%
Co	0.001998	2570
Ni	0.006992	10.00 wt%
Cu	0.004994	8150
Zn	0.009988	2230
Ga		450
As		1010
Se		70
Br		8
Rb		10
Sr		0.2
Y		5
Zr	97.789992	20
Nb	0.006992	300
Mo	0.004994	5500

Table 1. (continued).

Constituent or Impurity	Zircaloy Concentration (wt%)	Stainless Steel Concentration (ppm)
Ag		2
Cd	0.000050	
In		
Sn	1.598089	
Sb		17
Cs		0.3
Ba		500
La		2.1
Ce		550
Pr		
Nd		
Sm	0.000999	0.15
Eu		0.02
Gd	0.000499	
Tb		0.71
Dy		1
Ho		1
Er		
Tm		
Yb		2
Lu		0.8
Hf	0.003496	2
Ta	0.019976	
W	0.009988	520
Tl		
Pb	0.009988	139
Bi		
Th	0.000699	1
U	0.000350	2

Table 2. FERMI Core A.2 power history.

Cumulative Operational (days)	Cumulative Burnup (MWD)	Total Core Power (MW_{th})
1	1.3	1.30
2	11.1	9.80
4	37.1	13.00
5	37.1	0.00
6	61.7	24.60
7	68.8	7.10
8	68.8	0.00
10	137.6	34.40
16	137.6	0.00
18	289.6	76.00
19	289.6	0.00
20	336.0	46.40
22	382.8	23.40
23	382.8	0.00
27	974.1	147.83
52	974.1	0.00
59	2157.7	169.09
61	2170.9	6.60
62	2238.9	68.00
65	2238.9	0.00
67	2346.3	53.70
73	2346.3	0.00
74	2346.7	0.40
77	2495.2	49.50
103	2495.2	0.00
107	2863.6	92.10
110	2863.6	0.00
111	2864.1	0.50
112	2869.0	4.90
113	2922.8	53.80
132	2922.8	0.00
133	2925.3	2.50
135	3061.2	67.95
139	3061.2	0.00
140	3067.8	6.60
211	3067.8	0.00
213	3223.2	77.70
247	3223.2	0.00
248	3242.1	18.90
254	3242.1	0.00
258	3806.2	141.03
261	3806.2	0.00
263	3971.1	82.45
275	3971.1	0.00
279	4363.3	98.05
423	4363.3	0.00
426	4675.0	103.90
427	4675.0	0.00
435	5926.0	156.38
2261.25	5926.0	0.00
4087.5	5926.0	0.00
5913.75	5926.0	0.00
7740	5926.0	0.00
9566.25	5926.0	0.00
13218.75	5926.0	0.00
18697.5	5926.0	0.00
24176.25	5926.0	0.00
29655	5926.0	0.00
36960	5926.0	0.00

The ten dates with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling times designated for the template methodology.

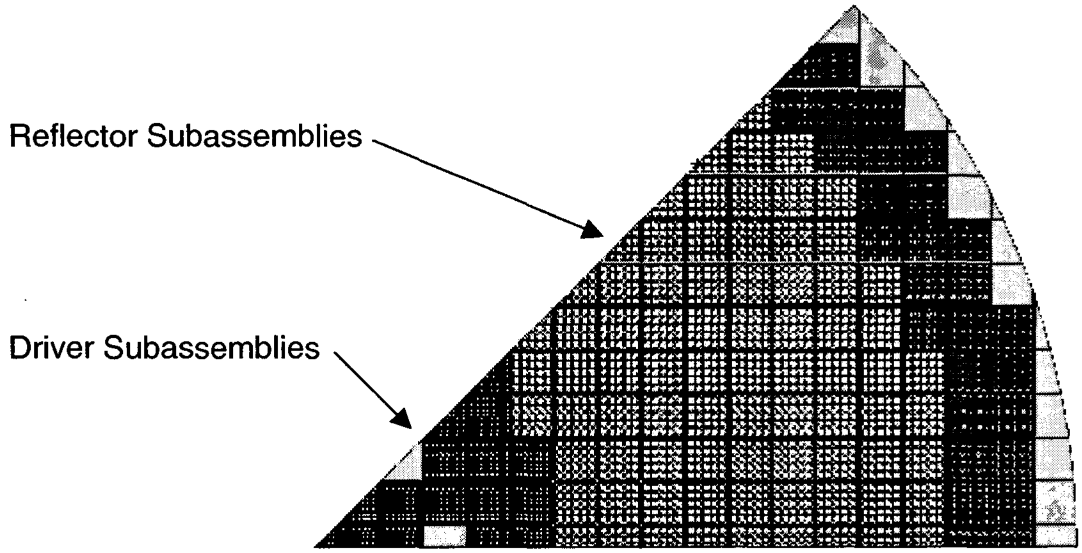

Figure 1. MCNP 1/8-core model cross-sectional view of the FERMI core.

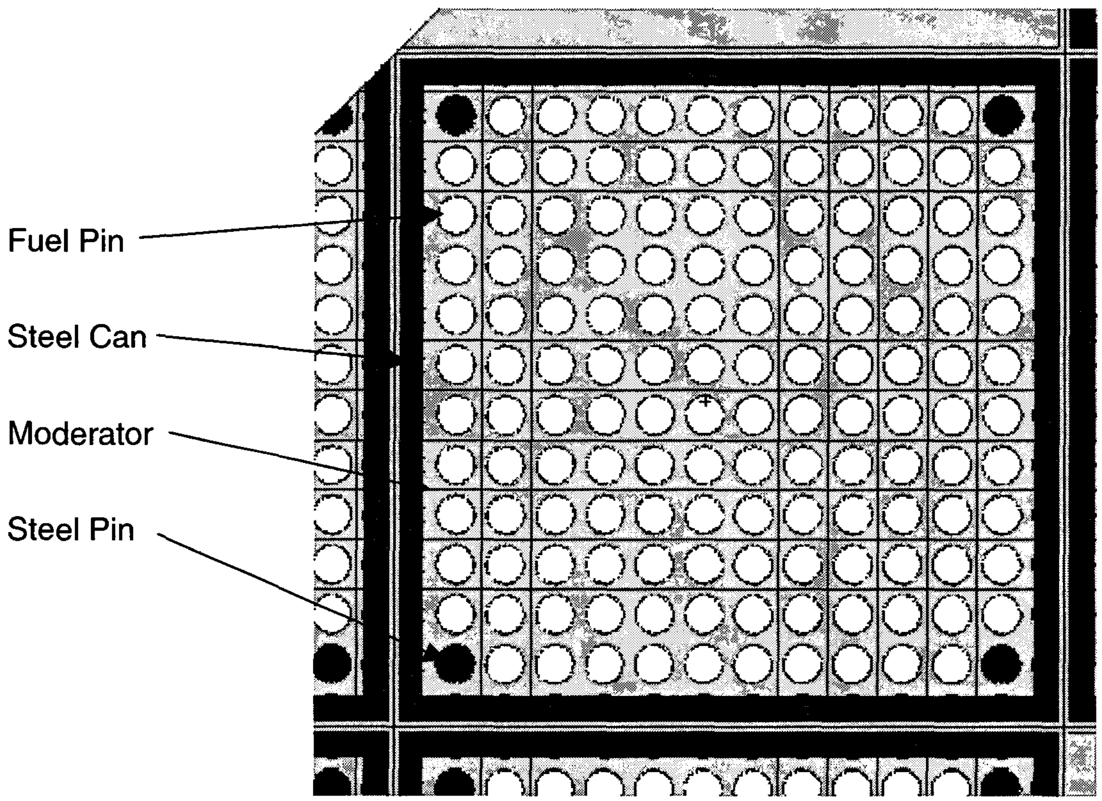

Figure 2. MCNP model cross-sectional view of a FERMI driver fuel assembly.

FERMI Subassembly Fuel

Zircaloy Cladding, 10 to 40%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Liquid metal sodium
Fuel Meat:	Uranium/molybdenum metal alloy
Clad:	Zircaloy
Burnup:	3,125.2 MWD/MTU
Burnup:	58.67 MWD/subassembly (average burnup)
Burnup:	1.4% U-235 depletion (fissioned and transmuted)
Basis of Calculation:	Single subassembly
Subassemblies	101 subassemblies in core
BOL U-235:	4,806.144 g U-235 per subassembly
BOL U-238:	13,967.856 g U-238 per subassembly
BOL Total U per element:	18,774.000 g U per subassembly
BOL Fuel Enrichment:	25.6 wt% U-235

DECAY TIMES (years out of core)

(Activities* in Ci/subassembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H 3	1.118E+00	8.444E-01	6.378E-01	4.817E-01	3.639E-01	2.076E-01	8.943E-02	3.853E-02	1.660E-02	5.403E-03
BE 10	7.874E-09	7.873E-09	7.873E-09	7.873E-09	7.873E-09	7.873E-09	7.873E-09	7.873E-09	7.873E-09	7.873E-09
C 14	1.279E-03	1.278E-03	1.277E-03	1.276E-03	1.276E-03	1.274E-03	1.272E-03	1.269E-03	1.267E-03	1.264E-03
CL 36	3.238E-06	3.238E-06	3.238E-06	3.238E-06	3.238E-06	3.238E-06	3.238E-06	3.238E-06	3.238E-06	3.237E-06
CR 51	1.282E-18	1.849E-38	2.668E-58	3.849E-78	5.554E-98	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	1.259E+00	2.191E-02	3.815E-04	6.642E-06	1.156E-07	3.505E-11	1.849E-16	9.757E-22	5.148E-27	4.729E-34
FE 55	2.474E+00	6.525E-01	1.721E-01	4.537E-02	1.196E-02	8.319E-04	1.525E-05	2.797E-07	5.128E-09	2.479E-11
FE 59	1.249E-12	7.580E-25	4.601E-37	2.793E-49	1.695E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	6.360E+00	3.295E+00	1.707E+00	8.842E-01	4.581E-01	1.229E-01	1.709E-02	2.377E-03	3.304E-04	2.380E-05
NI 59	3.985E-03	3.985E-03	3.985E-03	3.984E-03	3.984E-03	3.984E-03	3.983E-03	3.983E-03	3.982E-03	3.982E-03
NI 63	9.690E-02	9.332E-02	8.987E-02	8.655E-02	8.335E-02	7.730E-02	6.904E-02	6.166E-02	5.507E-02	4.737E-02
ZN 65	2.294E-03	1.277E-05	7.111E-08	3.959E-10	2.204E-12	6.832E-17	1.179E-23	2.035E-30	3.512E-37	3.374E-46
SE 79	9.677E-04	9.676E-04	9.676E-04	9.675E-04	9.675E-04	9.674E-04	9.672E-04	9.671E-04	9.669E-04	9.667E-04
KR 85	1.576E+01	1.140E+01	8.254E+00	5.974E+00	4.324E+00	2.265E+00	8.587E-01	3.256E-01	1.234E-01	3.387E-02
RB 87	4.841E-08	4.841E-08	4.841E-08	4.841E-08	4.841E-08	4.841E-08	4.841E-08	4.841E-08	4.841E-08	4.841E-08

DECAY TIMES (years out of core)
(Activities* in Ci/subassembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
SR 90	1.444E+02	1.282E+02	1.138E+02	1.010E+02	8.971E+01	7.071E+01	4.948E+01	3.462E+01	2.423E+01	1.505E+01
Y 90	1.444E+02	1.282E+02	1.138E+02	1.011E+02	8.973E+01	7.072E+01	4.949E+01	3.463E+01	2.423E+01	1.505E+01
Y 91	3.555E-06	1.427E-15	5.728E-25	2.299E-34	9.229E-44	1.487E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	3.859E-03	3.859E-03	3.859E-03	3.859E-03	3.859E-03	3.859E-03	3.859E-03	3.859E-03	3.859E-03	3.859E-03
ZR 95	2.492E-05	6.371E-14	1.628E-22	4.163E-31	1.064E-39	6.951E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M	9.163E-04	1.535E-03	2.015E-03	2.386E-03	2.674E-03	3.070E-03	3.389E-03	3.537E-03	3.607E-03	3.645E-03
NB 94	4.869E-04	4.868E-04	4.867E-04	4.866E-04	4.865E-04	4.864E-04	4.861E-04	4.859E-04	4.856E-04	4.853E-04
NB 95	5.533E-05	1.415E-13	3.615E-22	9.241E-31	2.362E-39	1.543E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M	1.849E-07	4.727E-16	1.208E-24	3.087E-33	7.893E-42	5.157E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	2.133E-03	2.130E-03	2.128E-03	2.126E-03	2.124E-03	2.120E-03	2.114E-03	2.107E-03	2.101E-03	2.093E-03
TC 99	2.631E-02	2.631E-02	2.631E-02	2.631E-02	2.631E-02	2.630E-02	2.630E-02	2.630E-02	2.630E-02	2.630E-02
RU103	7.758E-11	7.849E-25	7.940E-39	8.033E-53	8.126E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	1.653E+01	5.310E-01	1.706E-02	5.479E-04	1.760E-05	1.816E-08	6.017E-13	1.994E-17	6.610E-22	7.036E-28
RH103M	6.994E-11	7.075E-25	7.158E-39	7.241E-53	7.326E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	1.653E+01	5.310E-01	1.706E-02	5.479E-04	1.760E-05	1.816E-08	6.017E-13	1.994E-17	6.610E-22	7.036E-28
PD107	7.454E-05	7.454E-05	7.454E-05	7.454E-05	7.454E-05	7.454E-05	7.454E-05	7.454E-05	7.454E-05	7.454E-05
AG110	8.574E-06	5.409E-08	3.413E-10	2.153E-12	1.358E-14	5.406E-19	1.357E-25	3.410E-32	8.561E-39	1.356E-47
AG110M	6.447E-04	4.067E-06	2.566E-08	1.619E-10	1.021E-12	4.065E-17	1.021E-23	2.563E-30	6.437E-37	1.020E-45
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	9.607E-02	7.576E-02	5.974E-02	4.711E-02	3.715E-02	2.310E-02	1.133E-02	5.554E-03	2.723E-03	1.053E-03
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	9.489E-12	4.461E-24	2.097E-36	9.861E-49	4.636E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	3.257E-15	2.569E-26	2.025E-37	1.598E-48	1.260E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	3.402E-15	2.684E-26	2.117E-37	1.670E-48	1.317E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	6.669E-16	3.135E-28	1.474E-40	6.930E-53	3.258E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	1.230E-02	7.017E-05	4.004E-07	2.284E-09	1.303E-11	4.243E-16	7.881E-23	1.464E-29	2.719E-36	2.882E-45
SN121M	6.085E-04	5.678E-04	5.297E-04	4.942E-04	4.611E-04	4.014E-04	3.260E-04	2.648E-04	2.150E-04	1.629E-04
SN123	1.442E-03	7.994E-08	4.432E-12	2.457E-16	1.362E-20	4.186E-29	7.134E-42	1.216E-54	2.071E-67	1.957E-84
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	2.205E-03	2.204E-03	2.204E-03	2.204E-03	2.204E-03	2.204E-03	2.204E-03	2.204E-03	2.203E-03	2.203E-03

DECAY TIMES (years out of core)
(Activities* in Ci/subassembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
SB125	1.421E+01	4.065E+00	1.163E+00	3.329E-01	9.524E-02	7.799E-03	1.827E-04	4.282E-06	1.003E-07	6.726E-10
SB126	3.086E-04	3.086E-04	3.086E-04	3.086E-04	3.086E-04	3.086E-04	3.085E-04	3.085E-04	3.085E-04	3.084E-04
SB126M	2.205E-03	2.204E-03	2.204E-03	2.204E-03	2.204E-03	2.204E-03	2.204E-03	2.204E-03	2.203E-03	2.203E-03
TE123M	4.825E-09	1.230E-13	3.134E-18	7.987E-23	2.036E-27	1.322E-36	2.189E-50	3.623E-64	5.997E-78	2.530E-96
TE125M	3.466E+00	9.917E-01	2.838E-01	8.121E-02	2.324E-02	1.902E-03	4.459E-05	1.044E-06	2.448E-08	1.641E-10
TE127	6.284E-04	5.686E-09	5.145E-14	4.656E-19	4.213E-24	3.449E-34	2.556E-49	1.893E-64	1.403E-79	0.000E+00
TE127M	6.416E-04	5.805E-09	5.253E-14	4.753E-19	4.301E-24	3.522E-34	2.609E-49	1.933E-64	1.432E-79	0.000E+00
TE129	1.103E-14	4.792E-31	2.082E-47	9.047E-64	3.931E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129M	1.694E-14	7.362E-31	3.199E-47	1.390E-63	6.039E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	6.704E-05	6.704E-05	6.704E-05	6.704E-05	6.704E-05	6.704E-05	6.704E-05	6.704E-05	6.704E-05	6.704E-05
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	8.785E-01	1.636E-01	3.047E-02	5.673E-03	1.056E-03	3.664E-05	2.366E-07	1.528E-09	9.869E-12	1.187E-14
CS135	2.640E-03	2.640E-03	2.640E-03	2.640E-03	2.640E-03	2.640E-03	2.640E-03	2.640E-03	2.640E-03	2.640E-03
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	1.616E+02	1.440E+02	1.283E+02	1.143E+02	1.018E+02	8.082E+01	5.714E+01	4.041E+01	2.857E+01	1.800E+01
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	1.529E+02	1.362E+02	1.214E+02	1.081E+02	9.632E+01	7.645E+01	5.406E+01	3.822E+01	2.703E+01	1.703E+01
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	1.809E-13	2.228E-30	2.744E-47	3.379E-64	4.163E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	5.505E-08	5.505E-08	5.505E-08	5.505E-08	5.505E-08	5.505E-08	5.505E-08	5.505E-08	5.505E-08	5.505E-08
CE144	4.304E+01	5.010E-01	5.833E-03	6.790E-05	7.904E-07	1.071E-10	1.690E-16	2.666E-22	4.206E-28	7.726E-36
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	4.304E+01	5.010E-01	5.833E-03	6.790E-05	7.905E-07	1.071E-10	1.690E-16	2.666E-22	4.207E-28	7.726E-36
PR144M	5.165E-01	6.012E-03	6.999E-05	8.148E-07	9.485E-09	1.285E-12	2.028E-18	3.200E-24	5.048E-30	9.271E-38
ND144	2.239E-12	2.255E-12	2.255E-12	2.255E-12	2.255E-12	2.255E-12	2.255E-12	2.255E-12	2.255E-12	2.255E-12
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	1.609E-07	1.349E-07	1.110E-07	9.124E-08	7.502E-08	5.071E-08	2.818E-08	1.566E-08	8.706E-09	3.978E-09

DECAY TIMES (years out of core)
(Activities* in Ci/subassembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
PM148M	1.826E-12	8.893E-26	4.331E-39	2.109E-52	1.027E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	1.029E-13	5.009E-27	2.439E-40	1.188E-53	5.785E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	5.828E-08	1.409E-09	3.405E-11	8.230E-13	1.989E-14	1.162E-17	1.641E-22	2.317E-27	3.272E-32	1.117E-38
SM147	1.564E-08	1.902E-08	1.992E-08	2.016E-08	2.023E-08	2.025E-08	2.025E-08	2.025E-08	2.025E-08	2.025E-08
SM151	4.711E+00	4.533E+00	4.362E+00	4.197E+00	4.038E+00	3.739E+00	3.331E+00	2.968E+00	2.644E+00	2.266E+00
EU152	1.429E-03	1.108E-03	8.587E-04	6.656E-04	5.159E-04	3.099E-04	1.443E-04	6.717E-05	3.127E-05	1.129E-05
EU154	1.220E-01	8.151E-02	5.447E-02	3.641E-02	2.433E-02	1.086E-02	3.244E-03	9.684E-04	2.891E-04	5.767E-05
EU155	5.504E+00	2.736E+00	1.360E+00	6.763E-01	3.363E-01	8.310E-02	1.021E-02	1.255E-03	1.542E-04	9.419E-06
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	4.863E-06	2.602E-08	1.392E-10	7.448E-13	3.986E-15	1.141E-19	1.748E-26	2.677E-33	4.102E-40	3.362E-49
TB160	4.540E-09	1.131E-16	2.819E-24	7.025E-32	1.751E-39	1.087E-54	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	3.190E-19	3.190E-19	3.190E-19	3.190E-19	3.190E-19	3.190E-19	3.190E-19	3.190E-19	3.190E-19	3.190E-19
TL207	1.264E-07	3.892E-07	7.729E-07	1.260E-06	1.834E-06	3.195E-06	5.628E-06	8.370E-06	1.130E-05	1.538E-05
TL208	3.846E-07	4.231E-07	4.126E-07	3.948E-07	3.765E-07	3.418E-07	2.959E-07	2.562E-07	2.218E-07	1.832E-07
PB210	1.038E-12	6.477E-12	1.970E-11	4.358E-11	8.055E-11	2.019E-10	5.253E-10	1.044E-09	1.778E-09	3.108E-09
PB211	1.267E-07	3.903E-07	7.750E-07	1.263E-06	1.839E-06	3.204E-06	5.643E-06	8.393E-06	1.133E-05	1.543E-05
PB212	1.070E-06	1.178E-06	1.148E-06	1.099E-06	1.048E-06	9.513E-07	8.236E-07	7.130E-07	6.174E-07	5.100E-07
BI211	1.267E-07	3.903E-07	7.750E-07	1.263E-06	1.839E-06	3.204E-06	5.643E-06	8.393E-06	1.133E-05	1.543E-05
BI212	1.070E-06	1.178E-06	1.148E-06	1.099E-06	1.048E-06	9.513E-07	8.236E-07	7.130E-07	6.174E-07	5.100E-07
PO212	6.857E-07	7.545E-07	7.357E-07	7.039E-07	6.714E-07	6.095E-07	5.277E-07	4.568E-07	3.956E-07	3.267E-07
PO215	1.267E-07	3.903E-07	7.750E-07	1.263E-06	1.839E-06	3.204E-06	5.643E-06	8.393E-06	1.133E-05	1.543E-05
PO216	1.070E-06	1.178E-06	1.148E-06	1.099E-06	1.048E-06	9.513E-07	8.236E-07	7.130E-07	6.174E-07	5.100E-07
RN219	1.267E-07	3.903E-07	7.750E-07	1.263E-06	1.839E-06	3.204E-06	5.643E-06	8.393E-06	1.133E-05	1.543E-05
RN220	1.070E-06	1.178E-06	1.148E-06	1.099E-06	1.048E-06	9.513E-07	8.236E-07	7.130E-07	6.174E-07	5.100E-07
FR223	1.749E-09	5.382E-09	1.068E-08	1.741E-08	2.535E-08	4.417E-08	7.781E-08	1.157E-07	1.562E-07	2.127E-07
RA223	1.267E-07	3.903E-07	7.750E-07	1.263E-06	1.839E-06	3.204E-06	5.643E-06	8.393E-06	1.133E-05	1.543E-05
RA224	1.070E-06	1.178E-06	1.148E-06	1.099E-06	1.048E-06	9.513E-07	8.236E-07	7.130E-07	6.174E-07	5.100E-07
RA226	1.795E-11	6.332E-11	1.364E-10	2.372E-10	3.657E-10	7.054E-10	1.421E-09	2.384E-09	3.593E-09	5.584E-09
RA228	6.568E-10	9.525E-10	1.129E-09	1.234E-09	1.297E-09	1.357E-09	1.383E-09	1.389E-09	1.391E-09	1.392E-09
AC227	1.267E-07	3.900E-07	7.743E-07	1.262E-06	1.837E-06	3.201E-06	5.639E-06	8.385E-06	1.132E-05	1.541E-05

DECAY TIMES (years out of core)
(Activities* in Ci/subassembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TH228	1.070E-06	1.177E-06	1.147E-06	1.098E-06	1.047E-06	9.512E-07	8.235E-07	7.130E-07	6.174E-07	5.100E-07
TH229	2.933E-10	5.563E-10	8.211E-10	1.088E-09	1.356E-09	1.899E-09	2.727E-09	3.572E-09	4.434E-09	5.609E-09
TH230	1.455E-08	2.741E-08	4.028E-08	5.316E-08	6.605E-08	9.185E-08	1.306E-07	1.695E-07	2.084E-07	2.603E-07
TH231	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02
TH232	1.389E-09	1.389E-09	1.389E-09	1.389E-09	1.389E-09	1.390E-09	1.390E-09	1.391E-09	1.391E-09	1.392E-09
TH234	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03
PA231	1.359E-06	2.444E-06	3.529E-06	4.614E-06	5.698E-06	7.866E-06	1.112E-05	1.437E-05	1.762E-05	2.195E-05
PA233	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04
PA234M	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03
PA234	6.096E-06	6.096E-06	6.096E-06	6.096E-06	6.096E-06	6.096E-06	6.096E-06	6.096E-06	6.096E-06	6.096E-06
U232	1.234E-06	1.176E-06	1.121E-06	1.068E-06	1.018E-06	9.246E-07	8.003E-07	6.927E-07	5.996E-07	4.946E-07
U233	5.551E-07	5.593E-07	5.636E-07	5.678E-07	5.720E-07	5.805E-07	5.932E-07	6.059E-07	6.186E-07	6.355E-07
U234	2.856E-04	2.858E-04	2.861E-04	2.863E-04	2.865E-04	2.869E-04	2.875E-04	2.881E-04	2.886E-04	2.892E-04
U235	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02	1.025E-02
U236	7.411E-04	7.411E-04	7.412E-04	7.412E-04	7.412E-04	7.412E-04	7.412E-04	7.412E-04	7.412E-04	7.412E-04
U237	2.548E-10	2.003E-10	1.574E-10	1.238E-10	9.729E-11	6.012E-11	2.920E-11	1.418E-11	6.890E-12	2.631E-12
U238	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03	4.689E-03
NP237	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04	1.942E-04
PU236	3.377E-09	1.170E-09	5.155E-10	3.214E-10	2.638E-10	2.417E-10	2.396E-10	2.395E-10	2.395E-10	2.395E-10
PU237	2.519E-16	2.214E-28	1.946E-40	1.710E-52	1.503E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	1.275E-02	1.226E-02	1.179E-02	1.133E-02	1.089E-02	1.006E-02	8.939E-03	7.940E-03	7.053E-03	6.022E-03
PU239	1.143E+00	1.143E+00	1.143E+00	1.143E+00	1.142E+00	1.142E+00	1.142E+00	1.141E+00	1.141E+00	1.140E+00
PU240	3.998E-03	3.996E-03	3.993E-03	3.991E-03	3.989E-03	3.985E-03	3.979E-03	3.972E-03	3.966E-03	3.958E-03
PU241	1.039E-03	8.164E-04	6.418E-04	5.045E-04	3.966E-04	2.451E-04	1.190E-04	5.782E-05	2.809E-05	1.072E-05
PU242	2.567E-11	2.567E-11	2.567E-11	2.567E-11	2.567E-11	2.567E-11	2.567E-11	2.567E-11	2.567E-11	2.566E-11
PU244	4.073E-22	4.073E-22	4.073E-22	4.073E-22	4.073E-22	4.073E-22	4.073E-22	4.073E-22	4.073E-22	4.073E-22
AM241	9.985E-06	1.728E-05	2.293E-05	2.730E-05	3.067E-05	3.518E-05	3.849E-05	3.959E-05	3.962E-05	3.894E-05
AM242M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM242	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM243	4.929E-13	4.927E-13	4.924E-13	4.922E-13	4.920E-13	4.915E-13	4.908E-13	4.901E-13	4.894E-13	4.885E-13

DECAY TIMES (years out of core)
(Activities* in Ci/subassembly)

Radionuclide	5	10	15	20	25	35	50	65	80	100
CM243	1.886E-12	1.670E-12	1.479E-12	1.309E-12	1.159E-12	9.092E-13	6.313E-13	4.383E-13	3.043E-13	1.871E-13
CM244	9.687E-14	8.000E-14	6.606E-14	5.456E-14	4.505E-14	3.073E-14	1.730E-14	9.746E-15	5.489E-15	2.553E-15
CM245	1.252E-19	1.251E-19	1.251E-19	1.250E-19	1.250E-19	1.249E-19	1.247E-19	1.246E-19	1.244E-19	1.242E-19
CM246	4.105E-23	4.102E-23	4.099E-23	4.096E-23	4.093E-23	4.087E-23	4.078E-23	4.069E-23	4.060E-23	4.048E-23
CM247	1.985E-30	1.985E-30	1.985E-30	1.985E-30	1.985E-30	1.985E-30	1.985E-30	1.985E-30	1.985E-30	1.985E-30
SUBTOTAL**	9.686E+02	6.191E+02	5.102E+02	4.422E+02	3.896E+02	3.066E+02	2.158E+02	1.525E+02	1.081E+02	6.872E+01
TOTAL***	9.686E+02	6.192E+02	5.102E+02	4.422E+02	3.896E+02	3.066E+02	2.158E+02	1.525E+02	1.081E+02	6.872E+01

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 6

Fuel-Specific Source Term Calculations Fort Saint Vrain Graphite Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term template for a single Fort Saint Vrain (FSV) spent nuclear fuel element. This single-element source term is intended to bound all 2,208 irradiated FSV highly enriched, uranium-thorium-graphite spent nuclear fuel elements. The data sources for the analysis are documented in References 1 through 6, and the INEEL calculational methodology is described in Reference 7.

Fort Saint Vrain Reactor Data

The FSV reactor core and fuel elements are described in some detail in References 1 through 5. Data from these references have been used to develop reactor physics models needed to support the depletion/activation analysis.

The FSV fuel element is a hexagonal graphite block with 210 axial fuel rods and 108 helium gas channels. In addition, there is a centrally located fuel handling pickup hole and six peripheral burnable poison rods. The cylindrical fuel rods are composed of spherical fuel particles bound together in a graphite binder matrix. There are two types of spherical fuel particles, namely a fissile particle $(Th,U)C_2$ and a fertile particle ThC_2. The uranium enrichment in the fissile particle is 93.13 wt% U-235. The fertile particle contains 100% natural thorium (Th-232).

The following data provide specific fuel element dimensions, materials, densities, enrichment, etc., for a typical FSV fuel element. However, in order to achieve a bounding burnup for all FSV spent nuclear fuel elements, the uranium and thorium element loadings are based on the heaviest heavy-metal-loaded FSV elements that are installed and irradiated in the FSV core. Specifically, the heavy metal loadings are based on the element with ID number 1-5718. The beginning-of-life (BOL) data below were used in the burnup calculation for the FSV fuel element source term generation.

Fuel Element:	Hexagonal graphite block
Flat-to-flat :	14.17 in.
Length:	31.22 in.
Bulk graphite density:	1.74 g/cc
Material:	H-451 graphite
Graphite Mass:	154,794 g/element
Fuel Rod:	$(Th,U)C_2$ and ThC_2 spherical particles in a graphite binder matrix
Uranium Enrichment:	0.6389 wt% U-234
	93.133 wt% U-235
	0.2711 wt% U-236
	5.957 wt% U-238

Heavy Metal Loading:	7.978	g/element U-234 (BOL)
	1,163.000	g/element U-235 (BOL)
	3.385	g/element U-236 (BOL)
	74.388	g/element U-238 (BOL)
	1,248.752	g/element Total U
	11,454.000	g/element Th-232 (BOL)
	1.2702752E-2	Total MTIHM/element (BOL)

Coolant :	Helium gas
Coolant Temperature:	1535°F
Coolant Pressure:	700 psig
Coolant Density:	0.0021 g/cc

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single FSV fuel element. In addition, for the ORIGEN2 (Reference 8) depletion calculation, conservative and detailed impurity concentrations were added for H-451 graphite. For conservatism, a graphite mass (154.8 kg) equal to the entire fuel element volume was input along with the corresponding impurity masses for maximum activation. Table 1 lists the impurities and concentrations for graphite H-451.

Burnup

The burnup chosen for this template is 100,000 MWd/MTIHM, 1,270.275 MWd, and approximately 1,019 g of U-235 depleted for a single FSV element. Because the BOL uranium loading was 1,163 g of U-235, this burnup represents an 88% depletion of the BOL uranium. This relatively high burnup is needed to ensure the entire FSV element inventory is bounded.

Based on Reference 1 data, the entire FSV element inventory has ≤ 88% U-235 depletion with the exception of one element that has a 97% depletion. The vast majority of the FSV elements are between 40 and 70% U-235 depletion. Perhaps more importantly are the total grams of U-235 depleted. The heavily loaded template element here depletes 1,019 g of U-235. The highest FSV element depletion is approximately 800 g of U-235 (Reference 1). From this perspective, the template radionuclide inventory would definitely be bounding with approximately 20% higher levels of concentrations for fission products, activation products, and actinides other than U-235, U-238, and Th-232.

For the template analysis here, the burnup period in the analysis is assumed to start February 1, 1979, (start of Cycle 2) and end August 18, 1989, (FSV shutdown). The corresponding fuel element output power for the 100,000 MWd/MTIHM is approximately 330 kW and is assumed to be continuous over the burnup period (3,851 days) with no refueling shutdowns (see Table 2). The relatively high burnup (100,000 MWd/MTIHM) is conservative for the buildup of fission products, activation products, and minor actinides in the source term and nonconservative with regard to criticality safety, i.e., fissile concentrations of U-235.

Cross-Section Development

The neutron cross sections used in the burnup or depletion calculation for the source term generation of a single FSV fuel element are based on the methodology described in Reference 7. Cross sections from a standard ORIGEN2 high-temperature gas-cooled graphite reactor library were updated five times over the burnup period to ensure accurate FSV production and activity levels for actinides, fission products, and activation products. The first update developed cross sections for BOL conditions followed by four subsequent updates every 730 days of fuel element exposure. These cross-section updates take into account changes in the neutron flux spectrum and spatial profiles as a function of burnup and are essentially element-average cross sections. An explicit FSV fuel block (with reflective boundary conditions on the element peripheral surfaces) was used to determine volume-averaged flux and reaction rate profiles for the cross-section development (see Figure 1).

Fort Saint Vrain Single Element Exposure History

Table 2 summarizes the power or exposure history used in the burnup or source term calculations for a single FSV fuel element. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years.

Burnup Calculation

The ORIGEN2 computer code (Reference 8) was used to perform the depletion or burnup calculation for the FSV fuel element. The radionuclide inventory or source term template is for a single FSV fuel element or block. The fuel element masses and impurities (graphite, uranium, and thorium), neutron cross sections, burnup, power history, and power level discussed above are input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of time in the template table.

The 145 radionuclides listed in the template represent greater than 99.99% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. Data transfer (via diskette) from Public Service of Colorado (PSC) to the Westinghouse Idaho Nuclear Company, FFA-1994-0001, "Initial and Present Nuclide Content for Segments 1-10 for INEL/WEST." Spreadsheet database of the 2,208 irradiated FSV fuel elements with BOL and EOL heavy metal masses by element for FSV segments 1–10. Responsible engineers: W.A. Grover and S.M. Goebel, April 12, 1994.

2. R. P. Morissette and N. Tomsio, "Characterization of Fort St. Vrain Fuel," ORNL/Sub/86-22047/1, GA-C18511, October 1986.

3. DOE, *Characteristics of Potential Repository Wastes*, DOE/RW-0184-R1, Volume 1, July 1982.

4. G. E Bingham, *Final Safety Analysis Report for the Irradiated Fuels Storage Facility*, ICP-1052, Allied Chemical Corporation, February 1974.

5. J. J. Saurwein, C. M. Miller, and C. A. Young, *Postirradiation Examination and Evaluation of Fort St. Vrain Fuel Element 1-0743*, GA-A16258, May 1981.

6. "Fort Saint Vrain Safety Analysis Report," Revision 8, Section 3.4, 1990.

7. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

8. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

Table 1. H-451 graphite constituent and impurity concentrations for the Fort Saint Vrain fuel element.

Constituent or Impurity	Graphite Concentration (ppm)
H	
Li	0.45
Be	0.005
B	2.5
C	100 wt%
N	
O	
Na	10.4
Mg	1
Al	4.1
Si	26
P	1
S	9.4
Cl	3
K	3
Ca	22.5
Sc	0.01
Ti	16
V	18.9
Cr	1
Mn	1
Fe	11.1
Co	4
Ni	4.6
Cu	0.47
Zn	1
Ga	
As	
Se	
Br	
Rb	1
Sr	0.47
Y	
Zr	0.5
Nb	1.74
Mo	1
Ag	0.5
Cd	0.5
In	1
Sn	1
Sb	1

Table 1. (continued).

Constituent or Impurity	Graphite Concentration (ppm)
Cs	1
Ba	2.9
La	1.38
Ce	0.56
Pr	0.64
Nd	0.36
Sm	0.61
Eu	
Gd	0.08
Tb	0.26
Dy	0.16
Ho	0.08
Er	0.04
Tm	0.04
Yb	0.06
Lu	0.02
Hf	0.17
Ta	0.35
W	25.5
Tl	1
Pb	6.9
Bi	1
Th	
U	

Table 2. Burnup or power history for a 100,000 MWd/MTIHM burnup Fort St. Vrain fuel element.

Duration (days)	Cumulative Duration (days)	Time-Averaged Power (MWth)
365	365	0.3299
366	731	0.3299
365	1096	0.3299
365	1461	0.3299
365	1826	0.3299
366	2192	0.3299
365	2557	0.3299
365	2922	0.3299
365	3287	0.3299
564	3851	0.3299
1825	5676	0.0
1825	7501	0.0
1825	9326	0.0
1825	11151	0.0
1825	12976	0.0
3650	16626	0.0
5475	22101	0.0
5475	27576	0.0
5475	33051	0.0
7300	40351	0.0

The ten dates with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling times designated for the template methodology.

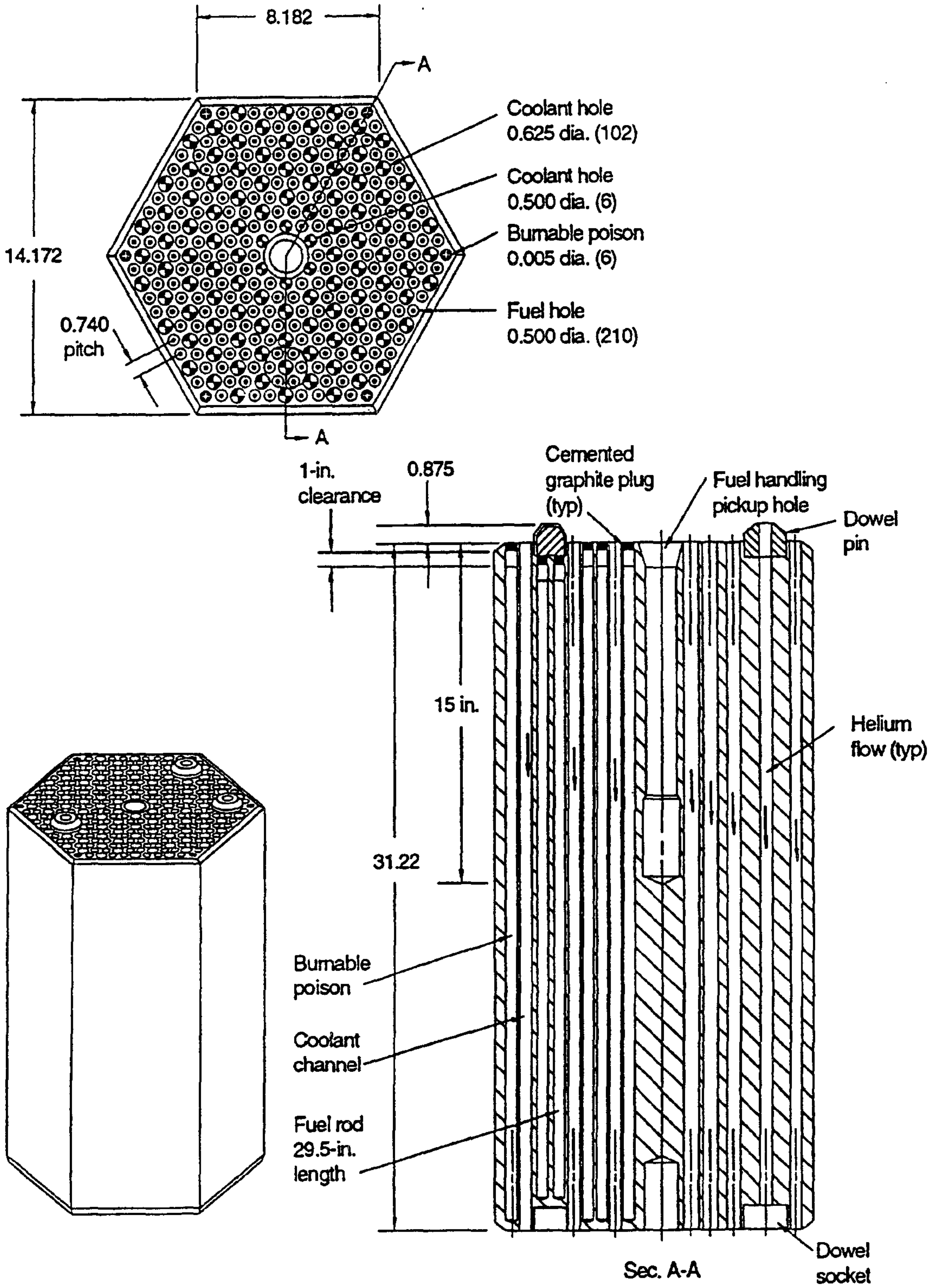

Figure 1. Standard Fort St. Vrain fuel element.

Fort Saint Vrain Reactor Element

Graphite Cladding, 60 to 100%-Enriched U-235/Th-232 Fuel

Reactor Moderator	Graphite
Reactor Coolant:	Helium Gas
Fuel Meat:	$(Th,U)C_2$
Clad:	Graphite
Burnup:	100,000 MWd/MTIHM
Burnup:	1,270.28 MWd/element (high burnup)
Burnup:	88% U-235 depletion (fissioned and transmuted)
Basis of Calculation:	Single fuel element
BOL U-235:	1,163.000 grams U-235 per element
BOL U-238:	74.388 grams U-238 per element
BOL U-234:	7.978 grams U-234 per element
BOL U-236:	3.385 grams U-236 per element
BOL Total U:	1,248.752 grams U per element
BOL Th-232:	11,454.000 grams Th-232 per element
BOL Total Heavy Metal:	12,702.752 grams Th + U per element
BOL U Enrichment:	93.13 wt% U-235

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H 3	2.675E+01	2.020E+01	1.526E+01	1.153E+01	8.705E+00	4.966E+00	2.139E+00	9.219E-01	3.972E-01	1.293E-01
BE 10	8.043E-04	8.043E-04	8.043E-04	8.043E-04	8.043E-04	8.043E-04	8.043E-04	8.043E-04	8.043E-04	8.043E-04
C 14	2.948E-02	2.946E-02	2.945E-02	2.943E-02	2.941E-02	2.937E-02	2.932E-02	2.927E-02	2.921E-02	2.914E-02
CL 36	1.355E-03	1.355E-03	1.355E-03	1.355E-03	1.355E-03	1.355E-03	1.355E-03	1.355E-03	1.355E-03	1.355E-03
CR 51	5.382E-21	7.813E-41	1.120E-60	1.616E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	1.207E-03	2.103E-05	3.658E-07	6.369E-09	1.109E-10	3.361E-14	1.773E-19	9.356E-25	4.937E-30	4.535E-37
FE 55	1.689E-01	4.455E-02	1.175E-02	3.097E-03	8.168E-04	5.679E-05	1.041E-06	1.909E-08	3.501E-10	1.693E-12
FE 59	1.542E-14	9.395E-27	5.681E-39	3.448E-51	2.093E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	2.958E+01	1.532E+01	7.938E+00	4.113E+00	2.131E+00	5.718E-01	7.950E-02	1.105E-02	1.537E-03	1.107E-04
NI 59	4.721E-04	4.721E-04	4.721E-04	4.721E-04	4.721E-04	4.720E-04	4.720E-04	4.719E-04	4.718E-04	4.718E-04
NI 63	6.261E-02	6.029E-02	5.806E-02	5.592E-02	5.385E-02	4.994E-02	4.460E-02	3.984E-02	3.558E-02	3.060E-02
ZN 65	1.209E-03	6.738E-06	3.749E-08	2.087E-10	1.162E-12	3.601E-17	6.215E-24	1.073E-30	1.851E-37	1.779E-46
SE 79	2.678E-02	2.678E-02	2.678E-02	2.678E-02	2.678E-02	2.678E-02	2.677E-02	2.677E-02	2.676E-02	2.676E-02
KR 85	3.492E+02	2.528E+02	1.829E+02	1.324E+02	9.583E+01	5.020E+01	1.903E+01	7.216E+00	2.736E+00	7.506E-01
RB 87	1.328E-06	1.328E-06	1.328E-06	1.328E-06	1.328E-06	1.328E-06	1.328E-06	1.328E-06	1.328E-06	1.328E-06
SR 89	1.996E-07	2.599E-18	3.362E-29	4.363E-40	5.663E-51	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	3.285E+03	2.917E+03	2.589E+03	2.299E+03	2.041E+03	1.609E+03	1.126E+03	7.876E+02	5.512E+02	3.424E+02

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
Y 91	6.795E-06	2.736E-15	1.095E-24	4.395E-34	1.764E-43	2.842E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	8.560E-02	8.560E-02	8.560E-02	8.560E-02	8.560E-02	8.560E-02	8.560E-02	8.560E-02	8.560E-02	8.560E-02
ZR 95	4.363E-05	1.118E-13	2.851E-22	7.287E-31	1.863E-39	1.217E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M	3.269E-02	4.363E-02	5.211E-02	5.868E-02	6.377E-02	7.078E-02	7.641E-02	7.903E-02	8.025E-02	8.093E-02
NB 94	6.255E-04	6.254E-04	6.253E-04	6.252E-04	6.251E-04	6.249E-04	6.246E-04	6.243E-04	6.239E-04	6.235E-04
NB 95	9.687E-05	2.483E-13	6.329E-22	1.618E-30	4.135E-39	2.702E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M	3.237E-07	8.296E-16	2.115E-24	5.406E-33	1.382E-41	9.028E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	1.318E-05	1.317E-05	1.315E-05	1.314E-05	1.313E-05	1.310E-05	1.306E-05	1.302E-05	1.298E-05	1.293E-05
TC 99	4.234E-01	4.234E-01	4.234E-01	4.234E-01	4.234E-01	4.234E-01	4.233E-01	4.233E-01	4.233E-01	4.233E-01
RU103	6.513E-11	6.618E-25	6.666E-39	6.744E-53	6.822E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	4.072E+01	1.309E+00	4.201E-02	1.350E-03	4.335E-05	4.472E-08	1.482E-12	4.912E-17	1.628E-21	1.733E-27
RH103M	5.872E-11	5.966E-25	6.009E-39	6.079E-53	6.150E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	4.072E+01	1.309E+00	4.201E-02	1.350E-03	4.335E-05	4.473E-08	1.482E-12	4.912E-17	1.628E-21	1.733E-27
PD107	6.831E-04	6.831E-04	6.831E-04	6.831E-04	6.831E-04	6.831E-04	6.831E-04	6.831E-04	6.831E-04	6.831E-04
AG110	1.411E-03	8.908E-06	5.616E-08	3.543E-10	2.235E-12	8.897E-17	2.234E-23	5.610E-30	1.409E-36	2.232E-45
AG110M	1.061E-01	6.698E-04	4.222E-06	2.664E-08	1.681E-10	6.689E-15	1.680E-21	4.218E-28	1.059E-34	1.678E-43
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	4.052E-01	3.195E-01	2.520E-01	1.987E-01	1.567E-01	9.742E-02	4.777E-02	2.342E-02	1.149E-02	4.441E-03
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	2.404E-12	1.134E-24	5.313E-37	2.497E-49	1.174E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	3.480E-12	2.754E-23	2.164E-34	1.708E-45	1.346E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	3.635E-12	2.878E-23	2.261E-34	1.784E-45	1.407E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	1.679E-16	7.924E-29	3.711E-41	1.745E-53	8.202E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	6.468E-03	3.693E-05	2.106E-07	1.202E-09	6.854E-12	2.231E-16	4.144E-23	7.698E-30	1.430E-36	1.516E-45
SN121M	7.842E-03	7.317E-03	6.826E-03	6.369E-03	5.942E-03	5.173E-03	4.201E-03	3.412E-03	2.771E-03	2.100E-03
SN123	1.323E-03	7.344E-08	4.066E-12	2.254E-16	1.249E-20	3.841E-29	6.545E-42	1.115E-54	1.900E-67	1.795E-84
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	2.820E-02	2.820E-02	2.820E-02	2.820E-02	2.820E-02	2.819E-02	2.819E-02	2.819E-02	2.819E-02	2.818E-02
SB124	2.230E-08	1.648E-17	1.211E-26	8.921E-36	6.573E-45	3.568E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	6.457E+01	1.848E+01	5.287E+00	1.513E+00	4.329E-01	3.545E-02	8.306E-04	1.946E-05	4.560E-07	3.058E-09
SB126	3.948E-03	3.948E-03	3.948E-03	3.948E-03	3.948E-03	3.947E-03	3.947E-03	3.946E-03	3.946E-03	3.945E-03
SB126M	2.820E-02	2.820E-02	2.820E-02	2.820E-02	2.820E-02	2.819E-02	2.819E-02	2.819E-02	2.819E-02	2.818E-02
TE123M	1.220E-05	3.113E-10	7.923E-15	2.019E-19	5.146E-24	3.342E-33	5.532E-47	9.158E-61	1.516E-74	6.395E-93
TE125M	1.575E+01	4.509E+00	1.290E+00	3.692E-01	1.056E-01	8.649E-03	2.026E-04	4.749E-06	1.112E-07	7.460E-10
TE127	1.906E-03	1.728E-08	1.561E-13	1.412E-18	1.278E-23	1.046E-33	7.753E-49	5.744E-64	4.255E-79	2.853E-99

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TE127M	1.946E-03	1.764E-08	1.594E-13	1.442E-18	1.305E-23	1.068E-33	7.915E-49	5.864E-64	4.344E-79	2.912E-99
TE129	1.897E-14	8.285E-31	3.581E-47	1.556E-63	6.761E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129M	2.914E-14	1.273E-30	5.502E-47	2.390E-63	1.039E-79	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	1.282E-03	1.282E-03	1.282E-03	1.282E-03	1.282E-03	1.282E-03	1.282E-03	1.282E-03	1.282E-03	1.282E-03
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	1.160E+03	2.160E+02	4.022E+01	7.490E+00	1.394E+00	4.838E-02	3.123E-04	2.018E-06	1.303E-08	1.567E-11
CS135	3.139E-02	3.139E-02	3.139E-02	3.139E-02	3.139E-02	3.139E-02	3.139E-02	3.139E-02	3.139E-02	3.139E-02
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	3.373E+03	3.005E+03	2.677E+03	2.385E+03	2.125E+03	1.686E+03	1.192E+03	8.431E+02	5.962E+02	3.756E+02
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	3.191E+03	2.842E+03	2.532E+03	2.256E+03	2.010E+03	1.595E+03	1.128E+03	7.976E+02	5.640E+02	3.553E+02
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	2.145E-13	2.656E-30	3.253E-47	4.006E-64	4.934E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	1.178E-06	1.178E-06	1.178E-06	1.178E-06	1.178E-06	1.178E-06	1.178E-06	1.178E-06	1.178E-06	1.178E-06
CE144	1.566E+02	1.824E+00	2.123E-02	2.471E-04	2.877E-06	3.898E-10	6.150E-16	9.703E-22	1.531E-27	2.812E-35
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	1.566E+02	1.825E+00	2.123E-02	2.471E-04	2.877E-06	3.899E-10	6.151E-16	9.704E-22	1.531E-27	2.812E-35
PR144M	1.880E+00	2.189E-02	2.547E-04	2.965E-06	3.452E-08	4.678E-12	7.381E-18	1.164E-23	1.837E-29	3.374E-37
ND144	7.244E-11	7.249E-11	7.250E-11	7.250E-11	7.250E-11	7.250E-11	7.250E-11	7.250E-11	7.250E-11	7.250E-11
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	5.580E-04	4.613E-04	3.793E-04	3.118E-04	2.564E-04	1.733E-04	9.633E-05	5.354E-05	2.975E-05	1.360E-05
PM147	5.328E+02	1.422E+02	3.794E+01	1.013E+01	2.702E+00	1.924E-01	3.656E-03	6.948E-05	1.320E-06	6.695E-09
PM148M	1.482E-11	7.245E-25	3.514E-38	1.711E-51	8.333E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	8.345E-13	4.081E-26	1.979E-39	9.638E-53	4.693E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	5.473E-05	1.323E-06	3.197E-08	7.728E-10	1.868E-11	1.091E-14	1.541E-19	2.176E-24	3.073E-29	1.049E-35
SM147	1.179E-07	1.275E-07	1.300E-07	1.307E-07	1.309E-07	1.310E-07	1.310E-07	1.310E-07	1.310E-07	1.310E-07
SM151	1.041E+01	1.002E+01	9.636E+00	9.271E+00	8.921E+00	8.260E+00	7.359E+00	6.555E+00	5.841E+00	5.006E+00
EU152	5.129E-01	3.976E-01	3.082E-01	2.388E-01	1.851E-01	1.111E-01	5.176E-02	2.410E-02	1.122E-02	4.049E-03
EU154	2.239E+02	1.497E+02	1.000E+02	6.684E+01	4.467E+01	1.995E+01	5.956E+00	1.778E+00	5.307E-01	1.059E-01
EU155	8.762E+01	4.356E+01	2.166E+01	1.077E+01	5.354E+00	1.323E+00	1.625E-01	1.997E-02	2.455E-03	1.500E-04
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	5.970E-03	3.197E-05	1.709E-07	9.144E-10	4.893E-12	1.401E-16	2.145E-23	3.287E-30	5.036E-37	4.128E-46

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TB160	2.368E-07	5.915E-15	1.471E-22	3.665E-30	9.130E-38	5.669E-53	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	8.711E-09	8.711E-09	8.711E-09	8.711E-09	8.711E-09	8.711E-09	8.711E-09	8.711E-09	8.711E-09	8.711E-09
TL207	1.459E-03	2.130E-03	2.702E-03	3.189E-03	3.605E-03	4.260E-03	4.923E-03	5.335E-03	5.589E-03	5.783E-03
TL208	9.283E-01	9.492E-01	9.152E-01	8.739E-01	8.331E-01	7.562E-01	6.545E-01	5.665E-01	4.904E-01	4.049E-01
PB210	9.730E-07	8.953E-07	8.635E-07	8.757E-07	9.304E-07	1.162E-06	1.803E-06	2.782E-06	4.089E-06	6.338E-06
PB211	1.463E-03	2.136E-03	2.709E-03	3.198E-03	3.615E-03	4.272E-03	4.937E-03	5.350E-03	5.605E-03	5.799E-03
PB212	2.584E+00	2.642E+00	2.547E+00	2.432E+00	2.319E+00	2.105E+00	1.822E+00	1.577E+00	1.365E+00	1.127E+00
BI211	1.463E-03	2.136E-03	2.709E-03	3.198E-03	3.615E-03	4.272E-03	4.937E-03	5.350E-03	5.605E-03	5.799E-03
BI212	2.584E+00	2.642E+00	2.547E+00	2.432E+00	2.319E+00	2.105E+00	1.822E+00	1.577E+00	1.365E+00	1.127E+00
PO212	1.655E+00	1.693E+00	1.632E+00	1.558E+00	1.486E+00	1.348E+00	1.167E+00	1.010E+00	8.745E-01	7.221E-01
PO215	1.463E-03	2.136E-03	2.709E-03	3.198E-03	3.615E-03	4.272E-03	4.937E-03	5.350E-03	5.605E-03	5.799E-03
PO216	2.584E+00	2.642E+00	2.547E+00	2.432E+00	2.319E+00	2.105E+00	1.822E+00	1.577E+00	1.365E+00	1.127E+00
RN219	1.463E-03	2.136E-03	2.709E-03	3.198E-03	3.615E-03	4.272E-03	4.937E-03	5.350E-03	5.605E-03	5.799E-03
RN220	2.584E+00	2.642E+00	2.547E+00	2.432E+00	2.319E+00	2.105E+00	1.822E+00	1.577E+00	1.365E+00	1.127E+00
FR223	2.017E-05	2.943E-05	3.733E-05	4.406E-05	4.980E-05	5.887E-05	6.805E-05	7.373E-05	7.724E-05	7.994E-05
RA223	1.463E-03	2.136E-03	2.709E-03	3.198E-03	3.615E-03	4.272E-03	4.937E-03	5.350E-03	5.605E-03	5.799E-03
RA224	2.584E+00	2.642E+00	2.547E+00	2.432E+00	2.319E+00	2.105E+00	1.822E+00	1.577E+00	1.365E+00	1.127E+00
RA226	3.214E-07	5.458E-07	8.031E-07	1.094E-06	1.418E-06	2.167E-06	3.547E-06	5.239E-06	7.249E-06	1.043E-05
RA228	9.265E-04	1.024E-03	1.082E-03	1.117E-03	1.138E-03	1.157E-03	1.166E-03	1.168E-03	1.168E-03	1.168E-03
AC227	1.462E-03	2.133E-03	2.705E-03	3.193E-03	3.609E-03	4.266E-03	4.931E-03	5.343E-03	5.597E-03	5.792E-03
TH227	1.443E-03	2.106E-03	2.672E-03	3.154E-03	3.565E-03	4.213E-03	4.869E-03	5.276E-03	5.528E-03	5.719E-03
TH228	2.582E+00	2.640E+00	2.545E+00	2.430E+00	2.317E+00	2.104E+00	1.822E+00	1.577E+00	1.365E[illegible]	1.127E+00
TH229	2.390E-03	3.624E-03	4.859E-03	6.092E-03	7.325E-03	9.789E-03	1.348E-02	1.717E-02	2.085E-02	2.575E-02
TH230	9.635E-05	1.117E-04	1.272E-04	1.429E-04	1.587E-04	1.908E-04	2.398E-04	2.899E-04	3.410E-04	4.103E-04
TH231	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04
TH232	1.168E-03	1.168E-03	1.168E-03	1.168E-03	1.168E-03	1.168E-03	1.168E-03	1.168E-03	1.168E-03	1.168E-03
TH234	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05
PA231	6.022E-03	6.021E-03	6.021E-03	6.020E-03	6.019E-03	6.018E-03	6.016E-03	6.015E-03	6.013E-03	6.010E-03
PA233	1.589E-02	1.589E-02	1.589E-02	1.590E-02	1.590E-02	1.591E-02	1.593E-02	1.595E-02	1.597E-02	1.600E-02
PA234M	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05
PA234	2.324E-08	2.324E-08	2.324E-08	2.324E-08	2.324E-08	2.324E-08	2.324E-08	2.324E-08	2.324E-08	2.324E-08
U232	2.733E+00	2.604E+00	2.482E+00	2.365E+00	2.254E+00	2.047E+00	1.772E+00	1.534E+00	1.327E+00	1.095E+00
U233	2.618E+00	2.618E+00	2.618E+00	2.617E+00	2.617E+00	2.617E+00	2.617E+00	2.617E+00	2.617E+00	2.617E+00
U234	3.395E-01	3.432E-01	3.467E-01	3.500E-01	3.532E-01	3.593E-01	3.676E-01	3.749E-01	3.814E-01	3.890E-01
U235	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04	3.102E-04

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
U236	1.096E-02	1.096E-02	1.096E-02	1.096E-02	1.096E-02	1.096E-02	1.096E-02	1.096E-02	1.096E-02	1.096E-02
U237	2.554E-05	2.008E-05	1.578E-05	1.241E-05	9.753E-06	6.027E-06	2.928E-06	1.423E-06	6.919E-07	2.649E-07
U238	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05	1.788E-05
NP237	1.589E-02	1.589E-02	1.589E-02	1.590E-02	1.590E-02	1.591E-02	1.593E-02	1.595E-02	1.597E-02	1.600E-02
PU236	5.247E-04	1.556E-04	4.614E-05	1.368E-05	4.059E-06	3.595E-07	1.215E-08	3.095E-09	2.859E-09	2.852E-09
PU237	1.727E-14	1.524E-26	1.334E-38	1.173E-50	1.031E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	2.616E+02	2.515E+02	2.417E+02	2.324E+02	2.234E+02	2.064E+02	1.833E+02	1.628E+02	1.446E+02	1.235E+02
PU239	1.725E-01	1.725E-01	1.725E-01	1.725E-01	1.725E-01	1.725E-01	1.724E-01	1.724E-01	1.723E-01	1.723E-01
PU240	2.876E-01	2.999E-01	3.100E-01	3.183E-01	3.252E-01	3.354E-01	3.447E-01	3.498E-01	3.524E-01	3.538E-01
PU241	1.041E+02	8.184E+01	6.433E+01	5.057E+01	3.976E+01	2.457E+01	1.194E+01	5.801E+00	2.820E+00	1.080E+00
PU242	4.937E-03	4.937E-03	4.937E-03	4.937E-03	4.937E-03	4.937E-03	4.937E-03	4.937E-03	4.936E-03	4.936E-03
PU244	3.070E-09	3.070E-09	3.070E-09	3.070E-09	3.070E-09	3.070E-09	3.070E-09	3.071E-09	3.071E-09	3.071E-09
AM241	1.139E+00	1.869E+00	2.435E+00	2.872E+00	3.208E+00	3.659E+00	3.987E+00	4.094E+00	4.095E+00	4.023E+00
AM242M	3.491E-03	3.412E-03	3.335E-03	3.260E-03	3.187E-03	3.045E-03	2.843E-03	2.655E-03	2.480E-03	2.264E-03
AM242	3.473E-03	3.395E-03	3.319E-03	3.244E-03	3.171E-03	3.029E-03	2.829E-03	2.642E-03	2.467E-03	2.252E-03
AM243	5.869E-02	5.866E-02	5.863E-02	5.860E-02	5.858E-02	5.852E-02	5.844E-02	5.836E-02	5.828E-02	5.817E-02
CM242	4.576E-02	2.827E-03	2.746E-03	2.684E-03	2.623E-03	2.505E-03	2.340E-03	2.185E-03	2.041E-03	1.863E-03
CM243	6.681E-02	5.916E-02	5.239E-02	4.639E-02	4.108E-02	3.221E-02	2.236E-02	1.553E-02	1.078E-02	6.628E-03
CM244	2.581E+01	2.132E+01	1.760E+01	1.454E+01	1.201E+01	8.188E+00	4.612E+00	2.597E+00	1.463E+00	6.803E-01
CM245	5.110E-03	5.108E-03	5.106E-03	5.104E-03	5.102E-03	5.098E-03	5.091E-03	5.085E-03	5.079E-03	5.071E-03
CM246	2.016E-03	2.015E-03	2.014E-03	2.012E-03	2.011E-03	2.008E-03	2.003E-03	1.999E-03	1.994E-03	1.989E-03
CM247	1.325E-08	1.325E-08	1.325E-08	1.325E-08	1.325E-08	1.325E-08	1.325E-08	1.325E-08	1.325E-08	1.325E-08
Subtotal**	1.645E+04	1.294E+04	1.116E+04	9.818E+03	8.689E+03	6.849E+03	4.830E+03	3.425E+03	2.441E+03	1.565E+03
TOTAL***	1.645E+04	1.294E+04	1.116E+04	9.818E+03	8.689E+03	6.849E+03	4.830E+03	3.425E+03	2.441E+03	1.565E+03

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 7
Fuel-Specific Source Term Calculations
N-Reactor Fuel

Introduction

The N-Reactor spent nuclear fuel (SNF) currently resides at the United States Department of Energy (DOE) Hanford Site. The SNF is stored in two water-filled pools, namely, the 105-KE Basin (KE Basin) and the 105-KW Basin (KW Basin). The combined total SNF mass of the two basins is approximately 2,100 MT. This mass represents greater than 91% of the total DOE SNF uranium mass and a significant fraction of the total DOE SNF source term as well.

The radionuclide inventory data or source term used to develop this template is based on N-Reactor radionuclide inventories previously calculated by the Hanford site and is taken directly from Reference 1. Specifically, the "Safety/Regulatory Assessment Feed" design basis radionuclide inventory (Table 3.9, Reference 1) was selected as the template basis. This particular design basis inventory represents a high burnup (16.49% Pu-240) isotopic mixture expected to yield the largest dose to people per unit of material released and thus a maximum per unit mass source term. The inventory is decayed to a single date (May 31, 1998) or 22.08 years following discharge from the reactor.

The N-Reactor radionuclide inventory data (Table 3.9, Reference 1) is a relatively comprehensive list of radionuclides and the corresponding activities in terms of Ci/MTU. However, the N-Reactor inventory does not provide radionuclide activities for all the radionuclides identified in "Guide for Estimating DOE Spent Nuclear Fuel Source Terms" (Reference 2). Specifically missing are the actinides Th-229, Th-232, U-232, and U-233, as well as the actinide daughter decay products Ac-227, Pa-231, Pb-210, Ra-226, and Ra-228. Because the N-Reactor fuel did not contain thorium in the initial or beginning-of-life (BOL) fuel mass, the four actinides (Th-229, Th-232, U-232, and U-233) are not expected to exist in any significant quantity in irradiated N-Reactor fuel. The five daughter decay products (Ac-227, Pa-231, Pb-210, Ra-226, and Ra-228) are dependent on the decay time following reactor discharge.

In order to provide activity values for these five daughter decay products and at the same time provide N-Reactor inventories as a function of additional decay times, the Table 3.9 data were decayed using the ORIGEN2 code (Reference 3) and various decay dates out to 100 years following reactor discharge. This way both the SNF template format is met and all the important radionuclides have an associated activity in the template as a function of decay time. However, it should be noted that the daughter decay product activities will be slightly underpredicted, because they are decayed from May 31, 1998 (Table 3.9 data) and not the discharge date.

It should be emphasized that the Idaho National Engineering and Environmental Laboratory SNF source term calculational methodology used to generate other template source terms is not used here to generate the N-Reactor source term. The N-Reactor source term is taken directly out of Table 3.9 from Reference 1. These data (Table 3.9, Reference 1) are simply decayed out to the 100-year timeframe and reported in this template radionuclide inventory along with the initial Table 3.9 data, which corresponds to the 22.08-year decay time. The decay calculation performed as part of the N-Reactor template development herein used the ORIGEN2 computer code and the standard ORIGEN2 decay libraries (Reference 3).

N-Reactor

The following description of the N-Reactor in this section is taken almost verbatim out of Reference 5.

The 105-N Reactor (N-Reactor) is a graphite-moderated, pressurized water-cooled reactor located in the 100-N Area of the Hanford Site. It was initially designed for plutonium production for national defense. Initial operation began in 1963. Two years later, N-Reactor was modified to produce steam to be used by the Washington Public Power Supply System to generate electricity. N-Reactor was the only dual-purpose reactor in the United States.

The core of the N-Reactor was a 1,800-ton graphite block, 33 feet (10 meters) high by 33 feet (10 meters) wide by 39 feet (12 meters) long. A total of 1,003 horizontal Zircaloy-2 process tubes held the fuel and contained the cooling water. The cooling water transferred the reaction heat from the 366 metric tons of uranium fuel to the secondary coolant water in steam generators. Perpendicular to the process tubes were 84 horizontal water-cooled, boron containing control rods. These rods entered the reactor from both sides and provided operating reactivity control, neutron flux shaping, and emergency shutdown control. Completely independent, backup emergency shutdown control was provided by 107 vertical channels penetrating the core that could be gravity-filled with special neutron absorbing balls.

When operating, N-Reactor produced up to 4,000 MW_{th} of heat energy and up to 13 million pounds per hour of low-pressure steam, which produced 860 MWe. The production of tritium and various nondefense target elements was also demonstrated.

N-Reactor ceased operation in 1987, but fuel remained in the core pending a possible restart. The final core was discharged in April 1989.

N-Reactor Fuel Element Data

The radionuclide inventory from Table 3.9 (Reference 1) is based on the N-Reactor MARK IV fuel assembly. This assembly consists of two concentric annular fuel elements (termed inner element and outer element). The fuel meat is uranium metal with Zircaloy-2 cladding on both inner and outer surfaces of each element. Both elements have a BOL enrichment of 0.947% U-235 and a combined total uranium weight of approximately 22.7 kg or 50 lb.

The following N-reactor fuel assembly table data is based on References 1 and 4.

Outer Element Diameters	
Zircaloy Clad OD	6.160 cm
Uranium meat OD	6.032 cm
Uranium meat ID	4.422 cm
Zircaloy Clad ID	4.321 cm
Outer Element Enrichments	
U-235	0.94700 wt%
U-236	0.03920 wt%
U-238	99.0138 wt%

Inner Element Diameters	
Zircaloy Clad OD	3.249 cm
Uranium meat OD	3.096 cm
Uranium meat ID	1.321 cm
Zircaloy Clad ID	1.219 cm
Inner Element Enrichments	
U-235	0.94700 wt%
U-236	0.03920 wt%
U-238	99.0138 wt%
Assembly Uranium Mass	22.7 kg
Assembly Dimensions	
Maximum Length	66.294 cm
End Cap Thickness	0.483 cm
Fuel Assembly Max. Weight	23.4 kg

Based on the above table data and the fact that the radionuclide inventory from Table 3.9 (Reference 1) is based on a BOL uranium total mass of 11.6 MTU, the following BOL isotopic uranium masses can be estimated.

Uranium Isotope	BOL Mass (grams)
U-235	109,852.0
U-236	4,547.0
U-238	11,485,601.0
Total U	11,600,000.0

Burnup and Time Since Discharge

The K Basin inventory of N-Reactor SNF is composed of assemblies that experienced a range of burnups and were discharged from the reactor between January 1971 and April 1987. The burnups range from 0.0 to approximately 6000 MWd per MTU.

Accountability records have been used to subdivide the K Basin N-Reactor assemblies by burnup and mass in order to estimate total radionuclide inventories. The accountability record run data listing includes (1) discharge date, (2) fuel type, and (3) other information for 497 keys of fuel assemblies. Each of the 497 keys includes assemblies of the same type, same burnup, and same discharge date from the reactor.

The burnup of a N-Reactor fuel key is historically ranked by End-of-Life (EOL) Pu-240 concentration or Pu-240 weight percent of the plutonium mass. Pu-240 concentration increases with burnup or exposure time in the core and is a direct indicator of an assembly or key burnup. Typically, seven bins (<5%, 5-7%, 7-9%, 9-11%, 11-13%, 13-15%, and >15% Pu-240) are used to categorize spent N-Reactor assemblies.

In the highest burnup bin (>15% Pu-240), there are two fuel keys with maximum burnups of 16.72% Pu-240 and 16.49% Pu-240 and discharge dates of February 20, 1976, and May 1, 1976, respectively. When decayed to May 31, 1998, the 16.49% Pu-240 fuel was found to have a mix of isotopes that produced a maximum dose to people. The total BOL uranium mass of this 16.49% Pu-240 fuel stored at the K Basins was 11.6 MTU. A complete listing of the specific radionuclide composition in Ci/MTU for this fuel key, decayed to May 31, 1998, is listed in the template column headed with a 22.08-year decay.

It should be noted that the application of the 16.49 wt% Pu-240 SNF template here to all the N-Reactor SNF K-Basin fuel inventory will produce a conservative or overestimate of the actual total radionuclide inventory.

Cross-Section Development

ORIGEN2 S.2 runs were used to generate the radionuclide inventories used to characterize the N-Reactor spent fuel. These same ORIGEN2 runs were apparently used to generate the Table 3.9 (Reference 1) radionuclide data and are based on improved cross-section libraries generated by the WIMS-E computer code (Reference 6).

Fuel/Clad Impurities

Fuel and cladding material constituents, both major and minor (impurities), activate, fission, and transmute into a wide variety of radionuclides. Comprehensive lists of BOL fuel, clad, and other structural and poison materials are key to fully characterizing the SNF and determining its EOL radionuclide inventory. Preirradiated impurity concentrations are typically low relative to the major constituent concentrations, but can lead through activation to significant quantities of important radionuclides. Hence, it is important for a depletion or activation calculation to include as many known impurity elements and their concentrations as possible.

The depletion calculation used to develop the N-Reactor radionuclide inventory (Table 3.9, Reference 1) is based on the major and minor impurity elements in the uranium metal fuel, the Zircaloy-2 clad, and the zirconium-beryllium braze material used to seal the fuel assemblies as given in Table 3.4, Reference 1. This elemental list and the associated elemental masses are for preirradiated conditions and given specifically in terms of the total N-Reactor fuel, clad, and braze mass, or 2,100,000 kg, 145,000 kg, and 3,000 kg, respectively. The Table 3.4 values are scaled to a parts-per-million basis for presentation purposes and conformity to the template format. These impurities are listed in Table 1.

Decay Calculation

The N-Reactor radionuclide inventory template is based on the "Safety/Regulatory Assessment Design Basis" according to Reference 1. This inventory is based on 16.49 wt% Pu-240 exposure fuel and is reported to have a discharge date of May 1, 1976, and is decayed to May 31, 1998. This would represent a 22.08-year decay period.

In order to further decay the radionuclide inventory out to 25, 35, 50, 65, 80, and 100 years for the template format, the ORIGEN2 computer code was used to perform the decay calculation. See Table 2 for the decay history. The first step was to modify the radionuclide inventory or source term from the Table 3.9 (Reference 1) "Safety/Regulatory Assessment Design Basis" radionuclide list (Ci/MTU) in order to load the mass vector into the ORIGEN2 decay input deck. The list was loaded as a mass (grams) vector where the Table 3.9 data were multiplied by the BOL 11.6 MTU (template basis) and divided by the appropriate radionuclide curie-to-gram conversion factor. The inventory was then decayed for the six additional decay dates with the radionuclide activities output in terms of curies. The total curies inventory for the 16.49% Pu-240 key was then divided by the total key BOL uranium mass (11.6 MTU) in order to convert back to the more convenient units of Ci/MTU, and it is these values that are reported in the attached radionuclide ir entory temple here.

References

1. M. J. Packer, "105-K Basin Material Design Basis Feed Description for Spent Nuclear Fuel Project Facilities," Volume 1, *Fuel*, HNF-SD-SNF-TI-009, Rev. 3, November 4, 1999.

2. National Spent Nuclear Fuel Program, *Guide for Estimating DOE Spent Nuclear Fuel Source Terms*, DOE/SNF/REP-059, July 2000.

3. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

4. Duke Engineering and Services, *Criticality Safety Evaluation Report for Spent Nuclear Fuel Processing and Storage Facilities*, HNF-SD-SNF-CSER-005, Revision 3, Fluor Daniel Northwest, Richland Washington, February 1997.

5. K. H. Bergsman, *Hanford Spent Fuel Inventory Baseline*, WHC-SD-SNF-TI-001, Rev. 0, July 15, 1994.

6. M. J. Packer, "Single Use Letter Report for the Verification and Validation of the RADNUC2A and ORIGEN S.2 Computer Codes," SNF-4503, Rev. 0, DE&S Hanford, Richland, Washington.

Table 1. N-Reactor fuel assembly material impurity concentrations.

Constituent or Impurity	Uranium Metal Concentration (ppm)	Zircaloy-2 Cladding Concentration (wt%)	Braze Filler Concentration (ppm)
H	2	25.5	47.3
Li			
Be	10	—	47333
B	0.25	0.51	0.47
C	366–738	280.7	473
N	75.2	81.4	189
O	—	—	2177
F			
Na	—	20.4	18.9
Mg		20.4	56.7
Al	705–905	76.5	566670
Si	124.3	102	236
P			
S			
Cl			
K			
Ca			
Sc			
Ti	—	51	47.3
V	—	51	47.3
Cr	65	510–1531	473–1420
Mn	25	51	56.7
Fe	301–401	717–2041	567–1987
Co	—	10.2	18.9
Ni	100.5	306–814	283–757
Cu	75.2	51	56.7
Zn			
Ga			
As			
Se			
Br			
Rb			
Sr			
Y			
Zr	358.6	100 wt%	926667
Nb			
Mo	—	51	47.3
Ag			
Cd	0.25	0.51	0.47
In			

Table 1. (continued).

Constituent or Impurity	Uranium Metal Concentration (ppm)	Zircaloy-2 Cladding Concentration (wt%)	Braze Filler Concentration (ppm)
Sn	—	12276–17379	10767–16067
Sb			
Cs			
Ba			
La			
Ce			
Pr			
Nd			
Sm			
Eu			
Gd			
Tb			
Dy			
Ho			
Er			
Tm			
Yb			
Lu			
Hf	—	204	189
Ta			
W	—	51	95
Tl			
Pb	—	102	123
Bi			
Th			
U	100 wt%	3.6	3.77

Table 2. N-Reactor decay history used in the template decay calculation.

Dates	Differential Decay Time (years)	Cumulative Decay Time (days)	Cumulative Decay Time (years)	Time-Averaged Power (MWth)
1-May-1976 (discharge)	0.0	0.0	0.0	0.0
31-May-1998 (Table 3.9 decay date)	22.08	8065.00	22.08	0.0
01-May-2001	2.92	9131.00	25.00	0.0
01-May-2011	12.92	12783.00	35.00	0.0
01-May-2026	27.92	18262.00	50.00	0.0
01-May-2041	42.92	23741.00	65.00	0.0
01-May-2056	57.92	29220.00	80.00	0.0
01-May-2076	77.92	36525.00	100.00	0.0

The radionuclide decay dates begin with May 31, 1998, or 22.08-years after discharge from the N-Reactor core followed by 25, 35, 50, 65, 80, and 100-year decay times in accordance with the template format.

N-Reactor Fuel

Zircaloy-2 Cladding, Uranium Metal Fuel

Fuel Meat:	Uranium Metal
BOL U-235 Fuel Enrichment:	0.947 wt%
Cladding:	Zircaloy-2

16.49% Pu-240 Key Data:

Burnup:	16.49% Pu-240 (maximum burnup)
BOL U-235:	109852.0 g U-235
BOL U-236:	4547.0 g U-236
BOL U-238:	11485601.0 g U-238
BOL Total U:	11.6 MTU

DECAY TIMES (years out of core)
(Activities* in Ci/MTU)

Radionuclide	5	10	15	22.08	25	35	50	65	80	100
H 3				2.610E+01	2.216E+01	1.264E+01	5.447E+00	2.347E+00	1.011E+00	3.291E-01
BE 10				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
C 14				5.530E-01	5.528E-01	5.522E-01	5.511E-01	5.501E-01	5.491E-01	5.478E-01
CL 36				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CR 51				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
FE 55				5.410E-01	2.484E-01	1.728E-02	3.168E-04	5.809E-06	1.065E-07	5.148E-10
FE 59				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60				2.091E+00	1.424E+00	3.822E-01	5.314E-02	7.388E-03	1.027E-03	7.398E-05
NI 59				3.179E-02	3.179E-02	3.179E-02	3.179E-02	3.178E-02	3.178E-02	3.178E-02
NI 63				3.470E+00	3.394E+00	3.148E+00	2.811E+00	2.511E+00	2.243E+00	1.929E+00
ZN 65				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 79				6.541E-02	6.540E-02	6.540E-02	6.538E-02	6.537E-02	6.536E-02	6.534E-02
KR 85				3.699E+02	3.063E+02	1.604E+02	6.083E+01	2.306E+01	8.741E+00	2.399E+00
RB 87				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 89				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90				6.928E+03	6.463E+03	5.094E+03	3.565E+03	2.494E+03	1.746E+03	1.084E+03
Y 90				6.930E+03	6.465E+03	5.096E+03	3.566E+03	2.495E+03	1.746E+03	1.084E+03
Y 91				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93				2.948E-01	2.948E-01	2.948E-01	2.948E-01	2.948E-01	2.948E-01	2.948E-01
ZR 95				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M				1.929E-01	2.049E-01	2.349E-01	2.591E-01	2.703E-01	2.755E-01	2.784E-01

DECAY TIMES (years out of core)
(Activities* in Ci/MTU)

Radionuclide	5	10	15	22.08	25	35	50	65	80	100
NB 94				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC 99				2.190E+00	2.190E+00	2.190E+00	2.190E+00	2.190E+00	2.190E+00	2.190E+00
RU103				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106				2.560E-02	3.441E-03	3.553E-06	1.177E-10	3.899E-15	1.291E-19	1.375E-25
RH103M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106				2.559E-02	3.441E-03	3.553E-06	1.177E-10	3.899E-15	1.291E-19	1.375E-25
PD107				1.560E-02	1.560E-02	1.560E-02	1.560E-02	1.560E-02	1.560E-02	1.560E-02
AG110				7.172E-10	3.728E-11	1.485E-15	3.728E-22	9.353E-29	2.347E-35	3.719E-44
AG110M				5.391E-08	2.803E-09	1.117E-13	2.803E-20	7.034E-27	1.765E-33	2.797E-42
AG111				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M				6.137E-08	3.009E-09	9.810E-14	1.821E-20	3.379E-27	6.272E-34	6.647E-43
SN121M				6.272E-02	6.024E-02	5.244E-02	4.259E-02	3.459E-02	2.809E-02	2.128E-02
SN123				1.720E-16	5.638E-19	1.738E-27	2.957E-40	5.032E-53	8.563E-66	8.089E-83
SN125				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB124				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB126				1.810E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB126M				1.291E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE123M				1.500E-21	3.124E-24	2.035E-33	3.364E-47	5.560E-61	9.190E-75	3.878E-93
TE125M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE127				2.119E-19	2.408E-22	1.978E-32	1.463E-47	1.082E-62	8.004E-78	5.366E-98
TE127M				2.160E-19	2.459E-22	2.019E-32	1.493E-47	1.105E-62	8.172E-78	5.478E-98
TE129				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DECAY TIMES (years out of core)
(Activities* in Ci/MTU)

Radionuclide	5	10	15	22.08	25	35	50	65	80	100
I129				5.160E-03	5.160E-03	5.160E-03	5.160E-03	5.160E-03	5.160E-03	5.160E-03
I131				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134				6.477E+00	2.428E+00	8.425E-02	5.440E-04	3.512E-06	2.267E-08	2.728E-11
CS135				6.040E-02	6.040E-02	6.040E-02	6.040E-02	6.040E-02	6.040E-02	6.039E-02
CS136				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137				9.655E+03	9.026E+03	7.167E+03	5.067E+03	3.584E+03	2.534E+03	1.596E+03
BA136M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M				9.138E+03	8.542E+03	6.780E+03	4.794E+03	3.390E+03	2.397E+03	1.509E+03
BA140				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE144				7.909E-04	5.878E-05	7.975E-09	1.258E-14	1.983E-20	3.126E-26	5.741E-34
PR143				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144				7.820E-04	5.807E-05	7.879E-09	1.242E-14	1.959E-20	3.089E-26	5.672E-34
PR144M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND144				0.000E+00	2.682E-19	2.897E-19	2.897E-19	2.897E-19	2.897E-19	2.897E-19
ND147				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM147				1.091E+02	5.041E+01	3.591E+00	6.823E-02	1.297E-03	2.463E-05	1.249E-07
PM148M				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM147				0.000E+00	1.436E-09	2.584E-09	2.671E-09	2.672E-09	2.672E-09	2.672E-09
SM151				1.020E+02	9.974E+01	9.233E+01	8.226E+01	7.328E+01	6.528E+01	5.597E+01
EU152				8.450E-01	7.282E-01	4.375E-01	2.037E-01	9.483E-02	4.415E-02	1.593E-02
EU154				1.129E+02	8.922E+01	3.987E+01	1.191E+01	3.553E+00	1.060E+00	2.116E-01
EU155				1.060E+01	7.051E+00	1.743E+00	2.141E-01	2.631E-02	3.233E-03	1.975E-04
EU156				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153				5.190E-10	2.450E-11	7.025E-16	1.075E-22	1.647E-29	2.520E-36	2.066E-45
TB160				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DECAY TIMES (years out of core)
(Activities* in Ci/MTU)

Radionuclide	5	10	15	22.08	25	35	50	65	80	100
TL207				0.000E+00	3.522E-08	6.234E-07	2.525E-06	5.233E-06	8.440E-06	1.317E-05
TL208				0.000E+00	1.428E-13	5.123E-12	2.063E-11	3.893E-11	5.785E-11	8.681E-11
PB210				0.000E+00	1.876E-10	1.516E-08	1.381E-07	4.552E-07	1.022E-06	2.222E-06
PB211				0.000E+00	3.532E-08	6.252E-07	2.532E-06	5.247E-06	8.464E-06	1.321E-05
PB212				0.000E+00	3.974E-13	1.426E-11	5.741E-11	1.084E-10	1.610E-10	2.416E-10
BI211				0.000E+00	3.532E-08	6.252E-07	2.532E-06	5.247E-06	8.464E-06	1.321E-05
BI212				0.000E+00	3.974E-13	1.426E-11	5.741E-11	1.084E-10	1.610E-10	2.416E-10
PO212				0.000E+00	2.547E-13	9.138E-12	3.678E-11	6.942E-11	1.032E-10	1.548E-10
PO215				0.000E+00	3.532E-08	6.252E-07	2.532E-06	5.247E-06	8.464E-06	1.321E-05
PO216				0.000E+00	3.974E-13	1.426E-11	5.741E-11	1.084E-10	1.610E-10	2.416E-10
RN219				0.000E+00	3.532E-08	6.252E-07	2.532E-06	5.247E-06	8.464E-06	1.321E-05
RN220				0.000E+00	3.974E-13	1.426E-11	5.741E-11	1.084E-10	1.610E-10	2.416E-10
FR223				0.000E+00	4.873E-10	8.629E-09	3.493E-08	7.236E-08	1.167E-07	1.822E-07
RA223				0.000E+00	3.532E-08	6.252E-07	2.532E-06	5.247E-06	8.464E-06	1.321E-05
RA224				0.000E+00	3.974E-13	1.426E-11	5.741E-11	1.084E-10	1.610E-10	2.416E-10
RA226				0.000E+00	6.381E-09	1.252E-07	5.862E-07	1.388E-06	2.533E-06	4.594E-06
RA228				0.000E+00	1.410E-12	2.046E-11	6.641E-11	1.179E-10	1.708E-10	2.416E-10
AC227				0.000E+00	3.532E-08	6.252E-07	2.531E-06	5.244E-06	8.456E-06	1.320E-05
TH227				0.000E+00	3.483E-08	6.166E-07	2.497E-06	5.175E-06	8.347E-06	1.303E-05
TH228				0.000E+00	3.974E-13	1.426E-11	5.741E-11	1.084E-10	1.610E-10	2.416E-10
TH229				0.000E+00	8.222E-11	1.638E-09	7.757E-09	1.864E-08	3.453E-08	6.399E-08
TH230				0.000E+00	1.010E-05	4.492E-05	9.776E-05	1.511E-04	2.051E-04	2.778E-04
TH231				0.000E+00	1.270E-02	1.270E-02	1.270E-02	1.271E-02	1.271E-02	1.271E-02
TH232				0.000E+00	1.031E-11	4.564E-11	9.871E-11	1.517E-10	2.049E-10	2.758E-10
TH234				0.000E+00	3.309E-01	3.309E-01	3.309E-01	3.309E-01	3.309E-01	3.309E-01
PA231				0.000E+00	7.839E-07	3.471E-06	7.500E-06	1.153E-05	1.556E-05	2.093E-05
PA233				0.000E+00	4.703E-02	4.865E-02	5.135E-02	5.421E-02	5.710E-02	6.093E-02
PA234M				0.000E+00	3.309E-01	3.309E-01	3.309E-01	3.309E-01	3.309E-01	3.309E-01
PA234				0.000E+00	4.303E-04	4.303E-04	4.303E-04	4.303E-04	4.303E-04	4.303E-04
U232				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U233				0.000E+00	5.975E-07	2.688E-06	5.966E-06	9.422E-06	1.308E-05	1.823E-05
U234				3.840E-01	3.851E-01	3.886E-01	3.934E-01	3.978E-01	4.016E-01	4.059E-01
U235				1.270E-02	1.270E-02	1.270E-02	1.270E-02	1.271E-02	1.271E-02	1.271E-02
U236				7.159E-02	7.160E-02	7.165E-02	7.171E-02	7.177E-02	7.183E-02	7.191E-02

DECAY TIMES (years out of core)
(Activities* in Ci/MTU)

Radionuclide	5	10	15	22.08	25	35	50	65	80	100
U237				0.000E+00	1.453E-03	8.983E-04	4.362E-04	2.119E-04	1.029E-04	3.929E-05
U238				3.309E-01	3.309E-01	3.309E-01	3.309E-01	3.309E-01	3.309E-01	3.309E-01
NP237				4.660E-02	4.703E-02	4.865E-02	5.135E-02	5.421E-02	5.710E-02	6.093E-02
PU236				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU237				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238				1.330E+02	1.300E+02	1.202E+02	1.068E+02	9.483E+01	8.429E+01	7.201E+01
PU239				1.730E+02	1.730E+02	1.730E+02	1.729E+02	1.728E+02	1.728E+02	1.727E+02
PU240				1.370E+02	1.369E+02	1.368E+02	1.366E+02	1.364E+02	1.361E+02	1.359E+02
PU241				6.817E+03	5.924E+03	3.661E+03	1.778E+03	8.638E+02	4.195E+02	1.602E+02
PU242				8.716E-02	8.716E-02	8.716E-02	8.716E-02	8.716E-02	8.716E-02	8.707E-02
PU244				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM241				4.339E+02	4.616E+02	5.290E+02	5.783E+02	5.946E+02	5.951E+02	5.847E+02
AM242M				3.721E-01	3.672E-01	3.508E-01	3.276E-01	3.059E-01	2.857E-01	2.608E-01
AM242				3.710E-01	3.653E-01	3.491E-01	3.259E-01	3.044E-01	2.843E-01	2.595E-01
AM243				2.780E-01	2.779E-01	2.777E-01	2.773E-01	2.769E-01	2.766E-01	2.760E-01
CM242				3.081E-01	3.028E-01	2.886E-01	2.696E-01	2.517E-01	2.351E-01	2.146E-01
CM243				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CM244				4.471E+00	3.998E+00	2.727E+00	1.535E+00	8.647E-01	4.871E-01	2.266E-01
CM245				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CM246				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CM247				0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL**				4.110E+04	3.791E+04	2.908E+04	1.994E+04	1.394E+04	9.914E+03	6.467E+03

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Total: total activity of the 145 isotopes listed in the table.

Template 8

Fuel-Specific Source Term Calculations
High Flux Beam Reactor Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term template for a single High Flux Beam Reactor (HFBR) spent nuclear fuel element. This single-element source term uses the highest burnup of the 240 elements stored at the INEEL and is considered to be a bounding source term for these highly enriched spent nuclear fuel elements. The data sources for the analysis are documented in References 1 through 7, and the INEEL calculational methodology is described in Reference 8.

HFBR Reactor Data

The HFBR core and fuel elements are described in References 1 through 7. Data from these references have been used to develop reactor physics models for the depletion and activation analysis.

The HFBR fuel elements are plate-type elements consisting of 19 curved plates. The plates are stacked, separated by a heavy water gap (102–129 mils), and held together as a rectangular structure by two aluminum side plates (140 mils thick). Plates 1 and 19 are aluminum plates containing no fuel. The fuel meat in Plates 2 through 18 is a mixture of U_3O_8 in an aluminum matrix and clad on both sides with aluminum, as shown in Figure 1. The uranium enrichment is nominally 93% high-enriched uranium metal. The uranium isotopic data are given below.

The following data provide specific fuel element dimensions, materials, densities, enrichment, etc., which are typical for a heavy-loaded KM-type HFBR fuel element. There is also a less heavily loaded fuel element in the HFBR called a KL-type fuel element. Both the KM and KL-type fuel elements are identical with the exception of the initial beginning-of-life (BOL) loading. The BOL data below was used in the burnup calculation for the source term generation and is based on a KM-type HFBR fuel element.

Fuel Element:	Curved plate
No. of Plates:	19
Fueled Plates:	17
Fuel Plate Thickness:	50 mils
XY dimensions :	2.820 in. by 3.194 in.
Length:	23.75 in.
Fuel Rod:	U_3O_8 in an Aluminum-6061T matrix
Fuel Density:	3.608 g/cc
Fuel Meat Thickness:	21 mils
Uranium Enrichment:	0.60 wt % U-234
	93.00 wt % U-235
	0.35 wt % U-236
	6.05 wt % U-238

Heavy Metal Loading:	2.26	g/element U-234 (BOL)
	350.61	g/element U-235 (BOL)
	1.32	g/element U-236 (BOL)
	22.81	g/element U-238 (BOL)
	377.00	g/element Total U

Clad:	Aluminum 6061T
Clad Density:	2.70 g/cc
Clad Thickness:	14.5 mils
Side Plates:	Aluminum 6061T
Side Plate Width:	140 mils
Total Aluminum Mass:	4,064.13 g/element

Coolant/Moderator :	Heavy Water (D_2O)
Coolant Temperature:	52 C
Coolant Pressure:	175.3 psig
Coolant Density:	1.09325 g/cc

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single HFBR fuel element. In addition, for the ORIGEN2 (Reference 9) depletion calculation, conservative and detailed impurity concentrations were added for the aluminum clad and structural components. Table 1 lists the Aluminum-6061T impurities and their concentrations (Reference 10).

Burnup

The burnup chosen for this template is 62.3% U-235 depletion, 164.6 MWd, and approximately 218.4 g of U-235 depleted for a single HFBR KM-type element. This is a relatively high burnup and represents the maximum burnup of the HFBR elements stored at the INEEL. This burnup is conservative with respect to the buildup of fission products, activation products, and minor actinides in the source term, but nonconservative with regard to criticality safety, in particular U-235 and U-238 end-of-life concentrations.

For the template analysis here, the burnup period is assumed to be a 3-cycle exposure. The first cycle runs for 24-days, followed by a 25-day cycle, and finally another 24-day cycle. Between Cycles 1 and 2 and Cycles 2 and 3, there is an assumed shutdown period of 14 days. At the end of the third cycle, the element is assumed to be removed from the core and the cooling or decay period begins. During the burnup period, the fuel element output power is assumed to be approximately 2.255 MW and is assumed to be the same and constant for each of the three cycles (see Table 2).

Cross-Section Development

The neutron cross sections used in the burnup or depletion calculation for the source term generation of a single HFBR fuel element are based on the methodology described in Reference 8. Cross sections from a standard ORIGEN2 heavy water reactor library were updated once using the specially developed BOL cross sections for the HFBR. The updated cross sections take into account the unique HFBR neutron flux spatial and spectral characteristics to ensure accurate calculation of the fission product and actinide production as a function of burnup.

In order to calculate the BOL HFBR neutron cross sections, an explicit HFBR fuel assembly was developed with reflective boundary conditions on the element peripheral surfaces. The reflective surfaces simulated an infinite array of HFBR fuel elements.

HFBR Single Element Exposure History

Table 2 summarizes the power or exposure history used in the burnup or source term calculations for a single HFBR fuel element. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years.

Burnup Calculation

The ORIGEN2 computer code (Reference 9) was used to perform the depletion or burnup calculation for the HFBR fuel element. The radionuclide inventory or source term template is for a single HFBR fuel element or assembly. The fuel element masses and impurities, neutron cross sections, burnup, power history, and power level as discussed above are input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of time in the template table.

The 145 radionuclides listed in the template represent greater than 99.99% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. Brookhaven National Laboratory to Westinghouse Idaho Nuclear Co., "Basin Storage Fuel Receipt Criteria, Part A," Idaho Chemical Processing Plant, May 4, 1989.

2. Paul Colsmann (Brookhaven National Laboratory) to Gary Offutt (Exxon Nuclear Idaho Co.), Letter report regarding fuel element description and data, February 11, 1983.

3. G. Price (Brookhaven National Laboratory) to G. Kinne, "MRR fuel elements in the MH-1A shipping cask," Memorandum, February 22, 1985.

4. Mark Davis (Brookhaven National Laboratory) to J. Sawyer (Westinghouse Idaho Nuclear Co.), Letter report regarding fuel element description and data, March 15, 1985.

5. Drawing BR 51-0400-1 Rev. A, "HFBR Fuel Element Type KL Details," Brookhaven National Laboratory, Upton, New York, August 11, 1988.

6. Drawing ME55-95 Rev. A, "HFBR Fuel Element," Brookhaven National Laboratory, Upton, New York.

7. "Research, Training, Test and Production Reactor Directory," 3rd edition, pages 50-57, published by the American Nuclear Society, 1988.

8. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

9. A. G. Croff, *ORIGEN2 – A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

10. ASTM B-209, Table 1, "Chemical Composition Limits," 1990.

Table 1. HFBR Aluminum-6061T material constituent and impurity concentrations.

Constituent or Impurity	Concentration (wt%)
H	0.02143
C	0.02143
O	0.02143
Mg	1.00000
Al	97.15499
Si	0.60000
Ti	0.07500
Cr	0.19500
Mn	0.07500
Fe	0.35000
Ni	0.02143
Cu	0.27500
Zn	0.12500
Zr	0.02143
Sn	0.02143
Pb	0.02143

Table 2. Assumed burnup or power history for a single HFBR fuel element.

Duration (days)	Cumulative Duration (days)	Time- Averaged Power (MW_{th})
24	24	2.255
14	38	0.0
25	63	2.255
14	77	0.0
24	101	2.255
1825	1926	0.0
1825	3751	0.0
1825	5576	0.0
1825	7401	0.0
1825	9226	0.0
3650	12876	0.0
5475	18351	0.0
5475	23826	0.0
5475	29301	0.0
7300	36601	0.0

The bottom ten dates with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling times designated for the template methodology.

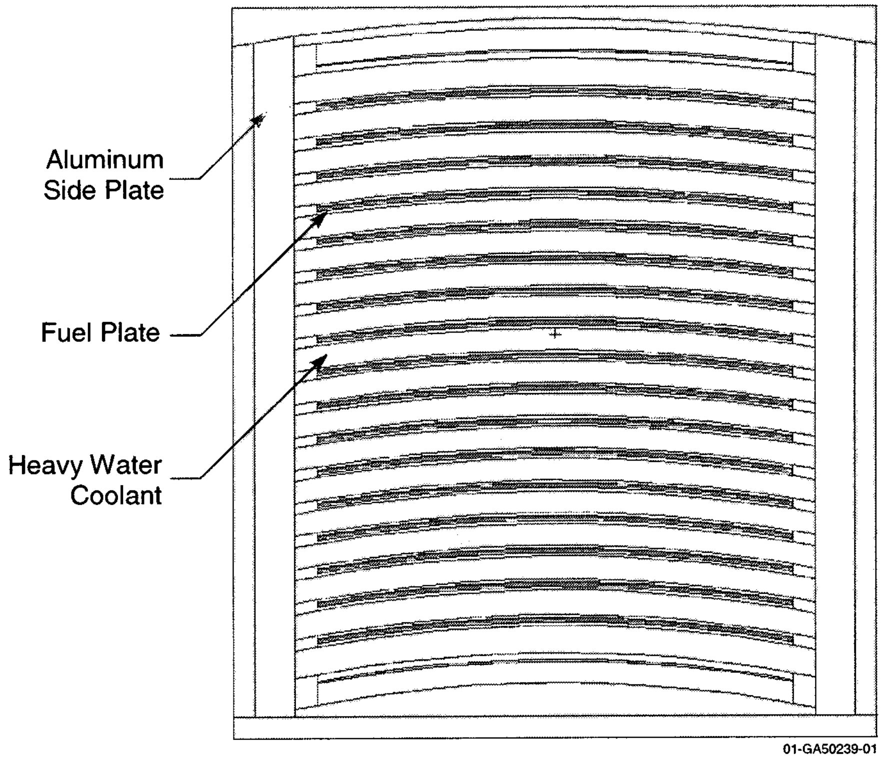

Figure 1. High Flux Beam Reactor curved-plate fuel assembly.

High Flux Beam Reactor Element

Aluminum Cladding, 40 to 100%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Heavy Water
Fuel Meat:	U_3O_8 in Aluminum
Clad:	Aluminum 6061T
Burnup:	436570 MWd/MTU
Burnup:	164.6 MWd/single element (high burnup)
Burnup:	62.3% U-235 depletion (fissioned and transmuted)
Basis of Calculation:	Single fuel element
BOL U-235:	350.61 g U-235 per element
BOL U-238:	22.81 g U-238 per element
BOL U-234:	2.26 g U-234 per element
BOL U-236:	1.32 g U-236 per element
BOL Total U per element:	377.00 g U per element
BOL Fuel Enrichment:	93 wt% U-235

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H 3	1.766E+00	1.334E+00	1.008E+00	7.614E-01	5.752E-01	3.283E-01	1.415E-01	6.101E-02	2.631E-02	8.566E-03
BE 10	1.531E-08	1.531E-08	1.531E-08	1.531E-08	1.531E-08	1.531E-08	1.531E-08	1.531E-08	1.531E-08	1.531E-08
C 14	4.364E-06	4.362E-06	4.358E-06	4.356E-06	4.354E-06	4.348E-06	4.340E-06	4.333E-06	4.325E-06	4.314E-06
CL 36	7.315E-29	7.315E-29	7.315E-29	7.315E-29	7.315E-29	7.315E-29	7.314E-29	7.314E-29	7.314E-29	7.314E-29
CR 51	3.092E-17	4.602E-37	6.851E-57	1.020E-76	1.518E-96	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	8.728E-03	1.524E-04	2.660E-06	4.644E-08	8.107E-10	2.471E-13	1.315E-18	6.994E-24	3.721E-29	3.457E-36
FE 55	1.214E+01	3.204E+00	8.457E-01	2.232E-01	5.891E-02	4.104E-03	7.545E-05	1.387E-06	2.550E-08	1.238E-10
FE 59	1.057E-11	6.542E-24	4.048E-36	2.505E-48	1.550E-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	5.753E-02	2.982E-02	1.545E-02	8.010E-03	4.152E-03	1.115E-03	1.553E-04	2.162E-05	3.010E-06	2.172E-07
NI 59	1.251E-03	1.251E-03	1.251E-03	1.251E-03	1.251E-03	1.251E-03	1.251E-03	1.250E-03	1.250E-03	1.250E-03
NI 63	2.467E-01	2.376E-01	2.288E-01	2.203E-01	2.122E-01	1.968E-01	1.758E-01	1.570E-01	1.403E-01	1.206E-01
ZN 65	8.871E-01	4.956E-03	2.769E-05	1.547E-07	8.644E-10	2.699E-14	4.707E-21	8.210E-28	1.432E-34	1.396E-43
SE 79	2.031E-03	2.031E-03	2.031E-03	2.031E-03	2.031E-03	2.030E-03	2.030E-03	2.030E-03	2.029E-03	2.029E-03
KR 85	4.689E+01	3.394E+01	2.457E+01	1.779E+01	1.288E+01	6.749E+00	2.560E+00	9.713E-01	3.685E-01	1.012E-01
RB 87	1.409E-07	1.409E-07	1.409E-07	1.409E-07	1.409E-07	1.409E-07	1.409E-07	1.409E-07	1.409E-07	1.409E-07
SR 89	6.465E-07	8.536E-18	1.127E-28	1.488E-39	1.965E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	4.484E+02	3.981E+02	3.535E+02	3.138E+02	2.787E+02	2.197E+02	1.537E+02	1.076E+02	7.532E+01	4.681E+01
Y 90	4.485E+02	3.982E+02	3.536E+02	3.139E+02	2.787E+02	2.197E+02	1.538E+02	1.076E+02	7.534E+01	4.682E+01
Y 91	2.270E-05	9.249E-15	3.768E-24	1.535E-33	6.253E-43	1.038E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	1.068E-02	1.068E-02	1.068E-02	1.068E-02	1.068E-02	1.068E-02	1.068E-02	1.068E-02	1.068E-02	1.068E-02

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
ZR 95	1.503E-04	3.893E-13	1.009E-21	2.613E-30	6.771E-39	4.545E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M	2.340E-03	4.097E-03	5.458E-03	6.513E-03	7.331E-03	8.457E-03	9.362E-03	9.783E-03	9.980E-03	1.009E-02
NB 94	1.265E-07	1.265E-07	1.264E-07	1.264E-07	1.264E-07	1.264E-07	1.263E-07	1.262E-07	1.262E-07	1.261E-07
NB 95	3.336E-04	8.643E-13	2.239E-21	5.802E-30	1.503E-38	1.009E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M	1.115E-06	2.888E-15	7.483E-24	1.939E-32	5.023E-41	3.372E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC 99	6.264E-02	6.264E-02	6.264E-02	6.264E-02	6.264E-02	6.264E-02	6.263E-02	6.263E-02	6.263E-02	6.262E-02
RU103	3.739E-10	3.867E-24	3.999E-38	4.136E-52	4.278E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	3.618E+01	1.165E+00	3.751E-02	1.208E-03	3.888E-05	4.031E-08	1.345E-12	4.490E-17	1.499E-21	1.611E-27
RH103M	3.371E-10	3.486E-24	3.605E-38	3.729E-52	3.856E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	3.618E+01	1.165E+00	3.751E-02	1.208E-03	3.888E-05	4.031E-08	1.345E-12	4.490E-17	1.499E-21	1.611E-27
PD107	8.699E-05	8.699E-05	8.699E-05	8.699E-05	8.699E-05	8.699E-05	8.699E-05	8.699E-05	8.699E-05	8.699E-05
AG110	2.696E-04	1.707E-06	1.081E-08	6.841E-11	4.331E-13	1.736E-17	4.404E-24	1.118E-30	2.836E-37	4.555E-46
AG110M	2.027E-02	1.283E-04	8.125E-07	5.144E-09	3.256E-11	1.305E-15	3.312E-22	8.403E-29	2.132E-35	3.425E-44
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	5.666E-02	4.469E-02	3.524E-02	2.780E-02	2.192E-02	1.364E-02	6.690E-03	3.282E-03	1.610E-03	6.229E-04
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	5.021E-12	2.407E-24	1.154E-36	5.531E-49	2.651E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	6.849E-13	5.498E-24	4.412E-35	3.542E-46	2.843E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	7.157E-13	5.744E-24	4.611E-35	3.701E-46	2.971E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	3.529E-16	1.692E-28	8.110E-41	3.887E-53	1.863E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	2.449E-02	1.402E-04	8.028E-07	4.597E-09	2.632E-11	8.630E-16	1.620E-22	3.041E-29	5.709E-36	6.138E-45
SN121M	6.173E-04	5.760E-04	5.374E-04	5.014E-04	4.679E-04	4.073E-04	3.308E-04	2.687E-04	2.183E-04	1.654E-04
SN123	1.608E-03	8.974E-08	5.009E-12	2.796E-16	1.560E-20	4.861E-29	8.451E-42	1.469E-54	2.555E-67	2.479E-84
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	1.678E-03	1.678E-03	1.678E-03	1.678E-03	1.678E-03	1.678E-03	1.678E-03	1.677E-03	1.677E-03	1.677E-03
SB124	9.331E-09	6.974E-18	5.214E-27	3.897E-36	2.913E-45	1.627E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	9.106E+00	2.608E+00	7.469E-01	2.139E-01	6.125E-02	5.025E-03	1.181E-04	2.773E-06	6.513E-08	4.382E-10
SB126	2.349E-04	2.349E-04	2.349E-04	2.349E-04	2.349E-04	2.349E-04	2.349E-04	2.348E-04	2.348E-04	2.348E-04
SB126M	1.678E-03	1.678E-03	1.678E-03	1.678E-03	1.678E-03	1.678E-03	1.678E-03	1.677E-03	1.677E-03	1.677E-03
TE123M	2.469E-06	6.339E-11	1.627E-15	4.178E-20	1.073E-24	7.066E-34	1.195E-47	2.022E-61	3.421E-75	1.485E-93
TE125M	2.222E+00	6.363E-01	1.822E-01	5.219E-02	1.494E-02	1.225E-03	2.879E-05	6.766E-07	1.589E-08	1.069E-10
TE127	1.161E-03	1.059E-08	9.657E-14	8.808E-19	8.034E-24	6.683E-34	5.071E-49	3.847E-64	2.919E-79	2.020E-99
TE127M	1.185E-03	1.081E-08	9.859E-14	8.992E-19	8.202E-24	6.823E-34	5.177E-49	3.928E-64	2.980E-79	2.063E-99
TE129	3.550E-14	1.583E-30	7.057E-47	3.146E-63	1.403E-79	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TE129M	5.454E-14	2.432E-30	1.084E-46	4.834E-63	2.155E-79	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	1.093E-04	1.093E-04	1.093E-04	1.093E-04	1.093E-04	1.093E-04	1.093E-04	1.093E-04	1.093E-04	1.093E-04
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	2.701E+02	5.036E+01	9.390E+00	1.751E+00	3.264E-01	1.134E-02	7.352E-05	4.764E-07	3.087E-09	3.730E-12
CS135	7.006E-04	7.006E-04	7.006E-04	7.006E-04	7.006E-04	7.006E-04	7.006E-04	7.006E-04	7.006E-04	7.006E-04
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	4.739E+02	4.222E+02	3.762E+02	3.351E+02	2.986E+02	2.370E+02	1.676E+02	1.186E+02	8.386E+01	5.284E+01
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	4.483E+02	3.994E+02	3.558E+02	3.170E+02	2.825E+02	2.242E+02	1.586E+02	1.122E+02	7.933E+01	4.999E+01
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	9.182E-13	1.161E-29	1.469E-46	1.858E-63	2.350E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	1.478E-07	1.478E-07	1.478E-07	1.478E-07	1.478E-07	1.478E-07	1.478E-07	1.478E-07	1.478E-07	1.478E-07
CE144	1.865E+02	2.178E+00	2.543E-02	2.970E-04	3.468E-06	4.728E-10	7.528E-16	1.199E-21	1.908E-27	3.548E-35
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	1.865E+02	2.178E+00	2.543E-02	2.970E-04	3.468E-06	4.729E-10	7.529E-16	1.199E-21	1.908E-27	3.548E-35
PR144M	2.238E+00	2.614E-02	3.052E-04	3.564E-06	4.161E-08	5.674E-12	9.034E-18	1.438E-23	2.290E-29	4.258E-37
ND144	7.955E-12	8.023E-12	8.024E-12	8.024E-12	8.024E-12	8.024E-12	8.024E-12	8.024E-12	8.024E-12	8.024E-12
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM147	2.108E+02	5.631E+01	1.504E+01	4.017E+00	1.073E+00	7.654E-02	1.458E-03	2.779E-05	5.295E-07	2.695E-09
PM148M	9.845E-12	4.896E-25	2.435E-38	1.211E-51	6.022E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	5.545E-13	2.758E-26	1.371E-39	6.820E-53	3.392E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM147	1.463E-08	1.842E-08	1.943E-08	1.970E-08	1.977E-08	1.979E-08	1.980E-08	1.980E-08	1.980E-08	1.980E-08
SM151	3.313E+00	3.188E+00	3.068E+00	2.952E+00	2.841E+00	2.630E+00	2.343E+00	2.088E+00	1.860E+00	1.595E+00
EU152	5.305E-04	4.112E-04	3.188E-04	2.471E-04	1.916E-04	1.151E-04	5.362E-05	2.498E-05	1.164E-05	4.202E-06
EU154	2.862E+01	1.914E+01	1.279E+01	8.552E+00	5.717E+00	2.555E+00	7.633E-01	2.280E-01	6.813E-02	1.361E-02
EU155	1.912E+01	9.510E+00	4.730E+00	2.353E+00	1.170E+00	2.895E-01	3.563E-02	4.384E-03	5.395E-04	3.302E-05
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	7.804E-04	4.191E-06	2.250E-08	1.208E-10	6.488E-13	1.871E-17	2.897E-24	4.486E-31	6.946E-38	5.776E-47
TB160	4.633E-08	1.168E-15	2.947E-23	7.431E-31	1.874E-38	1.192E-53	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	1.255E-13	1.255E-13	1.255E-13	1.255E-13	1.255E-13	1.255E-13	1.255E-13	1.255E-13	1.255E-13	1.255E-13

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TL207	3.538E-09	1.099E-08	2.179E-08	3.545E-08	5.153E-08	8.957E-08	1.575E-07	2.339E-07	3.157E-07	4.295E-07
TL208	4.476E-06	7.224E-06	8.031E-06	8.037E-06	7.781E-06	7.109E-06	6.157E-06	5.330E-06	4.614E-06	3.810E-06
PB210	1.936E-11	1.384E-10	4.447E-10	1.018E-09	1.931E-09	5.044E-09	1.380E-08	2.863E-08	5.065E-08	9.276E-08
PB211	3.548E-09	1.102E-08	2.185E-08	3.554E-08	5.168E-08	8.983E-08	1.579E-07	2.346E-07	3.166E-07	4.307E-07
PB212	1.246E-05	2.010E-05	2.235E-05	2.237E-05	2.166E-05	1.979E-05	1.714E-05	1.483E-05	1.284E-05	1.060E-05
BI211	3.548E-09	1.102E-08	2.185E-08	3.554E-08	5.168E-08	8.983E-08	1.579E-07	2.346E-07	3.166E-07	4.307E-07
BI212	1.246E-05	2.010E-05	2.235E-05	2.237E-05	2.166E-05	1.979E-05	1.714E-05	1.483E-05	1.284E-05	1.060E-05
PO212	7.982E-06	1.288E-05	1.432E-05	1.433E-05	1.388E-05	1.268E-05	1.098E-05	9.504E-06	8.227E-06	6.793E-06
PO215	3.548E-09	1.102E-08	2.185E-08	3.554E-08	5.168E-08	8.983E-08	1.579E-07	2.346E-07	3.166E-07	4.307E-07
PO216	1.246E-05	2.010E-05	2.235E-05	2.237E-05	2.166E-05	1.979E-05	1.714E-05	1.483E-05	1.284E-05	1.060E-05
RN219	3.548E-09	1.102E-08	2.185E-08	3.554E-08	5.168E-08	8.983E-08	1.579E-07	2.346E-07	3.166E-07	4.307E-07
RN220	1.246E-05	2.010E-05	2.235E-05	2.237E-05	2.166E-05	1.979E-05	1.714E-05	1.483E-05	1.284E-05	1.060E-05
FR223	4.896E-11	1.520E-10	3.013E-10	4.899E-10	7.122E-10	1.238E-09	2.177E-09	3.234E-09	4.364E-09	5.938E-09
RA223	3.548E-09	1.102E-08	2.185E-08	3.554E-08	5.168E-08	8.983E-08	1.579E-07	2.346E-07	3.166E-07	4.307E-07
RA224	1.246E-05	2.010E-05	2.235E-05	2.237E-05	2.166E-05	1.979E-05	1.714E-05	1.483E-05	1.284E-05	1.060E-05
RA226	3.675E-10	1.421E-09	3.199E-09	5.736E-09	9.066E-09	1.824E-08	3.870E-08	6.788E-08	1.064E-07	1.732E-07
RA228	1.568E-13	5.237E-13	1.016E-12	1.583E-12	2.195E-12	3.487E-12	5.492E-12	7.519E-12	9.550E-12	1.226E-11
AC227	3.548E-09	1.102E-08	2.183E-08	3.550E-08	5.161E-08	8.974E-08	1.578E-07	2.344E-07	3.163E-07	4.303E-07
TH227	3.499E-09	1.087E-08	2.155E-08	3.505E-08	5.097E-08	8.859E-08	1.557E-07	2.314E-07	3.122E-07	4.248E-07
TH228	1.246E-05	2.009E-05	2.233E-05	2.235E-05	2.164E-05	1.978E-05	1.714E-05	1.483E-05	1.284E-05	1.060E-05
TH229	6.538E-11	1.714E-10	3.308E-10	5.436E-10	8.098E-10	1.502E-09	2.941E-09	4.861E-09	7.261E-09	1.121E-08
TH230	3.254E-07	6.526E-07	9.971E-07	1.358E-06	1.736E-06	2.536E-06	3.843E-06	5.264E-06	6.787E-06	8.955E-06
TH231	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04
TH232	6.979E-13	1.375E-12	2.053E-12	2.730E-12	3.408E-12	4.763E-12	6.796E-12	8.828E-12	1.086E-11	1.357E-11
TH234	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06
PA231	3.879E-08	6.903E-08	9.926E-08	1.295E-07	1.597E-07	2.201E-07	3.107E-07	4.013E-07	4.918E-07	6.125E-07
PA233	5.185E-03	5.186E-03	5.187E-03	5.189E-03	5.191E-03	5.196E-03	5.203E-03	5.212E-03	5.220E-03	5.231E-03
PA234M	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06
PA234	7.951E-09	7.951E-09	7.951E-09	7.951E-09	7.951E-09	7.951E-09	7.951E-09	7.951E-09	7.951E-09	7.951E-09
U232	1.880E-05	2.246E-05	2.275E-05	2.208E-05	2.116E-05	1.927E-05	1.668E-05	1.444E-05	1.250E-05	1.031E-05
U233	1.669E-07	2.802E-07	3.935E-07	5.068E-07	6.202E-07	8.472E-07	1.188E-06	1.529E-06	1.871E-06	2.328E-06
U234	7.076E-03	7.471E-03	7.851E-03	8.216E-03	8.567E-03	9.229E-03	1.013E-02	1.093E-02	1.164E-02	1.246E-02
U235	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04	2.859E-04
U236	2.749E-03	2.749E-03	2.749E-03	2.749E-03	2.749E-03	2.749E-03	2.749E-03	2.749E-03	2.749E-03	2.749E-03
U237	1.116E-05	8.776E-06	6.900E-06	5.425E-06	4.265E-06	2.636E-06	1.281E-06	6.227E-07	3.027E-07	1.157E-07

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
U238	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06	6.116E-06
NP237	5.185E-03	5.186E-03	5.187E-03	5.189E-03	5.191E-03	5.196E-03	5.203E-03	5.212E-03	5.220E-03	5.231E-03
PU236	1.678E-04	4.980E-05	1.478E-05	4.389E-06	1.304E-06	1.172E-07	5.596E-09	2.677E-09	2.601E-09	2.598E-09
PU237	2.498E-14	2.238E-26	2.005E-38	1.796E-50	1.609E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	2.846E+01	2.736E+01	2.630E+01	2.528E+01	2.431E+01	2.246E+01	1.995E+01	1.772E+01	1.574E+01	1.345E+01
PU239	1.145E-01	1.145E-01	1.144E-01	1.144E-01	1.144E-01	1.144E-01	1.143E-01	1.143E-01	1.142E-01	1.142E-01
PU240	6.005E-02	6.068E-02	6.118E-02	6.160E-02	6.194E-02	6.243E-02	6.285E-02	6.304E-02	6.311E-02	6.309E-02
PU241	4.550E+01	3.577E+01	2.813E+01	2.211E+01	1.739E+01	1.075E+01	5.223E+00	2.538E+00	1.234E+00	4.716E-01
PU242	5.088E-04	5.088E-04	5.088E-04	5.088E-04	5.088E-04	5.088E-04	5.088E-04	5.088E-04	5.088E-04	5.088E-04
PU244	2.820E-09	2.820E-09	2.820E-09	2.820E-09	2.820E-09	2.820E-09	2.820E-09	2.820E-09	2.820E-09	2.820E-09
AM241	4.139E-01	7.334E-01	9.812E-01	1.173E+00	1.320E+00	1.519E+00	1.664E+00	1.713E+00	1.715E+00	1.686E+00
AM242M	2.414E-04	2.359E-04	2.306E-04	2.254E-04	2.204E-04	2.105E-04	1.966E-04	1.836E-04	1.715E-04	1.566E-04
AM242	2.402E-04	2.348E-04	2.295E-04	2.243E-04	2.193E-04	2.095E-04	1.956E-04	1.827E-04	1.707E-04	1.558E-04
AM243	6.115E-03	6.112E-03	6.109E-03	6.106E-03	6.104E-03	6.098E-03	6.089E-03	6.081E-03	6.072E-03	6.061E-03
CM242	1.144E-03	1.946E-04	1.899E-04	1.856E-04	1.814E-04	1.732E-04	1.618E-04	1.511E-04	1.411E-04	1.288E-04
CM243	1.352E-03	1.197E-03	1.060E-03	9.387E-04	8.312E-04	6.519E-04	4.527E-04	3.144E-04	2.184E-04	1.343E-04
CM244	1.360E+00	1.123E+00	9.278E-01	7.663E-01	6.329E-01	4.317E-01	2.432E-01	1.370E-01	7.722E-02	3.593E-02
CM245	3.192E-04	3.191E-04	3.190E-04	3.188E-04	3.187E-04	3.184E-04	3.180E-04	3.177E-04	3.173E-04	3.168E-04
CM246	3.676E-05	3.673E-05	3.670E-05	3.668E-05	3.665E-05	3.660E-05	3.652E-05	3.644E-05	3.636E-05	3.625E-05
CM247	2.180E-10	2.180E-10	2.180E-10	2.180E-10	2.180E-10	2.180E-10	2.180E-10	2.180E-10	2.180E-10	2.180E-10
Subtotal**	2.948E+03	1.870E+03	1.569E+03	1.368E+03	1.207E+03	9.489E+02	6.671E+02	4.719E+02	3.354E+02	2.142E+02
TOTAL***	2.948E+03	1.870E+03	1.569E+03	1.369E+03	1.207E+03	9.490E+02	6.672E+02	4.719E+02	3.354E+02	2.142E+02

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.

** Subtotal: total activity of the 145 isotopes listed in the table.

*** Total: total activity of the ORIGEN2 output isotopes.

Template 9

Representative Fuel Source Term Calculations

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term template to represent an aluminum clad, 10 to 20%-enriched, uranium-based fuel from a heavy water moderated reactor. No one specific fuel element in the Template 9 group of fuels was singled out for the template development. Because the spent fuels in this group are primarily MTR-type or plate-type fuels, the previously constructed High Flux Beam Reactor (HFBR) fuel element geometry model (Template 8) was modified to represent fuels in this group. Modifications included developing new cross sections and adjusting enrichment and burnup. Other differences include the fuel meat material and the number of fueled plates in the element. These data are included below. The calculational methodology used in the template development here is described in Reference 1.

Reactor Data

The hypothetical element is a plate-type element consisting of 19 curved plates. The plates are stacked, separated by a heavy water gap (102–129 mils), and held together as a rectangular structure by two aluminum side plates (140 mils thick). The fuel meat in plates 1 through 19 is a uranium-aluminum-silicon matrix and is clad with aluminum, as shown in Figure 1. The uranium enrichment is nominally 15% high-enriched uranium metal and represents the midpoint of the 10–20% U-235 enrichment characteristic of the Template 9 fuel group. The uranium isotopic data are given below.

The following data provide specific fuel element dimensions, materials, densities, enrichment, etc., which are used to represent the hypothetical fuel element. The BOL data below were used in the BOL cross-section development and the burnup calculation for the source term generation.

Fuel Element:	Curved plate
No. of Plates:	19
Fueled Plates:	19
Fuel Plate Thickness:	50 mils
XY dimensions:	2.820 in. by 3.194 in.
Length:	23.75 in.
Fuel Rod:	U-Al-Si (30% U, 68% Al, 2% Si)
Fuel Density:	3.616 g/cc
Fuel Meat Thickness:	21 mils
Uranium Enrichment:	0.60 wt % U-234
	15.00 wt % U-235
	0.35 wt % U-236
	84.05 wt % U-238
Heavy Metal Loading:	2.06 g/element U-234 (BOL)
	51.38 g/element U-235 (BOL)
	1.20 g/element U-236 (BOL)
	287.87 g/element U-238 (BOL)
	342.51 g/element Total U

Clad:	Aluminum 6061T
Clad Density:	2.70 g/cc
Clad Thickness:	14.5 mils
Side Plates:	Aluminum 6061T
Side Plate Width:	140 mils
Total Aluminum Mass:	4,064.13 g/element
Coolant/Moderator:	Heavy Water (D_2O)
Coolant Temperature:	52°C
Coolant Pressure:	175.3 psig
Coolant Density:	1.09325 g/cc

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single hypothetical fuel element. In addition, for the ORIGEN2 (Reference 2) depletion calculation, conservative and detailed impurity concentrations were added for the aluminum clad and structural components. Table 1 lists the Aluminum-6061T impurities and their concentrations (Reference 3).

Burnup

The burnup chosen for this template is 34.27% U-235 depletion or 15 MWd. Approximately 17.61 g U-235 were depleted for this single element. This burnup represents a medium range burnup for this element and its uranium loading.

For this analysis, the burnup period is assumed to be 1 year. The burnup and reactor power (approximately 0.041 MW) is further assumed to be constant and uniform over the 1-year period. At the end of the 1-year period, the element is assumed to be removed from the core, and the cooling or decay period begins. Table 2 gives the irradiation period and decay times following irradiation.

Cross-Section Development

The neutron cross sections used in the burnup or depletion calculation are based on the methodology described in Reference 1. Cross sections from a standard ORIGEN2 heavy water reactor library were updated once using the specially developed beginning-of-life (BOL) cross sections for the hypothetical fuel element. The updated cross sections take into account the unique neutron flux spatial and spectral characteristics to ensure accurate calculation of the fission product and actinide production as a function of burnup.

In order to calculate the BOL neutron cross sections, an explicit fuel assembly was developed with reflective boundary conditions on the element peripheral surfaces. The reflective surfaces simulated an infinite array of fuel elements. The fuel element model is shown in Figure 1.

Fuel Element Exposure History

Table 2 summarizes the power or exposure history used in the burnup or source term calculations for the single fuel element. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years.

Burnup Calculation

The ORIGEN2 computer code (Reference 2) was used to perform the depletion or burnup calculation for the fuel element. The radionuclide inventory or source term template is for a single fuel element or assembly. The fuel element masses and impurities, neutron cross sections, burnup, power history, and power level as discussed above are input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of time in the template table.

The 145 radionuclides listed in the template represent greater than 99.9% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

2. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

3. ASTM B-209, Table 1, "Chemical Composition Limits," 1990.

Table 1. Aluminum-6061T material constituent and impurity concentrations.

Constituent or Impurity	Concentration (wt%)
H	0.02143
C	0.02143
O	0.02143
Mg	1.00000
Al	97.15499
Si	0.60000
Ti	0.07500
Cr	0.19500
Mn	0.07500
Fe	0.35000
Ni	0.02143
Cu	0.27500
Zn	0.12500
Zr	0.02143
Sn	0.02143
Pb	0.02143

Table 2. Assumed burnup or power history.

Condition	Time (years)	Decay Time (days)	Cumulative Duration (days)	Time-Averaged Power (MW_{th})
Irradiation	1	—	365.25	0.041
Decay	5	1825.00	2191.50	0.0
Decay	10	3652.50	4017.75	0.0
Decay	15	5478.75	5844.00	0.0
Decay	20	7305.00	7670.25	0.0
Decay	25	9131.25	9496.50	0.0
Decay	35	12783.75	13149.00	0.0
Decay	50	18262.50	18627.75	0.0
Decay	65	23741.25	24106.50	0.0
Decay	80	29220.00	29585.25	0.0
Decay	100	36525.00	36890.25	0.0

The bottom ten dates with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling times designated for the template methodology.

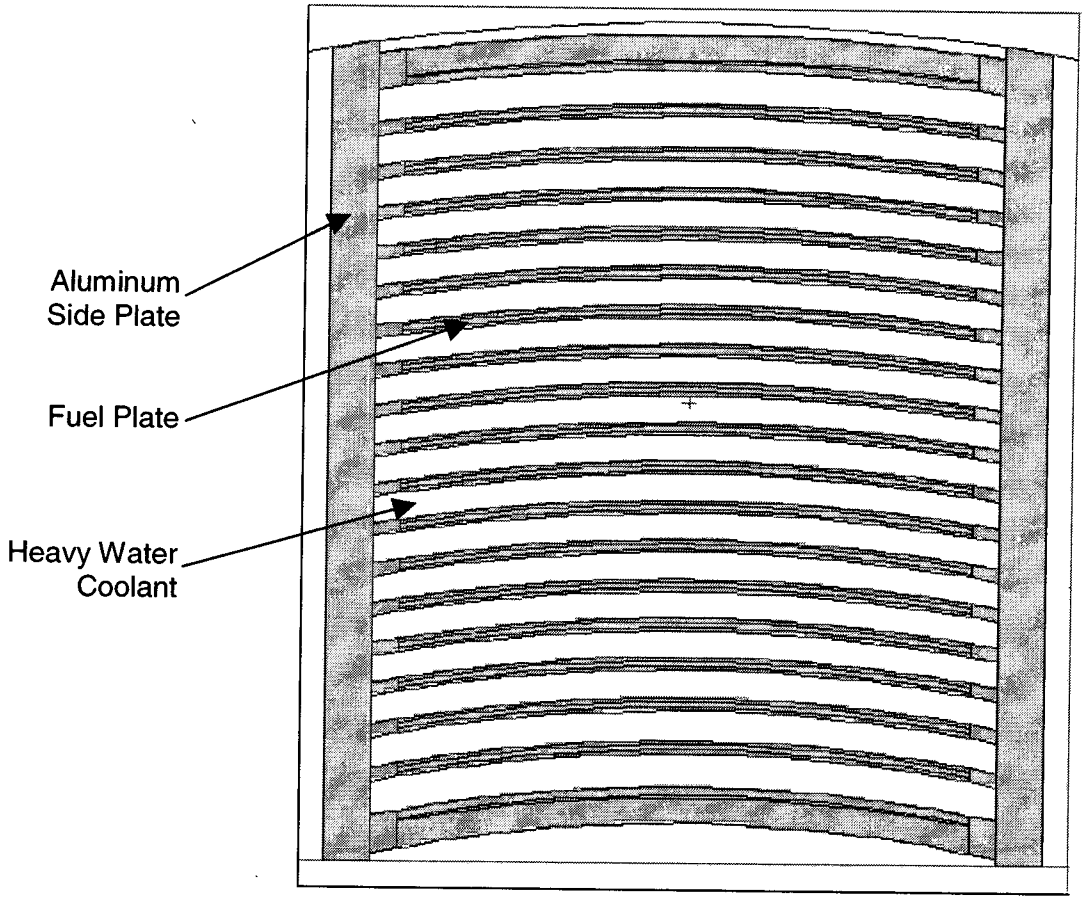

Figure 1. Curved-plate fuel assembly used in the analysis.

Representative Template 9 Reactor Element

Aluminum Cladding, 10 to 20%-Enriched U-235 Fuel, Heavy Water Moderated Reactor

Reactor Moderator/Coolant:	Heavy Water
Fuel Meat:	U-Al-Si (30% U, 68% Al, 2% Si) in Aluminum
Clad:	Aluminum 6061T
Burnup:	17.61 g U-235 depleted
Burnup:	15 MWd/single element (high burnup)
Burnup:	34.27% U-235 depletion (fissioned and transmuted)
Basis of Calculation:	Single fuel element
BOL U-234:	2.06 g U-234 per element
BOL U-235:	51.38 g U-235 per element
BOL U-236:	1.20 g U-236 per element
BOL U-238:	287.87 g U-238 per element
BOL Total U per element:	342.51 g U per element
BOL Fuel Enrichment:	15 wt% U-235

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H 3	1.624E-01	1.227E-01	9.266E-02	6.998E-02	5.285E-02	3.015E-02	1.299E-02	5.597E-03	2.412E-03	7.850E-04
BE 10	1.421E-09	1.421E-09	1.421E-09	1.421E-09	1.421E-09	1.421E-09	1.421E-09	1.421E-09	1.421E-09	1.421E-09
C 14	4.451E-07	4.448E-07	4.446E-07	4.443E-07	4.440E-07	4.435E-07	4.427E-07	4.419E-07	4.411E-07	4.400E-07
CL 36	8.927E-34	8.927E-34	8.927E-34	8.927E-34	8.926E-34	8.926E-34	8.926E-34	8.926E-34	8.925E-34	8.925E-34
CR 51	9.101E-19	1.313E-38	1.894E-58	2.733E-78	3.943E-98	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	9.224E-04	1.606E-05	2.796E-07	4.867E-09	8.473E-11	2.568E-14	1.355E-19	7.150E-25	3.772E-30	3.465E-37
FE 55	1.159E+00	3.056E-01	8.059E-02	2.125E-02	5.604E-03	3.897E-04	7.144E-06	1.310E-07	2.402E-09	1.161E-11
FE 59	3.117E-13	1.892E-25	1.149E-37	6.973E-50	4.233E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	1.763E-03	9.134E-04	4.732E-04	2.451E-04	1.270E-04	3.408E-05	4.739E-06	6.589E-07	9.161E-08	6.599E-09
NI 59	2.094E-04	2.094E-04	2.094E-04	2.094E-04	2.094E-04	2.094E-04	2.094E-04	2.093E-04	2.093E-04	2.093E-04
NI 63	3.030E-02	2.918E-02	2.810E-02	2.707E-02	2.606E-02	2.417E-02	2.159E-02	1.928E-02	1.722E-02	1.481E-02
ZN 65	6.440E-02	3.585E-04	1.996E-06	1.111E-08	6.187E-11	1.918E-15	3.310E-22	5.712E-29	9.857E-36	9.471E-45
SE 79	1.881E-04	1.881E-04	1.881E-04	1.880E-04	1.880E-04	1.880E-04	1.880E-04	1.880E-04	1.879E-04	1.879E-04
KR 85	4.051E+00	2.932E+00	2.122E+00	1.536E+00	1.112E+00	5.822E-01	2.207E-01	8.369E-02	3.173E-02	8.706E-03
RB 87	1.253E-08	1.253E-08	1.253E-08	1.253E-08	1.253E-08	1.253E-08	1.253E-08	1.253E-08	1.253E-08	1.253E-08
SR 89	1.966E-08	2.552E-19	3.313E-30	4.299E-41	5.580E-52	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	3.944E+01	3.501E+01	3.108E+01	2.760E+01	2.450E+01	1.931E+01	1.351E+01	9.455E+00	6.616E+00	4.110E+00
Y 90	3.945E+01	3.502E+01	3.109E+01	2.760E+01	2.451E+01	1.931E+01	1.352E+01	9.458E+00	6.618E+00	4.111E+00
Y 91	7.487E-07	3.005E-16	1.206E-25	4.842E-35	1.944E-44	3.131E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
ZR 93	9.761E-04	9.761E-04	9.761E-04	9.761E-04	9.760E-04	9.760E-04	9.760E-04	9.760E-04	9.760E-04	9.760E-04
ZR 95	5.352E-06	1.368E-14	3.496E-23	8.938E-32	2.284E-40	1.493E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M	2.272E-04	3.846E-04	5.067E-04	6.013E-04	6.746E-04	7.755E-04	8.566E-04	8.944E-04	9.119E-04	9.217E-04
NB 94	2.237E-08	2.237E-08	2.237E-08	2.236E-08	2.236E-08	2.235E-08	2.234E-08	2.233E-08	2.232E-08	2.230E-08
NB 95	1.188E-05	3.037E-14	7.763E-23	1.984E-31	5.072E-40	3.314E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M	3.970E-08	1.015E-16	2.594E-25	6.630E-34	1.695E-42	1.107E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC 99	6.531E-03	6.531E-03	6.530E-03	6.530E-03	6.530E-03	6.530E-03	6.530E-03	6.529E-03	6.529E-03	6.529E-03
RU103	1.232E-11	1.246E-25	1.261E-39	1.276E-53	1.291E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	3.837E+00	1.232E-01	3.959E-03	1.272E-04	4.085E-06	4.214E-09	1.397E-13	4.629E-18	1.534E-22	1.633E-28
RH103M	1.111E-11	1.124E-25	1.137E-39	1.150E-53	1.163E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	3.837E+00	1.232E-01	3.959E-03	1.272E-04	4.085E-06	4.214E-09	1.397E-13	4.629E-18	1.534E-22	1.633E-28
PD107	1.398E-05	1.398E-05	1.398E-05	1.398E-05	1.398E-05	1.398E-05	1.398E-05	1.398E-05	1.398E-05	1.398E-05
AG110	9.694E-06	6.116E-08	3.858E-10	2.434E-12	1.536E-14	6.112E-19	1.535E-25	3.854E-32	9.679E-39	1.533E-47
AG110M	7.289E-04	4.598E-06	2.901E-08	1.830E-10	1.155E-12	4.596E-17	1.154E-23	2.898E-30	7.277E-37	1.153E-45
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	4.962E-03	3.913E-03	3.086E-03	2.433E-03	1.919E-03	1.193E-03	5.850E-04	2.868E-04	1.407E-04	5.438E-05
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	2.306E-13	1.084E-25	5.098E-38	2.397E-50	1.127E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	4.232E-15	3.339E-26	2.633E-37	2.077E-48	1.637E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	4.423E-15	3.488E-26	2.752E-37	2.170E-48	1.712E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	1.621E-17	7.621E-30	3.583E-42	1.684E-54	7.919E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	1.834E-03	1.046E-05	5.969E-08	3.405E-10	1.943E-12	6.326E-17	1.175E-23	2.182E-30	4.054E-37	4.296E-46
SN121M	6.625E-05	6.181E-05	5.767E-05	5.381E-05	5.021E-05	4.370E-05	3.550E-05	2.882E-05	2.341E-05	1.774E-05
SN123	9.145E-05	5.070E-09	2.811E-13	1.558E-17	8.640E-22	2.656E-30	4.525E-43	7.711E-56	1.314E-68	1.241E-85
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.708E-04	1.708E-04
SB124	6.877E-11	5.066E-20	3.733E-29	2.750E-38	2.027E-47	1.100E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	8.982E-01	2.570E-01	7.354E-02	2.105E-02	6.022E-03	4.931E-04	1.155E-05	2.707E-07	6.343E-09	4.252E-11
SB126	2.393E-05	2.393E-05	2.393E-05	2.393E-05	2.393E-05	2.393E-05	2.392E-05	2.392E-05	2.392E-05	2.392E-05
SB126M	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.709E-04	1.708E-04	1.708E-04
TE123M	2.852E-09	7.268E-14	1.853E-18	4.721E-23	1.203E-27	7.815E-37	1.293E-50	2.142E-64	3.545E-78	1.495E-96
TE125M	2.192E-01	6.271E-02	1.795E-02	5.134E-03	1.469E-03	1.203E-04	2.819E-06	6.604E-08	1.548E-09	1.038E-11
TE127	6.763E-05	6.120E-10	5.538E-15	5.011E-20	4.534E-25	3.712E-35	2.750E-50	2.038E-65	1.510E-80	1.012-100
TE127M	6.905E-05	6.248E-10	5.654E-15	5.116E-20	4.629E-25	3.790E-35	2.808E-50	2.080E-65	1.541E-80	1.033-100

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TE129	1.070E-15	4.647E-32	2.019E-48	8.774E-65	3.812E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129M	1.643E-15	7.140E-32	3.102E-48	1.348E-64	5.856E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	1.074E-05	1.074E-05	1.074E-05	1.074E-05	1.074E-05	1.074E-05	1.074E-05	1.074E-05	1.074E-05	1.074E-05
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	4.959E+00	9.235E-01	1.720E-01	3.203E-02	5.964E-03	2.068E-04	1.336E-06	8.626E-09	5.571E-11	6.700E-14
CS135	7.291E-05	7.291E-05	7.291E-05	7.291E-05	7.291E-05	7.291E-05	7.291E-05	7.291E-05	7.291E-05	7.291E-05
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	4.291E+01	3.823E+01	3.406E+01	3.034E+01	2.703E+01	2.145E+01	1.517E+01	1.073E+01	7.585E+00	4.778E+00
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	4.059E+01	3.616E+01	3.222E+01	2.870E+01	2.557E+01	2.030E+01	1.435E+01	1.015E+01	7.176E+00	4.520E+00
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	2.430E-14	2.993E-31	3.686E-48	4.540E-65	5.591E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	1.333E-08	1.333E-08	1.333E-08	1.333E-08	1.333E-08	1.333E-08	1.333E-08	1.333E-08	1.333E-08	1.333E-08
CE144	1.248E+01	1.453E-01	1.691E-03	1.969E-05	2.292E-07	3.106E-11	4.900E-17	7.731E-23	1.220E-28	2.240E-36
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	1.248E+01	1.453E-01	1.691E-03	1.969E-05	2.292E-07	3.106E-11	4.900E-17	7.731E-23	1.220E-28	2.240E-36
PR144M	1.497E-01	1.743E-03	2.029E-05	2.362E-07	2.750E-09	3.727E-13	5.880E-19	9.277E-25	1.464E-30	2.688E-38
ND144	7.663E-13	7.709E-13	7.710E-13	7.710E-13	7.710E-13	7.710E-13	7.710E-13	7.710E-13	7.710E-13	7.710E-13
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM147	3.655E+01	9.755E+00	2.603E+00	6.946E-01	1.854E-01	1.320E-02	2.508E-04	4.767E-06	9.058E-08	4.593E-10
PM148M	7.302E-13	3.556E-26	1.732E-39	8.434E-53	4.107E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	4.113E-14	2.003E-27	9.754E-41	4.750E-54	2.313E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM147	2.897E-09	3.554E-09	3.729E-09	3.776E-09	3.788E-09	3.793E-09	3.793E-09	3.793E-09	3.793E-09	3.793E-09
SM151	6.897E-02	6.636E-02	6.385E-02	6.144E-02	5.912E-02	5.474E-02	4.877E-02	4.345E-02	3.871E-02	3.318E-02
EU152	5.751E-04	4.457E-04	3.454E-04	2.677E-04	2.075E-04	1.247E-04	5.804E-05	2.702E-05	1.258E-05	4.540E-06
EU154	1.049E+00	7.014E-01	4.687E-01	3.133E-01	2.094E-01	9.351E-02	2.791E-02	8.333E-03	2.487E-03	4.962E-04
EU155	4.988E-01	2.480E-01	1.233E-01	6.130E-02	3.047E-02	7.532E-03	9.255E-04	1.137E-04	1.397E-05	8.537E-07
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	1.590E-05	8.509E-08	4.553E-10	2.436E-12	1.303E-14	3.732E-19	5.716E-26	8.757E-33	1.342E-39	1.100E-48
TB160	1.073E-09	2.673E-17	6.661E-25	1.660E-32	4.136E-40	2.568E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00

	DECAY TIMES (years out of core) (Activities* in Ci/element)									
Radionuclide	**5**	**10**	**15**	**20**	**25**	**35**	**50**	**65**	**80**	**100**
TL206	1.333E-15	1.333E-15	1.333E-15	1.333E-15	1.333E-15	1.333E-15	1.333E-15	1.333E-15	1.333E-15	1.333E-15
TL207	8.136E-10	2.624E-09	5.305E-09	8.727E-09	1.278E-08	2.242E-08	3.968E-08	5.918E-08	8.005E-08	1.091E-07
TL208	8.648E-08	1.120E-07	1.165E-07	1.140E-07	1.096E-07	9.983E-08	8.643E-08	7.481E-08	6.475E-08	5.346E-08
PB210	4.649E-15	2.966E-14	1.119E-13	2.993E-13	6.497E-13	2.110E-12	7.340E-12	1.819E-11	3.692E-11	7.792E-11
PB211	8.158E-10	2.632E-09	5.320E-09	8.752E-09	1.282E-08	2.248E-08	3.979E-08	5.934E-08	8.027E-08	1.094E-07
PB212	2.407E-07	3.116E-07	3.241E-07	3.174E-07	3.051E-07	2.779E-07	2.406E-07	2.082E-07	1.802E-07	1.488E-07
BI211	8.158E-10	2.632E-09	5.320E-09	8.752E-09	1.282E-08	2.248E-08	3.979E-08	5.934E-08	8.027E-08	1.094E-07
BI212	2.407E-07	3.116E-07	3.241E-07	3.174E-07	3.051E-07	2.779E-07	2.406E-07	2.082E-07	1.802E-07	1.488E-07
PO212	1.542E-07	1.996E-07	2.077E-07	2.034E-07	1.955E-07	1.780E-07	1.541E-07	1.334E-07	1.155E-07	9.532E-08
PO215	8.158E-10	2.632E-09	5.320E-09	8.752E-09	1.282E-08	2.248E-08	3.979E-08	5.934E-08	8.027E-08	1.094E-07
PO216	2.407E-07	3.116E-07	3.241E-07	3.174E-07	3.051E-07	2.779E-07	2.406E-07	2.082E-07	1.802E-07	1.488E-07
RN219	8.158E-10	2.632E-09	5.320E-09	8.752E-09	1.282E-08	2.248E-08	3.979E-08	5.934E-08	8.027E-08	1.094E-07
RN220	2.407E-07	3.116E-07	3.241E-07	3.174E-07	3.051E-07	2.779E-07	2.406E-07	2.082E-07	1.802E-07	1.488E-07
FR223	1.126E-11	3.629E-11	7.334E-11	1.206E-10	1.766E-10	3.099E-10	5.487E-10	8.182E-10	1.107E-09	1.509E-09
RA223	8.158E-10	2.632E-09	5.320E-09	8.752E-09	1.282E-08	2.248E-08	3.979E-08	5.934E-08	8.027E-08	1.094E-07
RA224	2.407E-07	3.116E-07	3.241E-07	3.174E-07	3.051E-07	2.779E-07	2.406E-07	2.082E-07	1.802E-07	1.488E-07
RA226	6.467E-14	3.304E-13	9.237E-13	1.965E-12	3.571E-12	8.916E-12	2.380E-11	4.915E-11	8.719E-11	1.610E-10
RA228	1.264E-14	3.950E-14	7.493E-14	1.155E-13	1.591E-13	2.510E-13	3.934E-13	5.374E-13	6.817E-13	8.742E-13
AC227	8.158E-10	2.630E-09	5.315E-09	8.741E-09	1.280E-08	2.246E-08	3.976E-08	5.929E-08	8.019E-08	1.093E-07
TH227	8.046E-10	2.595E-09	5.246E-09	8.631E-09	1.264E-08	2.217E-08	3.925E-08	5.853E-08	7.917E-08	1.079E-07
TH228	2.407E-07	3.114E-07	3.239E-07	3.171E-07	3.048E-07	2.778E-07	2.405E-07	2.082E-07	1.802E-07	1.488E-07
TH229	9.131E-13	2.048E-12	3.746E-12	6.009E-12	8.842E-12	1.624E-11	3.175E-11	5.272E-11	7.934E-11	1.240E-10
TH230	6.632E-11	1.891E-10	3.692E-10	6.044E-10	8.925E-10	1.619E-09	3.058E-09	4.873E-09	7.023E-09	1.035E-08
TH231	7.302E-05	7.302E-05	7.302E-05	7.302E-05	7.303E-05	7.303E-05	7.303E-05	7.303E-05	7.303E-05	7.304E-05
TH232	5.304E-14	1.011E-13	1.492E-13	1.973E-13	2.454E-13	3.416E-13	4.859E-13	6.303E-13	7.747E-13	9.672E-13
TH234	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05
PA231	9.174E-09	1.690E-08	2.463E-08	3.236E-08	4.009E-08	5.553E-08	7.869E-08	1.018E-07	1.250E-07	1.558E-07
PA233	5.425E-05	5.449E-05	5.486E-05	5.531E-05	5.584E-05	5.703E-05	5.904E-05	6.116E-05	6.331E-05	6.614E-05
PA234M	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05
PA234	1.255E-07	1.255E-07	1.255E-07	1.255E-07	1.255E-07	1.255E-07	1.255E-07	1.255E-07	1.255E-07	1.255E-07
U232	3.095E-07	3.289E-07	3.234E-07	3.112E-07	2.975E-07	2.705E-07	2.342E-07	2.027E-07	1.754E-07	1.447E-07
U233	1.799E-09	2.988E-09	4.183E-09	5.387E-09	6.602E-09	9.068E-09	1.287E-08	1.681E-08	2.089E-08	2.655E-08
U234	2.075E-06	3.373E-06	4.621E-06	5.821E-06	6.975E-06	9.150E-06	1.211E-05	1.474E-05	1.707E-05	1.978E-05
U235	7.302E-05	7.302E-05	7.302E-05	7.302E-05	7.303E-05	7.303E-05	7.303E-05	7.303E-05	7.303E-05	7.304E-05
U236	1.950E-04	1.950E-04	1.950E-04	1.950E-04	1.950E-04	1.950E-04	1.951E-04	1.951E-04	1.951E-04	1.952E-04

Radionuclide	5	10	15	20	25	35	50	65	80	100
	DECAY TIMES (years out of core) (Activities* in Ci/element)									
U237	2.847E-06	2.238E-06	1.759E-06	1.383E-06	1.087E-06	6.716E-07	3.262E-07	1.585E-07	7.698E-08	2.939E-08
U238	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05	9.654E-05
NP237	5.425E-05	5.449E-05	5.486E-05	5.531E-05	5.584E-05	5.703E-05	5.904E-05	6.116E-05	6.331E-05	6.614E-05
PU236	1.251E-06	3.710E-07	1.100E-07	3.263E-08	9.681E-09	8.600E-10	3.178E-11	1.019E-11	9.625E-12	9.609E-12
PU237	1.460E-17	1.283E-29	1.128E-41	9.914E-54	8.713E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	9.332E-02	8.971E-02	8.624E-02	8.291E-02	7.970E-02	7.366E-02	6.544E-02	5.813E-02	5.165E-02	4.411E-02
PU239	1.548E-01	1.548E-01	1.548E-01	1.547E-01	1.547E-01	1.547E-01	1.546E-01	1.545E-01	1.545E-01	1.544E-01
PU240	8.139E-02	8.135E-02	8.131E-02	8.127E-02	8.123E-02	8.114E-02	8.101E-02	8.088E-02	8.076E-02	8.059E-02
PU241	1.160E+01	9.121E+00	7.170E+00	5.636E+00	4.431E+00	2.738E+00	1.330E+00	6.460E-01	3.138E-01	1.198E-01
PU242	4.607E-05	4.607E-05	4.607E-05	4.607E-05	4.607E-05	4.607E-05	4.607E-05	4.607E-05	4.607E-05	4.607E-05
PU244	1.680E-12	1.680E-12	1.680E-12	1.680E-12	1.680E-12	1.680E-12	1.680E-12	1.680E-12	1.680E-12	1.680E-12
AM241	1.103E-01	1.917E-01	2.549E-01	3.038E-01	3.413E-01	3.918E-01	4.288E-01	4.411E-01	4.415E-01	4.339E-01
AM242M	1.432E-04	1.400E-04	1.368E-04	1.337E-04	1.307E-04	1.249E-04	1.166E-04	1.089E-04	1.017E-04	9.284E-05
AM242	1.425E-04	1.393E-04	1.361E-04	1.330E-04	1.300E-04	1.242E-04	1.160E-04	1.084E-04	1.012E-04	9.238E-05
AM243	9.615E-05	9.610E-05	9.606E-05	9.601E-05	9.597E-05	9.588E-05	9.574E-05	9.561E-05	9.547E-05	9.529E-05
CM242	3.659E-04	1.153E-04	1.126E-04	1.101E-04	1.076E-04	1.028E-04	9.596E-05	8.962E-05	8.369E-05	7.640E-05
CM243	4.771E-05	4.225E-05	3.741E-05	3.313E-05	2.934E-05	2.300E-05	1.597E-05	1.109E-05	7.700E-06	4.734E-06
CM244	2.931E-03	2.421E-03	1.999E-03	1.651E-03	1.363E-03	9.297E-04	5.236E-04	2.949E-04	1.661E-04	7.725E-05
CM245	9.205E-08	9.201E-08	9.198E-08	9.194E-08	9.190E-08	9.183E-08	9.171E-08	9.160E-08	9.149E-08	9.134E-08
CM246	4.760E-09	4.757E-09	4.753E-09	4.750E-09	4.746E-09	4.739E-09	4.729E-09	4.718E-09	4.708E-09	4.694E-09
CM247	3.521E-15	3.521E-15	3.521E-15	3.521E-15	3.521E-15	3.521E-15	3.521E-15	3.521E-15	3.521E-15	3.521E-15
Subtotal**	2.569E+02	1.700E+02	1.421E+02	1.234E+02	1.084E+02	8.463E+01	5.895E+01	4.135E+01	2.914E+01	1.842E+01
TOTAL***	2.569E+02	1.700E+02	1.421E+02	1.234E+02	1.084E+02	8.463E+01	5.895E+01	4.134E+01	2.914E+01	1.842E+01

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 10

Representative Fuel Source Term Calculations

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term template to represent a stainless steel clad, 0–5%-enriched, uranium-based fuel from a heavy water-moderated reactor. Because the spent fuels in this group are primarily MTR-type or plate-fuels, the previously constructed High Flux Beam Reactor fuel element geometry model (Template 8) was modified to represent fuels in this group. Modifications included developing new cross sections and adjusting enrichment and burnup. Other differences include the fuel meat material and the number of fueled plates in the element. These data are included below. The calculation methodology used is described in Reference 1.

Reactor Data

The hypothetical element is a plate-type element consisting of 19 curved plates. The plates are stacked, separated by a heavy water gap (102–129 mils), and held together as a rectangular structure by two stainless steel side plates (140 mils thick). The fuel meat in the plates is a uranium-aluminum-silicon matrix and is clad with stainless steel, as shown in Figure 1. The uranium enrichment is nominally 5%-enriched uranium metal and represents the upper end of the 0–5% U-235 enrichment characteristic of the Template 10 fuel group.

The following data provide the specific fuel element dimensions, materials, densities, enrichment, etc. The beginning-of-life (BOL) data below were used in the BOL cross-section development and the burnup calculation for the source term generation.

Fuel Element:	Curved plate
No. of Plates:	19
Fueled Plates:	19
Fuel Plate Thickness:	50 mils
Cross Sectional Dimensions:	2.820 in. by 3.194 in.
Length:	23.75 in.
Fuel Rod:	U-Al-Si (30% U, 68% Al, 2% Si)
Fuel Density:	3.616 g/cc
Fuel Meat Thickness:	21 mils
Uranium Enrichment:	0.60 wt % U-234
	5.00 wt % U-235
	0.35 wt % U-236
	94.05 wt % U-238
Heavy Metal Loading:	2.06 g/element U-234 (BOL)
	17.13 g/element U-235 (BOL)
	1.20 g/element U-236 (BOL)
	322.12 g/element U-238 (BOL)
	342.51 g/element Total U
	776.33 g/element Aluminum-6061 (Fuel Meat)
	22.83 g/element Silicon (Fuel Meat)

Clad:	Stainless Steel 304
Clad Density:	8.02 g/cc
Clad Thickness:	14.5 mils
Side Plates:	Stainless Steel 304
Side Plate Width:	140 mils
Total Stainless Steel 304 Mass:	9,765.95 g/element
Coolant/Moderator:	Heavy Water (D_2O)
Coolant Temperature:	52°C
Coolant Pressure:	175.3 psig
Coolant Density:	1.09325 g/cc

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single fuel element. In addition, for the ORIGEN2 (Reference 2) depletion calculation, conservative and detailed impurity concentrations were added for the stainless steel clad and aluminum/silicon fuel meat constituents. Tables 1 and 2 list the stainless steel 304 and Aluminum-6061T impurities and their concentrations, respectively, according to References 3, 4, 5, and 6.

Burnup

The burnup chosen for this template is 23.1% U-235 depletion, 5.0 MWd, and approximately 3.96 grams of U-235 depleted for this single element. This burnup represents a nominal range burnup one might expect for this element and uranium loading.

For the analysis, the burnup period is assumed to be 1 year. The burnup and reactor power (approximately 0.0137 MW) is further assumed to be constant and uniform over the 1-year period. At the end of the 1-year period, the element is removed from the core, and the cooling or decay period begins. Table 3 gives the irradiation period and decay times following irradiation.

Cross-Section Development

The neutron cross sections used in the burnup or depletion calculation are based on the methodology described in Reference 1. Cross sections from a standard ORIGEN2 heavy water reactor library were updated once using the BOL cross sections developed for the hypothetical fuel element. These updated cross sections take into account the neutron flux spatial and spectral characteristics to ensure accurate calculation of the actinide production as a function of burnup.

In order to calculate the BOL neutron cross sections, an explicit fuel element was developed with reflective boundary conditions on the element peripheral surfaces. The reflective surfaces simulated an infinite array of fuel elements. The fuel element model is shown in Figure 1.

Fuel Element Exposure History

Table 3 summarizes the power or exposure history used in the burnup or source term calculations for a single fuel element. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years.

Burnup Calculation

The ORIGEN2 computer code (Reference 2) was used to perform the depletion or burnup calculation for a single fuel element. The fuel element masses and impurities, neutron cross sections, burnup, power history, and power level discussed above are input data for the ORIGEN2 calculation. The resulting radionuclide concentrations are given as a function of time in the template table.

The 145 radionuclides listed in the template represent greater than 99.9% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

2. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

3. J. C. Evans et al., "Long-Lived Activation Products in Reactor Materials," NUREG/CR-3474, Prepared for the U.S. Nuclear Regulatory Commission by Battelle, Pacific Northwest Laboratory, Richland, WA, August 1984.

4. E. A. Avallone and T. Baumeister III, "MARK'S Standard Handbook for Mechanical Engineers," Ninth Edition.

5. F.W. Walker et al., "Nuclides and Isotopes: Chart of the Nuclides," General Electric Co., 1989.

6. John Logan, INEEL, to Tom Clements, Appendix data in a letter, "Assessment of Neutron-Activation Products in Low Level Waste Discharged from Nuclear Reactors at the Test Reactor Area; and Sent to the Radioactive Waste Management Complex for Disposal," JAL-04-99, September 9, 1999.

Table 1. Stainless steel304 material constituent and impurity concentrations.

Constituent or Impurity	Impurity (ppm)	Weight Fraction (wt%)
H		0.0007
Li	0.13	
B		0.0005
C		0.07
N		0.047
O		0.015
Na	37	
Al		0.01
Si		0.6
P		0.0375
S		0.02
Cl	130	
K	3	
Ca	19	
Sc	0.03	
Ti		0.05
V		0.05
Cr		18.8
Mn		1.41
Fe		68.8
Co		0.17
Ni		9.23
Cu		0.25
Zn		0.01
Ga	450	
As		0.01
Se		0.02
Br	8	
Rb	10	
Sr	0.2	
Y	5	
Zr	20	
Nb		0.012
Mo		0.37
Ag	2	
Sn		0.01
Sb		0.01
Cs	0.3	
Ba	500	
La	2.1	
Ce	550	
Sm	0.15	
Eu	0.02	
Tb	0.71	
Dy	1	
Ho	1	
Yb	2	
Lu	0.8	
Hf	2	
W	520	
Pb		0.002
Th	1	
U	2	

Table 2. Aluminum-6061T material constituent and impurity concentrations.

Constituent or Impurity	Weight Fraction (wt%)
H	
Li	0.0005
B	0.022
C	0.02
N	0.0005
O	0.05
Na	0.00002
Mg	0.9
Al	97.39387
Si	0.65
P	0.001
S	0.002
Ti	0.02
V	0.02
Cr	0.05
Mn	0.03
Fe	0.2
Co	0.05
Ni	0.04
Cu	0.25
Zn	0.02
Ga	0.05
Sr	0.00001
Zr	0.02
Nb	0.01
Mo	0.0001
Cd	0.05
Sn	0.02
Sb	0.01
Hf	0.05
Ta	0.05
Pb	0.02

Table 3. Assumed burnup or power history for a single hypothetical fuel element.

Condition	Time (years)	Decay Time (days)	Cumulative Duration (days)	Time-Averaged Power (MW_{th})
Irradiation	1	—	365.25	0.0137
Decay	5	1825.00	2191.50	0.0
Decay	10	3652.50	4017.75	0.0
Decay	15	5478.75	5844.00	0.0
Decay	20	7305.00	7670.25	0.0
Decay	25	9131.25	9496.50	0.0
Decay	35	12783.75	13149.00	0.0
Decay	50	18262.50	18627.75	0.0
Decay	65	23741.25	24106.50	0.0
Decay	80	29220.00	29585.25	0.0
Decay	100	36525.00	36890.25	0.0

The dates with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling times designated for the template methodology.

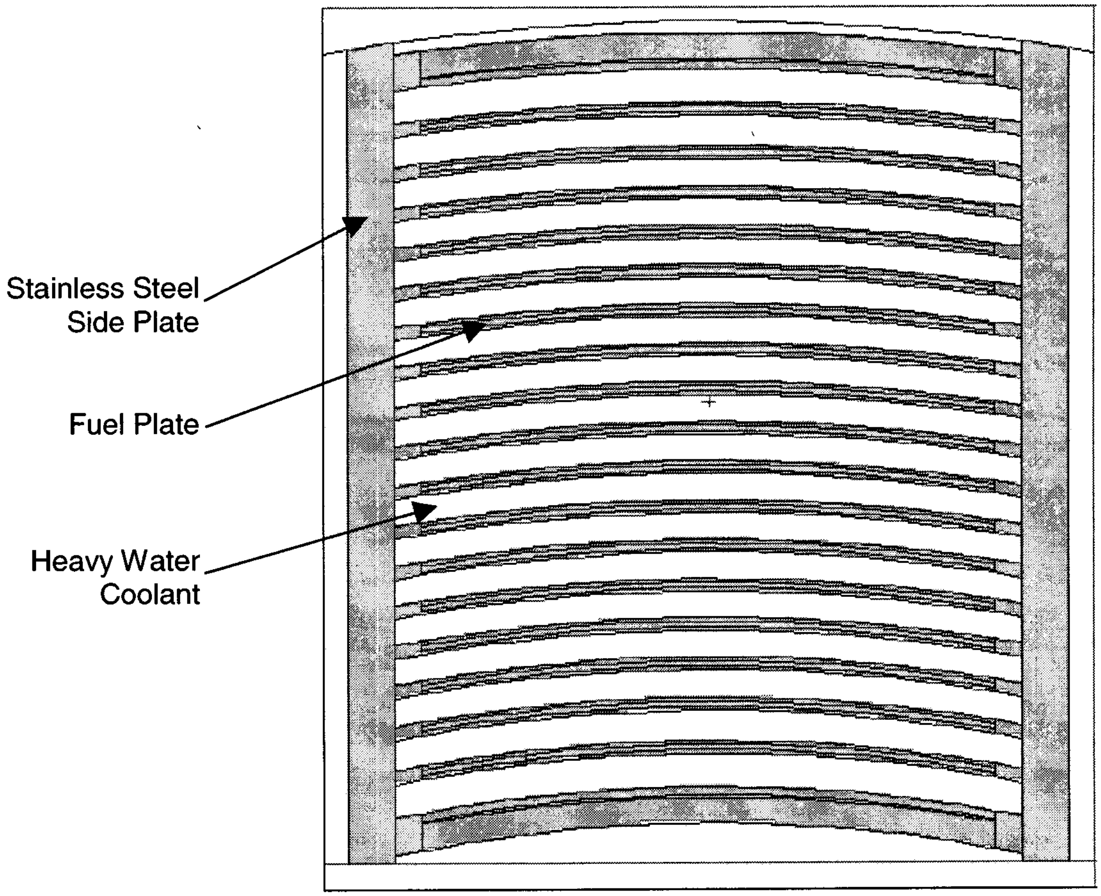

Figure 1. Curved-plate fuel element used in the analysis.

Template 10

Stainless Steel Cladding, 0 to 5%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Heavy Water
Fuel Meat:	U-Al-Si (30% U, 68% Al, 2%Si) in Aluminum
Clad:	Stainless Steel 304
Burnup:	3.96 g U-235 depleted
Burnup:	5 MWd/single element
Burnup:	23.1% U-235 depletion (fissioned and transmuted)
Basis of Calculation:	Single fuel element
BOL U-235:	17.13 g U-235 per element
BOL U-238:	322.12 g U-238 per element
BOL U-234:	2.06 g U-234 per element
BOL U-236:	1.20 g U-236 per element
BOL Total U per element:	342.51 g U per element
BOL Fuel Enrichment:	5 wt% U-235

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H 3	1.199E+00	9.062E-01	6.844E-01	5.170E-01	3.904E-01	2.228E-01	9.597E-02	4.135E-02	1.782E-02	5.797E-03
BE 10	1.766E-09	1.766E-09	1.766E-09	1.766E-09	1.766E-09	1.766E-09	1.766E-09	1.766E-09	1.766E-09	1.766E-09
C 14	1.112E-01	1.111E-01	1.110E-01	1.110E-01	1.109E-01	1.108E-01	1.106E-01	1.104E-01	1.102E-01	1.099E-01
CL 36	2.095E-03	2.095E-03	2.095E-03	2.095E-03	2.094E-03	2.094E-03	2.094E-03	2.094E-03	2.094E-03	2.094E-03
CR 51	2.423E-16	3.496E-36	5.044E-56	7.277E-76	1.050E-95	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	6.151E-01	1.071E-02	1.864E-04	3.245E-06	5.650E-08	1.712E-11	9.035E-17	4.767E-22	2.515E-27	2.311E-34
FE 55	7.991E+02	2.107E+02	5.556E+01	1.465E+01	3.863E+00	2.686E-01	4.926E-03	9.031E-05	1.656E-06	8.006E-09
FE 59	1.781E-10	1.081E-22	6.562E-35	3.983E-47	2.418E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	1.332E+03	6.898E+02	3.574E+02	1.851E+02	9.592E+01	2.574E+01	3.579E+00	4.976E-01	6.919E-02	4.984E-03
NI 59	3.123E-01	3.123E-01	3.123E-01	3.123E-01	3.123E-01	3.123E-01	3.122E-01	3.122E-01	3.121E-01	3.121E-01
NI 63	4.493E+01	4.327E+01	4.167E+01	4.013E+01	3.865E+01	3.584E+01	3.201E+01	2.859E+01	2.554E+01	2.197E+01
ZN 65	2.108E-02	1.173E-04	6.533E-07	3.637E-09	2.025E-11	6.276E-16	1.083E-22	1.869E-29	3.226E-36	3.100E-45
SE 79	1.425E-04	1.425E-04	1.425E-04	1.425E-04	1.425E-04	1.425E-04	1.424E-04	1.424E-04	1.424E-04	1.424E-04
KR 85	1.126E+00	8.153E-01	5.901E-01	4.271E-01	3.091E-01	1.619E-01	6.138E-02	2.327E-02	8.823E-03	2.421E-03
RB 87	5.801E-09	5.801E-09	5.801E-09	5.801E-09	5.801E-09	5.801E-09	5.801E-09	5.801E-09	5.801E-09	5.801E-09
SR 89	4.876E-09	6.329E-20	8.215E-31	1.066E-41	1.384E-52	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	1.059E+01	9.402E+00	8.347E+00	7.411E+00	6.579E+00	5.186E+00	3.629E+00	2.539E+00	1.777E+00	1.104E+00
Y 90	1.059E+01	9.405E+00	8.349E+00	7.413E+00	6.581E+00	5.187E+00	3.630E+00	2.540E+00	1.777E+00	1.104E+00
Y 91	1.935E-07	7.769E-17	3.118E-26	1.252E-35	5.024E-45	8.095E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	2.853E-04	2.853E-04	2.853E-04	2.853E-04	2.853E-04	2.853E-04	2.853E-04	2.853E-04	2.853E-04	2.853E-04

Radionuclide	DECAY TIMES (years out of core) (Activities* in Ci/element) 5	10	15	20	25	35	50	65	80	100
ZR 95	1.615E-06	4.127E-15	1.055E-23	2.697E-32	6.894E-41	4.504E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M	6.681E-05	1.128E-04	1.484E-04	1.760E-04	1.974E-04	2.268E-04	2.505E-04	2.615E-04	2.666E-04	2.694E-04
NB 94	9.969E-04	9.967E-04	9.966E-04	9.964E-04	9.962E-04	9.959E-04	9.954E-04	9.949E-04	9.944E-04	9.937E-04
NB 95	3.585E-06	9.164E-15	2.342E-23	5.988E-32	1.530E-40	9.999E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M	1.198E-08	3.062E-17	7.827E-26	2.001E-34	5.113E-43	3.341E-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	7.223E-04	7.216E-04	7.209E-04	7.202E-04	7.195E-04	7.180E-04	7.159E-04	7.138E-04	7.117E-04	7.088E-04
TC 99	2.168E-03	2.168E-03	2.168E-03	2.168E-03	2.168E-03	2.168E-03	2.168E-03	2.168E-03	2.167E-03	2.167E-03
RU103	5.649E-12	5.715E-26	5.782E-40	5.849E-54	5.917E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	3.370E+00	1.082E-01	3.477E-03	1.117E-04	3.587E-06	3.701E-09	1.227E-13	4.065E-18	1.347E-22	1.434E-28
RH103M	5.093E-12	5.152E-26	5.212E-40	5.273E-54	5.334E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	3.370E+00	1.082E-01	3.477E-03	1.117E-04	3.587E-06	3.701E-09	1.227E-13	4.065E-18	1.347E-22	1.434E-28
PD107	1.485E-05	1.485E-05	1.485E-05	1.485E-05	1.485E-05	1.485E-05	1.485E-05	1.485E-05	1.485E-05	1.485E-05
AG110	3.771E-05	2.379E-07	1.501E-09	9.469E-12	5.974E-14	2.377E-18	5.971E-25	1.499E-31	3.766E-38	5.965E-47
AG110M	2.835E-03	1.788E-05	1.129E-07	7.119E-10	4.492E-12	1.788E-16	4.490E-23	1.127E-29	2.831E-36	4.485E-45
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	3.248E-03	2.561E-03	2.020E-03	1.593E-03	1.256E-03	7.810E-04	3.829E-04	1.878E-04	9.207E-05	3.560E-05
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	2.192E-13	1.031E-25	4.845E-38	2.278E-50	1.071E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	9.470E-15	7.470E-26	5.892E-37	4.646E-48	3.665E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	9.895E-15	7.805E-26	6.156E-37	4.855E-48	3.830E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	1.017E-17	4.783E-30	2.248E-42	1.057E-54	4.970E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	2.970E-03	1.695E-05	9.670E-08	5.516E-10	3.148E-12	1.025E-16	1.904E-23	3.535E-30	6.567E-37	6.960E-46
SN121M	7.795E-05	7.273E-05	6.785E-05	6.331E-05	5.906E-05	5.141E-05	4.175E-05	3.391E-05	2.754E-05	2.087E-05
SN123	4.829E-05	2.677E-09	1.485E-13	8.228E-18	4.562E-22	1.402E-30	2.389E-43	4.071E-56	6.937E-69	6.554E-86
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	8.899E-05	8.898E-05	8.898E-05	8.898E-05	8.897E-05	8.897E-05	8.896E-05	8.895E-05	8.894E-05	8.893E-05
SB124	3.051E-08	2.248E-17	1.656E-26	1.221E-35	8.994E-45	4.882E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	5.609E-01	1.605E-01	4.593E-02	1.314E-02	3.761E-03	3.080E-04	7.216E-06	1.691E-07	3.962E-09	2.656E-11
SB126	1.246E-05	1.246E-05	1.246E-05	1.246E-05	1.246E-05	1.246E-05	1.245E-05	1.245E-05	1.245E-05	1.245E-05
SB126M	8.899E-05	8.898E-05	8.898E-05	8.898E-05	8.897E-05	8.897E-05	8.896E-05	8.895E-05	8.894E-05	8.893E-05
TE123M	5.949E-06	1.517E-10	3.864E-15	9.849E-20	2.510E-24	1.631E-33	2.698E-47	4.467E-61	7.394E-75	3.119E-93
TE125M	1.368E-01	3.916E-02	1.120E-02	3.206E-03	9.177E-04	7.514E-05	1.760E-06	4.125E-08	9.665E-10	6.480E-12
TE127	3.762E-05	3.404E-10	3.080E-15	2.787E-20	2.522E-25	2.065E-35	1.530E-50	1.133E-65	8.396E-81	0.000E+00
TE127M	3.840E-05	3.475E-10	3.144E-15	2.845E-20	2.575E-25	2.108E-35	1.562E-50	1.157E-65	8.572E-81	0.000E+00
TE129	4.909E-16	2.133E-32	9.268E-49	4.027E-65	1.750E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TE129M	7.542E-16	3.277E-32	1.424E-48	6.187E-65	2.688E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	4.583E-06	4.583E-06	4.583E-06	4.583E-06	4.583E-06	4.583E-06	4.583E-06	4.583E-06	4.583E-06	4.583E-06
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	2.074E+00	3.863E-01	7.193E-02	1.339E-02	2.494E-03	8.650E-05	5.586E-07	3.608E-09	2.330E-11	2.802E-14
CS135	1.874E-05	1.874E-05	1.874E-05	1.874E-05	1.873E-05	1.873E-05	1.873E-05	1.873E-05	1.873E-05	1.873E-05
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	1.443E+01	1.285E+01	1.145E+01	1.020E+01	9.088E+00	7.213E+00	5.100E+00	3.607E+00	2.550E+00	1.606E+00
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	1.365E+01	1.216E+01	1.083E+01	9.650E+00	8.597E+00	6.824E+00	4.825E+00	3.412E+00	2.412E+00	1.520E+00
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	8.081E-15	9.952E-32	1.225E-48	1.509E-65	1.859E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	1.871E-08	1.871E-08	1.871E-08	1.871E-08	1.871E-08	1.871E-08	1.871E-08	1.871E-08	1.871E-08	1.871E-08
CE144	3.740E+00	4.354E-02	5.069E-04	5.901E-06	6.869E-08	9.309E-12	1.469E-17	2.317E-23	3.656E-29	6.714E-37
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	3.740E+00	4.354E-02	5.069E-04	5.901E-06	6.869E-08	9.310E-12	1.469E-17	2.317E-23	3.656E-29	6.714E-37
PR144M	4.488E-02	5.225E-04	6.083E-06	7.081E-08	8.243E-10	1.117E-13	1.762E-19	2.781E-25	4.387E-31	8.057E-39
ND144	2.453E-13	2.466E-13	2.466E-13	2.466E-13	2.466E-13	2.466E-13	2.466E-13	2.466E-13	2.466E-13	2.466E-13
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	5.249E-06	4.403E-06	3.622E-06	2.978E-06	2.449E-06	1.655E-06	9.200E-07	5.113E-07	2.842E-07	1.299E-07
PM147	1.092E+01	2.915E+00	7.779E-01	2.076E-01	5.539E-02	3.945E-03	7.496E-05	1.424E-06	2.707E-08	1.373E-10
PM148M	2.218E-13	1.080E-26	5.260E-40	2.562E-53	1.247E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	1.249E-14	6.084E-28	2.963E-41	1.443E-54	7.026E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	1.976E-06	4.777E-08	1.155E-09	2.791E-11	6.745E-13	3.941E-16	5.565E-21	7.858E-26	1.110E-30	3.787E-37
SM147	8.673E-10	1.064E-09	1.116E-09	1.130E-09	1.134E-09	1.135E-09	1.135E-09	1.135E-09	1.135E-09	1.135E-09
SM151	2.626E-02	2.527E-02	2.432E-02	2.339E-02	2.251E-02	2.084E-02	1.857E-02	1.654E-02	1.474E-02	1.263E-02
EU152	1.824E-04	1.414E-04	1.095E-04	8.489E-05	6.579E-05	3.952E-05	1.841E-05	8.567E-06	3.989E-06	1.439E-06
EU154	5.170E-01	3.455E-01	2.309E-01	1.543E-01	1.031E-01	4.607E-02	1.375E-02	4.106E-03	1.226E-03	2.445E-04
EU155	2.694E-01	1.339E-01	6.659E-02	3.310E-02	1.646E-02	4.068E-03	4.999E-04	6.142E-05	7.547E-06	4.610E-07
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	1.054E-04	5.644E-07	3.020E-09	1.616E-11	8.645E-14	2.475E-18	3.792E-25	5.809E-32	8.897E-39	7.294E-48
TB160	3.921E-08	9.770E-16	2.434E-23	6.066E-31	1.512E-38	9.387E-54	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	1.179E-15	1.179E-15	1.179E-15	1.179E-15	1.179E-15	1.179E-15	1.179E-15	1.179E-15	1.179E-15	1.179E-15

Radionuclide	DECAY TIMES (years out of core) (Activities* in Ci/element) 5	10	15	20	25	35	50	65	80	100
TL207	2.839E-09	5.552E-09	8.309E-09	1.110E-08	1.393E-08	1.965E-08	2.837E-08	3.721E-08	4.611E-08	5.803E-08
TL208	7.898E-07	9.137E-07	9.109E-07	8.788E-07	8.405E-07	7.639E-07	6.612E-07	5.724E-07	4.954E-07	4.091E-07
PB210	4.527E-11	2.678E-10	7.935E-10	1.730E-09	3.168E-09	7.854E-09	2.026E-08	4.008E-08	6.802E-08	1.186E-07
PB211	2.847E-09	5.567E-09	8.332E-09	1.113E-08	1.397E-08	1.970E-08	2.845E-08	3.731E-08	4.624E-08	5.820E-08
PB212	2.198E-06	2.543E-06	2.535E-06	2.446E-06	2.339E-06	2.126E-06	1.840E-06	1.593E-06	1.379E-06	1.139E-06
BI211	2.847E-09	5.567E-09	8.332E-09	1.113E-08	1.397E-08	1.970E-08	2.845E-08	3.731E-08	4.624E-08	5.820E-08
BI212	2.198E-06	2.543E-06	2.535E-06	2.446E-06	2.339E-06	2.126E-06	1.840E-06	1.593E-06	1.379E-06	1.139E-06
PO212	1.408E-06	1.629E-06	1.624E-06	1.567E-06	1.499E-06	1.362E-06	1.179E-06	1.021E-06	8.835E-07	7.295E-07
PO215	2.847E-09	5.567E-09	8.332E-09	1.113E-08	1.397E-08	1.970E-08	2.845E-08	3.731E-08	4.624E-08	5.820E-08
PO216	2.198E-06	2.543E-06	2.535E-06	2.446E-06	2.339E-06	2.126E-06	1.840E-06	1.593E-06	1.379E-06	1.139E-06
RN219	2.847E-09	5.567E-09	8.332E-09	1.113E-08	1.397E-08	1.970E-08	2.845E-08	3.731E-08	4.624E-08	5.820E-08
RN220	2.198E-06	2.543E-06	2.535E-06	2.446E-06	2.339E-06	2.126E-06	1.840E-06	1.593E-06	1.379E-06	1.139E-06
FR223	3.928E-11	7.675E-11	1.148E-10	1.534E-10	1.924E-10	2.716E-10	3.922E-10	5.143E-10	6.374E-10	8.023E-10
RA223	2.847E-09	5.567E-09	8.332E-09	1.113E-08	1.397E-08	1.970E-08	2.845E-08	3.731E-08	4.624E-08	5.820E-08
RA224	2.198E-06	2.543E-06	2.535E-06	2.446E-06	2.339E-06	2.126E-06	1.840E-06	1.593E-06	1.379E-06	1.139E-06
RA226	7.623E-10	2.555E-09	5.399E-09	9.292E-09	1.423E-08	2.724E-08	5.456E-08	9.118E-08	1.371E-07	2.125E-07
RA228	4.820E-10	7.091E-10	8.445E-10	9.252E-10	9.734E-10	1.019E-09	1.039E-09	1.043E-09	1.044E-09	1.045E-09
AC227	2.846E-09	5.562E-09	8.321E-09	1.112E-08	1.395E-08	1.968E-08	2.842E-08	3.727E-08	4.619E-08	5.814E-08
TH227	2.808E-09	5.491E-09	8.217E-09	1.098E-08	1.378E-08	1.943E-08	2.806E-08	3.680E-08	4.560E-08	5.739E-08
TH228	2.198E-06	2.541E-06	2.533E-06	2.444E-06	2.337E-06	2.126E-06	1.840E-06	1.593E-06	1.379E-06	1.139E-06
TH229	1.052E-09	2.016E-09	2.981E-09	3.946E-09	4.911E-09	6.843E-09	9.745E-09	1.265E-08	1.556E-08	1.946E-08
TH230	5.856E-07	1.073E-06	1.560E-06	2.048E-06	2.536E-06	3.511E-06	4.976E-06	6.440E-06	7.906E-06	9.860E-06
TH231	2.848E-05	2.848E-05	2.848E-05	2.849E-05	2.849E-05	2.849E-05	2.850E-05	2.850E-05	2.851E-05	2.851E-05
TH232	1.044E-09	1.044E-09	1.044E-09	1.044E-09	1.044E-09	1.044E-09	1.045E-09	1.045E-09	1.045E-09	1.045E-09
TH234	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04
PA231	1.975E-08	2.276E-08	2.578E-08	2.879E-08	3.180E-08	3.782E-08	4.685E-08	5.588E-08	6.491E-08	7.695E-08
PA233	8.641E-05	8.703E-05	8.794E-05	8.907E-05	9.038E-05	9.336E-05	9.837E-05	1.037E-04	1.090E-04	1.161E-04
PA234M	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04
PA234	1.373E-07	1.373E-07	1.373E-07	1.373E-07	1.373E-07	1.373E-07	1.373E-07	1.373E-07	1.373E-07	1.373E-07
U232	2.617E-06	2.589E-06	2.495E-06	2.386E-06	2.276E-06	2.068E-06	1.790E-06	1.550E-06	1.341E-06	1.106E-06
U233	2.042E-06	2.044E-06	2.046E-06	2.048E-06	2.050E-06	2.054E-06	2.060E-06	2.066E-06	2.073E-06	2.083E-06
U234	1.083E-02	1.083E-02	1.083E-02	1.084E-02	1.084E-02	1.084E-02	1.085E-02	1.086E-02	1.086E-02	1.087E-02
U235	2.848E-05	2.848E-05	2.848E-05	2.849E-05	2.849E-05	2.849E-05	2.850E-05	2.850E-05	2.851E-05	2.851E-05
U236	1.302E-04	1.302E-04	1.303E-04	1.303E-04	1.303E-04	1.303E-04	1.304E-04	1.305E-04	1.305E-04	1.306E-04
U237	7.079E-06	5.564E-06	4.374E-06	3.438E-06	2.703E-06	1.670E-06	8.113E-07	3.941E-07	1.914E-07	7.309E-08

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
U238	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04	1.057E-04
NP237	8.641E-05	8.703E-05	8.794E-05	8.907E-05	9.038E-05	9.336E-05	9.837E-05	1.037E-04	1.090E-04	1.161E-04
PU236	3.486E-06	1.034E-06	3.065E-07	9.092E-08	2.698E-08	2.405E-09	9.770E-11	3.753E-11	3.596E-11	3.591E-11
PU237	5.466E-17	4.804E-29	4.222E-41	3.711E-53	3.261E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	2.301E-01	2.213E-01	2.127E-01	2.045E-01	1.966E-01	1.817E-01	1.614E-01	1.434E-01	1.274E-01	1.089E-01
PU239	3.258E-01	3.258E-01	3.257E-01	3.257E-01	3.256E-01	3.255E-01	3.254E-01	3.252E-01	3.251E-01	3.249E-01
PU240	1.339E-01	1.338E-01	1.337E-01	1.337E-01	1.336E-01	1.335E-01	1.333E-01	1.331E-01	1.328E-01	1.326E-01
PU241	2.885E+01	2.268E+01	1.783E+01	1.402E+01	1.102E+01	6.808E+00	3.307E+00	1.606E+00	7.803E-01	2.979E-01
PU242	8.371E-05	8.371E-05	8.371E-05	8.371E-05	8.371E-05	8.371E-05	8.371E-05	8.371E-05	8.371E-05	8.371E-05
PU244	3.157E-12	3.157E-12	3.157E-12	3.157E-12	3.157E-12	3.157E-12	3.157E-12	3.157E-12	3.157E-12	3.157E-12
AM241	2.771E-01	4.797E-01	6.368E-01	7.583E-01	8.517E-01	9.772E-01	1.069E+00	1.100E+00	1.101E+00	1.082E+00
AM242M	5.906E-04	5.773E-04	5.643E-04	5.516E-04	5.392E-04	5.151E-04	4.811E-04	4.493E-04	4.196E-04	3.830E-04
AM242	5.877E-04	5.744E-04	5.615E-04	5.488E-04	5.365E-04	5.125E-04	4.787E-04	4.470E-04	4.175E-04	3.811E-04
AM243	2.627E-04	2.626E-04	2.625E-04	2.623E-04	2.622E-04	2.620E-04	2.616E-04	2.612E-04	2.609E-04	2.604E-04
CM242	1.142E-03	4.756E-04	4.646E-04	4.541E-04	4.438E-04	4.239E-04	3.959E-04	3.697E-04	3.452E-04	3.152E-04
CM243	1.739E-04	1.540E-04	1.363E-04	1.207E-04	1.069E-04	8.383E-05	5.820E-05	4.041E-05	2.806E-05	1.725E-05
CM244	1.156E-02	9.546E-03	7.883E-03	6.510E-03	5.376E-03	3.666E-03	2.065E-03	1.163E-03	6.550E-04	3.046E-04
CM245	6.429E-07	6.427E-07	6.424E-07	6.422E-07	6.419E-07	6.414E-07	6.406E-07	6.398E-07	6.390E-07	6.380E-07
CM246	1.877E-08	1.875E-08	1.874E-08	1.873E-08	1.871E-08	1.869E-08	1.865E-08	1.860E-08	1.856E-08	1.851E-08
CM247	2.297E-14	2.297E-14	2.297E-14	2.297E-14	2.297E-14	2.297E-14	2.297E-14	2.297E-14	2.297E-14	2.297E-14
SUBTOTAL**	2.287E+03	1.018E+03	5.157E+02	2.918E+02	1.832E+02	9.559E+01	5.841E+01	4.502E+01	3.708E+01	2.971E+01
TOTAL***	2.287E+03	1.018E+03	5.157E+02	2.919E+02	1.832E+02	9.560E+01	5.842E+01	4.503E+01	3.708E+01	2.972E+01

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 11

Representative Fuel Source Term Calculations

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term template to represent a Zircaloy-4 clad, 0–5%-enriched, uranium-based fuel from a heavy water-moderated reactor. Because the spent fuels in this group are primarily MTR-type or plate-fuels, the previously constructed High Flux Beam Reactor fuel element geometry model (Template 8) was modified to represent fuels in this group. Modifications included developing new cross sections and adjusting enrichment and burnup. Other differences include the fuel meat material and the number of fueled plates in the element. These data are included below. The calculation methodology used is described in Reference 1.

Reactor Data

The hypothetical element is a plate-type element consisting of 19 curved plates. The plates are stacked, separated by a heavy water gap (102–129 mils), and held together as a rectangular structure by two Zircaloy-4 side plates (140 mils thick). The fuel meat in the 19 plates is a uranium-aluminum-silicon matrix and is clad with Zircaloy-4, as shown in Figure 1. The uranium enrichment is nominally 5%-enriched uranium metal and represents the upper end of the 0–5% U-235 enrichment characteristic of the Template 11 fuel group.

The following data provide the specific fuel element dimensions, materials, densities, enrichment, etc. The beginning-of-life (BOL) data below were used in the BOL cross-section development and the burnup calculation for the source term generation.

Fuel Element:	Curved plate
No. of Plates:	19
Fueled Plates:	19
Fuel Plate Thickness:	50 mils
Cross Sectional Dimensions :	2.820 in. by 3.194 in.
Length:	23.75 in.
Fuel Rod:	U-Al-Si (30% U, 68% Al, 2% Si)
Fuel Density:	3.616 g/cc
Fuel Meat Thickness:	21 mils
Uranium Enrichment:	0.60 wt % U-234
	5.00 wt % U-235
	0.35 wt % U-236
	94.05 wt % U-238
Heavy Metal Loading:	2.06 g/element U-234 (BOL)
	17.13 g/element U-235 (BOL)
	1.20 g/element U-236 (BOL)
	322.12 g/element U-238 (BOL)
	342.51 g/element Total U
	776.33 g/element Aluminum-6061 (Fuel Meat)
	22.83 g/element Silicon (Fuel Meat)

Clad:	Zircaloy-4
Clad Density:	6.44 g/cc
Clad Thickness:	14.5 mils
Side Plates:	Zircaloy-4
Side Plate Width:	140 mils
Total Zircaloy-4 Mass:	7,841.99 g/element
Coolant/Moderator :	Heavy Water (D_2O)
Coolant Temperature:	52°C
Coolant Pressure:	175.3 psig
Coolant Density:	1.09325 g/cc

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single fuel element. In addition, for the ORIGEN2 (Reference 2) depletion calculation, conservative and detailed impurity concentrations were added for the Zircaloy-4 clad and aluminum/silicon fuel meat constituents. Tables 1 and 2 list the Zircaloy-4 and Aluminum 6061T impurities and their concentrations, respectively according to References 3 and 4.

Burnup

The burnup chosen for this template is 31.5% U-235 depletion, 5.0 MWd, and approximately 5.4 g U-235 depleted for this single element. This burnup represents a nominal range burnup one might expect for this element and uranium loading.

For the analysis, the burnup period is assumed to be 1 year. The burnup and reactor power (approximately 0.0137 MW) is further assumed to be constant and uniform over the 1-year period. At the end of the 1-year period, the element is removed from the core, and the cooling or decay period begins. Table 3 gives the irradiation period and decay times following irradiation.

Cross-Section Development

The neutron cross sections used in the burnup or depletion calculation are based on the methodology described in Reference 1. Cross sections from a standard ORIGEN2 heavy water reactor library were updated once using the BOL cross sections developed for the hypothetical fuel element. These updated cross sections take into account the neutron flux spatial and spectral characteristics to ensure accurate calculation of the actinide production as a function of burnup.

In order to calculate the BOL neutron cross sections, an explicit fuel element was developed with reflective boundary conditions on the element peripheral surfaces. The reflective surfaces simulated an infinite array of fuel elements. The fuel element model is shown in Figure 1.

Fuel Element Exposure History

Table 3 summarizes the power or exposure history used in the burnup or source term calculations for a single fuel element. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years.

Burnup Calculation

The ORIGEN2 computer code (Reference 2) was used to perform the depletion or burnup calculation for a single fuel element. The fuel element masses and impurities, neutron cross sections, burnup, power history, and power level discussed above are input data for the ORIGEN2 calculation. The resulting radionuclide concentrations are given as a function of time in the template table.

The 145 radionuclides listed in the template represent greater than 99.9% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

2. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

3. Oak Ridge National Laboratory, "Summary of the Nuclear Design and Performance of the Light Water Breeder Reactor (LWBR)," WAPD-TM-1326, June 1979. *Characteristics of Potential Repository Wastes*, DOE/RW-0184-V1-R1, Volume 1, Oak Ridge, TN 37831, July 1992.

4. John Logan to Tom Clements, Appendix data in a letter, "Assessment of Neutron-Activation Products in Low Level Waste Discharged from Nuclear Reactors at the Test Reactor Area; and Sent to the Radioactive Waste Management Complex for Disposal," JAL-04-99, September 9, 1999.

Table 1. Zircaloy-4 material constituent and impurity concentrations.

Constituent or Impurity	Impurity (ppm)
H	25
Li	
B	0.5
C	270
N	80
O	950
Na	
Al	75
Si	120
P	100
S	35
Cl	
K	
Ca	
Sc	
Ti	50
V	50
Cr	1250
Mn	50
Fe	2250
Co	20
Ni	70
Cu	50
Zn	100
Ga	
As	
Se	
Br	
Rb	
Sr	
Y	
Zr	979069
Nb	70
Mo	50

Constituent or Impurity	Impurity (ppm)
Ag	
Cd	0.5
Sn	16000
Sb	
Cs	
Ba	
La	
Ce	
Sm	10
Gd	5
Eu	
Tb	
Dy	
Ho	
Yb	
Lu	
Hf	35
Ta	200
W	100
Pb	100
Th	7
U	3.5

Table 2. Aluminum-6061T material constituent and impurity concentrations.

Constituent or Impurity	Weight Fraction (wt%)
H	
Li	0.0005
B	0.022
C	0.02
N	0.0005
O	0.05
Na	0.00002
Mg	0.9
Al	97.39387
Si	0.65
P	0.001
S	0.002
Ti	0.02
V	0.02
Cr	0.05
Mn	0.03
Fe	0.2
Co	0.05
Ni	0.04
Cu	0.25
Zn	0.02
Ga	0.05
Sr	0.00001
Zr	0.02
Nb	0.01
Mo	0.0001
Cd	0.05
Sn	0.02
Sb	0.01
Hf	0.05
Ta	0.05
Pb	0.02

Table 3. Assumed burnup or power history for a single hypothetical fuel element.

Condition	Time (years)	Decay Time (days)	Cumulative Duration (days)	Time-Averaged Power (MW_{th})
Irradiation	1	—	365.25	0.0137
Decay	5	1825.00	2191.50	0.0
Decay	10	3652.50	4017.75	0.0
Decay	15	5478.75	5844.00	0.0
Decay	20	7305.00	7670.25	0.0
Decay	25	9131.25	9496.50	0.0
Decay	35	12783.75	13149.00	0.0
Decay	50	18262.50	18627.75	0.0
Decay	65	23741.25	24106.50	0.0
Decay	80	29220.00	29585.25	0.0
Decay	100	36525.00	36890.25	0.0

The entries with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling times designated for the template methodology.

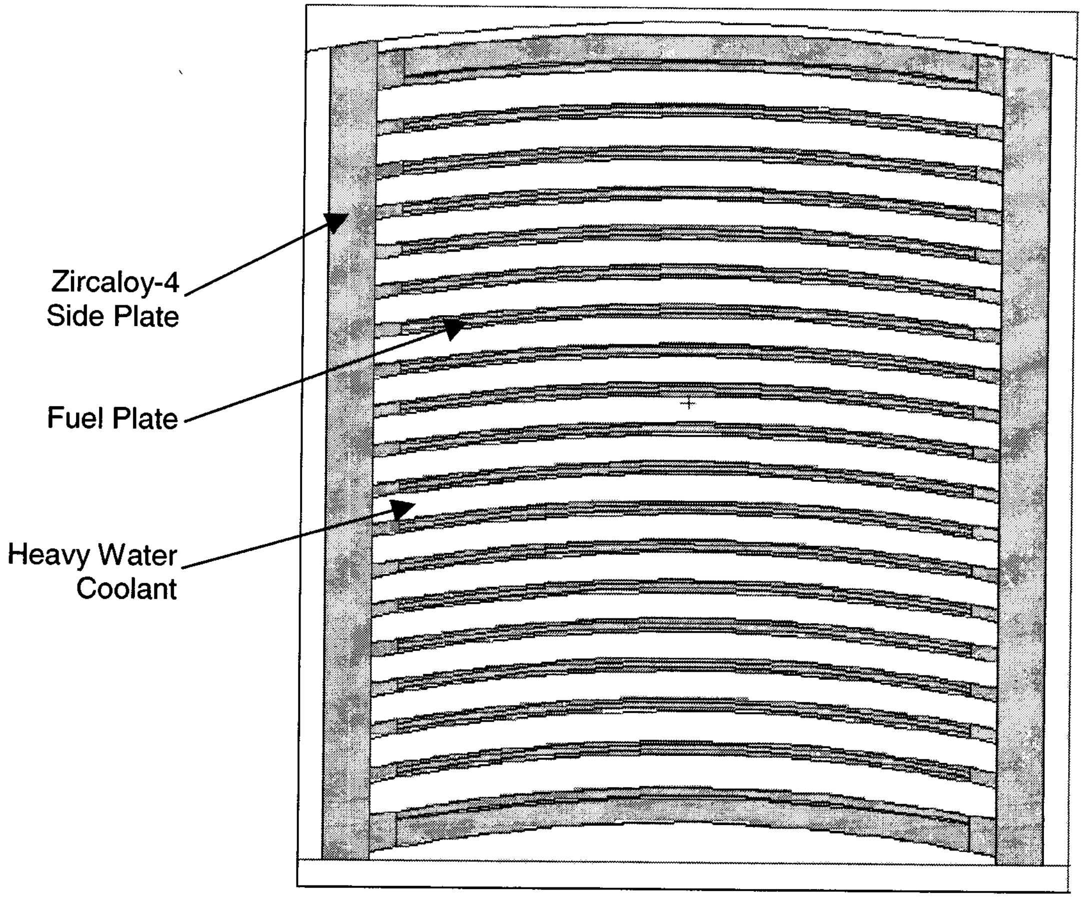

Figure 1. Curved-plate fuel element used in the analysis.

Template 11

Zircaloy-4 Cladding, 0 to 5%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Heavy Water
Fuel Meat:	U-Al-Si (30% U, 68% Al, 2%Si) in Aluminum
Clad:	Zircaloy-4
Burnup:	5.4 g U-235 depleted
Burnup:	5 MWd/single element
Burnup:	31.5% U-235 depletion (fissioned and transmuted)
Basis of Calculation:	Single fuel element
BOL U-235:	17.13 g U-235 per element
BOL U-238:	322.12 g U-238 per element
BOL U-234:	2.06 g U-234 per element
BOL U-236:	1.20 g U-236 per element
BOL Total U per element:	342.51 g U per element
BOL Fuel Enrichment:	5 wt% U-235

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H 3	6.411E-01	4.843E-01	3.657E-01	2.763E-01	2.087E-01	1.190E-01	5.128E-02	2.209E-02	9.520E-03	3.098E-03
BE 10	8.087E-10	8.087E-10	8.087E-10	8.087E-10	8.087E-10	8.087E-10	8.087E-10	8.087E-10	8.087E-10	8.087E-10
C 14	5.652E-03	5.649E-03	5.645E-03	5.642E-03	5.639E-03	5.632E-03	5.622E-03	5.611E-03	5.601E-03	5.588E-03
CL 36	4.189E-10	4.189E-10	4.188E-10	4.188E-10	4.188E-10	4.188E-10	4.188E-10	4.188E-10	4.188E-10	4.188E-10
CR 51	6.221E-19	8.975E-39	1.295E-58	1.868E-78	2.695E-98	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	6.789E-04	1.182E-05	2.058E-07	3.582E-09	6.236E-11	1.890E-14	9.973E-20	5.262E-25	2.776E-30	2.550E-37
FE 55	8.548E-01	2.254E-01	5.944E-02	1.567E-02	4.133E-03	2.874E-04	5.269E-06	9.661E-08	1.771E-09	8.564E-12
FE 59	2.225E-13	1.351E-25	8.200E-38	4.978E-50	3.021E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	1.666E+01	8.632E+00	4.472E+00	2.317E+00	1.200E+00	3.221E-01	4.478E-02	6.227E-03	8.658E-04	6.236E-05
NI 59	1.163E-04	1.163E-04	1.162E-04	1.162E-04	1.162E-04	1.162E-04	1.162E-04	1.162E-04	1.162E-04	1.162E-04
NI 63	1.619E-02	1.559E-02	1.502E-02	1.446E-02	1.393E-02	1.292E-02	1.154E-02	1.030E-02	9.203E-03	7.916E-03
ZN 65	6.459E-03	3.596E-05	2.002E-07	1.115E-09	6.205E-12	1.923E-16	3.319E-23	5.728E-30	9.886E-37	9.499E-46
SE 79	6.264E-05	6.263E-05	6.263E-05	6.263E-05	6.262E-05	6.262E-05	6.261E-05	6.260E-05	6.259E-05	6.257E-05
KR 85	1.330E+00	9.623E-01	6.965E-01	5.041E-01	3.648E-01	1.911E-01	7.246E-02	2.747E-02	1.041E-02	2.858E-03
RB 87	4.100E-09	4.100E-09	4.100E-09	4.100E-09	4.100E-09	4.100E-09	4.100E-09	4.100E-09	4.100E-09	4.100E-09
SR 89	6.372E-09	8.270E-20	1.073E-30	1.393E-41	1.808E-52	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	1.291E+01	1.146E+01	1.017E+01	9.031E+00	8.018E+00	6.319E+00	4.422E+00	3.094E+00	2.165E+00	1.345E+00
Y 90	1.291E+01	1.146E+01	1.017E+01	9.033E+00	8.020E+00	6.321E+00	4.423E+00	3.095E+00	2.166E+00	1.345E+00
Y 91	2.435E-07	9.771E-17	3.922E-26	1.574E-35	6.320E-45	1.018E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	1.371E-03	1.371E-03	1.371E-03	1.371E-03	1.371E-03	1.371E-03	1.371E-03	1.371E-03	1.371E-03	1.371E-03
ZR 95	3.233E-06	8.263E-15	2.112E-23	5.399E-32	1.380E-40	9.017E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M	3.180E-04	5.395E-04	7.111E-04	8.442E-04	9.473E-04	1.089E-03	1.203E-03	1.256E-03	1.281E-03	1.295E-03
NB 94	1.879E-04	1.879E-04	1.878E-04	1.878E-04	1.878E-04	1.877E-04	1.876E-04	1.875E-04	1.874E-04	1.873E-04

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
NB 95	7.178E-06	1.835E-14	4.689E-23	1.199E-31	3.063E-40	2.002E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M	2.398E-08	6.130E-17	1.567E-25	4.005E-34	1.024E-42	6.689E-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	2.900E-06	2.897E-06	2.894E-06	2.891E-06	2.888E-06	2.883E-06	2.874E-06	2.865E-06	2.857E-06	2.846E-06
TC 99	2.207E-03	2.207E-03	2.207E-03	2.207E-03	2.207E-03	2.207E-03	2.206E-03	2.206E-03	2.206E-03	2.206E-03
RU103	4.294E-12	4.344E-26	4.395E-40	4.446E-54	4.498E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	1.483E+00	4.764E-02	1.530E-03	4.916E-05	1.579E-06	1.629E-09	5.399E-14	1.789E-18	5.930E-23	6.313E-29
RH103M	3.871E-12	3.916E-26	3.962E-40	4.008E-54	4.055E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	1.483E+00	4.764E-02	1.530E-03	4.916E-05	1.579E-06	1.629E-09	5.399E-14	1.789E-18	5.930E-23	6.313E-29
PD107	5.642E-06	5.642E-06	5.642E-06	5.642E-06	5.642E-06	5.642E-06	5.642E-06	5.642E-06	5.642E-06	5.642E-06
AG110	2.289E-06	1.444E-08	9.110E-11	5.748E-13	3.626E-15	1.443E-19	3.624E-26	9.101E-33	2.285E-39	3.621E-48
AG110M	1.721E-04	1.086E-06	6.850E-09	4.321E-11	2.726E-13	1.085E-17	2.725E-24	6.843E-31	1.718E-37	2.722E-46
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	1.775E-03	1.400E-03	1.104E-03	8.705E-04	6.865E-04	4.269E-04	2.093E-04	1.026E-04	5.032E-05	1.946E-05
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	1.185E-13	5.572E-26	2.620E-38	1.232E-50	5.790E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	1.672E-13	1.318E-24	1.039E-35	8.201E-47	6.468E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	1.747E-13	1.377E-24	1.086E-35	8.570E-47	6.759E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	5.964E-18	2.804E-30	1.318E-42	6.197E-55	2.913E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	1.213E-01	6.919E-04	3.947E-06	2.253E-08	1.285E-10	4.183E-15	7.771E-22	1.443E-28	2.681E-35	2.841E-44
SN121M	2.137E-03	1.994E-03	1.861E-03	1.736E-03	1.619E-03	1.410E-03	1.145E-03	9.298E-04	7.552E-04	5.722E-04
SN123	3.057E-04	1.695E-08	9.396E-13	5.210E-17	2.888E-21	8.877E-30	1.513E-42	2.578E-55	4.393E-68	4.149E-85
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	6.028E-05	6.027E-05	6.027E-05	6.027E-05	6.027E-05	6.026E-05	6.026E-05	6.025E-05	6.024E-05	6.024E-05
SB124	1.015E-09	7.477E-19	5.508E-28	4.059E-37	2.991E-46	1.624E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	1.725E+00	4.935E-01	1.412E-01	4.041E-02	1.156E-02	9.468E-04	2.218E-05	5.198E-07	1.218E-08	8.166E-11
SB126	8.439E-06	8.438E-06	8.438E-06	8.438E-06	8.437E-06	8.437E-06	8.436E-06	8.435E-06	8.434E-06	8.433E-06
SB126M	6.028E-05	6.027E-05	6.027E-05	6.027E-05	6.027E-05	6.026E-05	6.026E-05	6.025E-05	6.024E-05	6.024E-05
TE123M	7.104E-08	1.811E-12	4.614E-17	1.175E-21	2.997E-26	1.946E-35	3.222E-49	5.334E-63	8.829E-77	3.725E-95
TE125M	4.208E-01	1.204E-01	3.446E-02	9.859E-03	2.821E-03	2.310E-04	5.413E-06	1.268E-07	2.972E-09	1.993E-11
TE127	2.436E-05	2.204E-10	1.995E-15	1.805E-20	1.633E-25	1.337E-35	9.907E-51	7.339E-66	5.438E-81	0.000E+00
TE127M	2.487E-05	2.250E-10	2.036E-15	1.843E-20	1.667E-25	1.365E-35	1.011E-50	7.493E-66	5.551E-81	0.000E+00
TE129	3.746E-16	1.628E-32	7.072E-49	3.073E-65	1.335E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129M	5.755E-16	2.500E-32	1.086E-48	4.720E-65	2.051E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	3.751E-06	3.751E-06	3.751E-06	3.751E-06	3.751E-06	3.751E-06	3.751E-06	3.751E-06	3.751E-06	3.751E-06
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	9.499E-01	1.769E-01	3.294E-02	6.135E-03	1.142E-03	3.962E-05	2.559E-07	1.652E-09	1.067E-11	1.283E-14
CS135	3.957E-05	3.957E-05	3.957E-05	3.957E-05	3.957E-05	3.957E-05	3.957E-05	3.957E-05	3.957E-05	3.957E-05
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
CS137	1.432E+01	1.275E+01	1.136E+01	1.012E+01	9.019E+00	7.158E+00	5.061E+00	3.579E+00	2.531E+00	1.594E+00
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	1.354E+01	1.207E+01	1.075E+01	9.576E+00	8.532E+00	6.771E+00	4.788E+00	3.386E+00	2.394E+00	1.508E+00
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	8.101E-15	9.977E-32	1.229E-48	1.513E-65	1.864E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	4.409E-09	4.409E-09	4.409E-09	4.409E-09	4.409E-09	4.409E-09	4.409E-09	4.409E-09	4.409E-09	4.409E-09
CE144	4.119E+00	4.795E-02	5.582E-04	6.498E-06	7.564E-08	1.025E-11	1.617E-17	2.552E-23	4.026E-29	7.393E-37
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	4.119E+00	4.795E-02	5.582E-04	6.498E-06	7.565E-08	1.025E-11	1.617E-17	2.552E-23	4.026E-29	7.394E-37
PR144M	4.942E-02	5.754E-04	6.698E-06	7.797E-08	9.077E-10	1.230E-13	1.941E-19	3.062E-25	4.831E-31	8.872E-39
ND144	2.305E-13	2.320E-13	2.320E-13	2.320E-13	2.320E-13	2.320E-13	2.320E-13	2.320E-13	2.320E-13	2.320E-13
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	1.084E-04	9.104E-05	7.489E-05	6.158E-05	5.063E-05	3.422E-05	1.902E-05	1.057E-05	5.875E-06	2.685E-06
PM147	1.378E+01	3.676E+00	9.810E-01	2.618E-01	6.986E-02	4.975E-03	9.453E-05	1.796E-06	3.414E-08	1.731E-10
PM148M	2.329E-13	1.134E-26	5.524E-40	2.690E-53	1.310E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	1.312E-14	6.389E-28	3.111E-41	1.515E-54	7.379E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	4.249E-05	1.027E-06	2.482E-08	6.000E-10	1.450E-11	8.472E-15	1.196E-19	1.689E-24	2.386E-29	8.143E-36
SM147	1.328E-09	1.575E-09	1.642E-09	1.659E-09	1.664E-09	1.665E-09	1.666E-09	1.666E-09	1.666E-09	1.666E-09
SM151	3.907E-02	3.760E-02	3.617E-02	3.481E-02	3.349E-02	3.101E-02	2.763E-02	2.461E-02	2.193E-02	1.880E-02
EU152	5.019E-04	3.890E-04	3.015E-04	2.337E-04	1.811E-04	1.088E-04	5.065E-05	2.358E-05	1.097E-05	3.962E-06
EU154	3.810E-01	2.546E-01	1.702E-01	1.137E-01	7.600E-02	3.395E-02	1.013E-02	3.025E-03	9.029E-04	1.802E-04
EU155	2.080E-01	1.034E-01	5.142E-02	2.556E-02	1.271E-02	3.140E-03	3.859E-04	4.743E-05	5.827E-06	3.560E-07
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	4.445E-04	2.378E-06	1.273E-08	6.809E-11	3.643E-13	1.043E-17	1.598E-24	2.448E-31	3.750E-38	3.074E-47
TB160	4.354E-10	1.085E-17	2.703E-25	6.736E-33	1.679E-40	1.042E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	4.308E-16	4.308E-16	4.308E-16	4.308E-16	4.308E-16	4.308E-16	4.308E-16	4.308E-16	4.308E-16	4.308E-16
TL207	2.179E-09	4.306E-09	6.515E-09	8.793E-09	1.113E-08	1.594E-08	2.342E-08	3.111E-08	3.893E-08	4.946E-08
TL208	2.494E-07	2.806E-07	2.766E-07	2.659E-07	2.541E-07	2.310E-07	2.003E-07	1.737E-07	1.506E-07	1.247E-07
PB210	4.912E-11	2.904E-10	8.600E-10	1.874E-09	3.432E-09	8.502E-09	2.192E-08	4.336E-08	7.356E-08	1.282E-07
PB211	2.185E-09	4.318E-09	6.533E-09	8.818E-09	1.116E-08	1.599E-08	2.349E-08	3.120E-08	3.904E-08	4.960E-08
PB212	6.940E-07	7.809E-07	7.698E-07	7.399E-07	7.071E-07	6.430E-07	5.574E-07	4.833E-07	4.191E-07	3.471E-07
BI211	2.185E-09	4.318E-09	6.533E-09	8.818E-09	1.116E-08	1.599E-08	2.349E-08	3.120E-08	3.904E-08	4.960E-08
BI212	6.940E-07	7.809E-07	7.698E-07	7.399E-07	7.071E-07	6.430E-07	5.574E-07	4.833E-07	4.191E-07	3.471E-07
PO212	4.447E-07	5.003E-07	4.932E-07	4.741E-07	4.530E-07	4.120E-07	3.572E-07	3.097E-07	2.685E-07	2.224E-07
PO215	2.185E-09	4.318E-09	6.533E-09	8.818E-09	1.116E-08	1.599E-08	2.349E-08	3.120E-08	3.904E-08	4.960E-08
PO216	6.940E-07	7.809E-07	7.698E-07	7.399E-07	7.071E-07	6.430E-07	5.574E-07	4.833E-07	4.191E-07	3.471E-07
RN219	2.185E-09	4.318E-09	6.533E-09	8.818E-09	1.116E-08	1.599E-08	2.349E-08	3.120E-08	3.904E-08	4.960E-08
RN220	6.940E-07	7.809E-07	7.698E-07	7.399E-07	7.071E-07	6.430E-07	5.574E-07	4.833E-07	4.191E-07	3.471E-07
FR223	3.015E-11	5.953E-11	9.004E-11	1.215E-10	1.538E-10	2.203E-10	3.238E-10	4.301E-10	5.381E-10	6.838E-10

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
RA223	2.185E-09	4.318E-09	6.533E-09	8.818E-09	1.116E-08	1.599E-08	2.349E-08	3.120E-08	3.904E-08	4.960E-08
RA224	6.940E-07	7.809E-07	7.698E-07	7.399E-07	7.071E-07	6.430E-07	5.574E-07	4.833E-07	4.191E-07	3.471E-07
RA226	8.271E-10	2.770E-09	5.849E-09	1.006E-08	1.541E-08	2.948E-08	5.902E-08	9.861E-08	1.482E-07	2.297E-07
RA228	2.755E-09	4.050E-09	4.823E-09	5.283E-09	5.557E-09	5.819E-09	5.932E-09	5.956E-09	5.961E-09	5.963E-09
AC227	2.185E-09	4.314E-09	6.525E-09	8.805E-09	1.114E-08	1.597E-08	2.346E-08	3.116E-08	3.899E-08	4.955E-08
TH227	2.155E-09	4.259E-09	6.443E-09	8.696E-09	1.101E-08	1.577E-08	2.316E-08	3.077E-08	3.850E-08	4.891E-08
TH228	6.939E-07	7.803E-07	7.691E-07	7.393E-07	7.065E-07	6.429E-07	5.574E-07	4.833E-07	4.191E-07	3.471E-07
TH229	2.333E-09	4.492E-09	6.651E-09	8.809E-09	1.097E-08	1.528E-08	2.174E-08	2.820E-08	3.464E-08	4.323E-08
TH230	6.348E-07	1.162E-06	1.689E-06	2.217E-06	2.744E-06	3.798E-06	5.380E-06	6.961E-06	8.542E-06	1.065E-05
TH231	2.536E-05	2.536E-05	2.536E-05	2.536E-05	2.536E-05	2.536E-05	2.537E-05	2.537E-05	2.537E-05	2.537E-05
TH232	5.962E-09	5.962E-09	5.962E-09	5.963E-09	5.963E-09	5.963E-09	5.963E-09	5.963E-09	5.963E-09	5.963E-09
TH234	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04
PA231	1.528E-08	1.796E-08	2.064E-08	2.332E-08	2.601E-08	3.137E-08	3.941E-08	4.745E-08	5.548E-08	6.619E-08
PA233	2.661E-05	2.667E-05	2.677E-05	2.689E-05	2.703E-05	2.735E-05	2.789E-05	2.845E-05	2.902E-05	2.978E-05
PA234M	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04
PA234	1.399E-07	1.399E-07	1.399E-07	1.399E-07	1.399E-07	1.399E-07	1.399E-07	1.399E-07	1.399E-07	1.399E-07
U232	8.088E-07	7.834E-07	7.503E-07	7.161E-07	6.828E-07	6.203E-07	5.369E-07	4.647E-07	4.022E-07	3.317E-07
U233	4.576E-06	4.577E-06	4.577E-06	4.578E-06	4.578E-06	4.579E-06	4.581E-06	4.582E-06	4.584E-06	4.586E-06
U234	1.171E-02	1.172E-02	1.172E-02	1.172E-02	1.172E-02	1.172E-02	1.172E-02	1.172E-02	1.172E-02	1.172E-02
U235	2.536E-05	2.536E-05	2.536E-05	2.536E-05	2.536E-05	2.536E-05	2.537E-05	2.537E-05	2.537E-05	2.537E-05
U236	1.331E-04	1.331E-04	1.331E-04	1.331E-04	1.331E-04	1.331E-04	1.331E-04	1.331E-04	1.331E-04	1.332E-04
U237	7.593E-07	5.969E-07	4.692E-07	3.688E-07	2.899E-07	1.792E-07	8.703E-08	4.227E-08	2.053E-08	7.840E-09
U238	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04	1.076E-04
NP237	2.661E-05	2.667E-05	2.677E-05	2.689E-05	2.703E-05	2.735E-05	2.789E-05	2.845E-05	2.902E-05	2.978E-05
PU236	4.654E-07	1.380E-07	4.092E-08	1.214E-08	3.600E-09	3.190E-10	1.095E-11	2.914E-12	2.704E-12	2.698E-12
PU237	3.435E-18	3.019E-30	2.653E-42	2.332E-54	2.050E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	4.071E-02	3.913E-02	3.762E-02	3.616E-02	3.476E-02	3.212E-02	2.854E-02	2.535E-02	2.252E-02	1.923E-02
PU239	9.380E-02	9.379E-02	9.377E-02	9.376E-02	9.374E-02	9.372E-02	9.368E-02	9.364E-02	9.360E-02	9.354E-02
PU240	4.191E-02	4.188E-02	4.186E-02	4.184E-02	4.182E-02	4.177E-02	4.171E-02	4.164E-02	4.157E-02	4.149E-02
PU241	3.095E+00	2.433E+00	1.913E+00	1.504E+00	1.182E+00	7.303E-01	3.548E-01	1.723E-01	8.370E-02	3.196E-02
PU242	1.020E-05	1.020E-05	1.020E-05	1.020E-05	1.020E-05	1.020E-05	1.020E-05	1.019E-05	1.019E-05	1.019E-05
PU244	1.453E-13	1.453E-13	1.453E-13	1.453E-13	1.453E-13	1.453E-13	1.453E-13	1.453E-13	1.453E-13	1.453E-13
AM241	2.945E-02	5.118E-02	6.804E-02	8.107E-02	9.109E-02	1.046E-01	1.144E-01	1.177E-01	1.178E-01	1.158E-01
AM242M	2.030E-05	1.984E-05	1.939E-05	1.895E-05	1.853E-05	1.770E-05	1.653E-05	1.544E-05	1.442E-05	1.316E-05
AM242	2.019E-05	1.974E-05	1.929E-05	1.886E-05	1.843E-05	1.761E-05	1.645E-05	1.536E-05	1.434E-05	1.309E-05
AM243	1.032E-05	1.031E-05	1.031E-05	1.030E-05	1.030E-05	1.029E-05	1.028E-05	1.026E-05	1.025E-05	1.023E-05
CM242	6.346E-05	1.635E-05	1.596E-05	1.560E-05	1.525E-05	1.457E-05	1.360E-05	1.270E-05	1.186E-05	1.083E-05
CM243	5.221E-06	4.623E-06	4.094E-06	3.625E-06	3.210E-06	2.517E-06	1.748E-06	1.213E-06	8.425E-07	5.180E-07

	DECAY TIMES (years out of core) (Activities* in Ci/element)									
Radionuclide	5	10	15	20	25	35	50	65	80	100
CM244	1.647E-04	1.360E-04	1.123E-04	9.277E-05	7.661E-05	5.225E-05	2.943E-05	1.657E-05	9.334E-06	4.341E-06
CM245	2.442E-09	2.441E-09	2.440E-09	2.439E-09	2.438E-09	2.436E-09	2.433E-09	2.430E-09	2.427E-09	2.423E-09
CM246	1.230E-10	1.229E-10	1.228E-10	1.227E-10	1.226E-10	1.225E-10	1.222E-10	1.219E-10	1.217E-10	1.213E-10
CM247	4.224E-17	4.224E-17	4.224E-17	4.224E-17	4.224E-17	4.224E-17	4.224E-17	4.224E-17	4.224E-17	4.224E-17
*SUBTOTAL***	1.054E+02	6.580E+01	5.169E+01	4.316E+01	3.706E+01	2.832E+01	1.957E+01	1.372E+01	9.692E+00	6.151E+00
TOTAL***	1.054E+02	6.580E+01	5.170E+01	4.317E+01	3.706E+01	2.832E+01	1.957E+01	1.372E+01	9.692E+00	6.152E+00

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 12

Fuel-Specific Source Term Calculations Advanced Test Reactor Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a generic source term for the Advanced Test Reactor (ATR) spent nuclear fuel elements currently stored at the INEEL. The data sources for the analysis are documented in Reference 1 and the INEEL calculational methodology is described in Reference 2.

Advanced Test Reactor Data

The ATR is a 250-MW_{th}-rated light-water reactor designed specifically to study the effects of intense radiation on reactor fuels and materials. The core contains nine individual test irradiation flux traps in a 3×3 array within a four-leaf clover or serpentine driver core configuration as shown in Figure 1. The serpentine driver core is composed of 40 high-enriched, 48-in. active length U-Al_x plate-type fuel elements. The core driver elements are light water cooled and beryllium reflected. Hafnium absorber drums located in the beryllium reflector coupled with hafnium shim rods control the local power levels in each quadrant of the core. The beryllium reflector is contained within an aluminum tank, and the entire reactor core is enclosed in a stainless steel reactor pressure vessel.

Each driver fuel element contains 19 curved aluminum-clad fuel plates. Figure 2 shows the geometrical configuration of a fuel element along with pertinent dimensions. The fuel meat is an intermetallic uranium/aluminum compound with each successive plate (wider arc plate) containing proportionally more uranium (Table 1).

In a fresh ATR element, the uranium enrichment is nominally 93.15 wt% U-235. However, for the source term calculations here, in order to maximize the production of higher order actinides, the maximum U-234 and U-236 impurity concentrations have been used that result in an effective enrichment of approximately 92 wt%. This assumption is not conservative with regard to criticality safety.

There are two different types of aluminum used in the ATR elements. One is a high purity Aluminum-1100 and is used exclusively in the fuel meat. The other is a lower purity Aluminum-6061T and is used everywhere else in the fuel element (clad, end boxes, side plates). For the source term calculations, all aluminum in the ATR element is assumed to be Aluminum-6061T. This results in slightly higher impurity concentrations, which in turn produces slightly higher activation or a slightly more conservative source term. Table 2 lists the impurities and their concentrations (Reference 3).

The data below give specific dimensions, materials, loadings, densities, enrichment, etc., for the ATR driver element used in the burnup calculation for the source term generation.

Fuel Element:

Fuel Meat:	U-Al_x Enriched uranium in Aluminum-1100 Average Density = ~4.00 g/cc
Clad:	Aluminum-6061T Density = 2.70 g/cc
Loading:	1075.0 g/element U-235 BOL (nominal) 69.93 g/element U-238 BOL (nominal) 13.87 g/element U-234 BOL (nominal) 8.09 g/element U-236 BOL (nominal) 92.13% effective enrichment U-235 BOL (calculated) 93.15% nominal enrichment U-235 BOL (ATR)
Active Fuel Length:	48.0 in.
Fuel Element Length:	66.0 in. (5.5 ft end-to-end of the end boxes)
Structural Materials:	2,797.36 g/element aluminum side plates 1,174.32 g/element aluminum in the fuel meat 3,766.74 g/element aluminum clad 1,200.00 g/element upper/lower aluminum end boxes 8,938.42 g/element total aluminum

Core Coolant Water Temperature:
Inlet: <125°F
Outlet: 160°F (average)

Core Coolant Water Pressure:
Inlet: 355 psi (gauge)
Outlet: 255 psi

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single ATR driver fuel element. In addition, for the ORIGEN2 (Reference 4) depletion calculation, conservative and detailed impurity concentrations were added for aluminum (Al-1100 and Al-6061T) based on the estimated aluminum masses including the cladding, fuel meat, side plates, and end boxes.

Burnup

The burnup chosen for this template is based on a 35.95% burnup of the initial U-235. This burnup is equivalent to 367.2 MWd, 314,683 MWd/MTU, and 463.3 g U-235 depleted per element and represents the upper end of typical ATR fuel element burnups. The assumption of maximum burnup is conservative for the buildup of fission products, activation products, and minor actinides in the source term and nonconservative with regard to criticality safety.

Cross-Section Development

The neutron cross sections used in the burnup or depletion calculation for the source term generation of a single ATR fuel element are based on a special ORIGEN2 cross section library developed for beginning-of-life (BOL) conditions. These cross sections are spectrally and spatially weighted over an ATR element and are used extensively in ATR depletion calculations.

The special ATR ORIGEN2 library cross sections have recently been compared to cross sections independently generated using the INEEL Monte Carlo method (Reference 2). The development process utilized a full model of the ATR core and depleted an element in position No.2 in the Northeast reactor lobe (NOTE: in Figure 1, the NORTH direction vector is towards the top of the page). Both cross section sets were found to be in excellent agreement at BOL. The INEEL Monte Carlo cross sections were further calculated as a function of burnup and were found to be relatively insensitive to burnups approaching one half the maximum burnup (367.2 MWd), giving further justification to using the BOL cross sections to perform the depletion analysis.

Advanced Test Reactor Single Element Exposure History

Table 3 summarizes the hypothetical power or exposure history used in the burnup or source term calculations for a single ATR fuel element. Although the three cycles, 15-day or 30-day shutdowns, and element powers are hypothetical, they are based on both typical and conservative assumptions.

In general, typical ATR elements are in the core over their multiyear lifetime for 2–5 cycles at variable cycle lengths and power levels. Cycle lengths typically range from 20–45 days, but there are some infrequent shorter cycles. Also, typical ATR elements may operate at different power levels from cycle-to-cycle depending on core position, element reactivity, and core lobe power splits. For example, elements around the serpentine configuration may range anywhere in power from 1–10 MW_{th}. Actual elements normally experience much longer cooling times between cycles (months to years), rather than the relatively short 15 or 30-days between cycles used here for the hypothetical power history. Hence, the hypothetical three cycles followed by either a 15-day or 30-day shutdown will add conservatism to the source term calculation.

The hypothetical element powers over the three cycles were intentionally selected to produce a very high burnup element. In fact, the 3-cycle exposure results in a 367.2 MWd total accumulated burnup for the single ATR element. When compared to current ATR spent fuel inventory records, the hypothetical burnup here represents a maximum exposure or maximum burnup element. Typical ATR end-of-life elements do not exceed this exposure; therefore, this hypothetical power history for a single ATR element is bounding for ATR spent fuel elements currently in the spent fuel inventory. The assumption of maximum burnup is conservative for the buildup of fission products, activation products, and minor actinides in the source term and nonconservative with regard to criticality safety.

Burnup Calculation

The ORIGEN2 computer code was used to perform the depletion or burnup calculation for the ATR driver fuel element. The radionuclide inventory or source term template that follows is for a single ATR driver fuel element. The fuel element component masses and impurities (fuel meat, uranium, clad, end fixtures), neutron cross sections, burnup, and hypothetical power history and power level as discussed above are input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of decay time in the template table.

The 145 radionuclides listed in the template represent greater than 99.9% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. Advance Test Reactor drawings: 401570, 401571, 401572, 401573, 401574, 401575, 401576, and 401577.

2. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

3. ASTM B-209, Table 1, "Chemical Composition Limits," 1990.

4. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

Table 1. ATR element plate dimensions and uranium loading.

Plate No.	Plate Thickness (in.)	Fuel Meat Thickness (in.)	Clad Thickness (in.)	Inside Fuel Meat Radius (cm)	U-235 Loading (g/plate)
19	0.1	0.02	0.04	13.68	52.6
18	0.05	0.02	0.015	13.29	53.8
17	0.05	0.02	0.015	12.97	65.9
16	0.05	0.02	0.015	12.64	64.0
15	0.05	0.02	0.015	12.32	76.3
14	0.05	0.02	0.015	11.99	73.8
13	0.05	0.02	0.015	11.67	71.4
12	0.05	0.02	0.015	11.34	69.0
11	0.05	0.02	0.015	11.02	66.6
10	0.05	0.02	0.015	10.69	64.2
9	0.05	0.02	0.015	10.37	61.8
8	0.05	0.02	0.015	10.04	59.4
7	0.05	0.02	0.015	9.72	57.0
6	0.05	0.02	0.015	9.39	54.6
5	0.05	0.02	0.015	9.07	52.1
4	0.05	0.02	0.015	8.75	40.4
3	0.05	0.02	0.015	8.42	38.7
2	0.05	0.02	0.015	8.09	29.1
1	0.08	0.02	0.03	7.73	24.3

Table 2. ATR Aluminum-6061T material constituent and impurity concentrations.

Constituent or Impurity	Concentration (wt%)
H	0.02143
C	0.02143
O	0.02143
Mg	1.00000
Al	97.15499
Si	0.60000
Ti	0.07500
Cr	0.19500
Mn	0.07500
Fe	0.35000
Ni	0.02143
Cu	0.27500
Zn	0.12500
Zr	0.02143
Sn	0.02143
Pb	0.02143

Table 3. Hypothetical power history for a maximum burnup ATR driver fuel element.

Duration (days)	Cumulative Duration (days)	Time-Averaged Power (MW_{th})
15	15	10.0
15	30	0.0
30	60	5.0
30	90	0.0
30	120	2.4
1825	1945	0.0
1825	3770	0.0
1825	5595	0.0
1825	7420	0.0
1825	9245	0.0
3650	12895	0.0
5475	18370	0.0
5475	23845	0.0
5475	29320	0.0
7300	36620	0.0

The three-cycle exposure in the table above is followed by ten dates representing the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling or decay times designated for the template methodology.

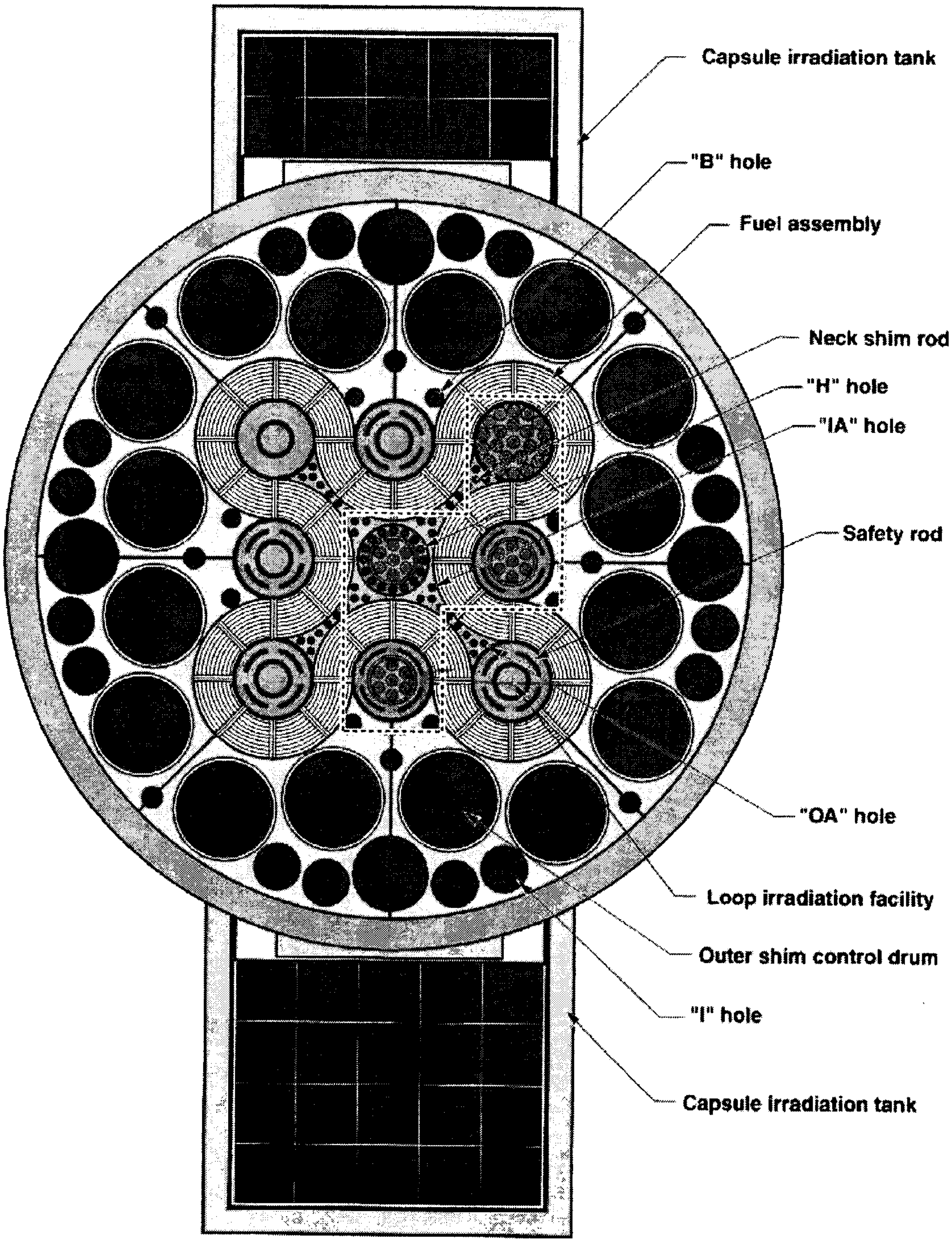

Figure 1. Cross-sectional view of the Advanced Test Reactor core.

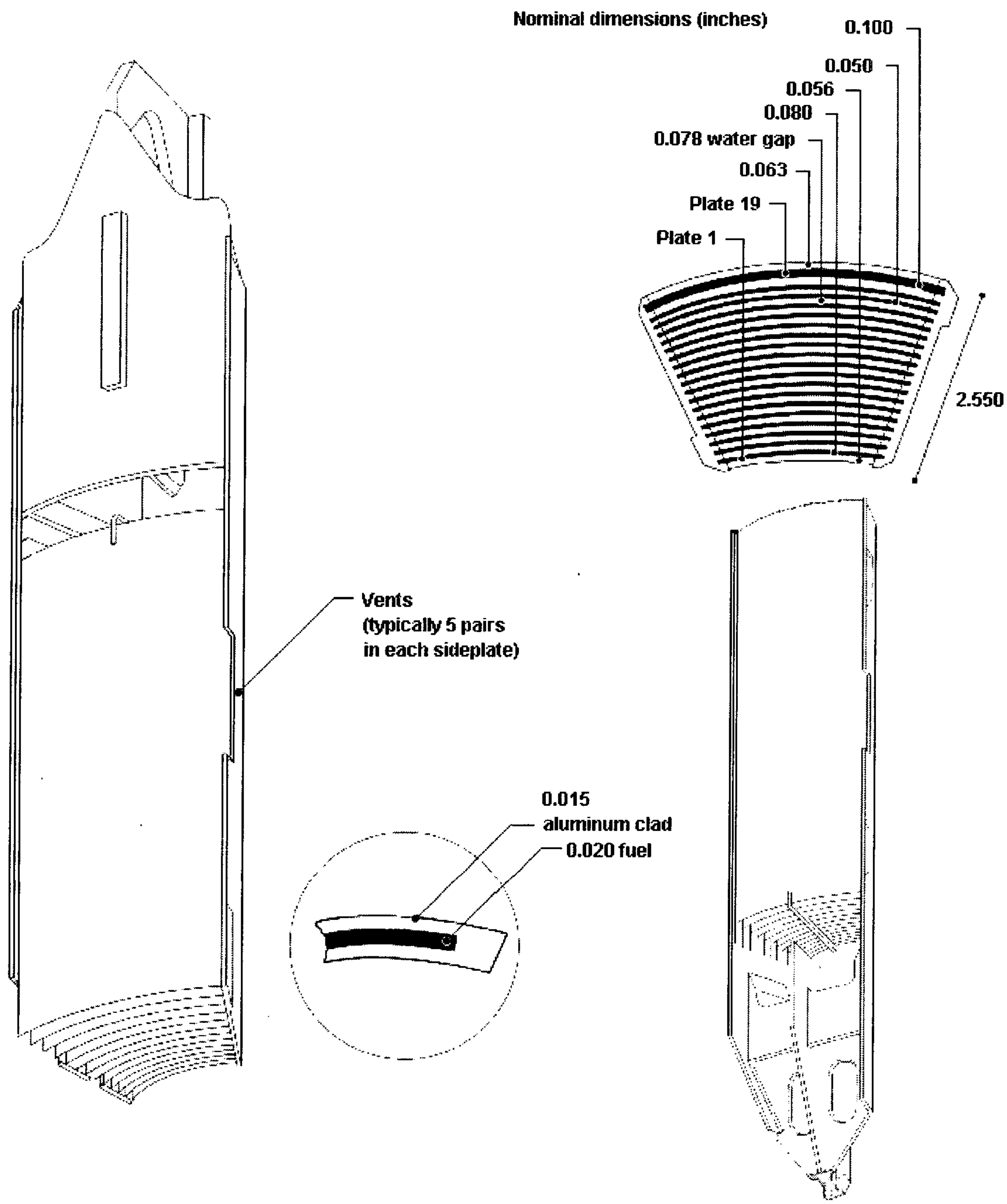

Figure 2. The configuration of an Advanced Test Reactor fuel element.

Advanced Test Reactor Element

Aluminum Cladding, 60 to 100%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Light Water
Fuel Meat:	U-Al_x
Clad:	Aluminum
Burnup:	367.2 MWd/element (maximum element burnup)
Burnup:	35.95 % U-235 burnup (fissioned)
Burnup:	43.10% U-235 depletion (fissioned and transmuted)
Basis of Calculation:	Single element
BOL U-235:	1075.00 g U-235 per element
BOL U-238:	69.93 g U-238 per element
BOL U-234:	13.87 g U-234 per element
BOL U-236:	8.09 g U-236 per element
BOL Total U per element:	1166.89 g U per element
BOL Fuel Enrichment:	92.13 wt%

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H-3	3.892E+00	2.940E+00	2.221E+00	1.678E+00	1.267E+00	7.233E-01	3.118E-01	1.344E-01	5.796E-02	1.887E-02
BE-10	3.600E-08	3.600E-08	3.600E-08	3.600E-08	3.600E-08	3.600E-08	3.600E-08	3.600E-08	3.600E-08	3.600E-08
C-14	2.102E-06	2.101E-06	2.099E-06	2.098E-06	2.097E-06	2.095E-06	2.091E-06	2.087E-06	2.083E-06	2.079E-06
CL-36	4.819E-30	4.819E-30	4.819E-30	4.819E-30	4.819E-30	4.819E-30	4.819E-30	4.818E-30	4.818E-30	4.818E-30
CR-51	3.839E-18	5.715E-38	8.507E-58	1.266E-77	1.885E-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN-54	4.247E-02	7.414E-04	1.294E-05	2.259E-07	3.944E-09	1.202E-12	6.396E-18	3.403E-23	1.811E-28	1.682E-35
FE-55	2.476E+00	6.535E-01	1.725E-01	4.552E-02	1.201E-02	8.369E-04	1.539E-05	2.829E-07	5.201E-09	2.524E-11
FE-59	1.368E-12	8.464E-25	5.238E-37	3.241E-49	2.006E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO-60	1.403E-02	7.270E-03	3.768E-03	1.953E-03	1.012E-03	2.719E-04	3.786E-05	5.271E-06	7.338E-07	5.295E-08
NI-59	4.667E-04	4.667E-04	4.667E-04	4.667E-04	4.666E-04	4.666E-04	4.665E-04	4.665E-04	4.664E-04	4.663E-04
NI-63	7.098E-02	6.835E-02	6.583E-02	6.340E-02	6.105E-02	5.663E-02	5.058E-02	4.518E-02	4.035E-02	3.471E-02
ZN-65	2.029E-01	1.134E-03	6.335E-06	3.540E-08	1.978E-10	6.174E-15	1.077E-21	1.878E-28	3.276E-35	3.193E-44
SE-79	4.750E-03	4.750E-03	4.749E-03	4.749E-03	4.749E-03	4.748E-03	4.747E-03	4.747E-03	4.746E-03	4.745E-03
KR-85	1.050E+02	7.603E+01	5.504E+01	3.984E+01	2.884E+01	1.512E+01	5.734E+00	2.176E+00	8.254E-01	2.267E-01
RB-87	3.188E-07	3.188E-07	3.188E-07	3.188E-07	3.188E-07	3.188E-07	3.188E-07	3.188E-07	3.188E-07	3.188E-07
SR-89	1.021E-06	1.348E-17	1.780E-28	2.350E-39	3.103E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-90	1.010E+03	8.966E+02	7.961E+02	7.068E+02	6.276E+02	4.947E+02	3.463E+02	2.424E+02	1.696E+02	1.054E+02
Y-90	1.010E+03	8.968E+02	7.963E+02	7.070E+02	6.277E+02	4.948E+02	3.463E+02	2.424E+02	1.697E+02	1.054E+02
Y-91	3.816E-05	1.555E-14	6.334E-24	2.580E-33	1.051E-42	1.745E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR-93	2.445E-02	2.445E-02	2.445E-02	2.445E-02	2.445E-02	2.445E-02	2.445E-02	2.445E-02	2.445E-02	2.445E-02

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
ZR-95	2.534E-04	6.565E-13	1.701E-21	4.407E-30	1.142E-38	7.665E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-93M	5.422E-03	9.424E-03	1.253E-02	1.493E-02	1.680E-02	1.936E-02	2.142E-02	2.239E-02	2.283E-02	2.308E-02
NB-94	2.626E-07	2.626E-07	2.626E-07	2.625E-07	2.625E-07	2.624E-07	2.622E-07	2.621E-07	2.620E-07	2.618E-07
NB-95	5.625E-04	1.458E-12	3.776E-21	9.784E-30	2.535E-38	1.702E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-95M	1.880E-06	4.870E-15	1.262E-23	3.269E-32	8.471E-41	5.686E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-93	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC-99	1.551E-01	1.551E-01	1.551E-01	1.551E-01	1.551E-01	1.551E-01	1.551E-01	1.551E-01	1.551E-01	1.551E-01
RU-103	5.452E-10	5.639E-24	5.832E-38	6.031E-52	6.237E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	6.997E+01	2.253E+00	7.253E-02	2.335E-03	7.519E-05	7.794E-08	2.601E-12	8.683E-17	2.898E-21	3.114E-27
RH-103M	4.915E-10	5.083E-24	5.257E-38	5.437E-52	5.623E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	6.997E+01	2.253E+00	7.253E-02	2.335E-03	7.519E-05	7.794E-08	2.601E-12	8.683E-17	2.898E-21	3.114E-27
PD-107	1.830E-04	1.830E-04	1.830E-04	1.830E-04	1.830E-04	1.830E-04	1.830E-04	1.830E-04	1.830E-04	1.830E-04
AG-110	3.393E-04	2.148E-06	1.360E-08	8.609E-11	5.450E-13	2.184E-17	5.542E-24	1.406E-30	3.568E-37	5.732E-46
AG-110M	2.551E-02	1.615E-04	1.022E-06	6.473E-09	4.098E-11	1.642E-15	4.167E-22	1.057E-28	2.683E-35	4.310E-44
AG-111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-113M	1.215E-01	9.579E-02	7.555E-02	5.959E-02	4.699E-02	2.923E-02	1.434E-02	7.035E-03	3.451E-03	1.335E-03
CD-113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-115M	1.133E-11	5.431E-24	2.604E-36	1.248E-48	5.983E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114	1.089E-13	8.740E-25	7.015E-36	5.631E-47	4.520E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114M	1.138E-13	9.132E-25	7.330E-36	5.883E-47	4.723E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-115M	7.963E-16	3.817E-28	1.830E-40	8.771E-53	4.205E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-119M	2.773E-02	1.588E-04	9.092E-07	5.207E-09	2.981E-11	9.773E-16	1.835E-22	3.444E-29	6.466E-36	6.950E-45
SN-121M	1.096E-03	1.022E-03	9.539E-04	8.901E-04	8.305E-04	7.229E-04	5.873E-04	4.770E-04	3.875E-04	2.937E-04
SN-123	3.516E-03	1.962E-07	1.095E-11	6.112E-16	3.411E-20	1.063E-28	1.848E-41	3.212E-54	5.585E-67	5.419E-84
SN-125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-126	4.250E-03	4.250E-03	4.250E-03	4.250E-03	4.250E-03	4.249E-03	4.249E-03	4.248E-03	4.248E-03	4.247E-03
SB-124	8.220E-09	6.144E-18	4.593E-27	3.432E-36	2.566E-45	1.433E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB-125	2.311E+01	6.618E+00	1.896E+00	5.428E-01	1.555E-01	1.275E-02	2.995E-04	7.038E-06	1.654E-07	1.112E-09
SB-126	5.950E-04	5.950E-04	5.950E-04	5.950E-04	5.949E-04	5.949E-04	5.948E-04	5.948E-04	5.947E-04	5.946E-04
SB-126M	4.250E-03	4.250E-03	4.250E-03	4.250E-03	4.250E-03	4.249E-03	4.249E-03	4.248E-03	4.248E-03	4.247E-03
TE-123M	4.118E-07	1.057E-11	2.714E-16	6.966E-21	1.788E-25	1.178E-34	1.994E-48	3.372E-62	5.705E-76	2.477E-94
TE-125M	5.639E+00	1.614E+00	4.625E-01	1.325E-01	3.794E-02	3.112E-03	7.309E-05	1.717E-06	4.033E-08	2.714E-10
TE-127	2.511E-03	2.290E-08	2.089E-13	1.905E-18	1.738E-23	1.445E-33	1.097E-48	8.322E-64	6.314E-79	4.369E-99
TE-127M	2.563E-03	2.338E-08	2.132E-13	1.945E-18	1.774E-23	1.476E-33	1.120E-48	8.496E-64	6.446E-79	4.461E-99
TE-129	5.027E-14	2.241E-30	9.993E-47	4.455E-63	1.986E-79	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TE-129M	7.723E-14	3.443E-30	1.535E-46	6.844E-63	3.051E-79	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-129	2.765E-04	2.765E-04	2.765E-04	2.765E-04	2.765E-04	2.765E-04	2.765E-04	2.765E-04	2.765E-04	2.765E-04
I-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-134	1.788E+02	3.334E+01	6.217E+00	1.159E+00	2.161E-01	7.511E-03	4.867E-05	3.154E-07	2.044E-09	2.470E-12
CS-135	1.266E-03	1.266E-03	1.266E-03	1.266E-03	1.266E-03	1.266E-03	1.266E-03	1.266E-03	1.266E-03	1.266E-03
CS-136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-137	1.055E+03	9.396E+02	8.372E+02	7.459E+02	6.646E+02	5.275E+02	3.731E+02	2.639E+02	1.866E+02	1.176E+02
BA-136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-137M	9.976E+02	8.889E+02	7.920E+02	7.056E+02	6.287E+02	4.990E+02	3.530E+02	2.496E+02	1.766E+02	1.113E+02
BA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-141	1.251E-12	1.583E-29	2.002E-46	2.532E-63	3.203E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-142	3.290E-07	3.290E-07	3.290E-07	3.290E-07	3.290E-07	3.290E-07	3.290E-07	3.290E-07	3.290E-07	3.290E-07
CE-144	3.914E+02	4.570E+00	5.337E-02	6.232E-04	7.277E-06	9.922E-10	1.580E-15	2.515E-21	4.004E-27	7.445E-35
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	3.914E+02	4.570E+00	5.337E-02	6.232E-04	7.277E-06	9.922E-10	1.580E-15	2.515E-21	4.005E-27	7.445E-35
PR-144M	4.697E+00	5.484E-02	6.404E-04	7.478E-06	8.732E-08	1.191E-11	1.896E-17	3.018E-23	4.805E-29	8.934E-37
ND-144	1.672E-11	1.686E-11	1.686E-11	1.686E-11	1.686E-11	1.686E-11	1.686E-11	1.686E-11	1.686E-11	1.686E-11
ND-147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-147	9.346E+02	2.496E+02	6.667E+01	1.781E+01	4.756E+00	3.393E-01	6.465E-03	1.232E-04	2.347E-06	1.195E-08
PM-148M	3.851E-11	1.915E-24	9.524E-38	4.737E-51	2.356E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-148	2.169E-12	1.079E-25	5.364E-39	2.668E-52	1.327E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM-145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM-147	6.700E-08	8.379E-08	8.827E-08	8.947E-08	8.979E-08	8.990E-08	8.991E-08	8.991E-08	8.991E-08	8.991E-08
SM-151	4.154E+00	3.997E+00	3.846E+00	3.701E+00	3.561E+00	3.298E+00	2.938E+00	2.618E+00	2.332E+00	2.000E+00
EU-152	2.244E-02	1.739E-02	1.348E-02	1.045E-02	8.102E-03	4.869E-03	2.268E-03	1.056E-03	4.921E-04	1.777E-04
EU-154	3.013E+01	2.014E+01	1.346E+01	9.001E+00	6.017E+00	2.689E+00	8.034E-01	2.400E-01	7.171E-02	1.432E-02
EU-155	1.437E+01	7.149E+00	3.556E+00	1.769E+00	8.797E-01	2.176E-01	2.678E-02	3.296E-03	4.055E-04	2.482E-05
EU-156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD-153	5.951E-04	3.195E-06	1.716E-08	9.213E-11	4.947E-13	1.427E-17	2.209E-24	3.421E-31	5.297E-38	4.404E-47
TB-160	4.593E-08	1.158E-15	2.921E-23	7.367E-31	1.858E-38	1.182E-53	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL-206	4.206E-15	4.206E-15	4.206E-15	4.206E-15	4.206E-15	4.206E-15	4.206E-15	4.206E-15	4.206E-15	4.206E-15

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuciide	5	10	15	20	25	35	50	65	80	100
TL-207	1.776E-08	5.329E-08	1.042E-07	1.681E-07	2.432E-07	4.202E-07	7.354E-07	1.090E-06	1.469E-06	1.995E-06
TL-208	1.178E-05	1.618E-05	1.715E-05	1.690E-05	1.628E-05	1.484E-05	1.285E-05	1.112E-05	9.627E-06	7.949E-06
PB-210	1.994E-10	1.381E-09	4.347E-09	9.779E-09	1.826E-08	4.631E-08	1.216E-07	2.430E-07	4.150E-07	7.277E-07
PB-211	1.781E-08	5.344E-08	1.045E-07	1.686E-07	2.439E-07	4.214E-07	7.375E-07	1.093E-06	1.473E-06	2.001E-06
PB-212	3.280E-05	4.502E-05	4.772E-05	4.703E-05	4.530E-05	4.129E-05	3.576E-05	3.095E-05	2.679E-05	2.212E-05
BI-211	1.781E-08	5.344E-08	1.045E-07	1.686E-07	2.439E-07	4.214E-07	7.375E-07	1.093E-06	1.473E-06	2.001E-06
BI-212	3.280E-05	4.502E-05	4.772E-05	4.703E-05	4.530E-05	4.129E-05	3.576E-05	3.095E-05	2.679E-05	2.212E-05
PO-212	2.101E-05	2.885E-05	3.058E-05	3.013E-05	2.902E-05	2.646E-05	2.291E-05	1.983E-05	1.717E-05	1.417E-05
PO-215	1.781E-08	5.344E-08	1.045E-07	1.686E-07	2.439E-07	4.214E-07	7.375E-07	1.093E-06	1.473E-06	2.001E-06
PO-216	3.280E-05	4.502E-05	4.772E-05	4.703E-05	4.530E-05	4.129E-05	3.576E-05	3.095E-05	2.679E-05	2.212E-05
RN-219	1.781E-08	5.344E-08	1.045E-07	1.686E-07	2.439E-07	4.214E-07	7.375E-07	1.093E-06	1.473E-06	2.001E-06
RN-220	3.280E-05	4.502E-05	4.772E-05	4.703E-05	4.530E-05	4.129E-05	3.576E-05	3.095E-05	2.679E-05	2.212E-05
FR-223	2.457E-10	7.370E-10	1.440E-09	2.323E-09	3.361E-09	5.810E-09	1.017E-08	1.507E-08	2.030E-08	2.759E-08
RA-223	1.781E-08	5.344E-08	1.045E-07	1.686E-07	2.439E-07	4.214E-07	7.375E-07	1.093E-06	1.473E-06	2.001E-06
RA-224	3.280E-05	4.502E-05	4.772E-05	4.703E-05	4.530E-05	4.129E-05	3.576E-05	3.095E-05	2.679E-05	2.212E-05
RA-226	3.720E-09	1.397E-08	3.075E-08	5.407E-08	8.392E-08	1.632E-07	3.309E-07	5.570E-07	8.413E-07	1.311E-06
RA-228	3.338E-13	1.098E-12	2.120E-12	3.296E-12	4.563E-12	7.239E-12	1.139E-11	1.558E-11	1.979E-11	2.540E-11
AC-227	1.781E-08	5.341E-08	1.043E-07	1.684E-07	2.435E-07	4.210E-07	7.369E-07	1.092E-06	1.471E-06	1.999E-06
TH-227	1.756E-08	5.271E-08	1.030E-07	1.662E-07	2.405E-07	4.156E-07	7.273E-07	1.078E-06	1.452E-06	1.973E-06
TH-228	3.280E-05	4.500E-05	4.768E-05	4.699E-05	4.526E-05	4.129E-05	3.576E-05	3.095E-05	2.679E-05	2.212E-05
TH-229	3.710E-10	6.921E-10	1.049E-09	1.442E-09	1.871E-09	2.837E-09	4.556E-09	6.598E-09	8.963E-09	1.262E-08
TH-230	3.227E-06	6.258E-06	9.294E-06	1.233E-05	1.538E-05	2.148E-05	3.066E-05	3.986E-05	4.909E-05	6.144E-05
TH-231	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03
TH-232	1.467E-12	2.869E-12	4.271E-12	5.674E-12	7.076E-12	9.880E-12	1.409E-11	1.829E-11	2.250E-11	2.811E-11
TH-234	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05
PA-231	1.880E-07	3.279E-07	4.678E-07	6.077E-07	7.476E-07	1.027E-06	1.446E-06	1.865E-06	2.284E-06	2.843E-06
PA-233	3.506E-03	3.506E-03	3.507E-03	3.508E-03	3.509E-03	3.511E-03	3.516E-03	3.520E-03	3.525E-03	3.531E-03
PA-234M	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05
PA-234	2.851E-08	2.851E-08	2.851E-08	2.851E-08	2.851E-08	2.851E-08	2.851E-08	2.851E-08	2.851E-08	2.851E-08
U-232	4.405E-05	4.829E-05	4.790E-05	4.620E-05	4.420E-05	4.020E-05	3.481E-05	3.013E-05	2.608E-05	2.152E-05
U-233	6.419E-07	7.184E-07	7.950E-07	8.717E-07	9.483E-07	1.102E-06	1.332E-06	1.562E-06	1.793E-06	2.101E-06
U-234	6.735E-02	6.746E-02	6.756E-02	6.765E-02	6.775E-02	6.792E-02	6.816E-02	6.836E-02	6.855E-02	6.877E-02
U-235	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03
U-236	5.689E-03	5.689E-03	5.689E-03	5.689E-03	5.689E-03	5.689E-03	5.689E-03	5.689E-03	5.689E-03	5.689E-03
U-237	6.195E-06	4.871E-06	3.829E-06	3.011E-06	2.367E-06	1.463E-06	7.110E-07	3.456E-07	1.679E-07	6.417E-08

	DECAY TIMES (years out of core) (Activities* in Ci/element)									
Radionuclide	**5**	**10**	**15**	**20**	**25**	**35**	**50**	**65**	**80**	**100**
U-238	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05	2.193E-05
NP-237	3.506E-03	3.506E-03	3.507E-03	3.508E-03	3.509E-03	3.511E-03	3.516E-03	3.520E-03	3.525E-03	3.531E-03
PU-236	2.331E-04	6.917E-05	2.053E-05	6.095E-06	1.811E-06	1.619E-07	6.794E-09	2.741E-09	2.634E-09	2.631E-09
PU-237	8.648E-15	7.746E-27	6.939E-39	6.216E-51	5.568E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU-238	7.546E+00	7.254E+00	6.973E+00	6.703E+00	6.444E+00	5.955E+00	5.290E+00	4.699E+00	4.174E+00	3.565E+00
PU-239	1.573E-01	1.573E-01	1.573E-01	1.572E-01	1.572E-01	1.572E-01	1.571E-01	1.570E-01	1.570E-01	1.569E-01
PU-240	8.960E-02	8.956E-02	8.952E-02	8.948E-02	8.944E-02	8.935E-02	8.922E-02	8.908E-02	8.894E-02	8.875E-02
PU-241	2.525E+01	1.985E+01	1.561E+01	1.227E+01	9.649E+00	5.964E+00	2.899E+00	1.409E+00	6.846E-01	2.616E-01
PU-242	1.334E-04	1.334E-04	1.334E-04	1.334E-04	1.334E-04	1.334E-04	1.334E-04	1.334E-04	1.334E-04	1.334E-04
PU-244	2.396E-11	2.396E-11	2.396E-11	2.396E-11	2.396E-11	2.396E-11	2.396E-11	2.396E-11	2.396E-11	2.396E-11
AM-241	2.337E-01	4.109E-01	5.484E-01	6.548E-01	7.366E-01	8.466E-01	9.272E-01	9.542E-01	9.553E-01	9.390E-01
AM-242M	1.668E-04	1.630E-04	1.594E-04	1.558E-04	1.523E-04	1.455E-04	1.359E-04	1.269E-04	1.185E-04	1.082E-04
AM-242	1.660E-04	1.622E-04	1.586E-04	1.550E-04	1.515E-04	1.448E-04	1.352E-04	1.263E-04	1.179E-04	1.076E-04
AM-243	5.479E-04	5.476E-04	5.474E-04	5.471E-04	5.469E-04	5.464E-04	5.456E-04	5.448E-04	5.441E-04	5.430E-04
CM-242	5.028E-04	1.344E-04	1.312E-04	1.282E-04	1.253E-04	1.197E-04	1.118E-04	1.044E-04	9.752E-05	8.902E-05
CM-243	8.694E-05	7.699E-05	6.818E-05	6.038E-05	5.347E-05	4.193E-05	2.912E-05	2.023E-05	1.405E-05	8.639E-06
CM-244	1.911E-02	1.579E-02	1.304E-02	1.077E-02	8.894E-03	6.067E-03	3.418E-03	1.926E-03	1.085E-03	5.049E-04
CM-245	1.124E-06	1.124E-06	1.123E-06	1.123E-06	1.123E-06	1.122E-06	1.120E-06	1.119E-06	1.118E-06	1.116E-06
CM-246	7.669E-08	7.663E-08	7.657E-08	7.652E-08	7.646E-08	7.635E-08	7.618E-08	7.602E-08	7.585E-08	7.563E-08
CM-247	8.015E-14	8.015E-14	8.015E-14	8.015E-14	8.015E-14	8.015E-14	8.015E-14	8.015E-14	8.015E-14	8.015E-14
SUBTOTAL**	6.336E+03	4.066E+03	3.399E+03	2.961E+03	2.612E+03	2.052E+03	1.438E+03	1.011E+03	7.122E+02	4.473E+02
TOTAL***	6.336E+03	4.066E+03	3.399E+03	2.961E+03	2.612E+03	2.052E+03	1.438E+03	1.011E+03	7.122E+02	4.473E+02

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 15

Fuel-Specific Source Term Calculations Pathfinder Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term template for a single Pathfinder superheater spent nuclear fuel element. The data sources for the analysis are documented in References 1 through 5, and the INEEL calculational methodology is described in Reference 6.

Pathfinder Data

The Pathfinder core consisted of a superheater region of elements surrounded by an annular boiler region of elements. See Figure 1 for a detailed sketch of the superheater fuel element materials and geometry. The geometric detail of the superheater fuel element was fully incorporated into the Monte Carlo N-Particle (MCNP) geometry model as was the boiler fuel element geometry. Although the boiler fuel element is not considered in the source term calculation, it is part of the partial core model used in the MCNP neutron transport calculation. Figures 2 through 5 show cross-sectional views of the 3-D MCNP geometry model. Figure 2 shows the superheater element. Figure 3 shows the superheater lattice. Figure 4 shows a partial core cross section with superheater elements in the center of the core surrounded by boiler region elements and an outer water reflector region. Figure 5 shows an axial cross-sectional view of the core.

The data below and resulting source term calculation are for an average burnup superheater fuel element.

Superheater Fuel Element:

Fuel Meat:	UO_2 + 316L Stainless Steel Cermet
	Density = 8.1799 g/cc
Clad:	316L Stainless Steel
	Density = 8.03 g/cc
Loading:	120.4 g/element U-235 BOL
	0.05 g/element U-236 BOL
	8.37 g/element U-238 BOL
	Enrichment 93.5% U-235 BOL
	Inner fuel tube: 51.2 g/element U-235 BOL
	Outer fuel tube: 69.2 g/element U-235 BOL
Active Fuel Length:	72.0 in.
Fuel Element Length:	74.5 in.
Boron-Al_2O_3 Poison:	Length = 72.5 in.
	Pellet Radius: 0.511 cm
	Natural boron
	Loading = 1.4808 g boron/rod
	Density of Al_2O_3 = 2.59 g/cc (70% TD)

Boiler Fuel Element:

UO_2 fuel meat
2.2 and 3.2 wt% U-235 enrichment
Upper core half pellet radius = 0.448 cm
Upper core half clad thickness = 0.028 in.
Lower core half pellet radius = 0.400 cm
Lower core half clad thickness = 0.026 in.
UO_2 Density = 10.41 g/cc

Superheater Core Power Fraction: 15% (conservative)
No. of Superheater Elements in the Core: 409 total

Water Temperature:

Boiler Inlet	486°F
Steam Region	626°F

Water Pressure:

Boiler Inlet	642 psia
Steam Region	0.01665 g/cc

Aluminum-6061 per Element:	205.501 g
Stainless Steel-316L per Element:	3228.5 g
Stainless Steel 304 per Element:	456.03 g

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single Pathfinder fuel element. In addition, for the ORIGEN2 (Reference 7) depletion calculation, conservative and detailed impurity concentrations were added for the UO_2, stainless steel 316L, stainless steel 304, and aluminum (Al-6061). Table 1 lists the impurities and their concentrations (References 8 through 12).

Burnup

The burnup chosen for this template is 6.46% U-235 depletion, 6.01 MWd/element, or approximately 7.78 g of U-235 depleted for a single Pathfinder fuel element. This burnup is reasonable for an average superheater element and the depletion accounts for buildup of fission products, activation products, and minor actinides in the source term, but nonconservative with regard to criticality safety, in particular U-235 and U-238 end-of-life concentrations.

Cross-Section Development

The MCNP model was used to develop neutron cross sections specifically for the Pathfinder superheater elements. These cross sections are in turn used in the superheater fuel element ORIGEN2 depletion calculation.

The neutron cross sections used in the burnup or depletion calculation for the source term generation of a single Pathfinder fuel element are based on the methodology described in Reference 6. Cross sections from a standard ORIGEN2 light water reactor library were updated once using the specially developed beginning-of-life (BOL) cross sections for the Pathfinder. The updated cross sections take into account the unique Pathfinder neutron flux spatial and spectral characteristics to ensure accurate calculation of the fission product and actinide production as a function of burnup.

Pathfinder Exposure History

Table 2 summarizes the detailed power or exposure history used in the burnup or source term calculations for a single Pathfinder superheater fuel element. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years.

Burnup Calculation

The ORIGEN2 computer code (Reference 7) was used to perform the depletion or burnup calculation for the Pathfinder fuel element. The radionuclide inventory or source term template is for a single Pathfinder superheater fuel element or assembly. The fuel element masses and impurities, neutron cross sections, burnup, power history, and power level as discussed above are input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of time in the template table.

The 145 radionuclides listed in the template represent greater than 99.99% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. Lockheed Martin Idaho Technologies Company, *Pathfinder Fuel Summary Report*, INEL/INT-97-00127, February 1997.

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3. Northern States Power Company Pathfinder Atomic Power Plant, *Six Month Report No. 3—May 19, 1967 to November 19, 1967*, NSP-6603, June 27, 1967.

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5. Northern States Power Company Pathfinder Atomic Power Plant, *Six Month Report No. 1—May 19, 1966 to November 19, 1966*, TID-23646. January 9, 1967.

6. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

7. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

8. A. G. Croft, M. A. Bjerke, G. W. Morrison, and L. M. Petrie, *Revised Uranium-Plutonium Cycle PWR and BWR Models for the ORIGEN Computer Code*, ORNL/TM-6051, Oak Ridge National Laboratory.

9. J. C. Evans et al., *Long-Lived Activation Products in Reactor Materials,* NUREG/CR-3474, August 1984.

10. E. A. Avallone and T. Baumeister III, *MARK'S Standard Handbook for Mechanical Engineers*, Ninth Edition.

11. F. W. Walker et al., "Nuclides and Isotopes: Chart of the Nuclides," General Electric Company, 1989.

12. ASTM B-209, Table 1, "Chemical Composition Limits," 1990.

Table 1. Pathfinder fuel assembly material impurity concentrations.

Constituent or Impurity	UO_2 Concentration (ppm)	Stainless Steel 316L Concentration (ppm)	Stainless Steel 304 Concentration (wt%)	Aluminum-6061 Concentration (wt%)
H				0.02143
Li	1	0.18	0.13	
Be				
B	1			
C	89.4	0.03 wt%	0.08 wt%	0.02143
N	25	357	525	
O	134454			0.02143
F	10.7			
Na	15	6	37	
Mg	2			1
Al	16.7	50	200	97.15499
Si	12.1	1 wt%	1 wt%	0.6
P	35	0.045 wt%		
S		0.03 wt%		
Cl	5.3		130	
K		3	3	
Ca	2	14	19	
Sc			0.03	
Ti	1	200	600	0.075
V	3	630	690	
Cr	4	17.3 wt%	18.4 wt%	0.195
Mn	1.7	2 wt%	1.53 wt%	0.075
Fe	18	64.24 wt%	68.99 wt%	0.35
Co	1	1630	2570	
Ni	24	13.2 wt%	10 wt%	0.02143
Cu	1	2900	8150	0.275
Zn	40.3	71	2230	0.125
Ga		60	450	
As		95	1010	
Se		9	70	
Br		2	8	
Rb			10	
Sr		0.23	0.2	
Y		5	5	
Zr		6	20	0.02143
Nb		64	300	
Mo	10	2.16 wt%	5500	

Table 1. (continued).

Constituent or Impurity	UO_2 Concentration (ppm)	Stainless Steel 316L Concentration (ppm)	Stainless Steel 304 Concentration (wt%)	Aluminum-6061 Concentration (wt%)
Ag	0.1	5	2	
Cd	25			
In	2			
Sn	4			0.02143
Sb		13	17	
Cs			0.3	
Ba			500	
La		0.2	2.1	
Ce			550	
Pr				
Nd				
Sm		0.2	0.15	
Eu		0.07	0.02	
Gd				
Tb		9	0.71	
Dy			1	
Ho		1	1	
Er				
Tm				
Yb		2	2	
Lu		0.8	0.8	
Hf			2	
Ta				
W	2	218	520	
Tl				
Pb	1	30	139	0.02143
Bi	0.4			
Th			1	
U		5	2	

Table 2. Assumed power or exposure history for a single Pathfinder fuel element.

Duration (days)	Cumulative Duration (days)	Time-Averaged Power (MW_{th})
226	226	1.14E-05
184	410	0.00E+00
65	475	1.14E-05
74	549	2.32E-05
42	591	1.28E-03
31	622	9.62E-04
30	652	1.22E-02
31	683	0.00E+00
31	714	9.46E-03
8	722	3.07E-03
20	742	0.00E+00
2	744	1.06E-02
31	775	2.82E-02
24	799	1.77E-02
10	809	0.00E+00
26	835	2.06E-02
31	866	1.70E-03
30	896	8.03E-03
18	914	8.48E-03
25	939	0.00E+00
1	940	1.20E-02
1	941	0.00E+00
9	950	3.34E-02
2	952	0.00E+00
5	957	3.31E-02
3	960	0.00E+00
1	961	4.85E-02
1	962	0.00E+00
1	963	6.77E-02
1	964	0.00E+00
7	971	4.34E-02
3	974	2.67E-02
1	975	0.00E+00
3	978	4.46E-02
2	980	0.00E+00
4	984	2.17E-02
3	987	0.00E+00
1	988	5.01E-02
3	991	3.69E-02
2	993	4.43E-02
3	996	3.33E-02
4	1000	5.91E-02
1	1001	0.00E+00
1	1002	2.96E-02
4	1006	4.25E-02
1	1007	0.00E+00
7	1014	5.38E-02
1	1015	0.00E+00
3	1018	4.62E-02
2	1020	0.00E+00
3	1023	3.41E-02
4	1027	5.30E-02
3	1030	0.00E+00
4	1034	5.30E-02
1825	2859	0.00E+00
1825	4684	0.00E+00
1825	6509	0.00E+00
1825	8334	0.00E+00
1825	10159	0.00E+00
3650	13809	0.00E+00
5475	19284	0.00E+00
5475	24759	0.00E+00
5475	30234	0.00E+00
7300	37534	0.00E+00

The bottom ten dates with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling times designated for the template methodology.

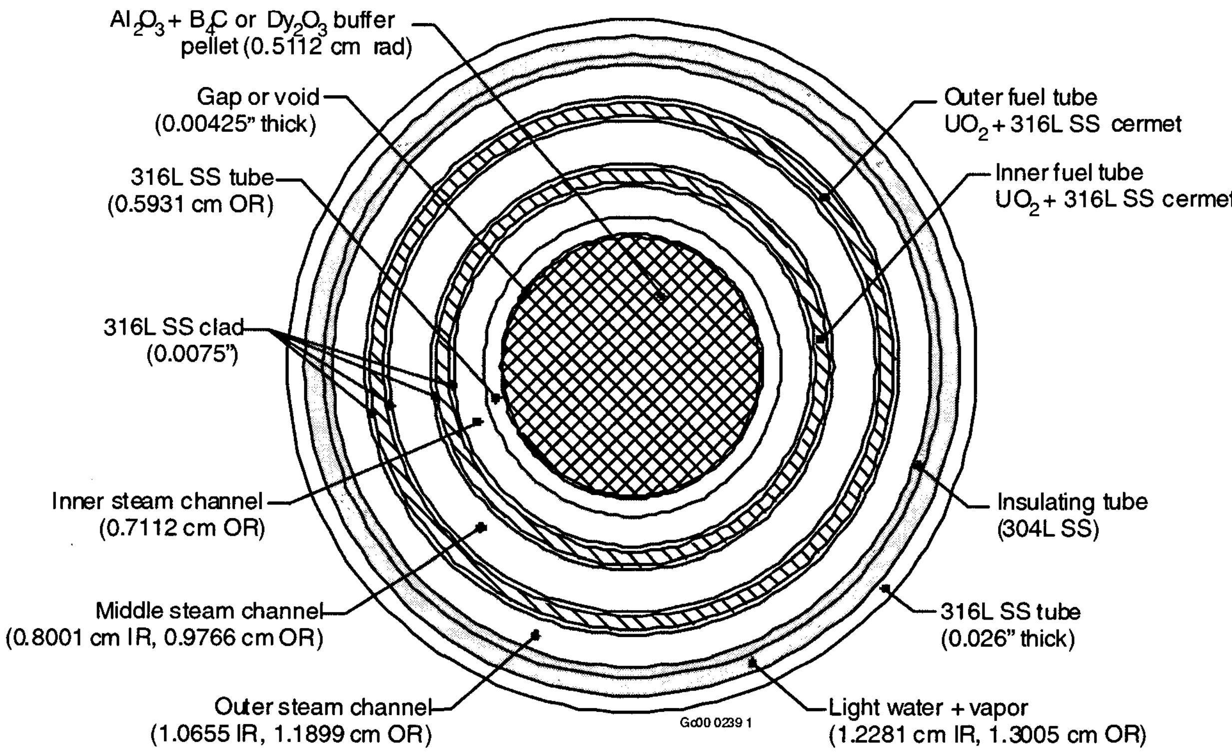

Figure 1. Cross sectional view of an actual Pathfinder superheater element.

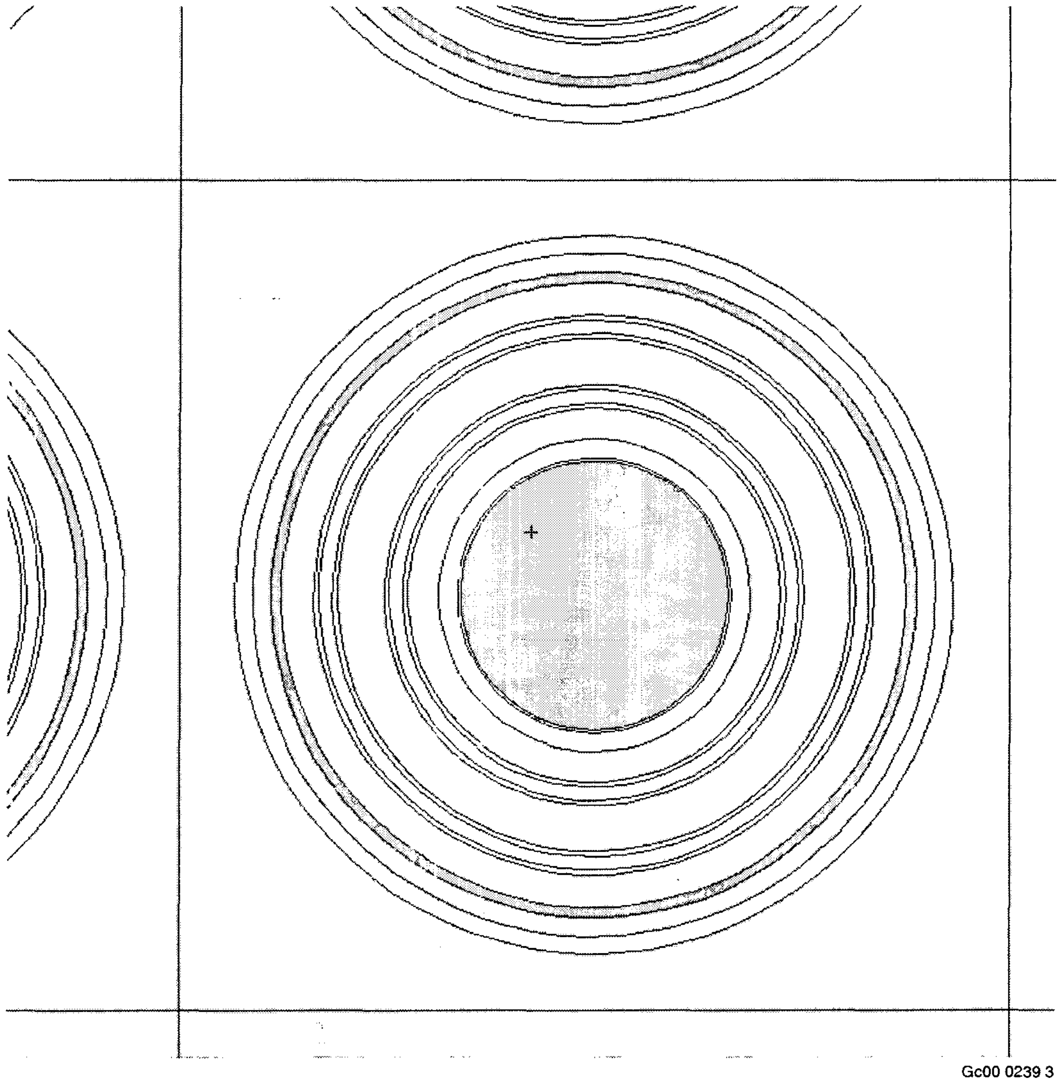

Figure 2. MCNP model representation of a Pathfinder superheater element.

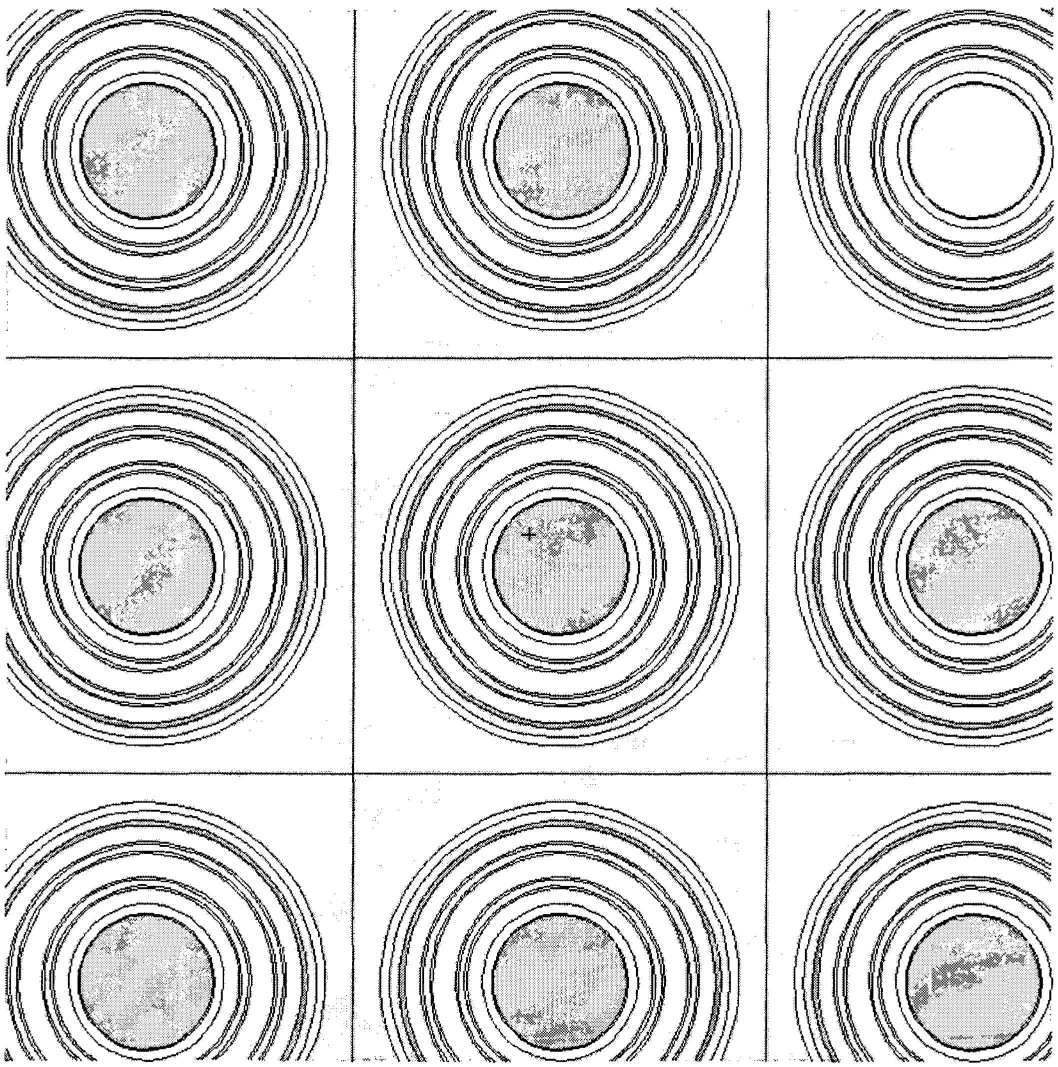

Figure 3. MCNP model representation of a Pathfinder superheater lattice.

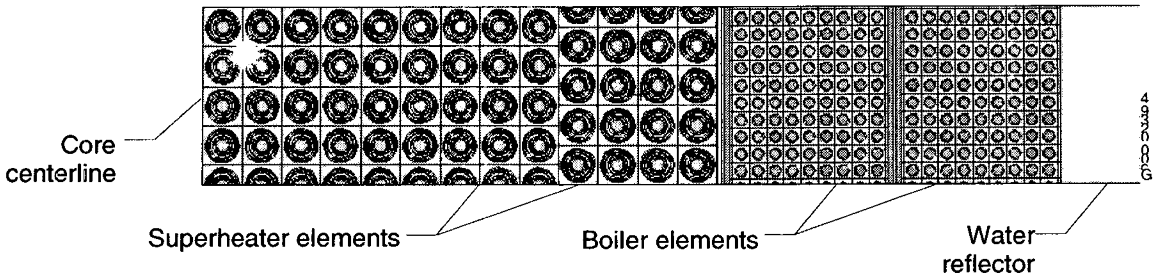

Figure 4. MCNP model representation of a section of the Pathfinder core.

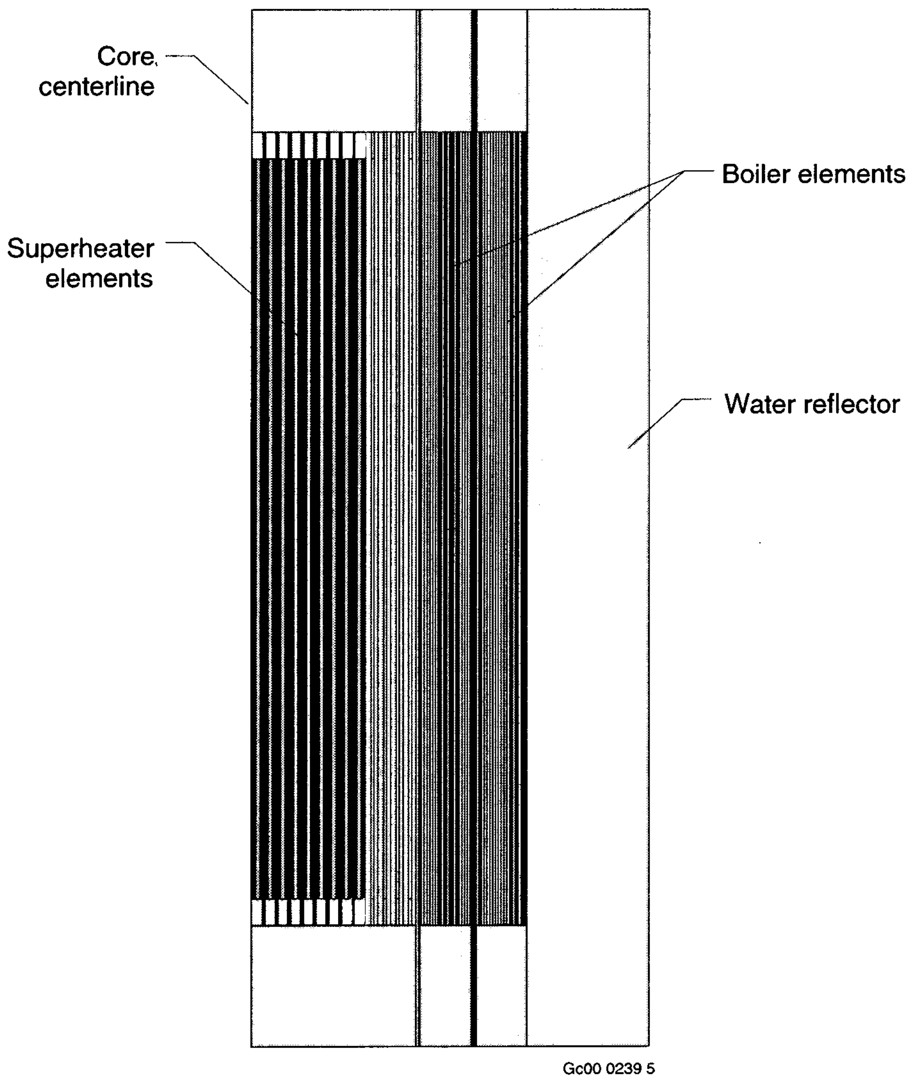

Figure 5. MCNP model axial view of the Pathfinder core.

Pathfinder Superheater Element

Stainless Steel Cladding, 60 to 100%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Light Water
Fuel Meat:	UO_2-316L Stainless Steel (cermet)
Clad:	316L Stainless Steel
Burnup:	6.01 MWd/element (average element burnup)
Burnup:	5.25% U-235 burnup (amount fissioned)
Burnup:	6.46% U-235 depletion (amount fissioned and transmuted)
Core Power Fraction:	15.00% Superheater core power fraction (max assumed)
Basis of Calculation	Single superheater element with double annuli
BOL U-235:	120.40 grams U-235 per element (design basis)
BOL U-238:	8.37 grams U-238 per element
BOL U-234:	0.00 grams U-234 per element
BOL U-236:	0.05 grams U-236 per element
BOL Total U per element:	128.82 grams U per element
BOL Fuel Enrichment:	93.5 wt%

DECAY TIMES (years)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H 3	8.128E-02	6.140E-02	4.638E-02	3.504E-02	2.647E-02	1.511E-02	6.512E-03	2.808E-03	1.210E-03	3.942E-04
BE 10	7.557E-10	7.557E-10	7.557E-10	7.557E-10	7.557E-10	7.557E-10	7.557E-10	7.557E-10	7.557E-10	7.557E-10
C 14	1.388E-03	1.387E-03	1.387E-03	1.386E-03	1.385E-03	1.383E-03	1.381E-03	1.378E-03	1.376E-03	1.372E-03
CL 36	7.369E-06	7.369E-06	7.369E-06	7.369E-06	7.369E-06	7.369E-06	7.369E-06	7.368E-06	7.368E-06	7.368E-06
CR 51	1.481E-17	2.204E-37	3.281E-57	4.884E-77	7.270E-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	2.539E-01	4.432E-03	7.738E-05	1.351E-06	2.358E-08	7.187E-12	3.824E-17	2.035E-22	1.083E-27	1.005E-34
FE 55	2.190E+01	5.780E+00	1.526E+00	4.026E-01	1.063E-01	7.403E-03	1.361E-04	2.502E-06	4.601E-08	2.233E-10
FE 59	9.776E-12	6.049E-24	3.744E-36	2.317E-48	1.434E-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	2.197E+01	1.138E+01	5.900E+00	3.058E+00	1.585E+00	4.258E-01	5.928E-02	8.253E-03	1.149E-03	8.291E-05
NI 59	1.302E-02	1.302E-02	1.302E-02	1.302E-02	1.302E-02	1.302E-02	1.302E-02	1.301E-02	1.301E-02	1.301E-02
NI 63	1.762E+00	1.697E+00	1.634E+00	1.574E+00	1.516E+00	1.406E+00	1.256E+00	1.121E+00	1.002E+00	8.617E-01
ZN 65	2.803E-03	1.566E-05	8.751E-08	4.889E-10	2.732E-12	8.528E-17	1.488E-23	2.595E-30	4.526E-37	4.411E-46
SE 79	7.950E-05	7.950E-05	7.949E-05	7.949E-05	7.948E-05	7.947E-05	7.946E-05	7.945E-05	7.944E-05	7.942E-05
KR 85	1.724E+00	1.248E+00	9.033E-01	6.539E-01	4.734E-01	2.481E-01	9.412E-02	3.571E-02	1.355E-02	3.721E-03
RB 87	5.427E-09	5.427E-09	5.427E-09	5.427E-09	5.427E-09	5.427E-09	5.427E-09	5.427E-09	5.427E-09	5.427E-09
SR 89	1.391E-08	1.837E-19	2.425E-30	3.202E-41	4.228E-52	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	1.674E+01	1.487E+01	1.320E+01	1.172E+01	1.041E+01	8.203E+00	5.742E+00	4.019E+00	2.813E+00	1.748E+00
Y 90	1.675E+01	1.487E+01	1.320E+01	1.172E+01	1.041E+01	8.205E+00	5.743E+00	4.020E+00	2.813E+00	1.748E+00

DECAY TIMES (years)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
Y 91	4.983E-07	2.030E-16	8.270E-26	3.369E-35	1.372E-44	2.278E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	4.090E-04	4.090E-04	4.090E-04	4.090E-04	4.090E-04	4.090E-04	4.090E-04	4.090E-04	4.090E-04	4.090E-04
ZR 95	3.324E-06	8.612E-15	2.231E-23	5.781E-32	1.498E-40	1.006E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M	9.386E-05	1.601E-04	2.115E-04	2.513E-04	2.822E-04	3.246E-04	3.588E-04	3.747E-04	3.821E-04	3.862E-04
NB 94	3.416E-05	3.415E-05	3.414E-05	3.414E-05	3.413E-05	3.412E-05	3.410E-05	3.409E-05	3.407E-05	3.405E-05
NB 95	7.379E-06	1.912E-14	4.954E-23	1.283E-31	3.325E-40	2.232E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M	2.466E-08	6.389E-17	1.655E-25	4.289E-34	1.111E-42	7.459E-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	2.431E-04	2.428E-04	2.426E-04	2.424E-04	2.421E-04	2.416E-04	2.409E-04	2.402E-04	2.395E-04	2.386E-04
TC 99	2.804E-03	2.804E-03	2.804E-03	2.804E-03	2.804E-03	2.804E-03	2.804E-03	2.803E-03	2.803E-03	2.803E-03
RU103	7.847E-12	8.116E-26	8.393E-40	8.681E-54	8.978E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	9.935E-01	3.199E-02	1.030E-03	3.316E-05	1.068E-06	1.107E-09	3.694E-14	1.233E-18	4.115E-23	4.422E-29
RH103M	7.074E-12	7.316E-26	7.567E-40	7.826E-54	8.093E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	9.935E-01	3.199E-02	1.030E-03	3.316E-05	1.068E-06	1.107E-09	3.694E-14	1.233E-18	4.115E-23	4.422E-29
PD107	2.885E-06	2.885E-06	2.885E-06	2.885E-06	2.885E-06	2.885E-06	2.885E-06	2.885E-06	2.885E-06	2.885E-06
AG110	6.377E-06	4.037E-08	2.556E-10	1.618E-12	1.024E-14	4.105E-19	1.042E-25	2.643E-32	6.706E-39	1.077E-47
AG110M	4.795E-04	3.035E-06	1.922E-08	1.216E-10	7.701E-13	3.087E-17	7.832E-24	1.987E-30	5.042E-37	8.100E-46
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	1.828E-03	1.441E-03	1.137E-03	8.966E-04	7.072E-04	4.399E-04	2.158E-04	1.059E-04	5.193E-05	2.009E-05
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	1.519E-13	7.283E-26	3.492E-38	1.674E-50	8.023E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	4.047E-15	3.249E-26	2.608E-37	2.093E-48	1.680E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	4.229E-15	3.395E-26	2.725E-37	2.187E-48	1.756E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	1.066E-17	5.108E-30	2.448E-42	1.174E-54	5.626E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	1.774E-04	1.015E-06	5.815E-09	3.329E-11	1.906E-13	6.250E-18	1.173E-24	2.202E-31	4.135E-38	4.445E-47
SN121M	1.547E-05	1.444E-05	1.346E-05	1.256E-05	1.173E-05	1.021E-05	8.291E-06	6.735E-06	5.471E-06	4.146E-06
SN123	4.457E-05	2.488E-09	1.388E-13	7.749E-18	4.325E-22	1.347E-30	2.342E-43	4.072E-56	7.080E-69	6.871E-86
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	6.908E-05	6.908E-05	6.908E-05	6.907E-05	6.907E-05	6.907E-05	6.906E-05	6.905E-05	6.904E-05	6.903E-05
SB124	4.254E-10	3.179E-19	2.377E-28	1.777E-37	1.328E-46	7.420E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	3.523E-01	1.009E-01	2.889E-02	8.276E-03	2.370E-03	1.944E-04	4.567E-06	1.073E-07	2.520E-09	1.696E-11
SB126	9.671E-06	9.671E-06	9.671E-06	9.670E-06	9.670E-06	9.669E-06	9.668E-06	9.667E-06	9.666E-06	9.665E-06
SB126M	6.908E-05	6.908E-05	6.908E-05	6.907E-05	6.907E-05	6.907E-05	6.906E-05	6.905E-05	6.904E-05	6.903E-05
TE123M	1.573E-08	4.038E-13	1.037E-17	2.662E-22	6.832E-27	4.502E-36	7.616E-50	1.288E-63	2.180E-77	9.464E-96
TE125M	8.595E-02	2.462E-02	7.049E-03	2.019E-03	5.782E-04	4.743E-05	1.114E-06	2.618E-08	6.148E-10	4.136E-12
TE127	3.223E-05	2.940E-10	2.681E-15	2.446E-20	2.231E-25	1.856E-35	1.408E-50	1.068E-65	8.106E-81	5.609-101
TE127M	3.291E-05	3.001E-10	2.738E-15	2.497E-20	2.277E-25	1.894E-35	1.437E-50	1.091E-65	8.275E-81	5.727-101

	DECAY TIMES (years) (Activities* in Ci/element)									
Radionuclide	**5**	**10**	**15**	**20**	**25**	**35**	**50**	**65**	**80**	**100**
TE129	7.493E-16	3.341E-32	1.490E-48	6.641E-65	2.961E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129M	1.151E-15	5.132E-32	2.288E-48	1.020E-64	4.549E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	4.399E-06	4.399E-06	4.399E-06	4.399E-06	4.399E-06	4.399E-06	4.399E-06	4.399E-06	4.399E-06	4.399E-06
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	4.331E-01	8.075E-02	1.505E-02	2.807E-03	5.233E-04	1.819E-05	1.179E-07	7.638E-10	4.950E-12	5.981E-15
CS135	1.822E-04	1.822E-04	1.822E-04	1.822E-04	1.822E-04	1.822E-04	1.822E-04	1.822E-04	1.822E-04	1.822E-04
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	1.743E+01	1.553E+01	1.384E+01	1.233E+01	1.099E+01	8.721E+00	6.168E+00	4.362E+00	3.085E+00	1.944E+00
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	1.649E+01	1.469E+01	1.309E+01	1.166E+01	1.039E+01	8.250E+00	5.835E+00	4.127E+00	2.919E+00	1.839E+00
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	1.915E-14	2.422E-31	3.064E-48	3.875E-65	4.901E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	6.111E-09	6.111E-09	6.111E-09	6.111E-09	6.111E-09	6.111E-09	6.111E-09	6.111E-09	6.111E-09	6.111E-09
CE144	5.635E+00	6.580E-02	7.683E-04	8.971E-06	1.048E-07	1.428E-11	2.274E-17	3.621E-23	5.765E-29	1.072E-36
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	5.635E+00	6.580E-02	7.683E-04	8.972E-06	1.048E-07	1.428E-11	2.274E-17	3.621E-23	5.765E-29	1.072E-36
PR144M	6.762E-02	7.896E-04	9.220E-06	1.077E-07	1.257E-09	1.714E-13	2.729E-19	4.345E-25	6.918E-31	1.286E-38
ND144	2.524E-13	2.544E-13	2.545E-13	2.545E-13	2.545E-13	2.545E-13	2.545E-13	2.545E-13	2.545E-13	2.545E-13
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	1.981E-07	1.666E-07	1.371E-07	1.127E-07	9.268E-08	6.267E-08	3.484E-08	1.937E-08	1.077E-08	4.925E-09
PM147	1.929E+01	5.151E+00	1.376E+00	3.675E-01	9.815E-02	7.002E-03	1.334E-04	2.542E-06	4.844E-08	2.465E-10
PM148M	4.160E-13	2.069E-26	1.029E-39	5.116E-53	2.544E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	2.343E-14	1.165E-27	5.795E-41	2.882E-54	1.433E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	8.242E-08	1.997E-09	4.840E-11	1.173E-12	2.842E-14	1.669E-17	2.375E-22	3.379E-27	4.809E-32	1.658E-38
SM147	1.484E-09	1.831E-09	1.923E-09	1.948E-09	1.955E-09	1.957E-09	1.957E-09	1.957E-09	1.957E-09	1.957E-09
SM151	3.133E-01	3.015E-01	2.901E-01	2.792E-01	2.686E-01	2.487E-01	2.216E-01	1.975E-01	1.759E-01	1.508E-01
EU152	8.228E-03	6.379E-03	4.945E-03	3.833E-03	2.972E-03	1.786E-03	8.317E-04	3.875E-04	1.805E-04	6.517E-05
EU154	4.509E-02	3.014E-02	2.015E-02	1.347E-02	9.004E-03	4.024E-03	1.203E-03	3.591E-04	1.073E-04	2.143E-05
EU155	2.772E-01	1.379E-01	6.859E-02	3.412E-02	1.697E-02	4.198E-03	5.166E-04	6.357E-05	7.823E-06	4.788E-07
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	3.431E-05	1.842E-07	9.892E-10	5.312E-12	2.852E-14	8.225E-19	1.274E-25	1.972E-32	3.054E-39	2.539E-48
TB160	5.925E-08	1.494E-15	3.767E-23	9.502E-31	2.396E-38	1.524E-53	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	1.143E-13	1.143E-13	1.143E-13	1.143E-13	1.143E-13	1.143E-13	1.143E-13	1.143E-13	1.143E-13	1.143E-13

DECAY TIMES (years)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TL207	4.620E-09	1.180E-08	2.170E-08	3.394E-08	4.815E-08	8.136E-08	1.400E-07	2.056E-07	2.756E-07	3.727E-07
TL208	1.456E-07	1.606E-07	1.569E-07	1.503E-07	1.434E-07	1.302E-07	1.127E-07	9.753E-08	8.442E-08	6.971E-08
PB210	1.174E-14	4.855E-14	1.414E-13	3.119E-13	5.790E-13	1.467E-12	3.875E-12	7.804E-12	1.344E-11	2.383E-11
PB211	4.633E-09	1.183E-08	2.177E-08	3.403E-08	4.829E-08	8.159E-08	1.404E-07	2.062E-07	2.764E-07	3.738E-07
PB212	4.052E-07	4.469E-07	4.367E-07	4.183E-07	3.990E-07	3.623E-07	3.136E-07	2.714E-07	2.350E-07	1.940E-07
BI211	4.633E-09	1.183E-08	2.177E-08	3.403E-08	4.829E-08	8.159E-08	1.404E-07	2.062E-07	2.764E-07	3.738E-07
BI212	4.052E-07	4.469E-07	4.367E-07	4.183E-07	3.990E-07	3.623E-07	3.136E-07	2.714E-07	2.350E-07	1.940E-07
PO212	2.596E-07	2.863E-07	2.798E-07	2.680E-07	2.557E-07	2.321E-07	2.009E-07	1.739E-07	1.505E-07	1.243E-07
PO215	4.633E-09	1.183E-08	2.177E-08	3.403E-08	4.829E-08	8.159E-08	1.404E-07	2.062E-07	2.764E-07	3.738E-07
PO216	4.052E-07	4.469E-07	4.367E-07	4.183E-07	3.990E-07	3.623E-07	3.136E-07	2.714E-07	2.350E-07	1.940E-07
RN219	4.633E-09	1.183E-08	2.177E-08	3.403E-08	4.829E-08	8.159E-08	1.404E-07	2.062E-07	2.764E-07	3.738E-07
RN220	4.052E-07	4.469E-07	4.367E-07	4.183E-07	3.990E-07	3.623E-07	3.136E-07	2.714E-07	2.350E-07	1.940E-07
FR223	6.392E-11	1.631E-10	3.000E-10	4.690E-10	6.654E-10	1.125E-09	1.936E-09	2.843E-09	3.810E-09	5.153E-09
RA223	4.633E-09	1.183E-08	2.177E-08	3.403E-08	4.829E-08	8.159E-08	1.404E-07	2.062E-07	2.764E-07	3.738E-07
RA224	4.052E-07	4.469E-07	4.367E-07	4.183E-07	3.990E-07	3.623E-07	3.136E-07	2.714E-07	2.350E-07	1.940E-07
RA226	1.202E-13	4.419E-13	9.691E-13	1.704E-12	2.650E-12	5.180E-12	1.061E-11	1.803E-11	2.749E-11	4.335E-11
RA228	2.767E-11	3.664E-11	4.200E-11	4.521E-11	4.713E-11	4.898E-11	4.984E-11	5.008E-11	5.019E-11	5.029E-11
AC227	4.632E-09	1.182E-08	2.174E-08	3.399E-08	4.822E-08	8.151E-08	1.403E-07	2.060E-07	2.761E-07	3.734E-07
TH227	4.570E-09	1.167E-08	2.147E-08	3.356E-08	4.762E-08	8.046E-08	1.385E-07	2.034E-07	2.726E-07	3.686E-07
TH228	4.052E-07	4.465E-07	4.363E-07	4.179E-07	3.987E-07	3.622E-07	3.136E-07	2.714E-07	2.350E-07	1.940E-07
TH229	9.227E-12	1.765E-11	2.614E-11	3.469E-11	4.332E-11	6.076E-11	8.743E-11	1.147E-10	1.426E-10	1.807E-10
TH230	1.017E-10	1.963E-10	2.923E-10	3.897E-10	4.883E-10	6.891E-10	9.987E-10	1.317E-09	1.644E-09	2.090E-09
TH231	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04
TH232	4.988E-11	4.991E-11	4.993E-11	4.995E-11	4.998E-11	5.003E-11	5.010E-11	5.017E-11	5.024E-11	5.034E-11
TH234	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06
PA231	4.030E-08	6.605E-08	9.179E-08	1.175E-07	1.433E-07	1.947E-07	2.719E-07	3.490E-07	4.261E-07	5.289E-07
PA233	6.898E-06	6.898E-06	6.898E-06	6.899E-06	6.900E-06	6.902E-06	6.905E-06	6.908E-06	6.911E-06	6.916E-06
PA234M	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06
PA234	3.635E-09	3.635E-09	3.635E-09	3.635E-09	3.635E-09	3.635E-09	3.635E-09	3.635E-09	3.635E-09	3.635E-09
U232	4.671E-07	4.474E-07	4.271E-07	4.072E-07	3.881E-07	3.526E-07	3.052E-07	2.642E-07	2.287E-07	1.886E-07
U233	1.778E-08	1.793E-08	1.808E-08	1.823E-08	1.838E-08	1.868E-08	1.914E-08	1.959E-08	2.004E-08	2.064E-08
U234	2.089E-06	2.120E-06	2.150E-06	2.179E-06	2.207E-06	2.259E-06	2.330E-06	2.393E-06	2.449E-06	2.515E-06
U235	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04	2.435E-04
U236	9.730E-05	9.730E-05	9.730E-05	9.730E-05	9.730E-05	9.730E-05	9.730E-05	9.730E-05	9.730E-05	9.730E-05
U237	4.464E-07	3.509E-07	2.759E-07	2.169E-07	1.706E-07	1.054E-07	5.123E-08	2.490E-08	1.210E-08	4.623E-09
U238	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06	2.796E-06

	DECAY TIMES (years) (Activities* in Ci/element)									
Radionuclide	**5**	**10**	**15**	**20**	**25**	**35**	**50**	**65**	**80**	**100**
NP237	6.898E-06	6.898E-06	6.898E-06	6.899E-06	6.900E-06	6.902E-06	6.905E-06	6.908E-06	6.911E-06	6.916E-06
PU236	8.420E-08	2.499E-08	7.416E-09	2.201E-09	6.535E-10	5.796E-11	1.950E-12	4.857E-13	4.474E-13	4.463E-13
PU237	6.292E-19	5.636E-31	5.048E-43	4.522E-55	4.051E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	2.248E-03	2.161E-03	2.078E-03	1.997E-03	1.920E-03	1.774E-03	1.576E-03	1.400E-03	1.244E-03	1.062E-03
PU239	4.017E-03	4.016E-03	4.015E-03	4.015E-03	4.014E-03	4.013E-03	4.011E-03	4.010E-03	4.008E-03	4.006E-03
PU240	5.236E-04	5.233E-04	5.230E-04	5.227E-04	5.224E-04	5.219E-04	5.211E-04	5.202E-04	5.194E-04	5.183E-04
PU241	1.820E-02	1.431E-02	1.125E-02	8.843E-03	6.952E-03	4.298E-03	2.089E-03	1.015E-03	4.933E-04	1.885E-04
PU242	1.185E-08	1.185E-08	1.185E-08	1.185E-08	1.185E-08	1.185E-08	1.185E-08	1.185E-08	1.185E-08	1.185E-08
PU244	3.988E-17	3.988E-17	3.988E-17	3.988E-17	3.988E-17	3.988E-17	3.988E-17	3.988E-17	3.988E-17	3.988E-17
AM241	1.696E-04	2.973E-04	3.964E-04	4.730E-04	5.319E-04	6.111E-04	6.692E-04	6.886E-04	6.894E-04	6.776E-04
AM242M	5.862E-08	5.730E-08	5.601E-08	5.475E-08	5.352E-08	5.113E-08	4.776E-08	4.460E-08	4.165E-08	3.803E-08
AM242	5.833E-08	5.702E-08	5.573E-08	5.448E-08	5.325E-08	5.088E-08	4.752E-08	4.438E-08	4.145E-08	3.784E-08
AM243	5.938E-09	5.935E-09	5.932E-09	5.929E-09	5.926E-09	5.921E-09	5.913E-09	5.904E-09	5.896E-09	5.885E-09
CM242	1.147E-07	4.720E-08	4.611E-08	4.507E-08	4.406E-08	4.208E-08	3.930E-08	3.670E-08	3.428E-08	3.129E-08
CM243	3.100E-09	2.745E-09	2.431E-09	2.153E-09	1.907E-09	1.495E-09	1.038E-09	7.212E-10	5.009E-10	3.081E-10
CM244	4.388E-08	3.624E-08	2.993E-08	2.472E-08	2.042E-08	1.393E-08	7.848E-09	4.422E-09	2.491E-09	1.159E-09
CM245	3.390E-13	3.388E-13	3.387E-13	3.386E-13	3.384E-13	3.381E-13	3.377E-13	3.373E-13	3.369E-13	3.364E-13
CM246	2.485E-15	2.483E-15	2.481E-15	2.480E-15	2.478E-15	2.474E-15	2.469E-15	2.463E-15	2.458E-15	2.451E-15
CM247	4.323E-22	4.323E-22	4.323E-22	4.323E-22	4.323E-22	4.323E-22	4.323E-22	4.323E-22	4.323E-22	4.323E-22
Subtotal**	1.493E+02	8.620E+01	6.519E+01	5.390E+01	4.634E+01	3.578E+01	2.516E+01	1.792E+01	1.285E+01	8.322E+00
TOTAL***	1.493E+02	8.621E+01	6.520E+01	5.391E+01	4.634E+01	3.578E+01	2.516E+01	1.792E+01	1.285E+01	8.323E+00

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 21

Fuel-Specific Source Term Calculations LWBR Seed Module

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term template for a single Light Water Breeder Reactor (LWBR) spent nuclear fuel seed module. The data sources for the analysis are documented here, and the INEEL calculational methodology is described in Reference 1.

Light Water Breeder Reactor History

The LWBR was a full-scale power production reactor with a core design power rating of 236 MW_{th}. The LWBR core operated over a time period extending from August 26, 1977, to December 2, 1982 (5+ years). The reactor design was conceived by the Westinghouse Atomic Power Development Laboratory (WAPD) and stationed at the Shippingport Atomic Power Station (APS).

The LWBR was a pressurized, light water moderated and cooled thermal reactor with zirconium-clad UO_2-ThO_2 fuel rods (Reference 6). The beginning-of-life (BOL) UO_2 was fully enriched in U-233 (>98%) and provided a total core fissile inventory of approximately 501 kg. In addition, to the UO_2-ThO_2 fuel rods, the entire fueled active core region was reflected radially or circumferentially around the core, and both above and below with ThO_2 fuel rods. The ThO_2 rods in the outer reflector regions and the very large ThO_2 loading in the active core were designed to reduce neutron leakage and breed U-233.

The LWBR core consisted of 39 modules (12 seed, 3 standard blanket Type I, 3 standard/power flattening blanket Type II, 6 standard/power flattening blanket Type III, 9 reflector Type IV, and 6 reflector Type V). These modules were in the core for the full operating period (5+ years). Over its lifetime, the core generated 29,047 EFPH (full power = 236 MW).

The reactor core design was complex; the primary design goal was to maximize the U-233 breeding ratio. The seed modules were moveable; operated on pneumatic pistons for reactivity control, supplanting the need for neutron absorbing control rods. The different fueled module types had different numbers of rods, rod diameters, and lattice pitch. In addition, each module type had complex radial and axial urania/thoria loadings. Reference 6 provides a good description of the different module loadings and geometries. In addition, Reference 6 contains an extensive listing of additional references from which data were obtained and used in the depletion calculations here.

Light Water Breeder Reactor Seed and Reactor Data

The LWBR reactor core and fuel elements are described in some detail in Reference 6. Data from this reference have been used to develop reactor physics models needed to develop neutron cross sections for the fuel depletion and radionuclide inventory analysis.

The LWBR seed modules consisted of 619 fuel rods arranged in 15 hexagonal rings in a Zircaloy-4 hexagonal can. The 9.59-in. flat-to-flat can had a 0.08 in. thickness. The fuel rod meat or fuel pellet material was either a urania-thoria (UO_2-ThO_2) binary composition or a pure thoria (ThO_2) composition. In the seed module, there were two binary compositions with different uranium loadings.

The fuel rod clad was Zircaloy-4. The fuel pellet and pin diameters were 0.262 in. and 0.306 in., respectively. The uranium metal was high enriched at 98.23 wt% U-233 at BOL. For modeling purposes, the thoria properties listed below for the binary pellet are also used for the pure thoria pellet.

The following data provide specific seed module dimensions, materials, densities, enrichment, etc., which are typical for an LWBR seed module (Reference 6). The BOL data below were used in the fuel depletion calculations for the LWBR seed module source term generation.

Seed Module:	15 concentric hexagonal rings of fuel rods
No. of rods:	619 fuel rods per seed module (631 lattice positions)
Types of rods:	4 (1 high zone and 3 low zones)
High Zone rods:	331 per module
Low Zone rods:	288 per module
Fuel Pellet Diameter:	0.262 in.
Fuel Rod Meat Length:	84 in.
Fuel Rod Pitch:	0.370 in. (hot)
Uranium Enrichment:	98.23 wt % U-233
	1.29 wt % U-234
	0.09 wt % U-235
	0.02 wt % U-236
	0.37 wt % U-238
Binary Fuel Rod Meat:	Urania-thoria (UO_2-ThO_2)
UO_2 Density:	10.96 g/cc (100% Theoretical Density [TD])
ThO_2 Density:	10.03 g/cc (100% TD)
UO_2 Density:	10.52 g/cc (96% TD)
ThO_2 Density:	9.93 g/cc (99% TD)
UO_2 Fraction:	4.337 wt% (Low Zone)
UO_2 Fraction:	5.202 wt% (High Zone)
U-233 Mass:	16,877.36 g per seed module
U-234 Mass:	221.64 g per seed module
U-235 Mass:	15.46 g per seed module
U-236 Mass:	3.44 g per seed module
U-238 Mass:	63.57 g per seed module
Th-232 Mass:	442,731.04 g per seed module
Clad:	Zircaloy-4
Clad Pin Outer Diameter:	0.306 in.
Clad Thickness:	0.022 in.
Clad Pin Length:	118 in.
Clad Density:	6.44 g/cc
Total Zircaloy Mass:	154,237.0 g per module (based conservatively on 631 fuel rods)

Can Geometry:	Hexagonal
Can Dimensions:	9.59 in. flat-to-flat
	0.08 in. wall thickness
Can Length:	118 in.
Can Material:	Zircaloy-4
Can Density:	6.44 g/cc
Can Mass:	33,114.6 g per module
Total Zircaloy-4 Mass:	187,351.6 g per module
Coolant:	Light water
Coolant Temperature:	531°F
Coolant Pressure:	2000 psig
Coolant Density:	0.6583 g/cc

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for the material components in a single LWBR seed module. In addition, for the ORIGEN2 (Reference 2) depletion calculation, conservative and detailed impurity concentrations were added for the zircaloy clad (Reference 3) and the urania-thoria fuel pellets (Reference 4). Table 1 lists the impurities and corresponding concentrations used in the calculations. NOTE: The impurities in the thoria pellets were assumed to be the same as in the urania-thoria pellets.

Burnup

The LWBR module burnup or depletion analysis was performed using the ORIGEN2 computer code (Reference 2). Three basic inputs are required to perform this analysis, which include: (1) neutron cross sections specific to the LWBR seed module, (2) power history or average burnup for a single LWBR seed module over its operating lifetime, and (3) BOL seed module fissile and fertile masses. The neutron cross sections are discussed below and were incorporated as an update into a standard ORIGEN2 pressurized water reactor (PWR) cross-section library.

The complete LWBR power history is given in References 4 and 8. These data have been used to derive a simplified power history and burnup for an average seed module. The derived data used in the ORIGEN2 code as input are given in Table 2 in terms of seed module power (MW_{th}) and cumulative or total seed module burnup (MWD).

The fissile and fertile BOL isotopic masses by module are derived from data found in Reference 6 and are given in the "LWBR Seed and Reactor Data" section above. Module masses are based on the following information: (1) total number of fuel rods for that particular module, (2) fuel rod radius and length, (3) number of fuel rods in a given radial loading zone, (4) axial loading step lengths, and (5) radial and axial step percent mass loadings of UO_2 in UO_2-ThO_2. From these data, the BOL uranium isotopic masses and Thorium-232 mass can be determined for each module type. In addition, the oxide fuel impurity masses are also included in the calculations. The impurity levels were obtained from LWBR UO_2-ThO_2 fuel fabrication specifications.

Cross-Section Development

The primary goal of the reactor physics analysis was to develop BOL neutron cross sections specifically for the LWBR seed module. This required that MCNP4B (Reference 5) computer models be developed to represent the module geometry and the complex radial and axial fuel loadings in both the seed and standard blanket modules. The cross sections were required as input data for the ORIGEN2 depletion or burnup calculations. (NOTE: No standard ORIGEN2 neutron cross-section libraries were available for this unique reactor type). The MCNP neutron cross-section generation methodology is documented in Reference 1, and validation work to support the physics and depletion methodology and its predictive capability is given Reference 7 specifically for the LWBR.

A fully explicit, three-dimensional MCNP4B computer model of the seed, standard blanket, and top and bottom thoria reflectors was developed specifically to generate three BOL cross-section library updates. The model was essentially an infinite lattice model of seed and standard reflector blankets with exact numbers of fuel rods, rod diameters, clad thicknesses, lattice pitch, fuel and clad materials, and the complex radial and axial urania-thoria loadings.

Figure 1 shows an x-y cross-sectional view of the infinite lattice model as drawn by the MCNP4B computer code. The complex geometry and radial binary fuel loading patterns of the UO_2-ThO_2 pellets are fully visible from the color scheme as are the variable rod diameters and pitches between the seed rods and the standard blanket rods. The axially stepped binary and thoria fuel loading patterns for the seed and standard blanket modules are given Reference 6, and although not shown in Figure 1, are appropriately modeled in the MCNP model.

Only BOL neutron cross sections were generated and used in the burnup calculations, i.e., burnup-dependent cross sections were not calculated at various time steps throughout the burnup calculations as was done in the validation work. Based on the validation work, good radionuclide inventories could be obtained with BOL cross sections only. Part of the reason for this is because during reactor operation, the seed modules burned their U-233 fissile inventory while the thoria bred new U-233. Therefore, because both the thoria and U-233 inventories remained relatively constant over the LWBR lifetime, the neutron cross sections would be weakly dependent on burnup, and here it is assumed that the BOL cross sections are reasonable estimates over the entire LWBR lifetime.

Light Water Breeder Reactor Seed Module Exposure History

Table 2 summarizes the LWBR single seed module power or exposure history used in the depletion calculations. The power history is based on data in References 4 and 8. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years.

Burnup Calculation

The ORIGEN2 computer code was used to perform the depletion or burnup calculation for a single LWBR seed module. The seed module masses and impurities, neutron cross sections, burnup, power history, and power level as discussed above are input data for the ORIGEN2 calculation. The ORIGEN2 output or radionuclide concentrations are given as a function of time in the attached template table representing a single average-burnup LWBR seed module.

The 145 radionuclides listed in the template represent greater than 99.99% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

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4. Bettis Atomic Power Laboratory, *Summary of the Nuclear Design and Performance of the Light water Breeder Reactor (LWBR)*, WAPD-TM-1326, June 1979.

5. "MCNP4B: Monte Carlo N-Particle Transport Code System," contributed by the Transport Methods Group, Los Alamos National Laboratory and distributed by the Radiation and Safety Information Computational Center as code package CCC-660, April 1997.

6. G. L. Olson, R. K. McCardell, and D. Illum, *Fuel Summary Report: Shippingport Light Water Breeder Reactor*, INEEL/EXT-98-00799, August 1998.

7. J. W. Sterbentz, *Validation Work to Support the Idaho National Engineering and Environmental Laboratory Calculational Burnup Methodology Using Shippingport Light Water Breeder Reactor (LWBR) Spent Fuel Assay Data*, INEEL/EXT-99-00581, August 1999.

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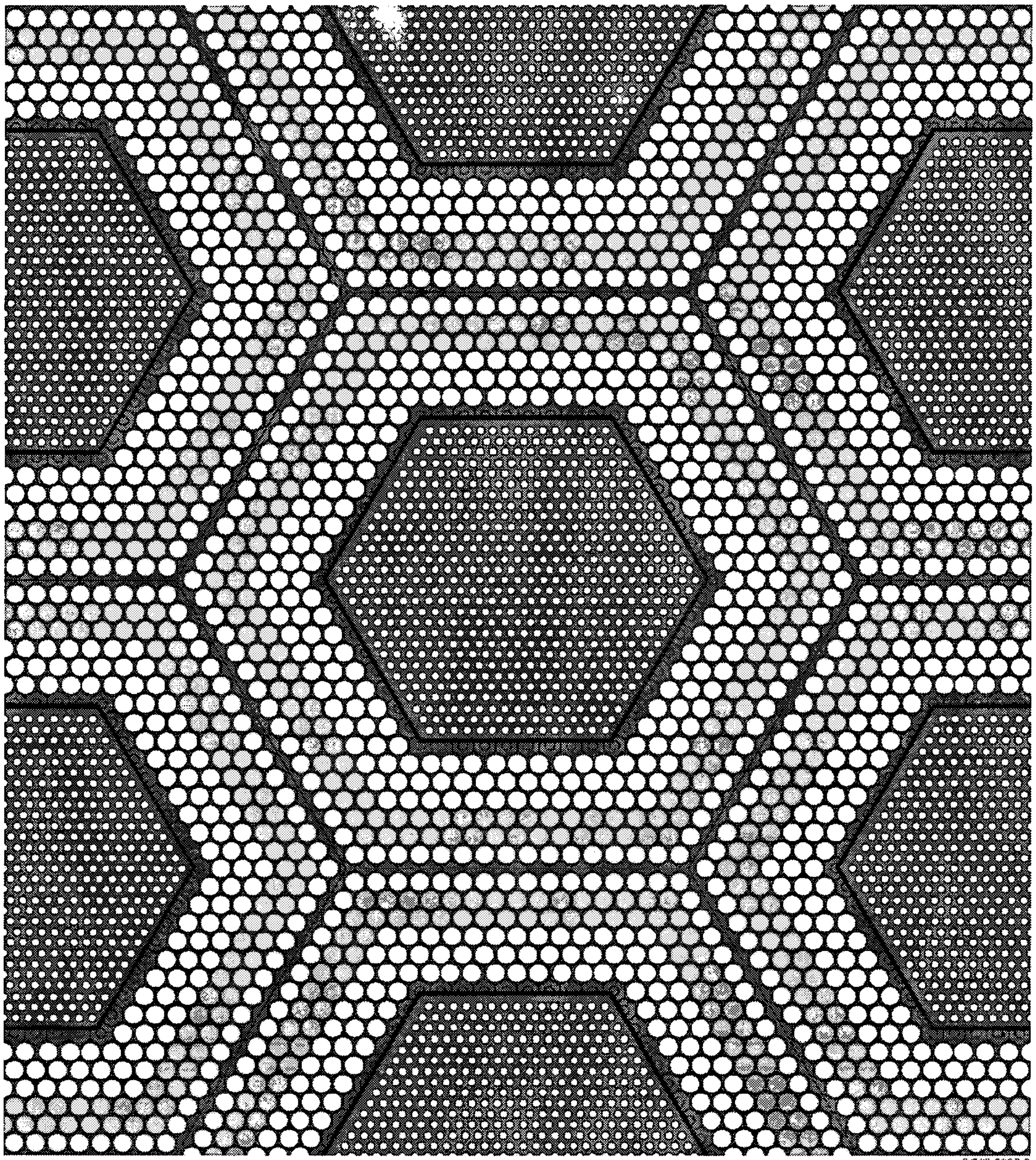

Figure 1. Infinite lattice model representation (MCNP) of the LWBR seed/standard blanket modules.

Table 1. Zircaloy-4 and UO_2-ThO_2 material constituent and impurity concentrations.

Constituent or Impurity	Zircaloy-4 Concentration (wt%)	UO2-ThO2 Concentration (ppm)
H	0.002497	
B	0.00005	1
C	0.026968	200
N	0.00799	50
O	0.094887	134454
Mg		100
Al	0.007491	500
Si	0.011986	300
P	0.009988	
S	0.003496	
Cl		15
Ca		20
Ti	0.004994	20
V	0.004994	25
Cr	0.124851	100
Mn	0.004994	10
Fe	0.224731	300
Co	0.001998	10
Ni	0.006992	200
Cu	0.004994	40
Zn	0.009988	
Zr	97.789992	
Nb	0.006992	
Mo	0.004994	100
Cd	0.000050	
Sn	1.598089	
Sm	0.000999	
Gd	0.000499	
Hf	0.003496	
Ta	0.019976	
W	0.009988	
Hg		1
Pb	0.009988	
Th	0.000699	
U	0.000350	

Table 2. Light Water Breeder Reactor seed module power history.

Operating Start Date	Operating End Date	Operational (days)	Cumulative Operating (days)	Seed Module Power (MW_{th})	Cumulative Burnup (MWD)
26-Aug-77	30-Sep-77	35	35	2.731274	95.59
30-Sep-77	31-Dec-77	92	127	5.971203	644.95
31-Dec-77	31-Mar-78	90	217	7.897081	1355.68
31-Mar-78	30-Jun-78	91	308	5.969611	1898.92
30-Jun-78	30-Sep-78	92	400	6.767031	2521.48
30-Sep-78	31-Dec-78	92	492	7.217013	3185.45
31-Dec-78	31-Mar-79	90	582	7.549443	3864.90
31-Mar-79	30-Jun-79	91	673	0.000000	3864.90
30-Jun-79	30-Sep-79	92	765	5.202659	4343.54
30-Sep-79	31-Dec-79	92	857	6.666736	4956.88
31-Dec-79	31-Mar-80	91	948	5.068303	5418.10
31-Mar-80	30-Jun-80	91	1039	5.999137	5964.02
30-Jun-80	30-Sep-80	92	1131	6.289765	6542.68
30-Sep-80	31-Dec-80	92	1223	2.911629	6810.55
31-Dec-80	31-Mar-81	90	1313	6.354118	7382.42
31-Mar-81	30-Jun-81	91	1404	3.731881	7722.02
30-Jun-81	30-Sep-81	92	1496	6.338568	8305.17
30-Sep-81	31-Dec-81	92	1588	5.039344	8768.79
31-Dec-81	31-Mar-82	90	1678	5.325345	9248.07
31-Mar-82	30-Jun-82	91	1769	5.670859	9764.12
30-Jun-82	30-Sep-82	92	1861	5.467423	10267.12
30-Sep-82	2-Dec-82	63	1924	0.031986	10269.14
2-Dec-82	2-Dec-87	1826.25	3750.25	0	10269.14
2-Dec-87	2-Dec-92	1826.25	5576.50	0	10269.14
2-Dec-92	2-Dec-97	1826.25	7402.75	0	10269.14
2-Dec-97	2-Dec-02	1826.25	9229.00	0	10269.14
2-Dec-02	2-Dec-07	1826.25	11055.25	0	10269.14
2-Dec-07	2-Dec-17	3652.50	14707.75	0	10269.14
2-Dec-17	2-Dec-32	5478.75	20186.50	0	10269.14
2-Dec-32	2-Dec-47	5478.75	25665.25	0	10269.14
2-Dec-47	2-Dec-62	5478.75	31144.00	0	10269.14
2-Dec-62	2-Dec-82	7305.00	38449.00	0	10269.14

The ten dates with zero associated power represent the ten different cooling or decay dates after exposure or post-December 1982. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling times designated for the template methodology.

LWBR Seed Module

Zircaloy Cladding, 60 to 100%-Enriched U-233 Fuel

Reactor Moderator/Coolant:	Light Water
Fuel Meat:	UO2-ThO2 (Urania-Thoria)
Clad:	Zircaloy-4
Burnup:	10,269.14 MWD
Burnup:	27, 749.70 MWD/MTHM
Basis of Calculation:	Single seed module
BOL U-233	16,877.36 g U-233 per seed module
BOL U-234	221.64 g U-234 per seed module
BOL U-235:	15.46 g U-235 per seed module
BOL U-236	3.44 g U-236 per seed module
BOL U-238:	63.57 g U-238 per seed module
BOL Th-232:	442,731.04 g Th-232 per seed module
BOL Fuel Enrichment:	98.23 wt% U-233

DECAY TIMES (years out of core)

(Activities* in Ci/seed module)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H 3	1.177E+02	8.889E+01	6.714E+01	5.071E+01	3.830E+01	2.185E+01	9.414E+00	4.056E+00	1.748E+00	5.687E-01
BE 10	2.437E-06	2.437E-06	2.437E-06	2.437E-06	2.437E-06	2.437E-06	2.437E-06	2.437E-06	2.437E-06	2.437E-06
C 14	9.526E-01	9.520E-01	9.515E-01	9.509E-01	9.503E-01	9.492E-01	9.475E-01	9.457E-01	9.440E-01	9.417E-01
CL 36	1.859E-02	1.859E-02	1.859E-02	1.859E-02	1.859E-02	1.859E-02	1.859E-02	1.859E-02	1.859E-02	1.859E-02
CR 51	3.260E-18	4.703E-38	6.786E-58	9.790E-78	1.412E-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	5.381E-01	9.368E-03	1.631E-04	2.839E-06	4.943E-08	1.498E-11	7.905E-17	4.171E-22	2.201E-27	2.022E-34
FE 55	7.030E+01	1.854E+01	4.888E+00	1.289E+00	3.399E-01	2.363E-02	4.333E-04	7.945E-06	1.457E-07	7.043E-10
FE 59	2.760E-12	1.675E-24	1.017E-36	6.173E-49	3.747E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	4.641E+02	2.404E+02	1.246E+02	6.453E+01	3.343E+01	8.972E+00	1.247E+00	1.734E-01	2.411E-02	1.737E-03
NI 59	6.503E-02	6.503E-02	6.503E-02	6.502E-02	6.502E-02	6.502E-02	6.501E-02	6.500E-02	6.499E-02	6.498E-02
NI 63	8.701E+00	8.379E+00	8.069E+00	7.771E+00	7.484E+00	6.941E+00	6.199E+00	5.537E+00	4.945E+00	4.253E+00
ZN 65	1.948E-01	1.085E-03	6.039E-06	3.362E-08	1.872E-10	5.802E-15	1.001E-21	1.728E-28	2.982E-35	2.865E-44
SE 79	3.638E-01	3.638E-01	3.638E-01	3.637E-01	3.637E-01	3.637E-01	3.636E-01	3.636E-01	3.635E-01	3.634E-01
KR 85	4.474E+03	3.238E+03	2.344E+03	1.696E+03	1.228E+03	6.431E+02	2.438E+02	9.244E+01	3.505E+01	9.617E+00
RB 87	1.429E-05	1.429E-05	1.429E-05	1.429E-05	1.429E-05	1.429E-05	1.429E-05	1.429E-05	1.429E-05	1.429E-05

DECAY TIMES (years out of core)

(Activities* in Ci/seed module)

Radionuclide	5	10	15	20	25	35	50	65	80	100
SR 89	1.585E-06	2.057E-17	2.670E-28	3.466E-39	4.498E-50	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	3.131E+04	2.779E+04	2.468E+04	2.191E+04	1.945E+04	1.533E+04	1.073E+04	7.506E+03	5.252E+03	3.263E+03
Y 90	3.131E+04	2.780E+04	2.468E+04	2.191E+04	1.945E+04	1.533E+04	1.073E+04	7.508E+03	5.254E+03	3.264E+03
Y 91	5.778E-05	2.319E-14	9.310E-24	3.737E-33	1.500E-42	2.417E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	8.719E-01	8.719E-01	8.719E-01	8.719E-01	8.719E-01	8.719E-01	8.718E-01	8.718E-01	8.718E-01	8.718E-01
ZR 95	4.013E-04	1.026E-12	2.621E-21	6.701E-30	1.713E-38	1.119E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M	2.721E-01	3.972E-01	4.942E-01	5.693E-01	6.275E-01	7.077E-01	7.721E-01	8.021E-01	8.161E-01	8.239E-01
NB 94	2.796E-02	2.795E-02	2.795E-02	2.795E-02	2.794E-02	2.793E-02	2.792E-02	2.790E-02	2.789E-02	2.787E-02
NB 95	8.908E-04	2.277E-12	5.821E-21	1.487E-29	3.803E-38	2.485E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M	2.976E-06	7.608E-15	1.945E-23	4.970E-32	1.271E-40	8.302E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	4.334E-03	4.330E-03	4.325E-03	4.321E-03	4.317E-03	4.308E-03	4.295E-03	4.283E-03	4.270E-03	4.253E-03
TC 99	3.341E+00	3.341E+00	3.341E+00	3.341E+00	3.341E+00	3.340E+00	3.340E+00	3.340E+00	3.340E+00	3.340E+00
RU103	2.716E-10	2.748E-24	2.780E-38	2.812E-52	2.845E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	3.759E+02	1.207E+01	3.879E-01	1.246E-02	4.002E-04	4.129E-07	1.368E-11	4.535E-16	1.503E-20	1.600E-26
RH103M	2.449E-10	2.477E-24	2.506E-38	2.535E-52	2.565E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	3.759E+02	1.207E+01	3.879E-01	1.246E-02	4.002E-04	4.129E-07	1.368E-11	4.535E-16	1.503E-20	1.600E-26
PD107	3.543E-03	3.543E-03	3.543E-03	3.543E-03	3.543E-03	3.543E-03	3.543E-03	3.543E-03	3.543E-03	3.543E-03
AG110	7.814E-03	4.930E-05	3.110E-07	1.962E-09	1.238E-11	4.927E-16	1.237E-22	3.107E-29	7.802E-36	1.236E-44
AG110M	5.875E-01	3.707E-03	2.338E-05	1.475E-07	9.308E-10	3.705E-14	9.303E-21	2.336E-27	5.866E-34	9.294E-43
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	3.574E+00	2.818E+00	2.222E+00	1.752E+00	1.382E+00	8.592E-01	4.213E-01	2.066E-01	1.013E-01	3.917E-02
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	1.621E-11	7.620E-24	3.582E-36	1.684E-48	7.918E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	7.035E-11	5.548E-22	4.377E-33	3.452E-44	2.723E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	7.351E-11	5.798E-22	4.573E-33	3.607E-44	2.845E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	1.138E-15	5.352E-28	2.516E-40	1.183E-52	5.562E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	1.551E+01	8.850E-02	5.048E-04	2.881E-06	1.643E-08	5.351E-13	9.939E-20	1.846E-26	3.429E-33	3.634E-42
SN121M	6.553E-01	6.114E-01	5.704E-01	5.322E-01	4.966E-01	4.322E-01	3.511E-01	2.851E-01	2.316E-01	1.755E-01
SN123	2.416E-02	1.339E-06	7.425E-11	4.117E-15	2.282E-19	7.015E-28	1.195E-40	2.036E-53	3.471E-66	3.279E-83
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	4.093E-01	4.092E-01	4.092E-01	4.092E-01	4.092E-01	4.092E-01	4.091E-01	4.091E-01	4.090E-01	4.090E-01
SB124	7.506E-08	5.531E-17	4.075E-26	3.002E-35	2.212E-44	1.201E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	1.521E+03	4.351E+02	1.245E+02	3.562E+01	1.019E+01	8.347E-01	1.956E-02	4.583E-04	1.074E-05	7.200E-08

DECAY TIMES (years out of core)

(Activities* in Ci/seed module)

Radionuclide	5	10	15	20	25	35	50	65	80	100
SB126	5.730E-02	5.729E-02	5.729E-02	5.729E-02	5.729E-02	5.728E-02	5.728E-02	5.727E-02	5.727E-02	5.726E-02
SB126M	4.093E-01	4.092E-01	4.092E-01	4.092E-01	4.092E-01	4.092E-01	4.091E-01	4.091E-01	4.090E-01	4.090E-01
TE123M	7.010E-05	1.786E-09	4.553E-14	1.160E-18	2.958E-23	1.921E-32	3.180E-46	5.263E-60	8.712E-74	3.676E-92
TE125M	3.710E+02	1.062E+02	3.038E+01	8.692E+00	2.487E+00	2.036E-01	4.772E-03	1.118E-04	2.619E-06	1.756E-08
TE127	2.778E-02	2.514E-07	2.275E-12	2.058E-17	1.862E-22	1.525E-32	1.130E-47	8.370E-63	6.201E-78	4.157E-98
TE127M	2.836E-02	2.566E-07	2.322E-12	2.101E-17	1.901E-22	1.557E-32	1.153E-47	8.545E-63	6.331E-78	4.244E-98
TE129	1.088E-13	4.728E-30	2.054E-46	8.927E-63	3.879E-79	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129M	1.672E-13	7.264E-30	3.156E-46	1.371E-62	5.958E-79	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	1.628E-02	1.628E-02	1.628E-02	1.628E-02	1.628E-02	1.628E-02	1.628E-02	1.628E-02	1.628E-02	1.628E-02
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	6.303E+03	1.174E+03	2.186E+02	4.071E+01	7.581E+00	2.629E-01	1.698E-03	1.096E-05	7.081E-08	8.516E-11
CS135	2.941E-01	2.941E-01	2.941E-01	2.941E-01	2.941E-01	2.941E-01	2.941E-01	2.941E-01	2.941E-01	2.941E-01
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	3.034E+04	2.703E+04	2.408E+04	2.146E+04	1.911E+04	1.517E+04	1.073E+04	7.586E+03	5.364E+03	3.379E+03
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	2.870E+04	2.557E+04	2.278E+04	2.030E+04	1.808E+04	1.435E+04	1.015E+04	7.176E+03	5.074E+03	3.196E+03
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	1.005E-12	1.238E-29	1.525E-46	1.878E-63	2.313E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	1.019E-05	1.019E-05	1.019E-05	1.019E-05	1.019E-05	1.019E-05	1.019E-05	1.019E-05	1.019E-05	1.019E-05
CE144	2.107E+03	2.453E+01	2.855E-01	3.324E-03	3.870E-05	5.244E-09	8.274E-15	1.305E-20	2.059E-26	3.782E-34
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	2.107E+03	2.453E+01	2.855E-01	3.324E-03	3.870E-05	5.244E-09	8.274E-15	1.305E-20	2.059E-26	3.782E-34
PR144M	2.528E+01	2.943E-01	3.427E-03	3.989E-05	4.644E-07	6.293E-11	9.929E-17	1.566E-22	2.471E-28	4.539E-36
ND144	4.212E-10	4.220E-10	4.220E-10	4.220E-10	4.220E-10	4.220E-10	4.220E-10	4.220E-10	4.220E-10	4.220E-10
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	1.075E-02	8.903E-03	7.322E-03	6.020E-03	4.949E-03	3.346E-03	1.859E-03	1.033E-03	5.744E-04	2.625E-04
PM147	7.457E+03	1.990E+03	5.310E+02	1.417E+02	3.781E+01	2.693E+00	5.117E-02	9.724E-04	1.848E-05	9.370E-08
PM148M	2.200E-10	1.071E-23	5.217E-37	2.541E-50	1.237E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	1.239E-11	6.034E-25	2.939E-38	1.431E-51	6.969E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	1.466E-03	3.543E-05	8.563E-07	2.070E-08	5.003E-10	2.923E-13	4.127E-18	5.828E-23	8.230E-28	2.809E-34

DECAY TIMES (years out of core)
(Activities* in Ci/seed module)

Radionuclide	5	10	15	20	25	35	50	65	80	100
SM147	1.120E-06	1.254E-06	1.290E-06	1.300E-06	1.302E-06	1.303E-06	1.303E-06	1.303E-06	1.303E-06	1.303E-06
SM151	1.402E+02	1.349E+02	1.298E+02	1.249E+02	1.202E+02	1.113E+02	9.918E+01	8.836E+01	7.872E+01	6.748E+01
EU152	2.065E+00	1.600E+00	1.240E+00	9.612E-01	7.450E-01	4.475E-01	2.084E-01	9.700E-02	4.516E-02	1.630E-02
EU154	9.913E+02	6.625E+02	4.428E+02	2.960E+02	1.978E+02	8.834E+01	2.637E+01	7.872E+00	2.350E+00	4.688E-01
EU155	4.493E+02	2.234E+02	1.111E+02	5.520E+01	2.744E+01	6.784E+00	8.336E-01	1.024E-01	1.258E-02	7.689E-04
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	2.054E-01	1.099E-03	5.879E-06	3.146E-08	1.683E-10	4.818E-15	7.382E-22	1.131E-28	1.732E-35	1.419E-44
TB160	3.487E-07	8.690E-15	2.166E-22	5.396E-30	1.345E-37	8.349E-53	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	1.518E-12	1.518E-12	1.518E-12	1.518E-12	1.518E-12	1.518E-12	1.518E-12	1.518E-12	1.518E-12	1.518E-12
TL207	2.525E-01	3.969E-01	5.200E-01	6.249E-01	7.144E-01	8.555E-01	9.982E-01	1.087E+00	1.142E+00	1.183E+00
TL208	1.723E+02	1.794E+02	1.734E+02	1.657E+02	1.580E+02	1.434E+02	1.241E+02	1.074E+02	9.297E+01	7.675E+01
PB210	1.657E-04	1.471E-04	1.338E-04	1.252E-04	1.208E-04	1.226E-04	1.463E-04	1.892E-04	2.466E-04	3.410E-04
PB211	2.532E-01	3.980E-01	5.214E-01	6.267E-01	7.164E-01	8.579E-01	1.001E+00	1.090E+00	1.145E+00	1.187E+00
PB212	4.795E+02	4.993E+02	4.827E+02	4.612E+02	4.397E+02	3.991E+02	3.454E+02	2.989E+02	2.587E+02	2.136E+02
BI211	2.532E-01	3.980E-01	5.214E-01	6.267E-01	7.164E-01	8.579E-01	1.001E+00	1.090E+00	1.145E+00	1.187E+00
BI212	4.795E+02	4.993E+02	4.827E+02	4.612E+02	4.397E+02	3.991E+02	3.454E+02	2 989E+02	2.587E+02	2.136E+02
PO212	3.072E+02	3.199E+02	3.093E+02	2.955E+02	2.817E+02	2.557E+02	2.213E+02	1.915E+02	1.658E+02	1.369E+02
PO215	2.532E-01	3.980E-01	5.214E-01	6.267E-01	7.164E-01	8.579E-01	1.001E+00	1.090E+00	1.145E+00	1.187E+00
PO216	4.795E+02	4.993E+02	4.827E+02	4.612E+02	4.397E+02	3.991E+02	3.454E+02	2.989E+02	2.587E+02	2.136E+02
RN219	2.532E-01	3.980E-01	5.214E-01	6.267E-01	7.164E-01	8.579E-01	1.001E+00	1.090E+00	1.145E+00	1.187E+00
RN220	4.795E+02	4.993E+02	4.827E+02	4.612E+02	4.397E+02	3.991E+02	3.454E+02	2.989E+02	2.587E+02	2.136E+02
FR223	3.492E-03	5.485E-03	7.185E-03	8.634E-03	9.870E-03	1.182E-02	1.380E-02	1.502E-02	1.578E-02	1.636E-02
RA223	2.532E-01	3.980E-01	5.214E-01	6.267E-01	7.164E-01	8.579E-01	1.001E+00	1.090E+00	1.145E+00	1.187E+00
RA224	4.795E+02	4.993E+02	4.827E+02	4.612E+02	4.397E+02	3.991E+02	3.454E+02	2.989E+02	2.587E+02	2.136E+02
RA226	2.659E-05	4.499E-05	6.416E-05	8.411E-05	1.048E-04	1.486E-04	2.200E-04	2.982E-04	3.833E-04	5.073E-04
RA228	3.075E-02	3.757E-02	4.163E-02	4.406E-02	4.550E-02	4.688E-02	4.748E-02	4.760E-02	4.763E-02	4.764E-02
AC227	2.530E-01	3.975E-01	5.206E-01	6.257E-01	7.152E-01	8.567E-01	9.998E-01	1.088E+00	1.143E+00	1.185E+00
TH227	2.497E-01	3.925E-01	5.142E-01	6.181E-01	7.066E-01	8.460E-01	9.872E-01	1.075E+00	1.129E+00	1.170E+00
TH228	4.793E+02	4.989E+02	4.823E+02	4.608E+02	4.393E+02	3.990E+02	3.454E+02	2.989E+02	2.587E+02	2.136E+02
TH229	1.158E-01	1.768E-01	2.377E-01	2.986E-01	3.594E-01	4.810E-01	6.632E-01	8.452E-01	1.027E+00	1.269E+00
TH230	8.339E-03	8.716E-03	9.094E-03	9.471E-03	9.849E-03	1.060E-02	1.174E-02	1.287E-02	1.400E-02	1.551E-02
TH231	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04
TH232	4.764E-02	4.764E-02	4.764E-02	4.764E-02	4.764E-02	4.764E-02	4.764E-02	4.764E-02	4.764E-02	4.764E-02

DECAY TIMES (years out of core)
(Activities* in Ci/seed module)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TH234	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05
PA231	1.235E+00	1.235E+00	1.234E+00	1.234E+00	1.234E+00	1.234E+00	1.233E+00	1.233E+00	1.233E+00	1.232E+00
PA233	1.268E-03	1.269E-03	1.272E-03	1.274E-03	1.278E-03	1.285E-03	1.296E-03	1.309E-03	1.321E-03	1.338E-03
PA234M	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05
PA234	2.362E-08	2.362E-08	2.362E-08	2.362E-08	2.362E-08	2.362E-08	2.362E-08	2.362E-08	2.362E-08	2.362E-08
U232	5.184E+02	4.941E+02	4.708E+02	4.487E+02	4.276E+02	3.884E+02	3.361E+02	2.909E+02	2.518E+02	2.077E+02
U233	1.292E+02	1.292E+02	1.292E+02	1.292E+02	1.292E+02	1.292E+02	1.292E+02	1.292E+02	1.292E+02	1.292E+02
U234	8.398E+00	8.397E+00	8.397E+00	8.397E+00	8.397E+00	8.397E+00	8.397E+00	8.397E+00	8.397E+00	8.396E+00
U235	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04	6.271E-04
U236	1.363E-03	1.363E-03	1.363E-03	1.363E-03	1.363E-03	1.363E-03	1.363E-03	1.363E-03	1.363E-03	1.363E-03
U237	1.569E-05	1.233E-05	9.694E-06	7.621E-06	5.990E-06	3.702E-06	1.798E-06	8.734E-07	4.243E-07	1.620E-07
U238	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05	1.817E-05
NP237	1.268E-03	1.269E-03	1.272E-03	1.274E-03	1.278E-03	1.285E-03	1.296E-03	1.309E-03	1.321E-03	1.338E-03
PU236	1.673E-04	4.960E-05	1.471E-05	4.364E-06	1.296E-06	1.164E-07	5.678E-09	2.791E-09	2.715E-09	2.713E-09
PU237	1.720E-15	1.512E-27	1.329E-39	1.168E-51	1.026E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	5.525E+00	5.311E+00	5.106E+00	4.909E+00	4.719E+00	4.362E+00	3.876E+00	3.444E+00	3.060E+00	2.615E+00
PU239	2.829E-01	2.828E-01	2.828E-01	2.828E-01	2.827E-01	2.826E-01	2.825E-01	2.824E-01	2.823E-01	2.821E-01
PU240	1.658E-01	1.660E-01	1.661E-01	1.661E-01	1.662E-01	1.662E-01	1.661E-01	1.659E-01	1.657E-01	1.654E-01
PU241	6.395E+01	5.027E+01	3.952E+01	3.106E+01	2.442E+01	1.509E+01	7.330E+00	3.560E+00	1.729E+00	6.604E-01
PU242	4.191E-04	4.191E-04	4.191E-04	4.191E-04	4.192E-04	4.192E-04	4.193E-04	4.193E-04	4.194E-04	4.194E-04
PU244	5.399E-11	5.399E-11	5.399E-11	5.399E-11	5.399E-11	5.399E-11	5.399E-11	5.399E-11	5.399E-11	5.399E-11
AM241	7.541E-01	1.202E+00	1.549E+00	1.817E+00	2.023E+00	2.299E+00	2.500E+00	2.564E+00	2.563E+00	2.517E+00
AM242M	1.745E-02	1.706E-02	1.668E-02	1.630E-02	1.593E-02	1.522E-02	1.422E-02	1.328E-02	1.240E-02	1.132E-02
AM242	1.737E-02	1.698E-02	1.659E-02	1.622E-02	1.585E-02	1.515E-02	1.415E-02	1.321E-02	1.234E-02	1.126E-02
AM243	3.208E-03	3.206E-03	3.205E-03	3.203E-03	3.202E-03	3.199E-03	3.194E-03	3.190E-03	3.185E-03	3.179E-03
CM242	2.021E-02	1.405E-02	1.373E-02	1.342E-02	1.312E-02	1.253E-02	1.170E-02	1.092E-02	1.020E-02	9.313E-03
CM243	6.518E-03	5.772E-03	5.111E-03	4.525E-03	4.007E-03	3.142E-03	2.182E-03	1.515E-03	1.052E-03	6.467E-04
CM244	4.580E-01	3.782E-01	3.123E-01	2.579E-01	2.130E-01	1.453E-01	8.181E-02	4.608E-02	2.595E-02	1.207E-02

DECAY TIMES (years out of core)
(Activities* in Ci/seed module)

Radionuclide	5	10	15	20	25	35	50	65	80	100
CM245	7.162E-05	7.159E-05	7.157E-05	7.154E-05	7.151E-05	7.145E-05	7.136E-05	7.127E-05	7.119E-05	7.107E-05
CM246	4.751E-06	4.747E-06	4.744E-06	4.741E-06	4.737E-06	4.730E-06	4.720E-06	4.709E-06	4.699E-06	4.685E-06
CM247	1.677E-11	1.677E-11	1.677E-11	1.677E-11	1.677E-11	1.677E-11	1.677E-11	1.677E-11	1.677E-11	1.677E-11
Subtotal**	1.531E+05	1.208E+05	1.044E+05	9.197E+04	8.149E+04	6.443E+04	4.565E+04	3.252E+04	2.329E+04	1.505E+04
Total***	1.531E+05	1.208E+05	1.044E+05	9.197E+04	8.151E+04	6.444E+04	4.565E+04	3.253E+04	2.330E+04	1.506E+04

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 24

Fuel-Specific Source Term Calculations Pressurized Water Reactor Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a generic source term for pressurized water reactor (PWR) or low-enriched uranium oxide spent nuclear fuel. The data sources for the analysis are documented in References 1 and 2, and the INEEL calculational methodology is described in Reference 3.

Pressurized Water Reactor Data

PWR characteristics are based on the Westinghouse PWR 17 × 17 fuel assembly and corresponding fuel rod dimensions and materials (Reference 1).

The uranium enrichment is chosen to be 3.2 wt% U-235. In addition, small amounts of U-234 and U-236 impurities are also included in the beginning-of-life (BOL) uranium composition in order to maximize and account for production of other actinides.

The cladding material is assumed to be Zircaloy-4. Assembly structural hardware, including the spacers and top and bottom tie grids, is also included in the activation analysis. The spacers are composed of Zircaloy-4 and Inconel-718 pieces. The top and bottom tie grids are stainless steel304. The total assembly spacer and grid masses are based on estimates found in Reference 2 data for a 15 × 15 PWR assembly. The assumption here is that the 15 × 15 hardware or structural materials are the same and of similar mass to those expected for a 17 × 17 assembly. The 15 × 15 assembly hardware total masses are then divided by 289 (17 × 17) in order to get the associated structural masses per rod for the 17 × 17 assembly. The mass basis for the PWR template here is a single fuel rod from a 17 × 17 assembly. Table 1 lists the impurities and their concentrations for the materials considered in the depletion/activation analysis, namely, UO_2, Zircaloy-4, Inconel-718, and stainless steel 304.

The data below give specific dimensions, materials, loadings, densities, enrichment, etc., for the PWR fuel rod used in the burnup calculation for the source term generation.

Fuel Element:	Single rod in a 17 × 17 assembly
Pitch:	1.25 cm
Fuel Pellet Diameter:	0.819 cm
Gas Gap Thickness:	0.0082 cm
Clad Thickness:	0.0572 cm
Fuel Meat:	UO_2 3.2 wt% U-235 enrichment (BOL) Average Density = 10.412 g/cc
Clad:	Zircaloy-4 Density = 6.44 g/cc

Loading:	56.61	g/rod U-235 (BOL)
	1,711.63	g/rod U-238 (BOL)
	0.70	g/rod U-234 (BOL)
	0.17	g/rod U-236 (BOL)
	1,769.11	g/rod TOTAL U
	2,006.26	g/rod UO2 (fuel meat)
	1.7691E-3	MTU/rod
Active Fuel Length:	144.0 in.	
Fuel Rode Length:	168.0 in.	

Assembly Structural Material/Masses:

456.40	g/rod Zircaloy-4 (clad + spacer)
2.20	g/rod Inconel-718 (spacer material)
62.78	g/rod stainless steel 304 (top/bottom tie grid plates)

Coolant/Moderator:	Light Water
Coolant Temperature:	600°F
Coolant Pressure:	2250 psi
Coolant Density:	0.6965 g/cc

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single PWR fuel rod. Impurities in these materials were also included in the ORIGEN2 (Reference 4) depletion calculation in order to maximize the induced activation (see Table 1).

Burnup

The burnup chosen for this template is 35,000 MWd/MTU or 61.92 MWd for the single rod containing 1.7691E-3 MTU. The burnup period is assumed to be continuous over a 3-year period or 1,096 days. The fuel rod operates at a constant power over the burnup period with no refueling shutdowns. The relatively high burnup (35,000 MWd/MTU) is conservative for the buildup of fission products, activation products, and minor actinides in the source term and nonconservative with regard to criticality safety (i.e., fissile isotope concentrations, in particular U-235).

Cross-Section Development

The neutron cross sections used in the burnup or depletion calculation for the source term generation of a single PWR fuel rod are based on the methodology described in Reference 3. Cross sections from a standard ORIGEN2 PWR library were updated six times over the 3-year burnup period to ensure accurate production and activity levels for actinides, fission products, and activation products. The first update developed cross sections for BOL conditions followed by five subsequent updates every 180-days of fuel rod exposure. These cross-section updates take into account changes in the neutron flux spectrum and spatial profiles as a function of burnup. A simple PWR unit cell lattice was used to determine volume-averaged flux and reaction rate profiles for the cross-section development. The basic library updated was a standard ORIGEN2 PWR cross-section library.

Pressurized Water Reactor Single Rod Exposure History

Table 2 summarizes the hypothetical power or exposure history used in the burnup calculations for a single PWR fuel rod in a 17 × 17 PWR assembly. No refueling shutdowns are assumed in the calculation. Following the 3-year exposure, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years. The relatively high burnup is conservative for the buildup of fission products, activation products, and minor actinides in the source term and nonconservative with regard to criticality safety. The 35,000 MWd/MTU exposure or burnup for the fuel is again relatively high and represents an upper burnup limit for most commercial spent nuclear fuels stored at the INEEL.

Burnup Calculation

The ORIGEN2 computer code was used to perform the depletion or burnup calculation for the PWR fuel rod. The radionuclide inventory or source term template that follows is for a single PWR 17 × 17 fuel rod. The fuel rod component masses and impurities (fuel meat, uranium, clad, spacers, and end fixtures), neutron cross sections, burnup, and hypothetical power history and power level as presented above are used as input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of decay time in the template table.

The 145 radionuclides listed in the template here represent greater than 99.9% of the total curie inventory relative to the 684 activation products, 880 fission products, and 127 actinide/daughter isotopes in the complete ORIGEN2 output.

References

1. J. J. Duderstadt and L. J. Hamilton, *Nuclear Reactor Analysis*, Appendix H, John Wiley & Sons, Inc., New York, 1976.

2. R. K. McCardell, *Characteristics of Commercial Nuclear Materials Stored in the TAN Pool*, INEL/INT-98-00767, September 1998.

3. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

4. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

Table 1. Material constituent and impurity concentrations for the various materials in a pressurized water reactor fuel rod/assembly.

Constituent or Impurity	UO2 Concentration (ppm)	Zircaloy-4 Concentration (ppm)	Inconel-718 Concentration (wt%)	Stainless Steel 304 Concentration (ppm)
H		25		
Li	1			0.13
Be				
B	1	0.5		
C	89.4	270	0.08	0.08 wt%
N	25	80		525
O	134454	950		
F	10.7			
Na	15			37
Mg	2			
Al	16.7	75	0.70	200
Si	12.1	120	0.70	1.00 wt%
P	35	100		
S		35	0.01	
Cl	5.3			130
K				3
Ca	2			19
Sc				0.03
Ti	1	50	2.30	600
V	3	50		690
Cr	4	1250	15.50	18.40 wt%
Mn	1.7	50	1.00	1.53 wt%
Fe	18	2250	5.90	68.99 wt%
Co	1	20	0.006488	2570
Ni	24	70	73.304	10.00 wt%
Cu	1	50	0.50	8150
Zn	40.3	100		2230
Ga				450
As				1010
Se				70
Br				8
Rb				10
Sr				0.2
Y				5
Zr		979069		20
Nb		70		300

Table 1. (continued).

Constituent or Impurity	UO$_2$ Concentration (ppm)	Zircaloy-4 Concentration (ppm)	Inconel-718 Concentration (wt%)	Stainless Steel 304 Concentration (ppm)
Mo	10	50		5500
Ag	0.1			2
Cd	25	0.5		
In	2			
Sn	4	16000		
Sb				17
Cs				0.3
Ba				500
La				2.1
Ce				550
Pr				
Nd				
Sm		10		0.15
Eu				0.02
Gd		5		
Tb				0.71
Dy				1
Ho				1
Er				
Tm				
Yb				2
Lu				0.8
Hf		35		2
Ta		200		
W	2	100		520
Tl				
Pb	1	100		139
Bi	0.4			
Th		7		1
U	1000000	3.5		2

Table 2. Hypothetical power history for a 35,000 MWd/MTU burnup PWR fuel rod.

Duration (days)	Cumulative Duration (days)	Time-Averaged Power (MWth)
180	180	0.0565
180	360	0.0565
180	540	0.0565
180	720	0.0565
180	900	0.0565
196	1096	0.0565
1825	2921	0.0
1825	4746	0.0
1825	6571	0.0
1825	8396	0.0
1825	10221	0.0
3650	13871	0.0
5475	19346	0.0
5475	24821	0.0
5475	30296	0.0
7300	37596	0.0

The ten dates with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling or decay times designated for the template methodology.

Pressurized Water Reactor Element

Zirconium Cladding, 0 to 5%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Light Water
Fuel Meat:	UO_2
Clad:	Zircaloy-4
Burnup:	35000 MWd/MTU
Burnup:	61.92 MWd/single rod (high burnup)
Burnup:	73.4 % U-235 depletion (fissioned and transmuted)
Basis of Calculation:	Single rod in a 17x17 assembly
BOL U-235:	56.61 g U-235 per rod
BOL U-238:	1711.63 g U-238 per rod
BOL U-234:	0.70 g U-234 per rod
BOL U-236:	0.17 g U-236 per rod
BOL Total U per element:	1769.11 g U per rod
BOL Fuel Enrichment:	3.2 wt% U-235

DECAY TIMES (years out of core)

(Activities* in Ci/rod)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H-3	6.915E+00	5.224E+00	3.946E+00	2.981E+00	2.253E+00	1.286E+00	5.541E-01	2.388E-01	1.030E-01	3.354E-02
BE-10	1.058E-08	1.058E-08	1.058E-08	1.058E-08	1.058E-08	1.058E-08	1.058E-08	1.058E-08	1.058E-08	1.058E-08
C-14	2.977E-03	2.975E-03	2.974E-03	2.972E-03	2.970E-03	2.966E-03	2.961E-03	2.956E-03	2.950E-03	2.943E-03
CL-36	4.973E-05	4.973E-05	4.973E-05	4.973E-05	4.972E-05	4.972E-05	4.972E-05	4.972E-05	4.972E-05	4.972E-05
CR-51	1.372E-18	2.042E-38	3.040E-58	4.526E-78	6.737E-98	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN-54	8.462E-02	1.477E-03	2.579E-05	4.502E-07	7.860E-09	2.396E-12	1.275E-17	6.781E-23	3.608E-28	3.351E-35
FE-55	7.901E+00	2.085E+00	5.504E-01	1.453E-01	3.834E-02	2.671E-03	4.910E-05	9.028E-07	1.660E-08	8.055E-11
FE-59	1.098E-12	6.797E-25	4.206E-37	2.603E-49	1.611E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO-60	8.171E+00	4.235E+00	2.195E+00	1.138E+00	5.896E-01	1.584E-01	2.205E-02	3.070E-03	4.275E-04	3.085E-05
NI-59	4.844E-03	4.844E-03	4.844E-03	4.843E-03	4.843E-03	4.843E-03	4.842E-03	4.841E-03	4.841E-03	4.840E-03
NI-63	6.543E-01	6.302E-01	6.069E-01	5.845E-01	5.629E-01	5.220E-01	4.663E-01	4.165E-01	3.720E-01	3.200E-01
ZN-65	2.761E-03	1.543E-05	8.619E-08	4.815E-10	2.690E-12	8.399E-17	1.465E-23	2.555E-30	4.457E-37	4.344E-46
SE-79	7.666E-04	7.666E-04	7.666E-04	7.665E-04	7.665E-04	7.664E-04	7.663E-04	7.661E-04	7.660E-04	7.659E-04
KR-85	1.214E+01	8.789E+00	6.363E+00	4.606E+00	3.334E+00	1.747E+00	6.630E-01	2.515E-01	9.542E-02	2.621E-02
RB-87	3.849E-08	3.849E-08	3.849E-08	3.849E-08	3.849E-08	3.849E-08	3.849E-08	3.849E-08	3.849E-08	3.849E-08
SR-89	1.631E-08	2.154E-19	2.843E-30	3.754E-41	4.957E-52	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-90	1.159E+02	1.029E+02	9.134E+01	8.110E+01	7.201E+01	5.676E+01	3.973E+01	2.781E+01	1.946E+01	1.210E+01
Y-90	1.159E+02	1.029E+02	9.136E+01	8.112E+01	7.202E+01	5.678E+01	3.974E+01	2.781E+01	1.947E+01	1.210E+01
Y-91	6.717E-07	2.736E-16	1.115E-25	4.542E-35	1.850E-44	3.071E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR-93	3.620E-03	3.620E-03	3.620E-03	3.620E-03	3.620E-03	3.620E-03	3.620E-03	3.620E-03	3.620E-03	3.620E-03

Radionuclide	DECAY TIMES (years out of core) (Activities* in Ci/rod) 5	10	15	20	25	35	50	65	80	100
ZR-95	6.572E-06	1.702E-14	4.412E-23	1.143E-31	2.961E-40	1.988E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-93M	9.813E-04	1.534E-03	1.962E-03	2.294E-03	2.551E-03	2.905E-03	3.190E-03	3.323E-03	3.384E-03	3.419E-03
NB-94	8.828E-05	8.826E-05	8.825E-05	8.823E-05	8.822E-05	8.819E-05	8.814E-05	8.810E-05	8.805E-05	8.799E-05
NB-95	1.459E-05	3.781E-14	9.795E-23	2.537E-31	6.575E-40	4.414E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-95M	4.875E-08	1.263E-16	3.273E-25	8.480E-34	2.197E-42	1.474E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-93	2.257E-05	2.255E-05	2.253E-05	2.250E-05	2.248E-05	2.244E-05	2.237E-05	2.230E-05	2.224E-05	2.215E-05
TC-99	2.437E-02	2.437E-02	2.437E-02	2.437E-02	2.437E-02	2.437E-02	2.437E-02	2.437E-02	2.437E-02	2.436E-02
RU-103	2.668E-11	2.759E-25	2.853E-39	2.951E-53	3.052E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	3.400E+01	1.095E+00	3.525E-02	1.135E-03	3.654E-05	3.787E-08	1.264E-12	4.219E-17	1.408E-21	1.513E-27
RH-103M	2.405E-11	2.487E-25	2.572E-39	2.660E-53	2.751E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	3.400E+01	1.095E+00	3.525E-02	1.135E-03	3.654E-05	3.788E-08	1.264E-12	4.219E-17	1.408E-21	1.513E-27
PD-107	2.296E-04	2.296E-04	2.296E-04	2.296E-04	2.296E-04	2.296E-04	2.296E-04	2.296E-04	2.296E-04	2.296E-04
AG-110	8.434E-04	5.339E-06	3.380E-08	2.140E-10	1.355E-12	5.430E-17	1.378E-23	3.496E-30	8.870E-37	1.425E-45
AG-110M	6.342E-02	4.014E-04	2.541E-06	1.609E-08	1.019E-10	4.082E-15	1.036E-21	2.628E-28	6.670E-35	1.072E-43
AG-111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-113M	9.764E-02	7.701E-02	6.073E-02	4.790E-02	3.778E-02	2.350E-02	1.153E-02	5.655E-03	2.774E-03	1.073E-03
CD-113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-115M	1.632E-12	7.823E-25	3.750E-37	1.797E-49	8.618E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114	1.075E-12	8.627E-24	6.924E-35	5.558E-46	4.461E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114M	1.123E-12	9.014E-24	7.236E-35	5.808E-46	4.661E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-115M	1.129E-16	5.412E-29	2.594E-41	1.244E-53	5.961E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-119M	8.362E-02	4.788E-04	2.741E-06	1.570E-08	8.987E-11	2.947E-15	5.532E-22	1.039E-28	1.950E-35	2.096E-44
SN-121M	1.768E-03	1.649E-03	1.539E-03	1.436E-03	1.340E-03	1.167E-03	9.475E-04	7.696E-04	6.252E-04	4.738E-04
SN-123	4.105E-04	2.291E-08	1.279E-12	7.136E-17	3.983E-21	1.241E-29	2.158E-42	3.751E-55	6.522E-68	6.328E-85
SN-125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-126	1.561E-03	1.561E-03	1.561E-03	1.561E-03	1.561E-03	1.561E-03	1.561E-03	1.560E-03	1.560E-03	1.560E-03
SB-124	2.599E-09	1.943E-18	1.452E-27	1.085E-36	8.113E-46	4.533E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB-125	9.405E+00	2.694E+00	7.715E-01	2.210E-01	6.328E-02	5.190E-03	1.220E-04	2.864E-06	6.729E-08	4.526E-10
SB-126	2.185E-04	2.185E-04	2.185E-04	2.185E-04	2.185E-04	2.185E-04	2.185E-04	2.185E-04	2.184E-04	2.184E-04
SB-126M	1.561E-03	1.561E-03	1.561E-03	1.561E-03	1.561E-03	1.561E-03	1.561E-03	1.560E-03	1.560E-03	1.560E-03
TE-123M	1.816E-06	4.663E-11	1.197E-15	3.072E-20	7.887E-25	5.197E-34	8.792E-48	1.487E-61	2.516E-75	1.093E-93
TE-125M	2.295E+00	6.572E-01	1.883E-01	5.390E-02	1.544E-02	1.266E-03	2.975E-05	6.988E-07	1.641E-08	1.104E-10
TE-127	2.330E-04	2.125E-09	1.938E-14	1.768E-19	1.613E-24	1.341E-34	1.018E-49	7.723E-65	5.860E-80	4.055-100
TE-127M	2.379E-04	2.170E-09	1.979E-14	1.805E-19	1.646E-24	1.370E-34	1.039E-49	7.884E-65	5.982E-80	4.140-100
TE-129	2.279E-15	1.016E-31	4.530E-48	2.020E-64	9.005E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

DECAY TIMES (years out of core)
(Activities* in Ci/rod)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TE-129M	3.501E-15	1.561E-31	6.959E-48	3.103E-64	1.383E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-129	6.086E-05	6.086E-05	6.086E-05	6.086E-05	6.086E-05	6.086E-05	6.086E-05	6.086E-05	6.086E-05	6.086E-05
I-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-134	5.977E+01	1.114E+01	2.077E+00	3.873E-01	7.221E-02	2.510E-03	1.626E-05	1.054E-07	6.830E-10	8.253E-13
CS-135	8.937E-04	8.937E-04	8.937E-04	8.937E-04	8.937E-04	8.937E-04	8.937E-04	8.937E-04	8.937E-04	8.937E-04
CS-136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-137	1.730E+02	1.542E+02	1.374E+02	1.224E+02	1.090E+02	8.656E+01	6.122E+01	4.330E+01	3.063E+01	1.930E+01
BA-136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-137M	1.637E+02	1.459E+02	1.300E+02	1.158E+02	1.032E+02	8.189E+01	5.792E+01	4.096E+01	2.897E+01	1.826E+01
BA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-141	3.156E-14	3.992E-31	5.050E-48	6.387E-65	8.078E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-142	5.022E-08	5.022E-08	5.022E-08	5.022E-08	5.022E-08	5.022E-08	5.022E-08	5.022E-08	5.022E-08	5.022E-08
CE-144	2.277E+01	2.659E-01	3.105E-03	3.625E-05	4.233E-07	5.772E-11	9.190E-17	1.463E-22	2.330E-28	4.331E-36
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	2.277E+01	2.659E-01	3.105E-03	3.625E-05	4.233E-07	5.772E-11	9.190E-17	1.463E-22	2.330E-28	4.331E-36
PR-144M	2.732E-01	3.191E-03	3.726E-05	4.350E-07	5.080E-09	6.926E-13	1.103E-18	1.756E-24	2.796E-30	5.197E-38
ND-144	2.777E-12	2.786E-12	2.786E-12	2.786E-12	2.786E-12	2.786E-12	2.786E-12	2.786E-12	2.786E-12	2.786E-12
ND-147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-145	2.823E-05	2.351E-05	1.934E-05	1.590E-05	1.308E-05	8.843E-06	4.917E-06	2.734E-06	1.520E-06	6.949E-07
PM-147	6.231E+01	1.664E+01	4.445E+00	1.187E+00	3.171E-01	2.262E-02	4.310E-04	8.213E-06	1.565E-07	7.965E-10
PM-148M	3.611E-12	1.796E-25	8.931E-39	4.441E-52	2.209E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-148	2.034E-13	1.011E-26	5.030E-40	2.502E-53	1.244E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM-145	6.700E-06	1.624E-07	3.935E-09	9.534E-11	2.310E-12	1.357E-15	1.931E-20	2.747E-25	3.909E-30	1.348E-36
SM-147	6.632E-09	7.751E-09	8.050E-09	8.130E-09	8.152E-09	8.159E-09	8.159E-09	8.159E-09	8.159E-09	8.159E-09
SM-151	7.859E-01	7.562E-01	7.277E-01	7.002E-01	6.738E-01	6.239E-01	5.558E-01	4.952E-01	4.412E-01	3.783E-01
EU-152	8.270E-03	6.411E-03	4.970E-03	3.852E-03	2.987E-03	1.794E-03	8.359E-04	3.894E-04	1.814E-04	6.550E-05
EU-154	1.401E+01	9.366E+00	6.261E+00	4.186E+00	2.799E+00	1.251E+00	3.735E-01	1.116E-01	3.334E-02	6.659E-03
EU-155	7.232E+00	3.597E+00	1.789E+00	8.900E-01	4.426E-01	1.095E-01	1.348E-02	1.659E-03	2.041E-04	1.249E-05
EU-156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD-153	8.191E-04	4.398E-06	2.361E-08	1.268E-10	6.810E-13	1.964E-17	3.041E-24	4.708E-31	7.290E-38	6.062E-47
TB-160	5.592E-08	1.410E-15	3.557E-23	8.970E-31	2.262E-38	1.439E-53	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL-206	3.867E-11	3.867E-11	3.867E-11	3.867E-11	3.867E-11	3.867E-11	3.867E-11	3.867E-11	3.867E-11	3.867E-11

	DECAY TIMES (years out of core) (Activities* in Ci/rod)									
Radionuclide	**5**	**10**	**15**	**20**	**25**	**35**	**50**	**65**	**80**	**100**
TL-207	8.190E-09	1.456E-08	2.049E-08	2.606E-08	3.131E-08	4.104E-08	5.424E-08	6.635E-08	7.778E-08	9.236E-08
TL-208	9.550E-06	1.217E-05	1.263E-05	1.237E-05	1.189E-05	1.082E-05	9.372E-06	8.113E-06	7.023E-06	5.799E-06
PB-210	2.969E-11	1.006E-10	2.493E-10	5.007E-10	8.770E-10	2.082E-09	5.268E-09	1.042E-08	1.783E-08	3.158E-08
PB-211	8.213E-09	1.460E-08	2.055E-08	2.613E-08	3.140E-08	4.116E-08	5.439E-08	6.654E-08	7.800E-08	9.262E-08
PB-212	2.658E-05	3.388E-05	3.516E-05	3.442E-05	3.308E-05	3.013E-05	2.609E-05	2.258E-05	1.955E-05	1.614E-05
BI-211	8.213E-09	1.460E-08	2.055E-08	2.613E-08	3.140E-08	4.116E-08	5.439E-08	6.654E-08	7.800E-08	9.262E-08
BI-212	2.658E-05	3.388E-05	3.516E-05	3.442E-05	3.308E-05	3.013E-05	2.609E-05	2.258E-05	1.955E-05	1.614E-05
PO-212	1.703E-05	2.171E-05	2.253E-05	2.205E-05	2.119E-05	1.930E-05	1.671E-05	1.447E-05	1.252E-05	1.034E-05
PO-215	8.213E-09	1.460E-08	2.055E-08	2.613E-08	3.140E-08	4.116E-08	5.439E-08	6.654E-08	7.800E-08	9.262E-08
PO-216	2.658E-05	3.388E-05	3.516E-05	3.442E-05	3.308E-05	3.013E-05	2.609E-05	2.258E-05	1.955E-05	1.614E-05
RN-219	8.213E-09	1.460E-08	2.055E-08	2.613E-08	3.140E-08	4.116E-08	5.439E-08	6.654E-08	7.800E-08	9.262E-08
RN-220	2.658E-05	3.388E-05	3.516E-05	3.442E-05	3.308E-05	3.013E-05	2.609E-05	2.258E-05	1.955E-05	1.614E-05
FR-223	1.133E-10	2.012E-10	2.832E-10	3.601E-10	4.326E-10	5.672E-10	7.498E-10	9.172E-10	1.075E-09	1.277E-09
RA-223	8.213E-09	1.460E-08	2.055E-08	2.613E-08	3.140E-08	4.116E-08	5.439E-08	6.654E-08	7.800E-08	9.262E-08
RA-224	2.658E-05	3.388E-05	3.516E-05	3.442E-05	3.308E-05	3.013E-05	2.609E-05	2.258E-05	1.955E-05	1.614E-05
RA-226	2.939E-10	7.807E-10	1.514E-09	2.502E-09	3.750E-09	7.054E-09	1.412E-08	2.384E-08	3.634E-08	5.752E-08
RA-228	1.835E-10	2.414E-10	2.761E-10	2.967E-10	3.091E-10	3.210E-10	3.264E-10	3.279E-10	3.284E-10	3.290E-10
AC-227	8.211E-09	1.458E-08	2.052E-08	2.609E-08	3.135E-08	4.110E-08	5.434E-08	6.646E-08	7.790E-08	9.253E-08
TH-227	8.100E-09	1.440E-08	2.026E-08	2.577E-08	3.097E-08	4.059E-08	5.365E-08	6.562E-08	7.692E-08	9.135E-08
TH-228	2.657E-05	3.386E-05	3.513E-05	3.439E-05	3.305E-05	3.012E-05	2.608E-05	2.258E-05	1.955E-05	1.614E-05
TH-229	1.156E-09	1.833E-09	2.516E-09	3.204E-09	3.899E-09	5.306E-09	7.466E-09	9.687E-09	1.197E-08	1.513E-08
TH-230	1.692E-07	2.821E-07	3.986E-07	5.184E-07	6.416E-07	8.974E-07	1.303E-06	1.732E-06	2.181E-06	2.809E-06
TH-231	3.258E-05	3.259E-05	3.259E-05	3.259E-05	3.260E-05	3.260E-05	3.262E-05	3.263E-05	3.264E-05	3.265E-05
TH-232	3.270E-10	3.271E-10	3.272E-10	3.273E-10	3.275E-10	3.277E-10	3.280E-10	3.284E-10	3.287E-10	3.292E-10
TH-234	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04
PA-231	4.975E-08	5.320E-08	5.664E-08	6.008E-08	6.352E-08	7.040E-08	8.072E-08	9.104E-08	1.014E-07	1.151E-07
PA-233	5.948E-04	6.001E-04	6.078E-04	6.173E-04	6.282E-04	6.530E-04	6.946E-04	7.385E-04	7.830E-04	8.417E-04
PA-234M	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04
PA-234	7.268E-07	7.268E-07	7.268E-07	7.268E-07	7.268E-07	7.268E-07	7.268E-07	7.268E-07	7.268E-07	7.268E-07
U-232	3.362E-05	3.567E-05	3.507E-05	3.374E-05	3.225E-05	2.933E-05	2.539E-05	2.198E-05	1.903E-05	1.570E-05
U-233	1.429E-06	1.442E-06	1.455E-06	1.468E-06	1.482E-06	1.510E-06	1.554E-06	1.601E-06	1.650E-06	1.721E-06
U-234	2.469E-03	2.550E-03	2.628E-03	2.703E-03	2.775E-03	2.911E-03	3.096E-03	3.261E-03	3.407E-03	3.576E-03
U-235	3.258E-05	3.259E-05	3.259E-05	3.259E-05	3.260E-05	3.260E-05	3.262E-05	3.263E-05	3.264E-05	3.265E-05
U-236	4.683E-04	4.684E-04	4.686E-04	4.687E-04	4.688E-04	4.691E-04	4.695E-04	4.699E-04	4.704E-04	4.709E-04
U-237	5.791E-05	4.553E-05	3.580E-05	2.814E-05	2.213E-05	1.368E-05	6.647E-06	3.231E-06	1.570E-06	6.001E-07

	DECAY TIMES (years out of core) (Activities* in Ci/rod)									
Radionuclide	**5**	**10**	**15**	**20**	**25**	**35**	**50**	**65**	**80**	**100**
U-238	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04	5.591E-04
NP-237	5.948E-04	6.001E-04	6.078E-04	6.173E-04	6.282E-04	6.530E-04	6.946E-04	7.385E-04	7.830E-04	8.417E-04
PU-236	1.340E-04	3.977E-05	1.180E-05	3.503E-06	1.041E-06	9.267E-08	3.521E-09	1.190E-09	1.129E-09	1.128E-09
PU-237	8.206E-15	7.350E-27	6.584E-39	5.898E-51	5.283E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU-238	5.847E+00	5.621E+00	5.404E+00	5.196E+00	4.995E+00	4.617E+00	4.103E+00	3.646E+00	3.241E+00	2.769E+00
PU-239	7.202E-01	7.201E-01	7.201E-01	7.200E-01	7.199E-01	7.197E-01	7.194E-01	7.191E-01	7.188E-01	7.184E-01
PU-240	9.197E-01	9.238E-01	9.271E-01	9.298E-01	9.319E-01	9.348E-01	9.370E-01	9.376E-01	9.373E-01	9.361E-01
PU-241	2.361E+02	1.856E+02	1.459E+02	1.147E+02	9.020E+01	5.575E+01	2.710E+01	1.317E+01	6.401E+00	2.446E+00
PU-242	3.979E-03	3.979E-03	3.979E-03	3.979E-03	3.979E-03	3.979E-03	3.979E-03	3.979E-03	3.979E-03	3.979E-03
PU-244	1.203E-09	1.203E-09	1.203E-09	1.203E-09	1.203E-09	1.203E-09	1.203E-09	1.203E-09	1.203E-09	1.203E-09
AM-241	2.420E+00	4.075E+00	5.359E+00	6.351E+00	7.114E+00	8.139E+00	8.887E+00	9.134E+00	9.140E+00	8.981E+00
AM-242M	2.038E-02	1.992E-02	1.947E-02	1.903E-02	1.860E-02	1.777E-02	1.660E-02	1.550E-02	1.448E-02	1.322E-02
AM-242	2.028E-02	1.982E-02	1.937E-02	1.894E-02	1.851E-02	1.769E-02	1.652E-02	1.543E-02	1.441E-02	1.315E-02
AM-243	3.885E-02	3.883E-02	3.882E-02	3.880E-02	3.878E-02	3.874E-02	3.869E-02	3.863E-02	3.858E-02	3.851E-02
CM-242	6.123E-02	1.642E-02	1.603E-02	1.567E-02	1.531E-02	1.463E-02	1.366E-02	1.276E-02	1.191E-02	1.088E-02
CM-243	3.220E-02	2.852E-02	2.526E-02	2.237E-02	1.981E-02	1.553E-02	1.079E-02	7.492E-03	5.203E-03	3.200E-03
CM-244	9.561E+00	7.897E+00	6.522E+00	5.387E+00	4.449E+00	3.035E+00	1.710E+00	9.635E-01	5.428E-01	2.526E-01
CM-245	1.223E-03	1.222E-03	1.222E-03	1.221E-03	1.221E-03	1.220E-03	1.218E-03	1.217E-03	1.215E-03	1.213E-03
CM-246	1.796E-04	1.795E-04	1.793E-04	1.792E-04	1.791E-04	1.788E-04	1.784E-04	1.780E-04	1.776E-04	1.771E-04
CM-247	6.257E-10	6.257E-10	6.257E-10	6.257E-10	6.257E-10	6.257E-10	6.257E-10	6.257E-10	6.257E-10	6.257E-10
SUBTOTAL**	1.130E+03	7.795E+02	6.452E+02	5.510E+02	4.760E+02	3.611E+02	2.449E+02	1.701E+02	1.207E+02	7.877E+01
TOTAL***	1.130E+03	7.795E+02	6.452E+02	5.510E+02	4.761E+02	3.612E+02	2.449E+02	1.702E+02	1.207E+02	7.879E+01

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 26

Fuel-Specific Source Term Calculations Aluminum-Clad TRIGA Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a generic source term for aluminum-clad TRIGA (Training, Research, and Isotope General Atomics) spent nuclear fuel elements currently stored at the INEEL. The data sources for the analysis are documented in References 1 and 2, and the INEEL calculational methodology is described in Reference 3.

TRIGA Data

TRIGA reactors are light-water-cooled reactors designed for training, research, and isotope production. One type of fuel element used in a TRIGA reactor is an aluminum-clad, uranium-zirconium-hydride (U-Zr-H) fuel element. The enriched uranium is homogeneously mixed in the ZrH matrix. The cylindrical active fuel region in each aluminum-clad element is approximately 1.4 in. in diameter and 14 or 15 in. in length. Figure 1 shows a typical aluminum-clad fuel element with dimensions and materials. The data below give specific dimensions, materials, loadings, densities, enrichment, etc., for the aluminum-clad element used in the burnup calculation for the source term generation.

Fuel Element:			
	Fuel Meat:	U-Zr-H	
		Zr:H ratio is 1.0	
		Density = 6.28 g/cc	
	Clad:	Aluminum-1100	
		Density = 2.70 g/cc	
	Loading:	36.0	g/element U-235 BOL
		144.0	g/element U-238 BOL
		180.0	g/element U BOL
		2070.0	g/element ZrH in fuel meat
		8.0	weight % U in U-$ZrH_{1.0}$
		20%	enrichment U-235 BOL
		280.0	g/element aluminum cladding
		450.0	g/element graphite top/bottom end reflectors
		19.7	g/element Sm_2O_3 (two poison disks)
Active Fuel Length:		14 in.	
Fuel Element Length:		28 in. (approximate)	
Water Temperature:		77.5°F	
Water Pressure:		14.7 psia	

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single aluminum-clad TRIGA fuel element. In addition, for the ORIGEN2 (Reference 4) depletion or burnup calculation, conservative and detailed impurity concentrations were added for the aluminum-clad, zirconium-hydride, and graphite end reflector masses. Table 1 gives the impurity concentrations for these three materials.

Burnup

Reference 1 is a parametric study and includes radionuclide inventories or source terms for eight different burnups ranging up to 19.44%. The burnup chosen for this template is based on the 19.44% burnup of the initial U-235 or the maximum burnup used in the parametric study. This burnup is equivalent to 6.65 MWd, 36,944 MWd/MTU, and 8.07 g of U-235 depleted per element and represents the upper end of typical aluminum-clad TRIGA fuel element burnups. The assumption of maximum burnup is conservative for the buildup of fission products, activation products, and minor actinides in the source term and nonconservative with regard to criticality safety.

Cross-Section Development

An MCNP4A (Reference 5) partial core model of a MARK I TRIGA reactor core was used to generate neutron cross sections specifically for the aluminum-clad TRIGA fuel element. The MCNP4A one-twelfth core model is shown in Figure 2. The cross sections are spectrally and spatially weighted over all the fuel elements shown in Figure 2. These cross sections are in turn used in the fuel element ORIGEN2 depletion calculation.

Parametric TRIGA Single Element Exposure History

Table 2 summarizes the single element exposure history of the aluminum-clad TRIGA fuel element from Reference 1. The burnup period is a hypothetical 4-year continuous exposure. TRIGA fuel elements typically remain in the core for much longer periods of time relative to the assumed 4-year in-core residency. Therefore, typical fuel elements would have more time to decay away their source term; therefore, the 4-year assumption is expected to produce a conservative source term.

Burnup Calculation

The ORIGEN2 computer code was used to perform the depletion or burnup calculation for the aluminum-clad TRIGA fuel element. The radionuclide inventory or source term template that follows is for a single aluminum-clad TRIGA fuel element. The fuel element component masses and impurities (fuel meat, uranium, clad, burnable poison, end fixtures), neutron cross sections, burnup, and hypothetical power history and power level as discussed above are input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of decay time in the template table.

The 145 radionuclides listed in the template represent greater than 99.9% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. J. W. Sterbentz, *Radionuclide Mass Inventory, Activity, Decay Heat, and Dose Rate Parametric Data for TRIGA Spent Nuclear Fuels*, INEL-96/0482, Idaho National Engineering Laboratory, March 1997.

2. N. Tomsio, *Characterization of TRIGA Fuel*, ORNL/Sub//86-22047/3, GA-C18542, GA Technologies, October 1986.

3. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

4. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

5. "MCNP4A: Monte Carlo N-Particle Transport Code System," LA-12625M, contributed by Los Alamos National Laboratory, Los Alamos, New Mexico, 1994, and distributed as package CCC-200 by Oak Ridge National Laboratory.

Table 1. Material constituent and impurity concentrations for the various materials in an aluminum-clad TRIGA fuel element.

Constituent or Impurity	Graphite Concentration (ppm)	ZrH Concentration (wt%)	Aluminum-1100 Concentration (wt%)
H		1.0628	
Li	0.45		
Be	0.005		
B	2.5	0.00005	
C	100 wt%	0.026968	
N		0.00799	
O		0.094887	
Na	10.4		
Mg	1		
Al	4.1	0.007491	99.3
Si	26	0.011986	0.25
P	1	0.009988	
S	9.4	0.003496	
Cl	3		
K	3		
Ca	22.5		
Sc	0.01		
Ti	16	0.004994	
V	18.9	0.004994	
Cr	1	0.124851	
Mn	1	0.004994	0.025
Fe	11.1	0.224731	0.25
Co	4	0.001998	
Ni	4.6	0.006992	
Cu	0.47	0.004994	0.125
Zn	1	0.009988	0.05
Rb	1		
Sr	0.47		
Zr	0.5	98.9082	
Nb	1.74	0.006992	
Mo	1	0.004994	
Ag	0.5		
Cd	0.5	0.000050	
In	1		
Sn	1	1.598089	
Sb	1		
Cs	1		
Ba	2.9		
La	1.38		

Table 1. (continued).

Constituent or Impurity	Graphite Concentration (ppm)	ZrH Concentration (wt%)	Aluminum-1100 Concentration (wt%)
Ce	0.56		
Pr	0.64		
Nd	0.36		
Sm	0.61	0.000999	
Gd	0.08	0.000499	
Tb	0.26		
Dy	0.16		
Ho	0.08		
Er	0.04		
Tm	0.04		
Yb	0.06		
Lu	0.02		
Hf	0.17	0.003496	
Ta	0.35	0.019976	
W	25.5	0.009988	
Tl	1		
Pb	6.9	0.009988	
Bi	1		
Th		0.000699	
U		0.000350	

Table 2. Hypothetical power history for a maximum burnup aluminum-clad TRIGA fuel element

Duration (days)	Cumulative Duration (days)	Time-Averaged Power (MWth)
365	365	0.004555
365	730	0.004555
365	1095	0.004555
365	1460	0.004555
1825	3285	0.0
1825	5110	0.0
1825	6935	0.0
1825	8760	0.0
1825	10585	0.0
3650	14235	0.0
5475	19710	0.0
5475	25185	0.0
5475	30660	0.0
7300	37960	0.0

The ten decay times following the hypothetical 4-year exposure are for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling time periods designated for the template methodology.

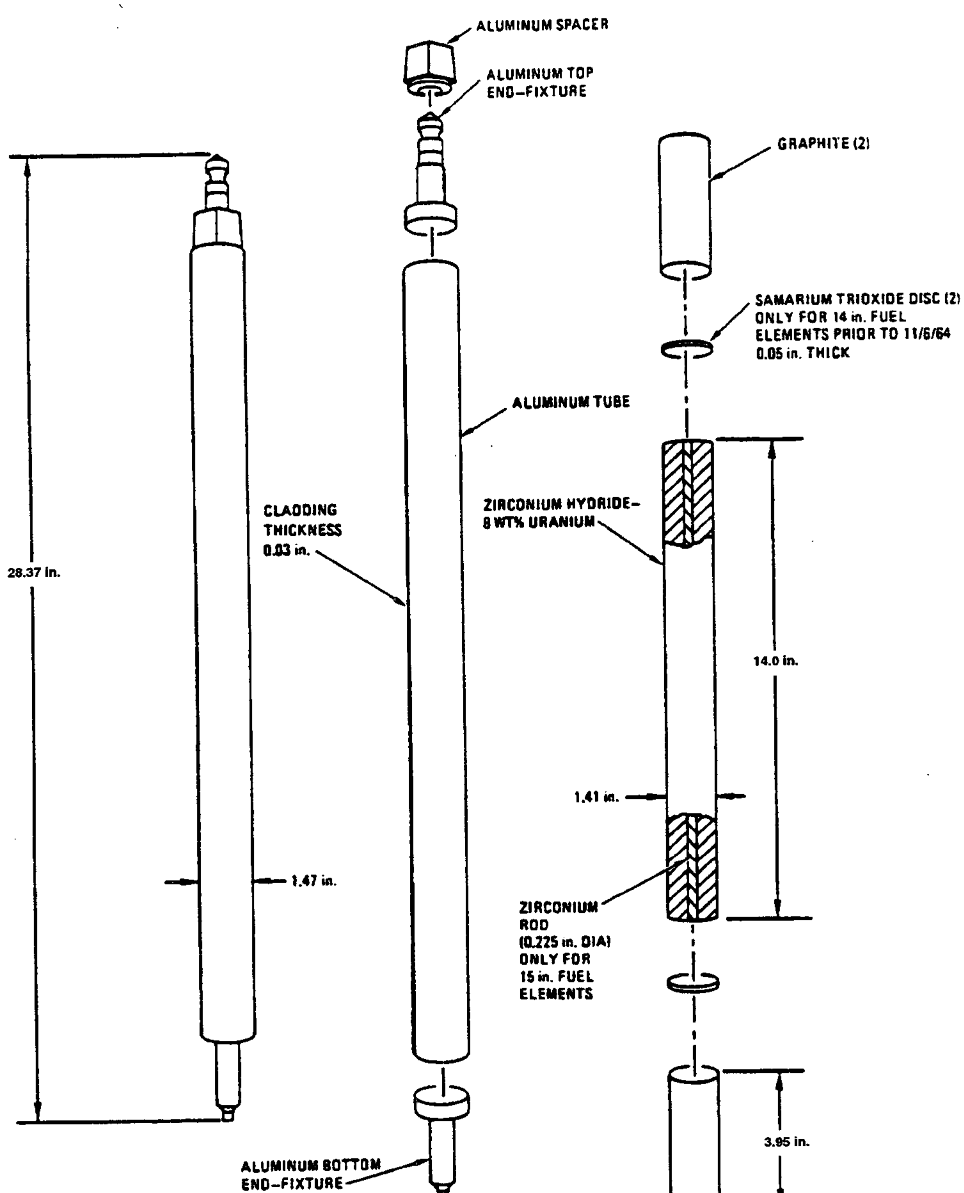

Figure 1. A typical aluminum-clad Mark I TRIGA fuel element.

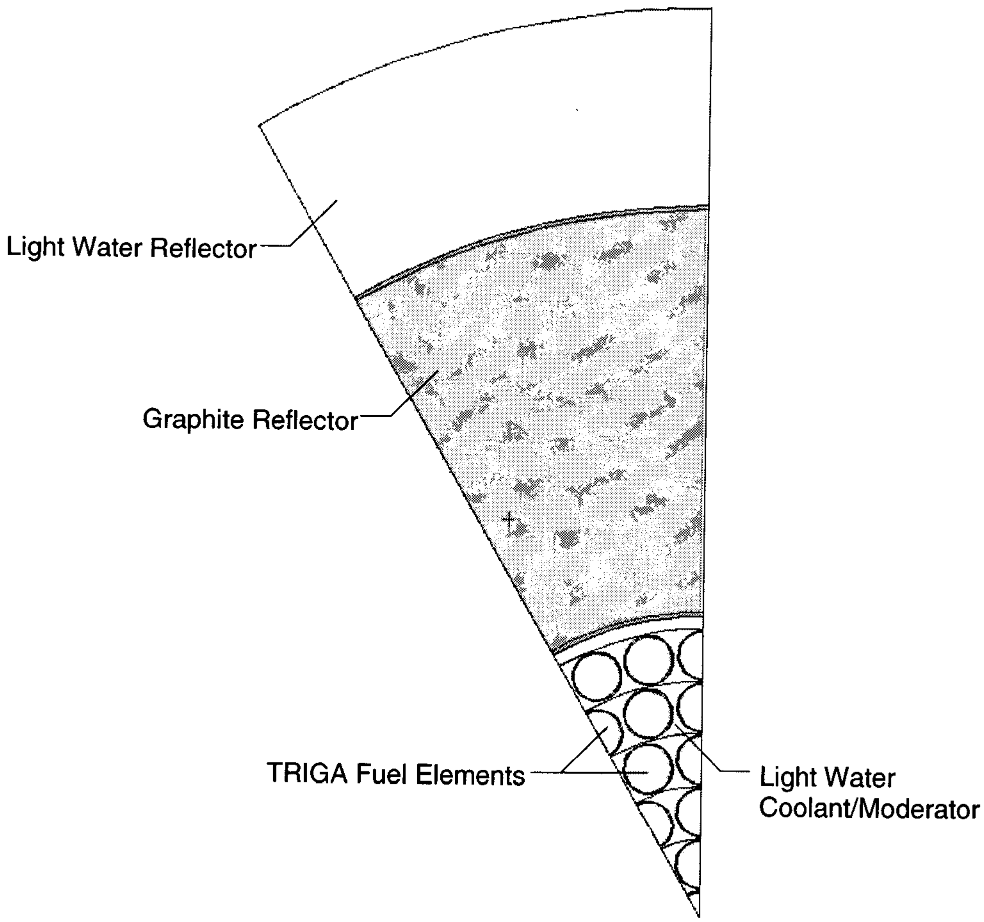

Figure 2. MCNP partial core model of a Mark I TRIGA reactor core.

TRIGA Element

Aluminum Cladding, 10 to 20%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Light Water
Fuel Meat:	U-Zr-$H_{1.0}$
Clad:	Aluminum
Burnup:	6.65 MWd/element (maximum element burnup)
Burnup:	19.44% U-235 burnup (amount fissioned)
Burnup:	8.07 g U-235 depletion (amount fissioned and transmuted)
Basis of Calculation:	Single element
BOL U-235:	36.0 g U-235 per element (design basis)
BOL U-238:	144.0 g U-238 per element
BOL Total U per element:	180.0 g U per element
BOL Fuel Enrichment:	20.0 wt%

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H-3	7.185E-02	5.427E-02	4.100E-02	3.097E-02	2.339E-02	1.335E-02	5.757E-03	2.482E-03	1.070E-03	3.485E-04
BE-10	1.565E-07	1.565E-07	1.565E-07	1.565E-07	1.565E-07	1.565E-07	1.565E-07	1.565E-07	1.565E-07	1.565E-07
C-14	2.880E-04	2.878E-04	2.877E-04	2.875E-04	2.873E-04	2.870E-04	2.865E-04	2.859E-04	2.854E-04	2.847E-04
CL-36	2.861E-07	2.861E-07	2.861E-07	2.861E-07	2.861E-07	2.861E-07	2.861E-07	2.861E-07	2.861E-07	2.860E-07
CR-51	1.398E-20	2.081E-40	3.097E-60	4.611E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN-54	5.494E-04	9.591E-06	1.674E-07	2.923E-09	5.103E-11	1.555E-14	8.274E-20	4.402E-25	2.342E-30	2.176E-37
FE-55	5.771E-02	1.523E-02	4.020E-03	1.061E-03	2.800E-04	1.951E-05	3.587E-07	6.594E-09	1.212E-10	5.883E-13
FE-59	6.039E-15	3.737E-27	2.312E-39	1.431E-51	8.855E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO-60	2.062E-01	1.069E-01	5.540E-02	2.872E-02	1.488E-02	3.998E-03	5.566E-04	7.750E-05	1.079E-05	7.786E-07
NI-59	7.771E-06	7.770E-06	7.770E-06	7.770E-06	7.769E-06	7.769E-06	7.768E-06	7.767E-06	7.766E-06	7.764E-06
NI-63	9.698E-04	9.340E-04	8.995E-04	8.662E-04	8.342E-04	7.737E-04	6.911E-04	6.173E-04	5.514E-04	4.743E-04
ZN-65	3.987E-04	2.228E-06	1.245E-08	6.954E-11	3.885E-13	1.213E-17	2.116E-24	3.690E-31	6.437E-38	6.273E-47
SE-79	8.604E-05	8.603E-05	8.603E-05	8.602E-05	8.602E-05	8.601E-05	8.599E-05	8.598E-05	8.597E-05	8.595E-05
KR-85	1.677E+00	1.214E+00	8.790E-01	6.363E-01	4.606E-01	2.414E-01	9.158E-02	3.475E-02	1.318E-02	3.620E-03
RB-87	5.715E-09	5.715E-09	5.715E-09	5.715E-09	5.715E-09	5.715E-09	5.715E-09	5.715E-09	5.715E-09	5.715E-09
SR-89	2.298E-09	3.034E-20	4.007E-31	5.290E-42	6.984E-53	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-90	1.729E+01	1.536E+01	1.363E+01	1.210E+01	1.075E+01	8.472E+00	5.930E+00	4.151E+00	2.905E+00	1.805E+00
Y-90	1.730E+01	1.536E+01	1.364E+01	1.211E+01	1.075E+01	8.475E+00	5.932E+00	4.152E+00	2.906E+00	1.806E+00
Y-91	8.752E-08	3.565E-17	1.452E-26	5.917E-36	2.411E-45	4.000E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR-93	5.433E-04	5.433E-04	5.433E-04	5.433E-04	5.433E-04	5.433E-04	5.433E-04	5.433E-04	5.433E-04	5.433E-04
ZR-95	6.734E-07	1.744E-15	4.521E-24	1.172E-32	3.034E-41	2.037E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-93M	1.542E-04	2.355E-04	2.986E-04	3.475E-04	3.854E-04	4.376E-04	4.795E-04	4.991E-04	5.081E-04	5.132E-04

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
NB-94	2.386E-05	2.386E-05	2.385E-05	2.385E-05	2.385E-05	2.384E-05	2.383E-05	2.381E-05	2.380E-05	2.379E-05
NB-95	1.495E-06	3.874E-15	1.004E-23	2.600E-32	6.737E-41	4.523E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-95M	4.996E-09	1.294E-17	3.353E-26	8.690E-35	2.252E-43	1.512E-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-93	5.903E-07	5.897E-07	5.891E-07	5.885E-07	5.880E-07	5.868E-07	5.851E-07	5.833E-07	5.816E-07	5.793E-07
TC-99	2.934E-03	2.934E-03	2.934E-03	2.934E-03	2.934E-03	2.934E-03	2.934E-03	2.934E-03	2.933E-03	2.933E-03
RU-103	1.281E-12	1.325E-26	1.370E-40	1.417E-54	1.466E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	6.234E-01	2.007E-02	6.463E-04	2.081E-05	6.700E-07	6.945E-10	2.318E-14	7.736E-19	2.582E-23	2.775E-29
RH-103M	1.155E-12	1.195E-26	1.235E-40	1.278E-54	1.321E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	6.234E-01	2.007E-02	6.463E-04	2.081E-05	6.700E-07	6.945E-10	2.318E-14	7.737E-19	2.582E-23	2.775E-29
PD-107	4.271E-06	4.271E-06	4.271E-06	4.271E-06	4.271E-06	4.271E-06	4.271E-06	4.271E-06	4.271E-06	4.271E-06
AG-110	9.707E-07	6.146E-09	3.890E-11	2.463E-13	1.559E-15	6.250E-20	1.585E-26	4.024E-33	1.021E-39	1.640E-48
AG-110M	7.299E-05	4.621E-07	2.925E-09	1.852E-11	1.173E-13	4.699E-18	1.193E-24	3.025E-31	7.676E-38	1.233E-46
AG-111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-113M	2.179E-03	1.718E-03	1.355E-03	1.069E-03	8.430E-04	5.244E-04	2.572E-04	1.262E-04	6.191E-05	2.395E-05
CD-113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-115M	3.075E-14	1.474E-26	7.065E-39	3.387E-51	1.624E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114	1.644E-14	1.320E-25	1.060E-36	8.503E-48	6.825E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114M	1.718E-14	1.379E-25	1.107E-36	8.885E-48	7.132E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-115M	2.159E-18	1.035E-30	4.960E-43	2.378E-55	1.140E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-119M	1.902E-02	1.089E-04	6.236E-07	3.570E-09	2.044E-11	6.702E-16	1.258E-22	2.362E-29	4.434E-36	4.767E-45
SN-121M	4.467E-04	4.168E-04	3.889E-04	3.629E-04	3.386E-04	2.947E-04	2.394E-04	1.945E-04	1.580E-04	1.197E-04
SN-123	2.183E-05	1.219E-09	6.802E-14	3.797E-18	2.119E-22	6.600E-31	1.148E-43	1.996E-56	3.469E-69	3.367E-86
SN-125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-126	8.139E-05	8.138E-05	8.138E-05	8.138E-05	8.138E-05	8.137E-05	8.136E-05	8.135E-05	8.134E-05	8.133E-05
SB-124	9.863E-12	7.372E-21	5.510E-30	4.119E-39	3.079E-48	1.720E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB-125	6.261E-01	1.793E-01	5.135E-02	1.471E-02	4.212E-03	3.455E-04	8.116E-06	1.907E-07	4.479E-09	3.013E-11
SB-126	1.139E-05	1.139E-05	1.139E-05	1.139E-05	1.139E-05	1.139E-05	1.139E-05	1.139E-05	1.139E-05	1.139E-05
SB-126M	8.139E-05	8.138E-05	8.138E-05	8.138E-05	8.138E-05	8.137E-05	8.136E-05	8.135E-05	8.134E-05	8.133E-05
TE-123M	5.982E-10	1.536E-14	3.943E-19	1.012E-23	2.598E-28	1.712E-37	2.896E-51	4.899E-65	8.289E-79	3.599E-97
TE-125M	1.527E-01	4.375E-02	1.253E-02	3.588E-03	1.028E-03	8.430E-05	1.980E-06	4.652E-08	1.093E-09	7.352E-12
TE-127	8.452E-06	7.709E-11	7.031E-16	6.413E-21	5.849E-26	4.866E-36	3.692E-51	2.801E-66	2.126E-81	0.000E+00
TE-127M	8.629E-06	7.871E-11	7.179E-16	6.547E-21	5.972E-26	4.968E-36	3.769E-51	2.860E-66	2.170E-81	0.000E+00
TE-129	1.160E-16	5.172E-33	2.306E-49	1.028E-65	4.583E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.782E-16	7.945E-33	3.542E-49	1.579E-65	7.041E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-129	4.908E-06	4.908E-06	4.908E-06	4.908E-06	4.908E-06	4.908E-06	4.908E-06	4.908E-06	4.908E-06	4.908E-06

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
I-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-134	6.894E-01	1.285E-01	2.396E-02	4.468E-03	8.329E-04	2.895E-05	1.876E-07	1.216E-09	7.879E-12	9.520E-15
CS-135	2.098E-04	2.098E-04	2.098E-04	2.098E-04	2.098E-04	2.098E-04	2.098E-04	2.098E-04	2.098E-04	2.098E-04
CS-136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-137	1.833E+01	1.633E+01	1.455E+01	1.296E+01	1.155E+01	9.169E+00	6.485E+00	4.586E+00	3.244E+00	2.044E+00
BA-136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-137M	1.734E+01	1.545E+01	1.376E+01	1.226E+01	1.093E+01	8.674E+00	6.135E+00	4.339E+00	3.069E+00	1.934E+00
BA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-141	2.761E-15	3.492E-32	4.417E-49	5.587E-66	7.066E-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-142	5.891E-09	5.891E-09	5.891E-09	5.891E-09	5.891E-09	5.891E-09	5.891E-09	5.891E-09	5.891E-09	5.891E-09
CE-144	2.304E+00	2.691E-02	3.142E-04	3.669E-06	4.284E-08	5.841E-12	9.300E-18	1.481E-23	2.358E-29	4.383E-37
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	2.304E+00	2.691E-02	3.142E-04	3.669E-06	4.284E-08	5.841E-12	9.301E-18	1.481E-23	2.358E-29	4.383E-37
PR-144M	2.765E-02	3.229E-04	3.770E-06	4.403E-08	5.141E-10	7.010E-14	1.116E-19	1.777E-25	2.829E-31	5.260E-39
ND-144	2.873E-13	2.882E-13	2.882E-13	2.882E-13	2.882E-13	2.882E-13	2.882E-13	2.882E-13	2.882E-13	2.882E-13
ND-147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-145	8.891E-03	7.387E-03	6.076E-03	4.996E-03	4.108E-03	2.778E-03	1.545E-03	8.587E-04	4.775E-04	2.183E-04
PM-147	1.381E+01	3.688E+00	9.849E-01	2.631E-01	7.027E-02	5.013E-03	9.551E-05	1.820E-06	3.468E-08	1.765E-10
PM-148M	1.009E-13	5.016E-27	2.495E-40	1.241E-53	6.170E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-148	5.681E-15	2.825E-28	1.405E-41	6.987E-55	3.475E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM-145	1.706E-03	4.135E-05	1.002E-06	2.428E-08	5.884E-10	3.455E-13	4.916E-18	6.996E-23	9.955E-28	3.433E-34
SM-147	6.419E-08	6.444E-08	6.451E-08	6.452E-08	6.453E-08	6.453E-08	6.453E-08	6.453E-08	6.453E-08	6.453E-08
SM-151	1.810E+00	1.742E+00	1.676E+00	1.612E+00	1.552E+00	1.437E+00	1.280E+00	1.141E+00	1.016E+00	8.711E-01
EU-152	5.693E-02	4.413E-02	3.421E-02	2.652E-02	2.056E-02	1.236E-02	5.755E-03	2.680E-03	1.249E-03	4.508E-04
EU-154	8.971E+00	5.997E+00	4.009E+00	2.680E+00	1.792E+00	8.007E-01	2.392E-01	7.146E-02	2.135E-02	4.264E-03
EU-155	2.918E+00	1.451E+00	7.220E-01	3.591E-01	1.786E-01	4.419E-02	5.438E-03	6.691E-04	8.235E-05	5.040E-06
EU-156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD-153	1.521E-04	8.172E-07	4.388E-09	2.356E-11	1.266E-13	3.648E-18	5.649E-25	8.747E-32	1.355E-38	1.126E-47
TB-160	1.431E-10	3.609E-18	9.101E-26	2.295E-33	5.788E-41	3.681E-56	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL-206	1.688E-12	1.688E-12	1.688E-12	1.688E-12	1.688E-12	1.688E-12	1.688E-12	1.688E-12	1.688E-12	1.688E-12
TL-207	2.692E-09	5.352E-09	8.560E-09	1.223E-08	1.631E-08	2.541E-08	4.083E-08	5.765E-08	7.534E-08	9.970E-08
TL-208	1.209E-07	1.294E-07	1.262E-07	1.210E-07	1.155E-07	1.049E-07	9.089E-08	7.876E-08	6.825E-08	5.645E-08

	DECAY TIMES (years out of core) (Activities* in Ci/element)									
Radionuclide	**5**	**10**	**15**	**20**	**25**	**35**	**50**	**65**	**80**	**100**
PB-210	2.012E-14	5.487E-14	1.253E-13	2.431E-13	4.200E-13	9.972E-13	2.589E-12	5.305E-12	9.409E-12	1.745E-11
PB-211	2.699E-09	5.367E-09	8.584E-09	1.227E-08	1.635E-08	2.548E-08	4.094E-08	5.781E-08	7.555E-08	9.998E-08
PB-212	3.364E-07	3.603E-07	3.513E-07	3.367E-07	3.214E-07	2.920E-07	2.530E-07	2.192E-07	1.899E-07	1.571E-07
BI-211	2.699E-09	5.367E-09	8.584E-09	1.227E-08	1.635E-08	2.548E-08	4.094E-08	5.781E-08	7.555E-08	9.998E-08
BI-212	3.364E-07	3.603E-07	3.513E-07	3.367E-07	3.214E-07	2.920E-07	2.530E-07	2.192E-07	1.899E-07	1.571E-07
PO-212	2.155E-07	2.308E-07	2.251E-07	2.157E-07	2.059E-07	1.871E-07	1.621E-07	1.404E-07	1.217E-07	1.007E-07
PO-215	2.699E-09	5.367E-09	8.584E-09	1.227E-08	1.635E-08	2.548E-08	4.094E-08	5.781E-08	7.555E-08	9.998E-08
PO-216	3.364E-07	3.603E-07	3.513E-07	3.367E-07	3.214E-07	2.920E-07	2.530E-07	2.192E-07	1.899E-07	1.571E-07
RN-219	2.699E-09	5.367E-09	8.584E-09	1.227E-08	1.635E-08	2.548E-08	4.094E-08	5.781E-08	7.555E-08	9.998E-08
RN-220	3.364E-07	3.603E-07	3.513E-07	3.367E-07	3.214E-07	2.920E-07	2.530E-07	2.192E-07	1.899E-07	1.571E-07
FR-223	3.723E-11	7.399E-11	1.183E-10	1.691E-10	2.253E-10	3.512E-10	5.645E-10	7.970E-10	1.041E-09	1.378E-09
RA-223	2.699E-09	5.367E-09	8.584E-09	1.227E-08	1.635E-08	2.548E-08	4.094E-08	5.781E-08	7.555E-08	9.998E-08
RA-224	3.364E-07	3.603E-07	3.513E-07	3.367E-07	3.214E-07	2.920E-07	2.530E-07	2.192E-07	1.899E-07	1.571E-07
RA-226	1.546E-13	3.814E-13	7.197E-13	1.181E-12	1.776E-12	3.411E-12	7.118E-12	1.254E-11	1.990E-11	3.302E-11
RA-228	9.560E-10	1.207E-09	1.357E-09	1.447E-09	1.500E-09	1.551E-09	1.573E-09	1.578E-09	1.579E-09	1.579E-09
AC-227	2.698E-09	5.362E-09	8.573E-09	1.225E-08	1.633E-08	2.545E-08	4.090E-08	5.775E-08	7.547E-08	9.988E-08
TH-227	2.662E-09	5.293E-09	8.465E-09	1.210E-08	1.613E-08	2.513E-08	4.038E-08	5.702E-08	7.451E-08	9.860E-08
TH-228	3.363E-07	3.600E-07	3.510E-07	3.364E-07	3.211E-07	2.919E-07	2.530E-07	2.192E-07	1.899E-07	1.571E-07
TH-229	5.691E-10	9.808E-10	1.392E-09	1.804E-09	2.215E-09	3.038E-09	4.271E-09	5.503E-09	6.734E-09	8.374E-09
TH-230	8.096E-11	1.300E-10	1.845E-10	2.444E-10	3.094E-10	4.540E-10	7.045E-10	9.914E-10	1.311E-09	1.781E-09
TH-231	6.040E-05	6.040E-05	6.040E-05	6.040E-05	6.040E-05	6.040E-05	6.041E-05	6.041E-05	6.041E-05	6.041E-05
TH-232	1.579E-09	1.579E-09	1.579E-09	1.579E-09	1.579E-09	1.579E-09	1.579E-09	1.579E-09	1.579E-09	1.579E-09
TH-234	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05
PA-231	1.753E-08	2.392E-08	3.030E-08	3.669E-08	4.308E-08	5.584E-08	7.498E-08	9.411E-08	1.132E-07	1.387E-07
PA-233	9.598E-06	9.618E-06	9.646E-06	9.681E-06	9.721E-06	9.810E-06	9.960E-06	1.012E-05	1.028E-05	1.049E-05
PA-234M	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05
PA-234	6.259E-08	6.259E-08	6.259E-08	6.259E-08	6.259E-08	6.259E-08	6.259E-08	6.259E-08	6.259E-08	6.259E-08
U-232	3.725E-07	3.581E-07	3.423E-07	3.265E-07	3.112E-07	2.827E-07	2.447E-07	2.118E-07	1.834E-07	1.513E-07
U-233	8.731E-07	8.733E-07	8.735E-07	8.736E-07	8.738E-07	8.742E-07	8.748E-07	8.754E-07	8.760E-07	8.769E-07
U-234	1.027E-06	1.152E-06	1.273E-06	1.389E-06	1.501E-06	1.711E-06	1.997E-06	2.252E-06	2.478E-06	2.742E-06
U-235	6.040E-05	6.040E-05	6.040E-05	6.040E-05	6.040E-05	6.040E-05	6.041E-05	6.041E-05	6.041E-05	6.041E-05
U-236	8.457E-05	8.457E-05	8.458E-05	8.458E-05	8.458E-05	8.458E-05	8.459E-05	8.460E-05	8.460E-05	8.461E-05
U-237	2.051E-07	1.613E-07	1.268E-07	9.969E-08	7.838E-08	4.845E-08	2.355E-08	1.144E-08	5.561E-09	2.125E-09
U-238	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05	4.814E-05
NP-237	9.598E-06	9.618E-06	9.646E-06	9.681E-06	9.721E-06	9.810E-06	9.960E-06	1.012E-05	1.028E-05	1.049E-05

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
PU-236	1.173E-07	3.483E-08	1.034E-08	3.069E-09	9.121E-10	8.206E-11	3.991E-12	1.950E-12	1.897E-12	1.895E-12
PU-237	1.346E-18	1.206E-30	1.080E-42	9.678E-55	8.669E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU-238	8.987E-03	8.640E-03	8.306E-03	7.985E-03	7.676E-03	7.094E-03	6.303E-03	5.600E-03	4.976E-03	4.250E-03
PU-239	3.787E-02	3.786E-02	3.786E-02	3.785E-02	3.785E-02	3.784E-02	3.782E-02	3.780E-02	3.779E-02	3.776E-02
PU-240	1.506E-02	1.505E-02	1.504E-02	1.504E-02	1.503E-02	1.501E-02	1.499E-02	1.496E-02	1.494E-02	1.491E-02
PU-241	8.362E-01	6.574E-01	5.169E-01	4.064E-01	3.195E-01	1.975E-01	9.598E-02	4.665E-02	2.267E-02	8.661E-03
PU-242	2.035E-06	2.035E-06	2.035E-06	2.035E-06	2.035E-06	2.035E-06	2.035E-06	2.035E-06	2.035E-06	2.035E-06
PU-244	4.531E-15	4.531E-15	4.531E-15	4.531E-15	4.531E-15	4.531E-15	4.531E-15	4.531E-15	4.531E-15	4.531E-15
AM-241	9.166E-03	1.502E-02	1.957E-02	2.308E-02	2.577E-02	2.939E-02	3.203E-02	3.289E-02	3.290E-02	3.232E-02
AM-242M	1.325E-05	1.296E-05	1.266E-05	1.238E-05	1.210E-05	1.156E-05	1.080E-05	1.008E-05	9.417E-06	8.597E-06
AM-242	1.319E-05	1.289E-05	1.260E-05	1.232E-05	1.204E-05	1.150E-05	1.074E-05	1.003E-05	9.370E-06	8.554E-06
AM-243	1.551E-06	1.550E-06	1.550E-06	1.549E-06	1.548E-06	1.547E-06	1.545E-06	1.542E-06	1.540E-06	1.537E-06
CM-242	3.330E-05	1.067E-05	1.043E-05	1.019E-05	9.961E-06	9.513E-06	8.884E-06	8.297E-06	7.749E-06	7.074E-06
CM-243	1.824E-06	1.615E-06	1.430E-06	1.267E-06	1.122E-06	8.797E-07	6.110E-07	4.243E-07	2.947E-07	1.812E-07
CM-244	2.095E-05	1.730E-05	1.429E-05	1.180E-05	9.749E-06	6.650E-06	3.747E-06	2.111E-06	1.189E-06	5.535E-07
CM-245	2.407E-10	2.406E-10	2.405E-10	2.404E-10	2.403E-10	2.401E-10	2.398E-10	2.395E-10	2.392E-10	2.388E-10
CM-246	7.528E-12	7.522E-12	7.517E-12	7.511E-12	7.506E-12	7.495E-12	7.478E-12	7.462E-12	7.446E-12	7.424E-12
CM-247	1.887E-18	1.887E-18	1.887E-18	1.887E-18	1.887E-18	1.887E-18	1.887E-18	1.887E-18	1.887E-18	1.887E-18
SUBTOTAL**	1.081E+02	7.800E+01	6.469E+01	5.559E+01	4.851E+01	3.764E+01	2.630E+01	1.862E+01	1.330E+01	8.573E+00
TOTAL***	1.081E+02	7.801E+01	6.469E+01	5.560E+01	4.852E+01	3.764E+01	2.631E+01	1.863E+01	1.330E+01	8.573E+00

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 27

Fuel-Specific Source Term Calculations
TRIGA FLIP Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term for the Training, Research, and Isotope General Atomics (TRIGA) high-enrichment Fuel Life Improvement Program (FLIP) spent nuclear fuel elements currently stored at the INEEL. The data sources are documented in References 1 and 2, and the INEEL calculational methodology is described in Reference 3.

TRIGA Data

TRIGA reactors are light-water-cooled reactors designed for training, research, and isotope production. One type of fuel element used in a TRIGA reactor is a highly enriched, stainless steel-clad, uranium-zirconium-hydride (U-Zr-H) fuel element. The highly enriched uranium is homogenously mixed in the ZrH matrix. The cylindrical active fuel region in each element is approximately 1.4 in. in diameter and 15 in. in length. Figure 1 shows a typical TRIGA FLIP fuel element with dimensions and materials. The data below give specific dimensions, materials, loadings, densities, enrichment, etc., for the fuel element used in the burnup calculation for the source term generation.

Fuel Element:

Fuel Meat:	U-Zr-H		
	Zr:H ratio is 1.6		
	Density = 5.92 g/cc		
Clad:	Stainless Steel		
	Density = 7.92 g/cc		
Loading:	137.0	g/element U-235 BOL	
	59.0	g/element U-238 BOL	
	196.0	g/element U BOL	
	2060.0	g/element Zr in fuel meat	
	8.5	weight % U in U-$ZrH_{1.6}$	
	70%	enrichment U-235 BOL	
	800.0	g/element stainless steel cladding (819.414 g/element with impurities)	
	450.0	g/element carbon in reflector	
	36.0	g/element natural erbium poison	

Active Fuel Length: 15 in.
Fuel Element Length: 29 in. (approximate)

Water Temperature: 77.5°F
Water Pressure: 14.7 psia

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single TRIGA FLIP fuel element. In addition, for the ORIGEN2 (Reference 4) depletion or burnup calculation, conservative and detailed impurity concentrations were added for the stainless steel clad, zirconium-hydride, and graphite end reflectors. Table 1 gives the impurity concentrations for these materials.

Burnup

Reference 1 is a parametric study and includes radionuclide inventories or source terms for 14 different burnups ranging up to 51.09%. The burnup chosen for this template is based on the 51.09% burnup of the initial U-235 or the maximum burnup used in the parametric study. This burnup is equivalent to 66.52 MWd, 339,388 MWd/MTU, and 81.84 grams of U-235 depleted per element and represents the upper end of typical TRIGA FLIP fuel element burnups. The assumption of maximum burnup is conservative for the buildup of fission products, activation products, and minor actinides in the source term and nonconservative with regard to criticality safety.

Cross-Section Development

An MCNP4A (Reference 5) partial core model of a MARK I TRIGA reactor core was used to generate neutron cross sections specifically for the TRIGA FLIP fuel element. The MCNP4A one-twelfth core model is shown in Figure 2 with all fuel elements modeled as TRIGA FLIP elements. The cross sections are spectrally and spatially weighted over all the fuel elements shown in Figure 2. These cross sections are in turn used in the fuel element ORIGEN2 depletion calculation.

Parametric TRIGA Single Element Exposure History

Table 2 summarizes the single element exposure history of the TRIGA FLIP fuel element from Reference 1. The burnup period is a hypothetical 4-year continuous exposure. TRIGA fuel elements typically remain in the core for much longer periods of time relative to the assumed 4-year in-core residency. Therefore, typical fuel elements would have more time to decay away their source term; therefore, the 4-year assumption is expected to produce a conservative source term.

Burnup Calculation

The ORIGEN2 computer code was used to perform the depletion or burnup calculation for the TRIGA FLIP fuel element. The radionuclide inventory or source term template that follows is for a single TRIGA FLIP fuel element. The fuel element component masses and impurities (fuel meat, uranium, clad, burnable poison, end fixtures), neutron cross sections, burnup, and hypothetical power history and power level as discussed above are input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of decay time in the template table.

The 145 radionuclides listed in the template represent greater than 99.1% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. J. W. Sterbentz, *Radionuclide Mass Inventory, Activity, Decay Heat, and Dose Rate Parametric Data for TRIGA Spent Nuclear Fuels*, INEL-96/0482, Idaho National Engineering Laboratory, March 1997.

2. N. Tomsio, *Characterization of TRIGA Fuel*, ORNL/Sub//86-22047/3, GA-C18542, GA Technologies, October 1986.

3. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

4. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

5. "MCNP4A: Monte Carlo N-Particle Transport Code System," LA-12625M, contributed by Los Alamos National Laboratory, Los Alamos, New Mexico, 1994, and distributed as package CCC-200 by Oak Ridge National Laboratory.

Table 1. Material constituent and impurity concentrations for the various materials in a TRIGA FLIP fuel element.

Constituent or Impurity	Graphite Concentration (ppm)	ZrH Concentration (wt%)	Stainless Steel Concentration (ppm)
H		1.7373	
Li	0.45		0.13
Be	0.005		
B	2.5	0.00005	
C	100 wt%	0.026968	0.08 wt%
N		0.00799	525
O		0.094887	
Na	10.4		37
Mg	1		
Al	4.1	0.007491	200
Si	26	0.011986	1.00 wt%
P	1	0.009988	
S	9.4	0.003496	
Cl	3		130
K	3		3
Ca	22.5		19
Sc	0.01		0.03
Ti	16	0.004994	600
V	18.9	0.004994	690
Cr	1	0.124851	18.40 wt%
Mn	1	0.004994	1.53 wt%
Fe	11.1	0.224731	68.99 wt%
Co	4	0.001998	2570
Ni	4.6	0.006992	10.00 wt%
Cu	0.47	0.004994	8150
Zn	1	0.009988	2230
Ga			450
As			1010
Se			70
Br			8
Rb	1		10
Sr	0.47		0.2
Y			5
Zr	0.5	98.2627	20
Nb	1.74	0.006992	300
Mo	1	0.004994	5500
Ag	0.5		2

Table 1. (continued).

Constituent or Impurity	Graphite Concentration (ppm)	ZrH Concentration (wt%)	Stainless Steel Concentration (ppm)
Cd	0.5	0.000050	
In	1		
Sn	1	1.598089	
Sb	1		17
Cs	1		0.3
Ba	2.9		500
La	1.38		2.1
Ce	0.56		550
Pr	0.64		
Nd	0.36		
Sm	0.61	0.000999	0.15
Eu			0.02
Gd	0.08	0.000499	
Tb	0.26		0.71
Dy	0.16		1
Ho	0.08		1
Er	0.04		
Tm	0.04		
Yb	0.06		2
Lu	0.02		0.8
Hf	0.17	0.003496	2
Ta	0.35	0.019976	
W	25.5	0.009988	520
Tl	1		
Pb	6.9	0.009988	139
Bi	1		
Th		0.000699	1
U		0.000350	2

Table 2. Hypothetical power history for a maximum burnup TRIGA FLIP fuel element.

Duration (days)	Cumulative Duration (days)	Time-Averaged Power (MWth)
365	365	0.04555
365	730	0.04555
365	1095	0.04555
365	1460	0.04555
1825	3285	0.0
1825	5110	0.0
1825	6935	0.0
1825	8760	0.0
1825	10585	0.0
3650	14235	0.0
5475	19710	0.0
5475	25185	0.0
5475	30660	0.0
7300	37960	0.0

The ten decay times following the hypothetical 4-year exposure are for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling time periods designated for the template methodology.

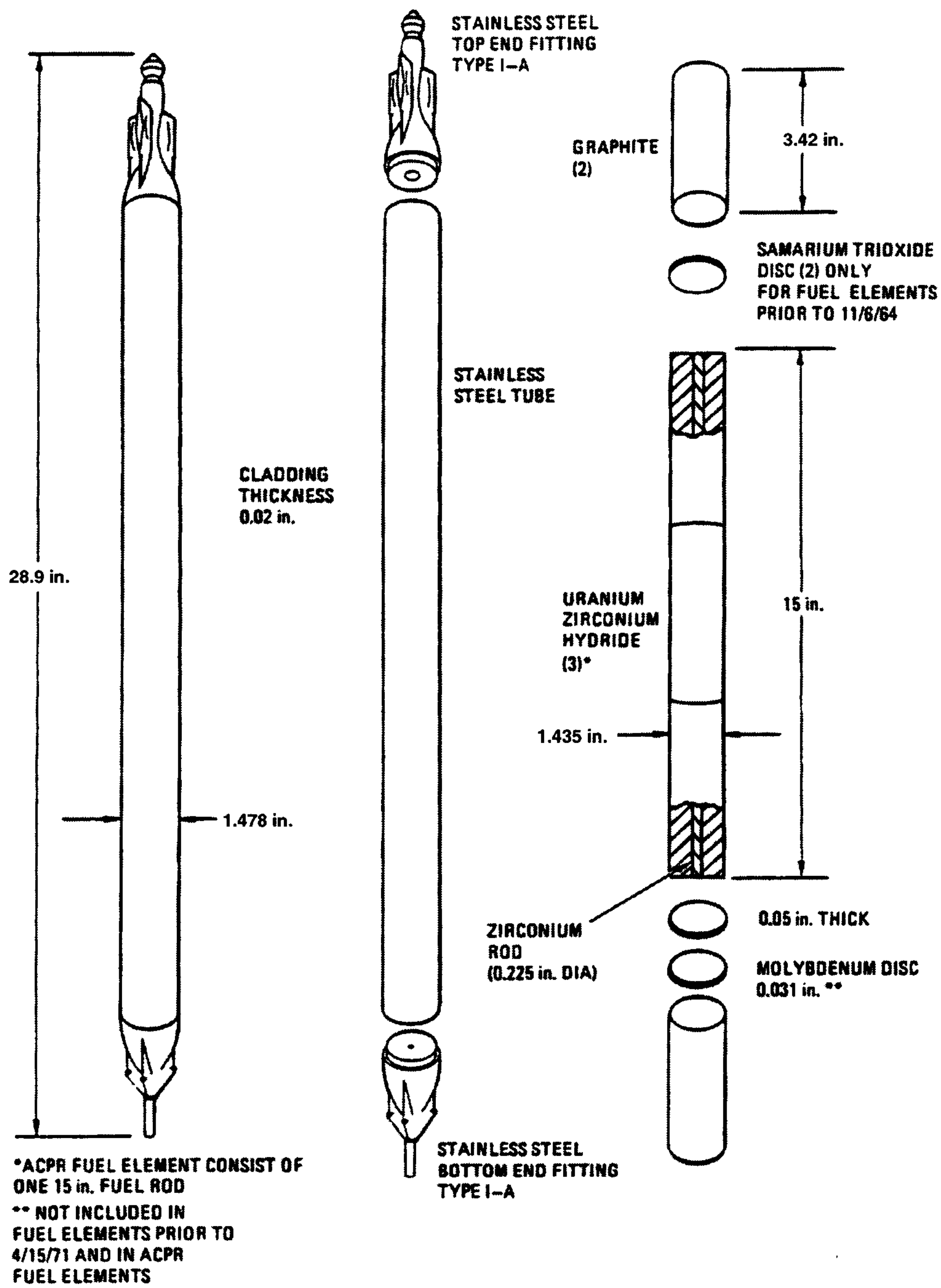

Figure 1. A typical stainless steel-clad Mark I TRIGA fuel element.

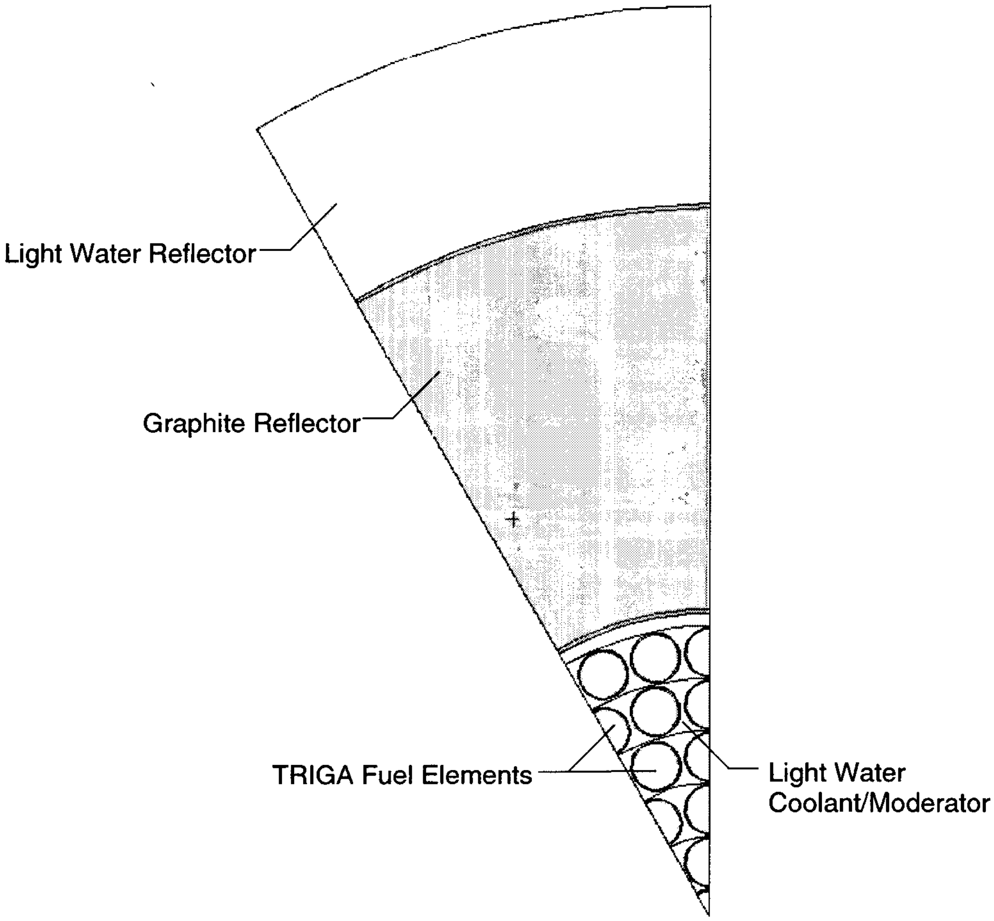

Figure 2. MCNP partial core model of a Mark I TRIGA reactor core.

TRIGA Element

FLIP, 60 to 100%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Light Water
Fuel Meat:	U-Zr-$H_{1.6}$
Clad:	Stainless Steel
Burnup:	66.52 MWd/element (maximum element burnup)
Burnup:	51.09% U-235 burnup (amount fissioned)
Burnup:	81.84 g U-235 depletion (amount fissioned and transmuted)
Basis of Calculation:	Single element
BOL U-235:	137.0 g U-235 per element (design basis)
BOL U-238:	59.0 g U-238 per element
BOL Total U per element:	196.0 g U per element
BOL Fuel Enrichment:	70.0 wt%

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H-3	7.005E-01	5.292E-01	3.998E-01	3.020E-01	2.282E-01	1.302E-01	5.613E-02	2.420E-02	1.043E-02	3.398E-03
BE-10	1.313E-06	1.313E-06	1.313E-06	1.313E-06	1.313E-06	1.313E-06	1.313E-06	1.313E-06	1.313E-06	1.313E-06
C-14	8.375E-03	8.369E-03	8.364E-03	8.359E-03	8.354E-03	8.344E-03	8.329E-03	8.314E-03	8.299E-03	8.279E-03
CL-36	1.771E-04	1.771E-04	1.771E-04	1.771E-04	1.771E-04	1.771E-04	1.771E-04	1.771E-04	1.771E-04	1.770E-04
CR-51	8.242E-18	1.227E-37	1.826E-57	2.718E-77	4.046E-97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN-54	5.368E-01	9.371E-03	1.636E-04	2.856E-06	4.986E-08	1.520E-11	8.085E-17	4.302E-22	2.289E-27	2.126E-34
FE-55	5.292E+01	1.397E+01	3.686E+00	9.730E-01	2.568E-01	1.789E-02	3.289E-04	6.047E-06	1.112E-07	5.395E-10
FE-59	6.733E-12	4.166E-24	2.578E-36	1.595E-48	9.873E-61	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO-60	8.255E+01	4.278E+01	2.218E+01	1.149E+01	5.957E+00	1.600E+00	2.228E-01	3.102E-02	4.318E-03	3.116E-04
NI-59	3.223E-02	3.223E-02	3.223E-02	3.223E-02	3.223E-02	3.222E-02	3.222E-02	3.221E-02	3.221E-02	3.220E-02
NI-63	4.106E+00	3.955E+00	3.808E+00	3.668E+00	3.532E+00	3.276E+00	2.926E+00	2.614E+00	2.335E+00	2.008E+00
ZN-65	2.221E-02	1.241E-04	6.934E-07	3.874E-09	2.165E-11	6.757E-16	1.179E-22	2.056E-29	3.586E-36	3.495E-45
SE-79	8.536E-04	8.535E-04	8.535E-04	8.534E-04	8.534E-04	8.533E-04	8.532E-04	8.530E-04	8.529E-04	8.527E-04
KR-85	1.660E+01	1.202E+01	8.699E+00	6.297E+00	4.559E+00	2.389E+00	9.063E-01	3.438E-01	1.304E-01	3.583E-02
RB-87	5.649E-08	5.649E-08	5.649E-08	5.649E-08	5.649E-08	5.649E-08	5.649E-08	5.649E-08	5.649E-08	5.649E-08
SR-89	2.078E-08	2.744E-19	3.624E-30	4.785E-41	6.318E-52	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-90	1.706E+02	1.514E+02	1.344E+02	1.194E+02	1.060E+02	8.355E+01	5.848E+01	4.093E+01	2.865E+01	1.780E+01
Y-90	1.706E+02	1.515E+02	1.345E+02	1.194E+02	1.060E+02	8.357E+01	5.849E+01	4.094E+01	2.866E+01	1.781E+01
Y-91	7.992E-07	3.256E-16	1.326E-25	5.403E-35	2.201E-44	3.653E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR-93	5.170E-03	5.170E-03	5.170E-03	5.170E-03	5.170E-03	5.170E-03	5.170E-03	5.169E-03	5.169E-03	5.169E-03
ZR-95	6.280E-06	1.627E-14	4.216E-23	1.092E-31	2.830E-40	1.900E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-93M	1.466E-03	2.240E-03	2.841E-03	3.306E-03	3.667E-03	4.163E-03	4.562E-03	4.749E-03	4.836E-03	4.884E-03

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
NB-94	5.086E-04	5.085E-04	5.084E-04	5.084E-04	5.083E-04	5.081E-04	5.078E-04	5.076E-04	5.073E-04	5.070E-04
NB-95	1.394E-05	3.613E-14	9.360E-23	2.425E-31	6.284E-40	4.218E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-95M	4.660E-08	1.208E-16	3.128E-25	8.104E-34	2.100E-42	1.410E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-93	2.140E-04	2.138E-04	2.136E-04	2.134E-04	2.132E-04	2.127E-04	2.121E-04	2.115E-04	2.108E-04	2.100E-04
TC-99	2.682E-02	2.682E-02	2.682E-02	2.682E-02	2.682E-02	2.682E-02	2.681E-02	2.681E-02	2.681E-02	2.681E-02
RU-103	1.208E-11	1.249E-25	1.292E-39	1.336E-53	1.381E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	6.880E+00	2.215E-01	7.132E-03	2.296E-04	7.394E-06	7.664E-09	2.558E-13	8.538E-18	2.850E-22	3.062E-28
RH-103M	1.089E-11	1.126E-25	1.164E-39	1.204E-53	1.245E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	6.880E+00	2.215E-01	7.132E-03	2.296E-04	7.394E-06	7.665E-09	2.558E-13	8.538E-18	2.850E-22	3.062E-28
PD-107	4.694E-05	4.694E-05	4.694E-05	4.694E-05	4.694E-05	4.694E-05	4.694E-05	4.694E-05	4.694E-05	4.694E-05
AG-110	8.759E-05	5.545E-07	3.510E-09	2.222E-11	1.407E-13	5.639E-18	1.431E-24	3.630E-31	9.212E-38	1.480E-46
AG-110M	6.585E-03	4.169E-05	2.639E-07	1.671E-09	1.058E-11	4.240E-16	1.076E-22	2.729E-29	6.926E-36	1.113E-44
AG-111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-113M	2.366E-02	1.866E-02	1.472E-02	1.161E-02	9.155E-03	5.695E-03	2.794E-03	1.371E-03	6.724E-04	2.601E-04
CD-113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-115M	2.911E-13	1.396E-25	6.689E-38	3.206E-50	1.537E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114	1.148E-12	9.216E-24	7.397E-35	5.937E-46	4.766E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114M	1.200E-12	9.629E-24	7.729E-35	6.204E-46	4.980E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-115M	2.043E-17	9.794E-30	4.695E-42	2.251E-54	1.079E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-119M	1.829E-01	1.048E-03	5.999E-06	3.435E-08	1.967E-10	6.449E-15	1.210E-21	2.273E-28	4.266E-35	4.586E-44
SN-121M	3.765E-03	3.513E-03	3.278E-03	3.058E-03	2.854E-03	2.484E-03	2.018E-03	1.639E-03	1.332E-03	1.009E-03
SN-123	2.127E-04	1.187E-08	6.626E-13	3.698E-17	2.064E-21	6.431E-30	1.118E-42	1.944E-55	3.380E-68	3.280E-85
SN-125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-126	8.042E-04	8.042E-04	8.042E-04	8.041E-04	8.041E-04	8.041E-04	8.040E-04	8.039E-04	8.038E-04	8.037E-04
SB-124	1.148E-09	8.584E-19	6.416E-28	4.795E-37	3.585E-46	2.003E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB-125	5.752E+00	1.647E+00	4.718E-01	1.351E-01	3.870E-02	3.174E-03	7.457E-05	1.752E-06	4.115E-08	2.769E-10
SB-126	1.126E-04	1.126E-04	1.126E-04	1.126E-04	1.126E-04	1.126E-04	1.126E-04	1.125E-04	1.125E-04	1.125E-04
SB-126M	8.042E-04	8.042E-04	8.042E-04	8.041E-04	8.041E-04	8.041E-04	8.040E-04	8.039E-04	8.038E-04	8.037E-04
TE-123M	6.604E-07	1.695E-11	4.352E-16	1.117E-20	2.868E-25	1.890E-34	3.197E-48	5.409E-62	9.150E-76	3.974E-94
TE-125M	1.403E+00	4.020E-01	1.151E-01	3.297E-02	9.442E-03	7.745E-04	1.819E-05	4.274E-07	1.004E-08	6.754E-11
TE-127	8.178E-05	7.459E-10	6.803E-15	6.205E-20	5.660E-25	4.708E-35	3.572E-50	2.711E-65	2.057E-80	1.423-100
TE-127M	8.349E-05	7.615E-10	6.946E-15	6.335E-20	5.778E-25	4.807E-35	3.647E-50	2.767E-65	2.100E-80	1.453-100
TE-129	1.045E-15	4.659E-32	2.077E-48	9.261E-65	4.129E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.605E-15	7.157E-32	3.191E-48	1.423E-64	6.343E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-129	4.742E-05	4.742E-05	4.742E-05	4.742E-05	4.742E-05	4.742E-05	4.742E-05	4.742E-05	4.742E-05	4.742E-05

	DECAY TIMES (years out of core) (Activities* in Ci/element)									
Radionuclide	5	10	15	20	25	35	50	65	80	100
I-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-134	4.354E+01	8.116E+00	1.514E+00	2.821E-01	5.260E-02	1.828E-03	1.184E-05	7.678E-08	4.975E-10	6.011E-13
CS-135	1.314E-03	1.314E-03	1.314E-03	1.314E-03	1.314E-03	1.313E-03	1.313E-03	1.313E-03	1.313E-03	1.313E-03
CS-136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-137	1.821E+02	1.622E+02	1.445E+02	1.288E+02	1.147E+02	9.108E+01	6.442E+01	4.556E+01	3.222E+01	2.031E+01
BA-136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-137M	1.723E+02	1.535E+02	1.367E+02	1.218E+02	1.085E+02	8.616E+01	6.094E+01	4.310E+01	3.048E+01	1.921E+01
BA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-141	2.429E-14	3.072E-31	3.886E-48	4.914E-65	6.216E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-142	5.961E-08	5.961E-08	5.961E-08	5.961E-08	5.961E-08	5.961E-08	5.961E-08	5.961E-08	5.961E-08	5.961E-08
CE-144	2.238E+01	2.613E-01	3.051E-03	3.563E-05	4.160E-07	5.673E-11	9.032E-17	1.438E-22	2.290E-28	4.257E-36
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	2.238E+01	2.613E-01	3.051E-03	3.563E-05	4.161E-07	5.673E-11	9.032E-17	1.438E-22	2.290E-28	4.257E-36
PR-144M	2.685E-01	3.136E-03	3.662E-05	4.276E-07	4.993E-09	6.807E-13	1.084E-18	1.726E-24	2.748E-30	5.108E-38
ND-144	3.266E-12	3.274E-12	3.274E-12	3.274E-12	3.274E-12	3.274E-12	3.274E-12	3.274E-12	3.274E-12	3.274E-12
ND-147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-145	7.672E-05	6.381E-05	5.249E-05	4.316E-05	3.549E-05	2.400E-05	1.334E-05	7.418E-06	4.125E-06	1.886E-06
PM-147	7.518E+01	2.008E+01	5.363E+00	1.432E+00	3.826E-01	2.729E-02	5.201E-04	9.910E-06	1.888E-07	9.610E-10
PM-148M	2.623E-12	1.304E-25	6.487E-39	3.226E-52	1.604E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-148	1.477E-13	7.347E-27	3.654E-40	1.817E-53	9.037E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM-145	1.629E-05	3.948E-07	9.566E-09	2.318E-10	5.617E-12	3.299E-15	4.694E-20	6.679E-25	9.504E-30	3.277E-36
SM-147	9.760E-09	1.112E-08	1.148E-08	1.157E-08	1.160E-08	1.161E-08	1.161E-08	1.161E-08	1.161E-08	1.161E-08
SM-151	6.322E-01	6.083E-01	5.853E-01	5.633E-01	5.420E-01	5.019E-01	4.471E-01	3.984E-01	3.550E-01	3.043E-01
EU-152	1.646E-02	1.276E-02	9.891E-03	7.667E-03	5.943E-03	3.572E-03	1.664E-03	7.750E-04	3.610E-04	1.303E-04
EU-154	8.198E+00	5.481E+00	3.663E+00	2.449E+00	1.637E+00	7.318E-01	2.187E-01	6.531E-02	1.951E-02	3.897E-03
EU-155	3.528E+00	1.755E+00	8.727E-01	4.341E-01	2.159E-01	5.341E-02	6.573E-03	8.089E-04	9.954E-05	6.092E-06
EU-156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD-153	7.084E-04	3.804E-06	2.043E-08	1.097E-10	5.889E-13	1.699E-17	2.629E-24	4.072E-31	6.305E-38	5.243E-47
TB-160	1.022E-08	2.577E-16	6.501E-24	1.639E-31	4.134E-39	2.630E-54	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL-206	1.413E-11	1.413E-11	1.413E-11	1.413E-11	1.413E-11	1.413E-11	1.413E-11	1.413E-11	1.413E-11	1.413E-11
TL-207	1.037E-08	1.891E-08	2.806E-08	3.771E-08	4.779E-08	6.898E-08	1.027E-07	1.379E-07	1.741E-07	2.232E-07
TL-208	7.503E-06	9.521E-06	9.883E-06	9.676E-06	9.301E-06	8.472E-06	7.335E-06	6.350E-06	5.497E-06	4.538E-06

	DECAY TIMES (years out of core) (Activities* in Ci/element)									
Radionuclide	5	10	15	20	25	35	50	65	80	100
PB-210	3.226E-12	4.100E-12	7.451E-12	1.514E-11	2.943E-11	8.833E-11	2.970E-10	7.267E-10	1.465E-09	3.078E-09
PB-211	1.040E-08	1.897E-08	2.813E-08	3.781E-08	4.793E-08	6.917E-08	1.030E-07	1.383E-07	1.746E-07	2.238E-07
PB-212	2.088E-05	2.650E-05	2.751E-05	2.693E-05	2.589E-05	2.358E-05	2.042E-05	1.767E-05	1.530E-05	1.263E-05
BI-211	1.040E-08	1.897E-08	2.813E-08	3.781E-08	4.793E-08	6.917E-08	1.030E-07	1.383E-07	1.746E-07	2.238E-07
BI-212	2.088E-05	2.650E-05	2.751E-05	2.693E-05	2.589E-05	2.358E-05	2.042E-05	1.767E-05	1.530E-05	1.263E-05
PO-212	1.338E-05	1.698E-05	1.762E-05	1.725E-05	1.659E-05	1.511E-05	1.308E-05	1.132E-05	9.801E-06	8.093E-06
PO-215	1.040E-08	1.897E-08	2.813E-08	3.781E-08	4.793E-08	6.917E-08	1.030E-07	1.383E-07	1.746E-07	2.238E-07
PO-216	2.088E-05	2.650E-05	2.751E-05	2.693E-05	2.589E-05	2.358E-05	2.042E-05	1.767E-05	1.530E-05	1.263E-05
RN-219	1.040E-08	1.897E-08	2.813E-08	3.781E-08	4.793E-08	6.917E-08	1.030E-07	1.383E-07	1.746E-07	2.238E-07
RN-220	2.088E-05	2.650E-05	2.751E-05	2.693E-05	2.589E-05	2.358E-05	2.042E-05	1.767E-05	1.530E-05	1.263E-05
FR-223	1.434E-10	2.615E-10	3.877E-10	5.211E-10	6.603E-10	9.535E-10	1.420E-09	1.907E-09	2.407E-09	3.086E-09
RA-223	1.040E-08	1.897E-08	2.813E-08	3.781E-08	4.793E-08	6.917E-08	1.030E-07	1.383E-07	1.746E-07	2.238E-07
RA-224	2.088E-05	2.650E-05	2.751E-05	2.693E-05	2.589E-05	2.358E-05	2.042E-05	1.767E-05	1.530E-05	1.263E-05
RA-226	4.133E-12	1.597E-11	4.084E-11	8.342E-11	1.482E-10	3.618E-10	9.513E-10	1.951E-09	3.448E-09	6.346E-09
RA-228	9.586E-10	1.212E-09	1.363E-09	1.453E-09	1.507E-09	1.559E-09	1.581E-09	1.587E-09	1.589E-09	1.590E-09
AC-227	1.039E-08	1.895E-08	2.810E-08	3.776E-08	4.785E-08	6.909E-08	1.029E-07	1.382E-07	1.744E-07	2.236E-07
TH-227	1.025E-08	1.870E-08	2.775E-08	3.729E-08	4.727E-08	6.822E-08	1.016E-07	1.364E-07	1.722E-07	2.207E-07
TH-228	2.088E-05	2.648E-05	2.748E-05	2.691E-05	2.586E-05	2.357E-05	2.041E-05	1.767E-05	1.530E-05	1.263E-05
TH-229	3.004E-09	5.147E-09	7.299E-09	9.457E-09	1.162E-08	1.598E-08	2.256E-08	2.921E-08	3.593E-08	4.499E-08
TH-230	3.216E-09	8.123E-09	1.526E-08	2.455E-08	3.591E-08	6.449E-08	1.209E-07	1.921E-07	2.762E-07	4.062E-07
TH-231	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04
TH-232	1.586E-09	1.586E-09	1.586E-09	1.587E-09	1.587E-09	1.587E-09	1.588E-09	1.589E-09	1.589E-09	1.590E-09
TH-234	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05
PA-231	6.209E-08	7.470E-08	8.731E-08	9.992E-08	1.125E-07	1.377E-07	1.755E-07	2.133E-07	2.511E-07	3.014E-07
PA-233	8.056E-04	8.063E-04	8.072E-04	8.084E-04	8.097E-04	8.128E-04	8.178E-04	8.232E-04	8.286E-04	8.358E-04
PA-234M	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05
PA-234	2.381E-08	2.381E-08	2.381E-08	2.381E-08	2.381E-08	2.381E-08	2.381E-08	2.381E-08	2.381E-08	2.381E-08
U-232	2.624E-05	2.789E-05	2.744E-05	2.640E-05	2.524E-05	2.295E-05	1.987E-05	1.720E-05	1.489E-05	1.228E-05
U-233	4.538E-06	4.556E-06	4.573E-06	4.591E-06	4.608E-06	4.644E-06	4.697E-06	4.750E-06	4.804E-06	4.876E-06
U-234	8.363E-05	1.343E-04	1.830E-04	2.298E-04	2.748E-04	3.596E-04	4.750E-04	5.774E-04	6.684E-04	7.742E-04
U-235	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04	1.193E-04
U-236	9.030E-04	9.030E-04	9.030E-04	9.030E-04	9.031E-04	9.031E-04	9.031E-04	9.031E-04	9.032E-04	9.032E-04
U-237	7.017E-06	5.517E-06	4.337E-06	3.410E-06	2.681E-06	1.657E-06	8.054E-07	3.914E-07	1.902E-07	7.269E-08
U-238	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05	1.832E-05
NP-237	8.056E-04	8.063E-04	8.072E-04	8.084E-04	8.097E-04	8.128E-04	8.178E-04	8.232E-04	8.286E-04	8.358E-04

	DECAY TIMES (years out of core) (Activities* in Ci/element)									
Radionuclide	**5**	**10**	**15**	**20**	**25**	**35**	**50**	**65**	**80**	**100**
PU-236	1.067E-04	3.166E-05	9.396E-06	2.789E-06	8.285E-07	7.395E-08	2.987E-09	1.132E-09	1.084E-09	1.082E-09
PU-237	3.072E-15	2.751E-27	2.465E-39	2.208E-51	1.978E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU-238	3.647E+00	3.506E+00	3.371E+00	3.240E+00	3.115E+00	2.878E+00	2.557E+00	2.272E+00	2.018E+00	1.724E+00
PU-239	9.350E-02	9.349E-02	9.347E-02	9.346E-02	9.345E-02	9.342E-02	9.338E-02	9.334E-02	9.330E-02	9.325E-02
PU-240	7.665E-02	7.674E-02	7.680E-02	7.685E-02	7.689E-02	7.692E-02	7.690E-02	7.684E-02	7.675E-02	7.661E-02
PU-241	2.860E+01	2.249E+01	1.768E+01	1.390E+01	1.093E+01	6.756E+00	3.283E+00	1.596E+00	7.754E-01	2.963E-01
PU-242	3.320E-04	3.320E-04	3.320E-04	3.320E-04	3.320E-04	3.320E-04	3.320E-04	3.320E-04	3.320E-04	3.320E-04
PU-244	4.447E-11	4.447E-11	4.447E-11	4.447E-11	4.447E-11	4.447E-11	4.447E-11	4.447E-11	4.447E-11	4.447E-11
AM-241	3.036E-01	5.040E-01	6.595E-01	7.796E-01	8.720E-01	9.960E-01	1.086E+00	1.116E+00	1.117E+00	1.097E+00
AM-242M	1.627E-03	1.590E-03	1.554E-03	1.519E-03	1.485E-03	1.419E-03	1.325E-03	1.237E-03	1.156E-03	1.055E-03
AM-242	1.618E-03	1.582E-03	1.546E-03	1.512E-03	1.477E-03	1.412E-03	1.318E-03	1.231E-03	1.150E-03	1.050E-03
AM-243	2.061E-03	2.060E-03	2.059E-03	2.058E-03	2.057E-03	2.055E-03	2.052E-03	2.049E-03	2.046E-03	2.042E-03
CM-242	5.433E-03	1.311E-03	1.279E-03	1.251E-03	1.222E-03	1.167E-03	1.090E-03	1.018E-03	9.510E-04	8.682E-04
CM-243	2.544E-03	2.253E-03	1.995E-03	1.767E-03	1.565E-03	1.227E-03	8.523E-04	5.919E-04	4.111E-04	2.528E-04
CM-244	2.728E-01	2.253E-01	1.861E-01	1.537E-01	1.270E-01	8.661E-02	4.880E-02	2.749E-02	1.549E-02	7.209E-03
CM-245	2.599E-05	2.598E-05	2.597E-05	2.596E-05	2.595E-05	2.593E-05	2.590E-05	2.586E-05	2.583E-05	2.579E-05
CM-246	3.089E-06	3.087E-06	3.085E-06	3.083E-06	3.080E-06	3.076E-06	3.069E-06	3.062E-06	3.056E-06	3.047E-06
CM-247	7.681E-12	7.681E-12	7.681E-12	7.681E-12	7.681E-12	7.681E-12	7.681E-12	7.681E-12	7.681E-12	7.681E-12
SUBTOTAL**	1.083E+03	7.579E+02	6.237E+02	5.358E+02	4.679E+02	3.641E+02	2.544E+02	1.793E+02	1.271E+02	8.087E+01
TOTAL***	1.093E+03	7.601E+02	6.245E+02	5.363E+02	4.684E+02	3.644E+02	2.546E+02	1.795E+02	1.272E+02	8.096E+01

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Template 28

Fuel-Specific Source Term Calculations Stainless Steel-Clad TRIGA Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a generic source term for stainless steel-clad TRIGA (Training, Research, and Isotope General Atomics) spent nuclear fuel elements currently stored at the INEEL. The data sources for the analysis are documented in References 1 and 2, and the INEEL calculational methodology is described in Reference 3.

TRIGA Data

TRIGA reactors are light-water-cooled reactors designed for training, research, and isotope production. One type of fuel element used in a TRIGA reactor is a stainless steel-clad, uranium-zirconium-hydride (U-Zr-H) fuel element. The enriched uranium is homogenously mixed in the ZrH matrix. The cylindrical active fuel region in each stainless steel-clad element is approximately 1.4 in. in diameter and 15 in. in length. Figure 1 shows a typical stainless steel-clad fuel element with dimensions and materials. The data below give specific dimensions, materials, loadings, densities, enrichment, etc., for the stainless steel-clad element used in the burnup calculation for the source term generation.

Fuel Element:

Fuel Meat:	U-Zr-H	
	Zr:H ratio is 1.7	
	Density = 5.76 g/cc	
Clad:	Stainless Steel	
	Density = 7.92 g/cc	
Loading:	39.0	g/element U-235 BOL
	156.0	g/element U-238 BOL
	195.0	g/element U BOL
	2088.0	g/element ZrH in fuel meat
	8.5	weight % U in U-$ZrH_{1.7}$
	20%	enrichment U-235 BOL
	800.0	g/element stainless steel cladding (819.414 g/element with impurities)
	450.0	g/element graphite top/bottom end reflectors
	8.38	g/element molybdenum (single poison disc)

Active Fuel Length:	15 in.
Fuel Element Length:	29 in. (approximate)
Water Temperature:	77.5°F
Water Pressure:	14.7 psia

From the above data (materials, enrichments, and densities), material masses and number densities were calculated for all the material components in a single stainless steel-clad TRIGA fuel element. In addition, for the ORIGEN2 (Reference 4) depletion or burnup calculation, conservative and detailed impurity concentrations were added for the stainless steel-clad, zirconium-hydride, and graphite end reflector masses. Table 1 gives the impurity concentrations for these three materials.

Burnup

Reference 1 is a parametric study and includes radionuclide inventories or source terms for eight different burnups ranging up to 17.95%. The burnup chosen for this template is based on the 17.95% burnup of the initial U-235 or the maximum burnup used in the parametric study. This burnup is equivalent to 6.65 MWd, 34,103 MWd/MTU, and 8.08 g U-235 depleted per element and represents the upper end of typical stainless steel-clad TRIGA fuel element burnups. The assumption of maximum burnup is conservative for the buildup of fission products, activation products, and minor actinides in the source term and nonconservative with regard to criticality safety.

Cross-Section Development

An MCNP4A (Reference 5) partial core model of a MARK I TRIGA reactor core was used to generate neutron cross sections specifically for the stainless steel-clad TRIGA fuel element. The MCNP4A one-twelfth core model is shown in Figure 2. The cross sections are spectrally and spatially weighted over all the fuel elements shown in Figure 2. These cross sections are in turn used in the fuel element ORIGEN2 depletion calculation.

Parametric TRIGA Single Element Exposure History

Table 2 summarizes the single element exposure history of the stainless steel-clad TRIGA fuel element from Reference 1. The burnup period is a hypothetical 4-year continuous exposure. TRIGA fuel elements typically remain in the core for much longer periods of time relative to the assumed 4-year in-core residency. Therefore, typical fuel elements would have more time to decay away their source term; therefore, the 4-year assumption is expected to produce a conservative source term.

Burnup Calculation

The ORIGEN2 computer code was used to perform the depletion or burnup calculation for the stainless steel-clad TRIGA fuel element. The radionuclide inventory or source term template that follows is for a single stainless steel-clad TRIGA fuel element. The fuel element component masses and impurities (fuel meat, uranium, clad, burnable poison, end fixtures), neutron cross sections, burnup, and hypothetical power history and power level as discussed above are input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of decay time in the template table.

The 145 radionuclides listed in the template represent greater than 99.9% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. J. W. Sterbentz, *Radionuclide Mass Inventory, Activity, Decay Heat, and Dose Rate Parametric Data for TRIGA Spent Nuclear Fuels*, INEL-96/0482, Idaho National Engineering Laboratory, March 1997.

2. N. Tomsio, *Characterization of TRIGA Fuel*, ORNL/Sub//86-22047/3, GA-C18542, GA Technologies, October 1986.

3. J. W. Sterbentz and C. A. Wemple, "Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels", INEL-96/0304, September 1996.

4. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

5. "MCNP4A: Monte Carlo N-Particle Transport Code System," LA-12625M, contributed by Los Alamos National Laboratory, Los Alamos, New Mexico, 1994, and distributed as package CCC-200 by Oak Ridge National Laboratory.

Table 1. Material constituent and impurity concentrations for the various materials in a stainless steel-clad TRIGA fuel element.

Constituent or Impurity	Graphite Concentration (ppm)	ZrH Concentration (wt%)	Stainless Steel Concentration (ppm)
H		1.8439	
Li	0.45		0.13
Be	0.005		
B	2.5	0.00005	
C	100 wt%	0.026968	0.08 wt%
N		0.00799	525
O		0.094887	
Na	10.4		37
Mg	1		
Al	4.1	0.007491	200
Si	26	0.011986	1.00 wt%
P	1	0.009988	
S	9.4	0.003496	
Cl	3		130
K	3		3
Ca	22.5		19
Sc	0.01		0.03
Ti	16	0.004994	600
V	18.9	0.004994	690
Cr	1	0.124851	18.40 wt%
Mn	1	0.004994	1.53 wt%
Fe	11.1	0.224731	68.99 wt%
Co	4	0.001998	2570
Ni	4.6	0.006992	10.00 wt%
Cu	0.47	0.004994	8150
Zn	1	0.009988	2230
Ga			450
As			1010
Se			70
Br			8
Rb	1		10
Sr	0.47		0.2
Y			5
Zr	0.5	98.1560	20
Nb	1.74	0.006992	300
Mo	1	0.004994	5500
Ag	0.5		2

Table 1. (continued).

Constituent or Impurity	Graphite Concentration (ppm)	ZrH Concentration (wt%)	Stainless Steel Concentration (ppm)
Cd	0.5	0.000050	
In	1		
Sn	1	1.598089	
Sb	1		17
Cs	1		0.3
Ba	2.9		500
La	1.38		2.1
Ce	0.56		550
Pr	0.64		
Nd	0.36		
Sm	0.61	0.000999	0.15
Eu			0.02
Gd	0.08	0.000499	
Tb	0.26		0.71
Dy	0.16		1
Ho	0.08		1
Er	0.04		
Tm	0.04		
Yb	0.06		2
Lu	0.02		0.8
Hf	0.17	0.003496	2
Ta	0.35	0.019976	
W	25.5	0.009988	520
Tl	1		
Pb	6.9	0.009988	139
Bi	1		
Th		0.000699	1
U		0.000350	2

Table 2. Hypothetical power history for a maximum burnup stainless steel-clad TRIGA fuel element

Duration (days)	Cumulative Duration (days)	Time-Averaged Power (MWth)
365	365	0.004555
365	730	0.004555
365	1095	0.004555
365	1460	0.004555
1825	3285	0.0
1825	5110	0.0
1825	6935	0.0
1825	8760	0.0
1825	10585	0.0
3650	14235	0.0
5475	19710	0.0
5475	25185	0.0
5475	30660	0.0
7300	37960	0.0

The ten decay times following the hypothetical 4-year exposure are for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling time periods designated for the template methodology.

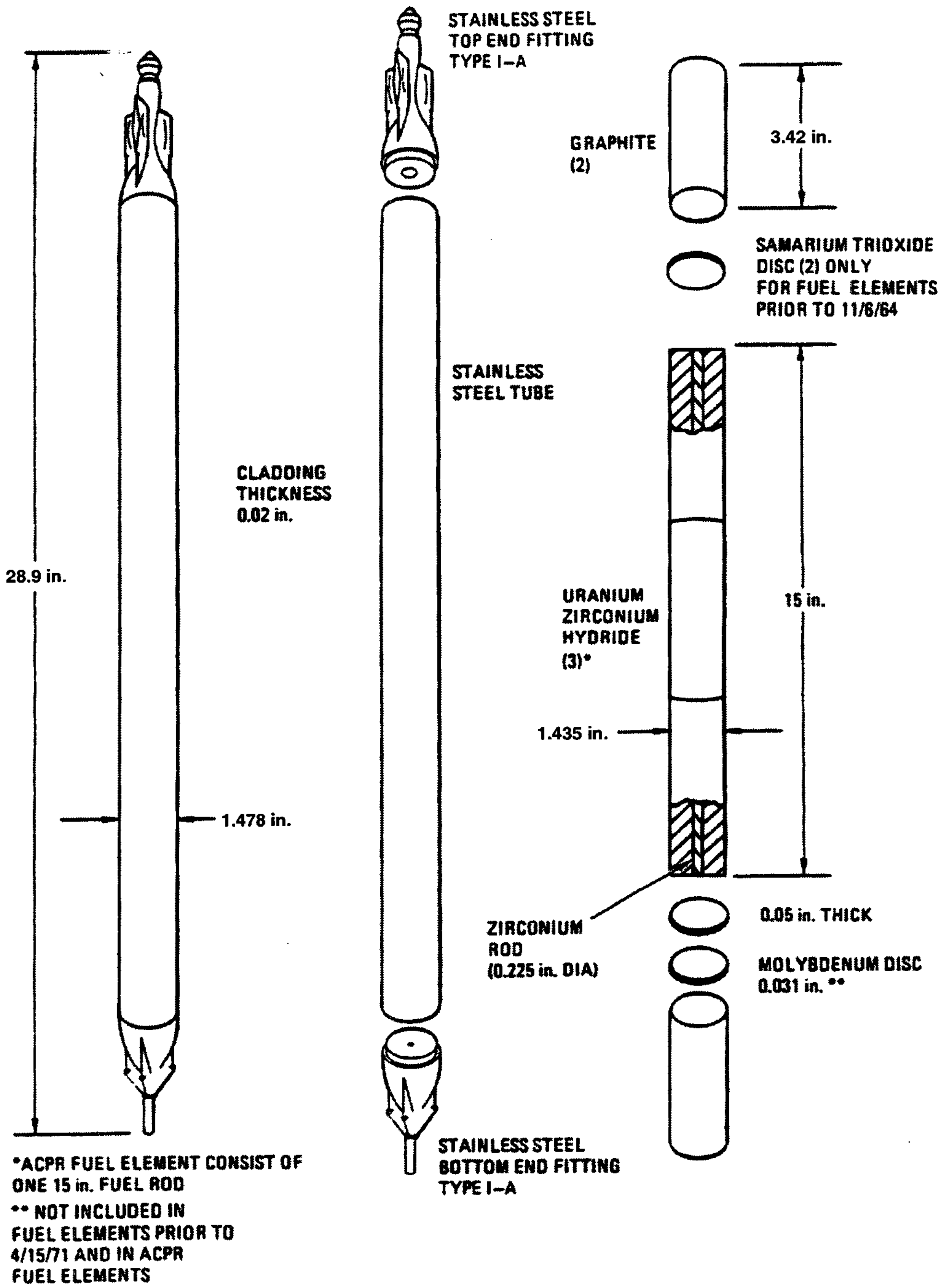

Figure 1. A typical stainless steel-clad Mark I TRIGA fuel element.

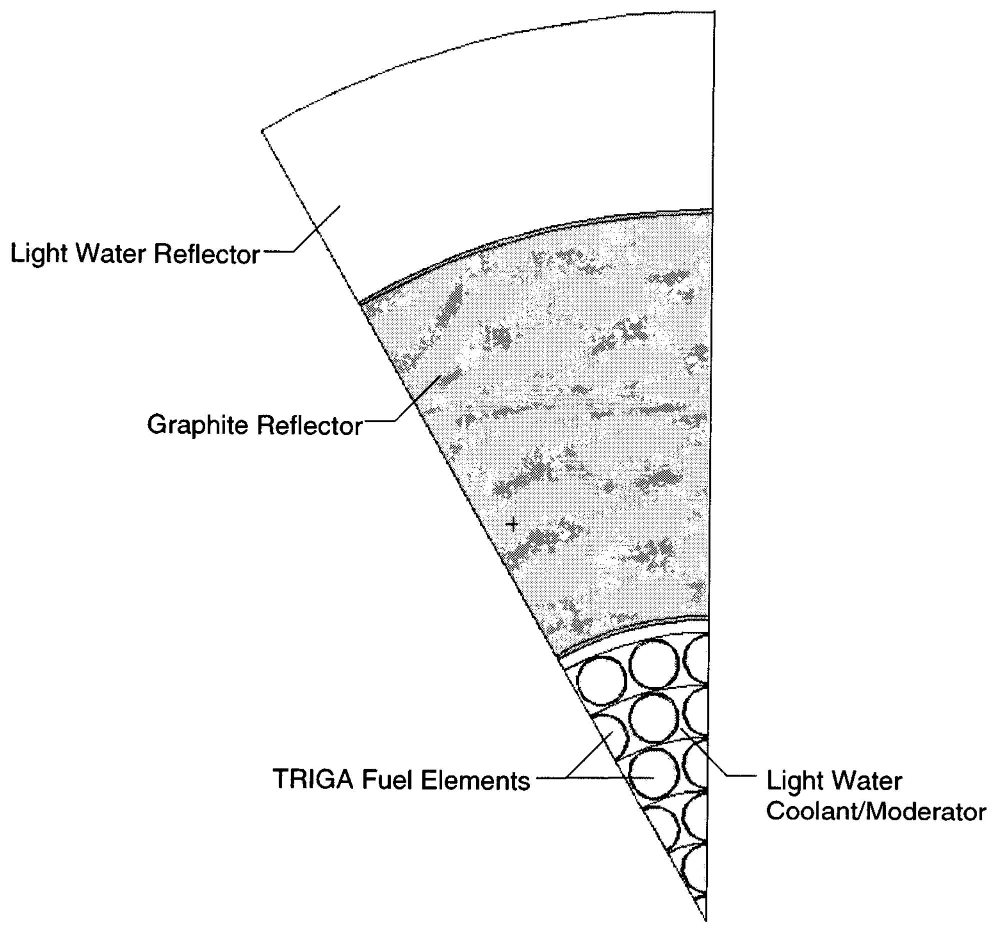

Figure 2. MCNP partial core model of a Mark I TRIGA reactor core.

TRIGA Element

Stainless Steel Cladding, 10 to 20%-Enriched U-235 Fuel

Reactor Moderator/Coolant:	Light Water
Fuel Meat:	U-Zr-$H_{1.7}$
Clad:	Stainless Steel
Burnup:	6.65 MWd/element (maximum element burnup)
Burnup:	17.95% U-235 burnup (amount fissioned)
Burnup:	8.08 g U-235 depletion (amount fissioned and transmuted)
Basis of Calculation:	Single element
BOL U-235:	39.0 grams U-235 per element (design basis)
BOL U-238:	156.0 grams U-238 per element
BOL Total U per element:	195.0 grams U per element
BOL Fuel Enrichment:	20.0 wt%

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H-3	7.389E-02	5.582E-02	4.217E-02	3.185E-02	2.406E-02	1.373E-02	5.921E-03	2.552E-03	1.100E-03	3.583E-04
BE-10	1.334E-07	1.334E-07	1.334E-07	1.334E-07	1.334E-07	1.334E-07	1.334E-07	1.334E-07	1.334E-07	1.334E-07
C-14	8.559E-04	8.554E-04	8.548E-04	8.543E-04	8.538E-04	8.528E-04	8.512E-04	8.497E-04	8.481E-04	8.461E-04
CL-36	1.870E-05	1.870E-05	1.870E-05	1.870E-05	1.870E-05	1.870E-05	1.870E-05	1.870E-05	1.870E-05	1.870E-05
CR-51	6.851E-19	1.020E-38	1.518E-58	2.260E-78	3.364E-98	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN-54	4.834E-02	8.439E-04	1.473E-05	2.572E-07	4.490E-09	1.368E-12	7.281E-18	3.874E-23	2.061E-28	1.914E-35
FE-55	5.131E+00	1.354E+00	3.574E-01	9.433E-02	2.490E-02	1.734E-03	3.189E-05	5.863E-07	1.078E-08	5.231E-11
FE-59	5.296E-13	3.277E-25	2.028E-37	1.255E-49	7.766E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO-60	8.538E+00	4.425E+00	2.293E+00	1.189E+00	6.161E-01	1.655E-01	2.304E-02	3.208E-03	4.466E-04	3.223E-05
NI-59	3.612E-03	3.612E-03	3.611E-03	3.611E-03	3.611E-03	3.611E-03	3.610E-03	3.610E-03	3.609E-03	3.609E-03
NI-63	4.280E-01	4.122E-01	3.970E-01	3.823E-01	3.682E-01	3.415E-01	3.050E-01	2.724E-01	2.433E-01	2.093E-01
ZN-65	1.938E-03	1.083E-05	6.050E-08	3.380E-10	1.889E-12	5.896E-17	1.028E-23	1.794E-30	3.129E-37	3.049E-46
SE-79	8.657E-05	8.656E-05	8.656E-05	8.655E-05	8.655E-05	8.654E-05	8.653E-05	8.651E-05	8.650E-05	8.648E-05
KR-85	1.680E+00	1.216E+00	8.802E-01	6.372E-01	4.613E-01	2.417E-01	9.171E-02	3.479E-02	1.320E-02	3.625E-03
RB-87	5.922E-09	5.922E-09	5.922E-09	5.922E-09	5.922E-09	5.922E-09	5.922E-09	5.922E-09	5.922E-09	5.922E-09
SR-89	2.308E-09	3.048E-20	4.025E-31	5.314E-42	7.016E-53	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR-90	1.732E+01	1.538E+01	1.366E+01	1.212E+01	1.077E+01	8.487E+00	5.940E+00	4.157E+00	2.910E+00	1.808E+00
Y-90	1.733E+01	1.538E+01	1.366E+01	1.213E+01	1.077E+01	8.489E+00	5.941E+00	4.159E+00	2.911E+00	1.809E+00
Y-91	8.787E-08	3.580E-17	1.458E-26	5.942E-36	2.421E-45	4.017E-64	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR-93	5.294E-04	5.294E-04	5.294E-04	5.294E-04	5.293E-04	5.293E-04	5.293E-04	5.293E-04	5.293E-04	5.292E-04
ZR-95	6.666E-07	1.727E-15	4.475E-24	1.159E-32	3.004E-41	2.017E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-93M	1.502E-04	2.295E-04	2.910E-04	3.386E-04	3.756E-04	4.263E-04	4.672E-04	4.862E-04	4.951E-04	5.001E-04

Radionuclide	DECAY TIMES (years out of core) (Activities* in Ci/element) 5	10	15	20	25	35	50	65	80	100
NB-94	5.404E-05	5.403E-05	5.402E-05	5.401E-05	5.400E-05	5.398E-05	5.395E-05	5.393E-05	5.390E-05	5.386E-05
NB-95	1.479E-06	3.834E-15	9.934E-24	2.574E-32	6.669E-41	4.477E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB-95M	4.946E-09	1.281E-17	3.319E-26	8.601E-35	2.228E-43	1.496E-60	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO-93	6.219E-05	6.213E-05	6.207E-05	6.201E-05	6.194E-05	6.182E-05	6.164E-05	6.146E-05	6.127E-05	6.103E-05
TC-99	2.942E-03	2.942E-03	2.942E-03	2.942E-03	2.942E-03	2.942E-03	2.942E-03	2.942E-03	2.942E-03	2.941E-03
RU-103	1.277E-12	1.321E-26	1.366E-40	1.413E-54	1.461E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU-106	6.097E-01	1.963E-02	6.320E-04	2.035E-05	6.552E-07	6.792E-10	2.267E-14	7.566E-19	2.525E-23	2.714E-29
RH-103M	1.152E-12	1.191E-26	1.232E-40	1.274E-54	1.317E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH-106	6.097E-01	1.963E-02	6.320E-04	2.035E-05	6.552E-07	6.792E-10	2.267E-14	7.566E-19	2.525E-23	2.714E-29
PD-107	4.165E-06	4.165E-06	4.165E-06	4.165E-06	4.165E-06	4.165E-06	4.165E-06	4.165E-06	4.165E-06	4.165E-06
AG-110	1.079E-06	6.829E-09	4.323E-11	2.737E-13	1.733E-15	6.944E-20	1.763E-26	4.471E-33	1.135E-39	1.822E-48
AG-110M	8.110E-05	5.134E-07	3.250E-09	2.057E-11	1.303E-13	5.221E-18	1.325E-24	3.362E-31	8.530E-38	1.370E-46
AG-111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-113M	2.149E-03	1.695E-03	1.337E-03	1.054E-03	8.314E-04	5.172E-04	2.537E-04	1.245E-04	6.106E-05	2.362E-05
CD-113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD-115M	3.028E-14	1.451E-26	6.958E-39	3.335E-51	1.599E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114	1.220E-14	9.789E-26	7.858E-37	6.307E-48	5.062E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-114M	1.274E-14	1.023E-25	8.211E-37	6.590E-48	5.290E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN-115M	2.126E-18	1.019E-30	4.885E-43	2.342E-55	1.123E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-119M	1.626E-02	9.310E-05	5.330E-07	3.052E-09	1.747E-11	5.730E-16	1.076E-22	2.019E-29	3.791E-36	4.075E-45
SN-121M	3.857E-04	3.598E-04	3.358E-04	3.133E-04	2.923E-04	2.545E-04	2.067E-04	1.680E-04	1.364E-04	1.034E-04
SN-123	2.044E-05	1.141E-09	6.368E-14	3.555E-18	1.984E-22	6.180E-31	1.074E-43	1.868E-56	3.248E-69	3.152E-86
SN-125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN-126	8.091E-05	8.091E-05	8.090E-05	8.090E-05	8.090E-05	8.089E-05	8.088E-05	8.088E-05	8.087E-05	8.086E-05
SB-124	3.777E-11	2.823E-20	2.110E-29	1.577E-38	1.179E-47	6.588E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB-125	5.772E-01	1.653E-01	4.735E-02	1.356E-02	3.884E-03	3.186E-04	7.483E-06	1.758E-07	4.129E-09	2.778E-11
SB-126	1.133E-05	1.133E-05	1.133E-05	1.133E-05	1.133E-05	1.132E-05	1.132E-05	1.132E-05	1.132E-05	1.132E-05
SB-126M	8.091E-05	8.091E-05	8.090E-05	8.090E-05	8.090E-05	8.089E-05	8.088E-05	8.088E-05	8.087E-05	8.086E-05
TE-123M	3.346E-09	8.588E-14	2.204E-18	5.659E-23	1.453E-27	9.574E-37	1.620E-50	2.739E-64	4.635E-78	2.013E-96
TE-125M	1.408E-01	4.033E-02	1.155E-02	3.309E-03	9.475E-04	7.772E-05	1.826E-06	4.288E-08	1.008E-09	6.778E-12
TE-127	8.388E-06	7.650E-11	6.978E-16	6.364E-21	5.805E-26	4.829E-36	3.664E-51	2.780E-66	2.109E-81	1.460-101
TE-127M	8.563E-06	7.811E-11	7.124E-16	6.498E-21	5.926E-26	4.930E-36	3.741E-51	2.838E-66	2.153E-81	1.490-101
TE-129	1.157E-16	5.160E-33	2.301E-49	1.026E-65	4.573E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE-129M	1.778E-16	7.927E-33	3.534E-49	1.576E-65	7.025E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I-129	4.900E-06	4.900E-06	4.900E-06	4.900E-06	4.900E-06	4.900E-06	4.900E-06	4.900E-06	4.900E-06	4.900E-06

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
I-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE-133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-134	6.021E-01	1.123E-01	2.093E-02	3.903E-03	7.275E-04	2.529E-05	1.638E-07	1.062E-09	6.882E-12	8.315E-15
CS-135	2.141E-04	2.141E-04	2.141E-04	2.141E-04	2.141E-04	2.141E-04	2.141E-04	2.141E-04	2.141E-04	2.141E-04
CS-136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS-137	1.833E+01	1.633E+01	1.455E+01	1.296E+01	1.155E+01	9.169E+00	6.485E+00	4.587E+00	3.244E+00	2.044E+00
BA-136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA-137M	1.734E+01	1.545E+01	1.377E+01	1.226E+01	1.093E+01	8.674E+00	6.135E+00	4.339E+00	3.069E+00	1.934E+00
BA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-141	2.771E-15	3.504E-32	4.432E-49	5.606E-66	7.090E-83	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE-142	7.084E-09	7.084E-09	7.084E-09	7.084E-09	7.084E-09	7.084E-09	7.084E-09	7.084E-09	7.084E-09	7.084E-09
CE-144	2.308E+00	2.695E-02	3.147E-04	3.675E-06	4.291E-08	5.850E-12	9.315E-18	1.483E-23	2.361E-29	4.390E-37
PR-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR-144	2.308E+00	2.695E-02	3.147E-04	3.675E-06	4.291E-08	5.851E-12	9.315E-18	1.483E-23	2.361E-29	4.390E-37
PR-144M	2.770E-02	3.234E-04	3.776E-06	4.410E-08	5.149E-10	7.021E-14	1.118E-19	1.780E-25	2.834E-31	5.268E-39
ND-144	2.861E-13	2.870E-13	2.870E-13	2.870E-13	2.870E-13	2.870E-13	2.870E-13	2.870E-13	2.870E-13	2.870E-13
ND-147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-145	8.156E-06	6.776E-06	5.574E-06	4.583E-06	3.769E-06	2.548E-06	1.417E-06	7.878E-07	4.380E-07	2.003E-07
PM-147	1.398E+01	3.735E+00	9.976E-01	2.665E-01	7.117E-02	5.077E-03	9.674E-05	1.843E-06	3.512E-08	1.788E-10
PM-148M	8.755E-14	4.354E-27	2.165E-40	1.077E-53	5.356E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM-148	4.931E-15	2.453E-28	1.220E-41	6.066E-55	3.017E-68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM-145	1.561E-06	3.782E-08	9.165E-10	2.221E-11	5.382E-13	3.160E-16	4.497E-21	6.399E-26	9.105E-31	3.140E-37
SM-147	1.801E-09	2.052E-09	2.119E-09	2.137E-09	2.142E-09	2.143E-09	2.144E-09	2.144E-09	2.144E-09	2.144E-09
SM-151	1.517E-01	1.460E-01	1.404E-01	1.352E-01	1.300E-01	1.204E-01	1.073E-01	9.560E-02	8.518E-02	7.302E-02
EU-152	9.765E-03	7.570E-03	5.869E-03	4.549E-03	3.526E-03	2.119E-03	9.871E-04	4.598E-04	2.142E-04	7.735E-05
EU-154	1.022E-01	6.828E-02	4.565E-02	3.052E-02	2.040E-02	9.118E-03	2.723E-03	8.138E-04	2.431E-04	4.856E-05
EU-155	1.948E-01	9.689E-02	4.820E-02	2.397E-02	1.192E-02	2.950E-03	3.630E-04	4.466E-05	5.496E-06	3.364E-07
EU-156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD-153	3.421E-05	1.837E-07	9.866E-10	5.298E-12	2.845E-14	8.203E-19	1.271E-25	1.967E-32	3.045E-39	2.532E-48
TB-160	4.416E-10	1.114E-17	2.809E-25	7.082E-33	1.786E-40	1.136E-55	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL-206	1.436E-12	1.436E-12	1.436E-12	1.436E-12	1.436E-12	1.436E-12	1.436E-12	1.436E-12	1.436E-12	1.436E-12
TL-207	2.810E-09	5.653E-09	9.117E-09	1.311E-08	1.756E-08	2.753E-08	4.450E-08	6.306E-08	8.260E-08	1.095E-07
TL-208	1.054E-07	1.127E-07	1.098E-07	1.052E-07	1.004E-07	9.126E-08	7.908E-08	6.853E-08	5.941E-08	4.915E-08

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
PB-210	1.703E-14	4.913E-14	1.142E-13	2.230E-13	3.857E-13	9.129E-13	2.350E-12	4.772E-12	8.392E-12	1.541E-11
PB-211	2.818E-09	5.669E-09	9.143E-09	1.315E-08	1.760E-08	2.760E-08	4.462E-08	6.324E-08	8.283E-08	1.098E-07
PB-212	2.932E-07	3.135E-07	3.056E-07	2.928E-07	2.795E-07	2.540E-07	2.201E-07	1.907E-07	1.653E-07	1.368E-07
BI-211	2.818E-09	5.669E-09	9.143E-09	1.315E-08	1.760E-08	2.760E-08	4.462E-08	6.324E-08	8.283E-08	1.098E-07
BI-212	2.932E-07	3.135E-07	3.056E-07	2.928E-07	2.795E-07	2.540E-07	2.201E-07	1.907E-07	1.653E-07	1.368E-07
PO-212	1.879E-07	2.009E-07	1.958E-07	1.876E-07	1.791E-07	1.627E-07	1.410E-07	1.222E-07	1.059E-07	8.765E-08
PO-215	2.818E-09	5.669E-09	9.143E-09	1.315E-08	1.760E-08	2.760E-08	4.462E-08	6.324E-08	8.283E-08	1.098E-07
PO-216	2.932E-07	3.135E-07	3.056E-07	2.928E-07	2.795E-07	2.540E-07	2.201E-07	1.907E-07	1.653E-07	1.368E-07
RN-219	2.818E-09	5.669E-09	9.143E-09	1.315E-08	1.760E-08	2.760E-08	4.462E-08	6.324E-08	8.283E-08	1.098E-07
RN-220	2.932E-07	3.135E-07	3.056E-07	2.928E-07	2.795E-07	2.540E-07	2.201E-07	1.907E-07	1.653E-07	1.368E-07
FR-223	3.887E-11	7.816E-11	1.260E-10	1.812E-10	2.426E-10	3.805E-10	6.152E-10	8.718E-10	1.142E-09	1.514E-09
RA-223	2.818E-09	5.669E-09	9.143E-09	1.315E-08	1.760E-08	2.760E-08	4.462E-08	6.324E-08	8.283E-08	1.098E-07
RA-224	2.932E-07	3.135E-07	3.056E-07	2.928E-07	2.795E-07	2.540E-07	2.201E-07	1.907E-07	1.653E-07	1.368E-07
RA-226	1.411E-13	3.510E-13	6.635E-13	1.087E-12	1.631E-12	3.109E-12	6.416E-12	1.119E-11	1.760E-11	2.892E-11
RA-228	1.018E-09	1.286E-09	1.445E-09	1.541E-09	1.597E-09	1.651E-09	1.675E-09	1.680E-09	1.681E-09	1.681E-09
AC-227	2.817E-09	5.664E-09	9.131E-09	1.313E-08	1.758E-08	2.757E-08	4.458E-08	6.317E-08	8.274E-08	1.097E-07
TH-227	2.779E-09	5.591E-09	9.017E-09	1.297E-08	1.736E-08	2.722E-08	4.401E-08	6.236E-08	8.169E-08	1.083E-07
TH-228	2.931E-07	3.133E-07	3.053E-07	2.925E-07	2.793E-07	2.539E-07	2.201E-07	1.907E-07	1.653E-07	1.368E-07
TH-229	5.293E-10	9.119E-10	1.294E-09	1.677E-09	2.059E-09	2.823E-09	3.969E-09	5.114E-09	6.258E-09	7.781E-09
TH-230	7.486E-11	1.203E-10	1.700E-10	2.238E-10	2.816E-10	4.083E-10	6.243E-10	8.684E-10	1.137E-09	1.530E-09
TH-231	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.687E-05	6.687E-05
TH-232	1.681E-09	1.681E-09	1.681E-09	1.681E-09	1.681E-09	1.681E-09	1.681E-09	1.681E-09	1.681E-09	1.682E-09
TH-234	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05
PA-231	1.854E-08	2.561E-08	3.268E-08	3.975E-08	4.682E-08	6.095E-08	8.214E-08	1.033E-07	1.245E-07	1.527E-07
PA-233	8.248E-06	8.264E-06	8.287E-06	8.315E-06	8.347E-06	8.420E-06	8.541E-06	8.670E-06	8.799E-06	8.971E-06
PA-234M	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05
PA-234	6.785E-08	6.785E-08	6.785E-08	6.785E-08	6.785E-08	6.785E-08	6.785E-08	6.785E-08	6.785E-08	6.785E-08
U-232	3.241E-07	3.113E-07	2.974E-07	2.836E-07	2.704E-07	2.456E-07	2.126E-07	1.840E-07	1.593E-07	1.314E-07
U-233	8.114E-07	8.115E-07	8.117E-07	8.119E-07	8.120E-07	8.124E-07	8.129E-07	8.134E-07	8.139E-07	8.146E-07
U-234	9.621E-07	1.059E-06	1.152E-06	1.241E-06	1.327E-06	1.489E-06	1.710E-06	1.906E-06	2.080E-06	2.284E-06
U-235	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.686E-05	6.687E-05	6.687E-05
U-236	8.440E-05	8.441E-05	8.441E-05	8.441E-05	8.441E-05	8.442E-05	8.442E-05	8.443E-05	8.443E-05	8.444E-05
U-237	1.663E-07	1.308E-07	1.028E-07	8.083E-08	6.355E-08	3.928E-08	1.909E-08	9.278E-09	4.509E-09	1.723E-09
U-238	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05	5.219E-05
NP-237	8.248E-06	8.264E-06	8.287E-06	8.315E-06	8.347E-06	8.420E-06	8.541E-06	8.670E-06	8.799E-06	8.971E-06

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
PU-236	9.008E-08	2.673E-08	7.935E-09	2.356E-09	7.002E-10	6.302E-11	3.091E-12	1.524E-12	1.483E-12	1.482E-12
PU-237	9.582E-19	8.583E-31	7.689E-43	6.887E-55	6.170E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU-238	6.905E-03	6.638E-03	6.382E-03	6.135E-03	5.898E-03	5.451E-03	4.843E-03	4.303E-03	3.823E-03	3.265E-03
PU-239	3.677E-02	3.677E-02	3.676E-02	3.676E-02	3.675E-02	3.674E-02	3.672E-02	3.671E-02	3.669E-02	3.667E-02
PU-240	1.415E-02	1.414E-02	1.413E-02	1.413E-02	1.412E-02	1.410E-02	1.408E-02	1.406E-02	1.404E-02	1.401E-02
PU-241	6.780E-01	5.331E-01	4.191E-01	3.295E-01	2.591E-01	1.601E-01	7.782E-02	3.782E-02	1.838E-02	7.023E-03
PU-242	1.538E-06	1.538E-06	1.538E-06	1.538E-06	1.538E-06	1.538E-06	1.538E-06	1.538E-06	1.538E-06	1.538E-06
PU-244	2.551E-15	2.551E-15	2.551E-15	2.551E-15	2.551E-15	2.551E-15	2.551E-15	2.551E-15	2.551E-15	2.551E-15
AM-241	7.438E-03	1.219E-02	1.587E-02	1.872E-02	2.090E-02	2.384E-02	2.598E-02	2.668E-02	2.668E-02	2.621E-02
AM-242M	9.396E-06	9.185E-06	8.978E-06	8.775E-06	8.578E-06	8.196E-06	7.654E-06	7.148E-06	6.676E-06	6.095E-06
AM-242	9.349E-06	9.139E-06	8.933E-06	8.732E-06	8.535E-06	8.155E-06	7.616E-06	7.113E-06	6.643E-06	6.064E-06
AM-243	9.825E-07	9.820E-07	9.816E-07	9.811E-07	9.807E-07	9.797E-07	9.784E-07	9.770E-07	9.756E-07	9.738E-07
CM-242	2.435E-05	7.568E-06	7.391E-06	7.224E-06	7.062E-06	6.744E-06	6.298E-06	5.882E-06	5.494E-06	5.015E-06
CM-243	1.193E-06	1.057E-06	9.360E-07	8.289E-07	7.340E-07	5.756E-07	3.998E-07	2.777E-07	1.928E-07	1.186E-07
CM-244	1.128E-05	9.315E-06	7.694E-06	6.355E-06	5.248E-06	3.580E-06	2.017E-06	1.137E-06	6.404E-07	2.980E-07
CM-245	1.101E-10	1.101E-10	1.100E-10	1.100E-10	1.099E-10	1.098E-10	1.097E-10	1.096E-10	1.094E-10	1.093E-10
CM-246	3.142E-12	3.140E-12	3.138E-12	3.135E-12	3.133E-12	3.129E-12	3.122E-12	3.115E-12	3.108E-12	3.099E-12
CM-247	6.602E-19	6.602E-19	6.602E-19	6.602E-19	6.602E-19	6.602E-19	6.602E-19	6.602E-19	6.602E-19	6.602E-19
SUBTOTAL**	1.086E+02	7.508E+01	6.143E+01	5.270E+01	4.610E+01	3.597E+01	2.521E+01	1.778E+01	1.259E+01	7.978E+00
TOTAL***	1.086E+02	7.509E+01	6.143E+01	5.271E+01	4.610E+01	3.597E+01	2.521E+01	1.778E+01	1.259E+01	7.979E+00

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Fuel-Specific Source Term Calculations
Hypothetical Fuel

Introduction

The following data have been used in the Idaho National Engineering and Environmental Laboratory (INEEL) spent nuclear fuel source term calculational methodology to generate a source term template for a single hypothetical spent nuclear fuel element. This single-element source term is intended to be a bounding source term for spent nuclear fuel elements with no specific fuel category and those fuels currently without a developed template. This fuel is a hypothetical construction of reactor materials and heavy metal constituents designed specifically with the intention of maximizing activation products, actinides, and fission products. A description of the construction data is given below, and the INEEL calculational methodology is described in Reference 1.

Hypothetical Fuel Data

The hypothetical fuel was chosen to be a ternary oxide fuel composed of urania (UO_2), plutonia (PuO_2), and thoria (ThO_2). The urania, plutonia, and thoria oxide volume percentages are 40%, 40%, and 20%, respectively. The uranium metal is assumed to be 50% enriched in U-235, the plutonium metal is reactor grade, and the thorium is 100% Th-232. This heavy metal oxide composition was designed specifically to maximize higher order actinide concentrations in the spent fuel.

The fuel pellet and inner clad are based on the dimensions of a Pressurized Water Reactor (PWR) Westinghouse 17 × 17 fuel assembly fuel rod. The ternary fuel rod here is assumed to have an inner and an outer clad. The inner clad is assumed to be stainless steel 304, and the outer clad is assumed to be Inconel X-750. The dual clads are intended to maximize the structural material mass and, therefore, the activation products. The dimensions for the fuel pellet and clads are given below.

In order to further increase the concentration and spectrum of activation products, cylindrical graphite reflectors are assumed to be located at the top and bottom of the active fuel.

Although the dimensions of the fuel element are similar to a PWR element, the neutron cross sections selected for the burnup calculation are based on a high-temperature graphite reactor in order to maximize the production of activation and transmutation products. Of course, a high-temperature reactor would not have metallic clad fuel rods. So again, it should be remembered that this fuel and reactor are strictly hypothetical.

The fuel element described above is a hypothetical construct intended to produce a maximum or bounding source term. The following data provide the specific fuel element dimensions, materials, densities, enrichment, etc., of the hypothetical fuel element described above.

Fuel Element:	Cylindrical rod
Length:	144.0 in.
Fuel Pellet:	Oxide Ceramic UO_2-PuO_2-ThO_2 matrix
Fuel Pellet Radius:	0.4095 cm

Uranium Enrichment:	4.0	wt % U-234
	50.0	wt % U-235
	6.0	wt % U-236
	40.0	wt % U-238
Plutonium Enrichment:	1.8	wt % Pu-238
	60.0	wt % Pu-239
	20.9	wt % Pu-240
	11.9	wt % Pu-241
	5.4	wt % Pu-242
Thorium Enrichment:	100.0	wt % Th-232
Heavy Metal Loading:	29.7592	g/element U-234 (BOL)
	371.9897	g/element U-235 (BOL)
	44.6388	g/element U-236 (BOL)
	297.5918	g/element U-238 (BOL)
	743.9795	g/element TOTAL U (BOL)
	14.0261	g/element Pu-238 (BOL)
	467.5381	g/element Pu-239 (BOL)
	162.8591	g/element Pu-240 (BOL)
	92.7284	g/element Pu-241 (BOL)
	42.0784	g/element Pu-242 (BOL)
	779.2301	g/element TOTAL Pu (BOL)
	345.4439	g/element Th-232 (BOL)
	1,868.6536	g/element total heavy metal (BOL)
	1.86865E-3	Total MTIHM/element (BOL)

Inner Clad Material:	Stainless Steel 304
Inner Clad Density:	8.02 g/cc
Inner Clad Mass:	486.03 g
Inner Clad Radius:	0.4695 cm
Outer Clad Material:	Inconel X-750
Outer Clad Density:	8.3 g/cc
Outer Clad Mass:	571.66 g
Outer Clad Radius:	0.5295 cm
End Reflector Material:	H451 Graphite
End Reflector Mass:	450.0 g

From the above data (materials, enrichments, and densities), material masses were calculated for all the material components in a single hypothetical fuel element. In addition, for the ORIGEN2 (Reference 2) depletion calculation, conservative and detailed impurity concentrations were added for UO_2-PuO_2-ThO_2, stainless steel 304, Inconel X-750, and H-451 fuel element materials. Impurities for the UO_2-PuO_2-ThO_2 fuel composition are based on the available UO_2 uranium metal impurities, and it is assumed to be the same for the plutonium and thorium metal as well. Table 1 lists the impurities and their concentrations for the mentioned materials.

Burnup

The burnup chosen for this template is 62.5 MWd or 33,447 MWd/MTIHM for a single hypothetical fuel element.

Cross-Section Development

The neutron cross sections used in the fuel burnup calculation and the source term generation are based on a standard High Temperature Gas Reactor (HTGR) cross-section library. This library comes with the ORIGEN2 computer code package. The selection of the HTGR cross section was based on a parametric study involving several cross-section libraries representing different reactor types (energy spectral characteristics). Included in the study were libraries for a fast reactor, heavy water reactor (CANDU), breeder water reactor, pressurized water reactor, Advanced Water Reactor, and the HTGR. The HTGR neutron cross sections produced the highest concentrations of higher-order actinides (plutonium, americium, and curium). Because of the hypothetical nature of the reactor, no attempt was made to update the HTGR cross sections as a function of burnup.

Single Element Exposure History

Table 2 summarizes the assumed 3-year constant power or exposure history used in the burnup or source term calculations for the single fuel element. Following the burnup or exposure period, the radionuclide activities are decayed for 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100 years.

Burnup Calculation

The ORIGEN2 computer code was used to perform the depletion or burnup calculation for a single fuel element. The fuel element masses and impurities (uranium, plutonium, thorium, steel, inconel, and graphite), neutron cross sections, burnup, power history, and power level as discussed above are input data for the ORIGEN2 calculation. The radionuclide concentrations are given as a function of time in the template table.

The 145 radionuclides listed in the template represent greater than 99.8% of the total curie inventory had all 684 activation products, 880 fission products, and 127 actinide/daughter isotopes from the ORIGEN2 output been included in the template.

References

1. J. W. Sterbentz and C. A. Wemple, *Calculational Burnup Methodology and Validation for the Idaho National Engineering Laboratory Spent Nuclear Fuels*, INEL-96/0304, September 1996.

2. A. G. Croff, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, July 1980.

Table 1. Hypothetical fuel element material impurity concentrations.

Constituent or Impurity	Uranium Metal Concentration (ppm)	Stainless Steel 304 Concentration (wt%)	Inconel X-750 Concentration (ppm)	Graphite Concentration (ppm)
H		0.0007		
Li	1	0.13 ppm		0.45
Be				0.005
B	1	0.0005		2.5
C	89.4	0.07	800	100 wt%
N	25	0.047	400	
O		0.015		
F	10.7			
Na	15	37 ppm		10.4
Mg	2			1
Al	16.7	0.01	10000	4.1
Si	12.1	0.6	5000	26
P	35	0.0375	400	1
S		0.02	100	9.4
Cl	5.3	130 ppm		3
K		3 ppm		3
Ca	2	19 ppm		22.5
Sc		0.03 ppm		0.01
Ti	1	0.05	27500	16
V	3	0.05		18.9
Cr	4	18.8	170000	1
Mn	1.7	1.41	10000	1
Fe	18	68.8	90000	11.1
Co	1	0.17	10000	4
Ni	24	9.23	651400	4.6
Cu	1	0.25	5000	0.47
Zn	40.3	0.01		1
Ga		450 ppm		
As		0.01		
Se		0.02		
Br		8 ppm		
Rb		10 ppm		1
Sr		0.2 ppm		0.47
Y		5 ppm		
Zr		20 ppm		0.5
Nb		0.012	9500	1.74
Mo	10	0.37	400	1

Table 1. (continued).

Constituent or Impurity	Uranium Metal Concentration (ppm)	Stainless Steel 304 Concentration (wt%)	Inconel X-750 Concentration (ppm)	Graphite Concentration (ppm)
Ag	0.1	2 ppm		0.5
Cd	25			0.5
In	2			1
Sn	4	0.01		1
Sb		0.01		1
Cs		0.3 ppm		1
Ba		500 ppm		2.9
La		2.1 ppm		1.38
Ce		550 ppm		0.56
Pr				0.64
Nd				0.36
Sm		0.15 ppm		0.61
Eu		0.02 ppm		
Gd				0.08
Tb		0.71 ppm		0.26
Dy		1 ppm		0.16
Ho		1 ppm		0.08
Er				0.04
Tm				0.04
Yb		2 ppm		0.06
Lu		0.8 ppm		0.02
Hf		2 ppm		0.17
Ta			9500	0.35
W	2	520 ppm		25.5
Tl				1
Pb	1	0.002		6.9
Bi	0.4			1
Th		1 ppm		
U		2 ppm		

Table 2. Hypothetical fuel power history for a 62.5 MWd burnup.

Duration (days)	Cumulative Duration (days)	Time-Averaged Power (MWth)
365.25	365.25	0.05704
365.25	730.50	0.05704
365.25	1095.75	0.05704
1826.25	2922.00	0.0
1826.25	4748.25	0.0
1826.25	6574.50	0.0
1826.25	8400.75	0.0
1826.25	10227.00	0.0
3652.50	13879.50	0.0
5478.75	19358.25	0.0
5478.75	24837.00	0.0
5478.75	30315.75	0.0
7305.00	37620.75	0.0

The ten dates with zero associated power represent the ten different cooling or decay dates after exposure. These ten dates are specifically the 5, 10, 15, 20, 25, 35, 50, 65, 80, and 100-year cooling times designated for the template methodology.

Hypothetical Fuel Element

Stainless Steel/Inconel Cladding, Uranium-Plutonium-Thorium Oxide Fuel

Fuel Meat:	Oxide ceramic UO_2-PuO_2-ThO_2 matrix
Inner Clad:	Stainless Steel 304
Outer Clad	Inconel X-750
Burnup:	62.5 MWd/element (maximum element burnup)
Basis of Calculation:	Single element (single rod)
BOL U-235:	371.9897 grams U-235 per element
BOL U-238:	297.5918 grams U-238 per element
BOL U-234:	29.7592 grams U-234 per element
BOL U-236:	44.6388 grams U-236 per element
BOL Total U:	743.9795 grams U per element
BOL Pu-238:	14.0261 grams Pu-238 per element
BOL Pu-239:	467.5381 grams Pu-239 per element
BOL Pu-240:	162.8591 grams Pu-240 per element
BOL Pu-241:	92.7284 grams Pu-241 per element
BOL Pu-242:	42.0784 grams Pu-242 per element
BOL Total Pu:	779.2301 grams Pu per element
BOL Th-232:	345.4439 grams th-232 per element
BOL U-235 Fuel Enrichment:	50 wt%
BOL Pu-239 Fuel Enrichment:	60 wt%

DECAY TIMES (years out of core)

(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
H 3	9.328E-01	7.046E-01	5.322E-01	4.019E-01	3.036E-01	1.732E-01	7.461E-02	3.215E-02	1.385E-02	4.507E-03
BE 10	1.775E-07	1.775E-07	1.775E-07	1.775E-07	1.775E-07	1.775E-07	1.775E-07	1.775E-07	1.775E-07	1.775E-07
C 14	9.719E-04	9.713E-04	9.708E-04	9.702E-04	9.696E-04	9.684E-04	9.667E-04	9.649E-04	9.632E-04	9.608E-04
CL 36	1.711E-05	1.711E-05	1.711E-05	1.711E-05	1.711E-05	1.711E-05	1.711E-05	1.711E-05	1.710E-05	1.710E-05
CR 51	1.334E-18	1.924E-38	2.776E-58	4.005E-78	5.778E-98	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN 54	5.235E-02	9.115E-04	1.587E-05	2.762E-07	4.809E-09	1.458E-12	7.691E-18	4.058E-23	2.141E-28	1.967E-35
FE 55	5.403E+00	1.425E+00	3.757E-01	9.906E-02	2.612E-02	1.816E-03	3.330E-05	6.106E-07	1.120E-08	5.413E-11
FE 59	5.842E-13	3.546E-25	2.153E-37	1.307E-49	7.932E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 60	3.631E+01	1.881E+01	9.746E+00	5.049E+00	2.616E+00	7.020E-01	9.760E-02	1.357E-02	1.887E-03	1.359E-04
NI 59	2.430E-02	2.430E-02	2.430E-02	2.429E-02	2.429E-02	2.429E-02	2.429E-02	2.428E-02	2.428E-02	2.428E-02
NI 63	2.893E+00	2.786E+00	2.683E+00	2.584E+00	2.488E+00	2.308E+00	2.061E+00	1.841E+00	1.644E+00	1.414E+00
ZN 65	1.943E-04	1.082E-06	6.022E-09	3.353E-11	1.866E-13	5.785E-18	9.984E-25	1.723E-31	2.974E-38	2.857E-47
SE 79	6.428E-04	6.428E-04	6.427E-04	6.427E-04	6.427E-04	6.426E-04	6.425E-04	6.424E-04	6.423E-04	6.421E-04
KR 85	9.283E+00	6.718E+00	4.863E+00	3.519E+00	2.547E+00	1.334E+00	5.059E-01	1.918E-01	7.271E-02	1.995E-02
RB 87	2.847E-08	2.847E-08	2.847E-08	2.847E-08	2.847E-08	2.847E-08	2.847E-08	2.847E-08	2.847E-08	2.847E-08

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
SR 89	1.455E-08	1.889E-19	2.452E-30	3.182E-41	4.130E-52	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	8.478E+01	7.527E+01	6.683E+01	5.933E+01	5.267E+01	4.151E+01	2.905E+01	2.033E+01	1.422E+01	8.837E+00
Y 90	8.481E+01	7.529E+01	6.684E+01	5.934E+01	5.268E+01	4.153E+01	2.906E+01	2.033E+01	1.423E+01	8.839E+00
Y 91	6.036E-07	2.423E-16	9.726E-26	3.904E-35	1.567E-44	2.525E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	2.791E-03	2.791E-03	2.791E-03	2.791E-03	2.791E-03	2.791E-03	2.791E-03	2.791E-03	2.791E-03	2.791E-03
ZR 95	6.008E-06	1.536E-14	3.925E-23	1.003E-31	2.564E-40	1.676E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 93M	7.534E-04	1.180E-03	1.511E-03	1.768E-03	1.967E-03	2.240E-03	2.460E-03	2.562E-03	2.610E-03	2.637E-03
NB 94	9.911E-04	9.909E-04	9.907E-04	9.906E-04	9.904E-04	9.901E-04	9.896E-04	9.891E-04	9.885E-04	9.879E-04
NB 95	1.334E-05	3.409E-14	8.714E-23	2.227E-31	5.693E-40	3.720E-57	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 95M	4.457E-08	1.139E-16	2.912E-25	7.443E-34	1.902E-42	1.243E-59	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 93	1.282E-05	1.280E-05	1.279E-05	1.278E-05	1.277E-05	1.274E-05	1.270E-05	1.267E-05	1.263E-05	1.258E-05
TC 99	2.705E-02	2.705E-02	2.705E-02	2.705E-02	2.705E-02	2.705E-02	2.705E-02	2.705E-02	2.704E-02	2.704E-02
RU103	2.683E-11	2.714E-25	2.746E-39	2.778E-53	2.810E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	4.723E+01	1.517E+00	4.873E-02	1.565E-03	5.028E-05	5.188E-08	1.719E-12	5.698E-17	1.888E-21	2.010E-27
RH103M	2.419E-11	2.447E-25	2.475E-39	2.504E-53	2.533E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH106	4.723E+01	1.517E+00	4.873E-02	1.565E-03	5.028E-05	5.188E-08	1.719E-12	5.698E-17	1.888E-21	2.010E-27
PD107	4.142E-04	4.142E-04	4.142E-04	4.142E-04	4.142E-04	4.142E-04	4.142E-04	4.142E-04	4.142E-04	4.142E-04
AG110	2.636E-04	1.662E-06	1.049E-08	6.618E-11	4.175E-13	1.661E-17	4.173E-24	1.048E-30	2.632E-37	4.169E-46
AG110M	1.982E-02	1.250E-04	7.886E-07	4.975E-09	3.139E-11	1.250E-15	3.138E-22	7.878E-29	1.979E-35	3.135E-44
AG111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	7.053E-02	5.562E-02	4.386E-02	3.458E-02	2.727E-02	1.696E-02	8.315E-03	4.077E-03	1.999E-03	7.730E-04
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115M	8.304E-13	3.904E-25	1.836E-37	8.629E-50	4.057E-62	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	2.717E-14	2.144E-25	1.691E-36	1.333E-47	1.052E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114M	2.839E-14	2.240E-25	1.766E-36	1.393E-47	1.099E-58	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN115M	5.824E-17	2.738E-29	1.287E-41	6.052E-54	2.845E-66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	1.236E-03	7.054E-06	4.024E-08	2.297E-10	1.310E-12	4.265E-17	7.922E-24	1.472E-30	2.734E-37	2.897E-46
SN121M	4.948E-04	4.617E-04	4.307E-04	4.019E-04	3.749E-04	3.263E-04	2.650E-04	2.153E-04	1.748E-04	1.325E-04
SN123	2.207E-04	1.224E-08	6.784E-13	3.761E-17	2.085E-21	6.409E-30	1.092E-42	1.861E-55	3.171E-68	2.995E-85
SN125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.393E-03	1.393E-03
SB124	4.256E-10	3.135E-19	2.310E-28	1.702E-37	1.254E-46	6.808E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	6.364E+00	1.821E+00	5.211E-01	1.491E-01	4.266E-02	3.493E-03	8.187E-05	1.918E-06	4.494E-08	3.013E-10
SB126	1.952E-04	1.952E-04	1.952E-04	1.952E-04	1.951E-04	1.951E-04	1.951E-04	1.951E-04	1.951E-04	1.950E-04
SB126M	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.394E-03	1.393E-03	1.393E-03

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
TE123M	2.881E-08	7.341E-13	1.871E-17	4.768E-22	1.215E-26	7.893E-36	1.306E-49	2.162E-63	3.580E-77	1.511E-95
TE125M	1.553E+00	4.443E-01	1.271E-01	3.638E-02	1.041E-02	8.525E-04	1.997E-05	4.680E-07	1.096E-08	7.353E-11
TE127	2.084E-04	1.886E-09	1.706E-14	1.544E-19	1.397E-24	1.144E-34	8.474E-50	6.278E-65	4.651E-80	0.000E+00
TE127M	2.128E-04	1.925E-09	1.742E-14	1.576E-19	1.426E-24	1.168E-34	8.652E-50	6.410E-65	4.749E-80	0.000E+00
TE129	2.111E-15	9.172E-32	3.985E-48	1.732E-64	7.524E-81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129M	3.243E-15	1.409E-31	6.122E-48	2.660E-64	1.156E-80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I129	6.993E-05	6.993E-05	6.993E-05	6.993E-05	6.993E-05	6.993E-05	6.993E-05	6.993E-05	6.993E-05	6.993E-05
I131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	9.325E+00	1.736E+00	3.234E-01	6.023E-02	1.121E-02	3.889E-04	2.512E-06	1.622E-08	1.047E-10	1.260E-13
CS135	2.882E-03	2.882E-03	2.882E-03	2.882E-03	2.882E-03	2.882E-03	2.882E-03	2.882E-03	2.882E-03	2.882E-03
CS136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	1.771E+02	1.578E+02	1.405E+02	1.252E+02	1.115E+02	8.854E+01	6.260E+01	4.427E+01	3.130E+01	1.972E+01
BA136M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	1.675E+02	1.492E+02	1.330E+02	1.184E+02	1.055E+02	8.376E+01	5.922E+01	4.188E+01	2.961E+01	1.865E+01
BA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	3.077E-14	3.790E-31	4.667E-48	5.748E-65	7.078E-82	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	4.827E-08	4.827E-08	4.827E-08	4.827E-08	4.827E-08	4.827E-08	4.827E-08	4.827E-08	4.827E-08	4.827E-08
CE144	2.163E+01	2.517E-01	2.931E-03	3.412E-05	3.972E-07	5.383E-11	8.492E-17	1.340E-22	2.114E-28	3.882E-36
PR143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR144	2.163E+01	2.518E-01	2.931E-03	3.412E-05	3.972E-07	5.383E-11	8.492E-17	1.340E-22	2.114E-28	3.882E-36
PR144M	2.595E-01	3.021E-03	3.517E-05	4.094E-07	4.766E-09	6.459E-13	1.019E-18	1.608E-24	2.536E-30	4.658E-38
ND144	1.998E-12	2.006E-12	2.006E-12	2.006E-12	2.006E-12	2.006E-12	2.006E-12	2.006E-12	2.006E-12	2.006E-12
ND147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM145	1.748E-07	1.455E-07	1.196E-07	9.837E-08	8.088E-08	5.467E-08	3.039E-08	1.689E-08	9.386E-09	4.289E-09
PM147	1.324E+02	3.533E+01	9.428E+00	2.516E+00	6.714E-01	4.781E-02	9.085E-04	1.726E-05	3.281E-07	1.664E-09
PM148M	2.514E-12	1.224E-25	5.962E-39	2.903E-52	1.414E-65	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	1.416E-13	6.895E-27	3.358E-40	1.635E-53	7.964E-67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	3.949E-08	9.545E-10	2.307E-11	5.576E-13	1.348E-14	7.874E-18	1.112E-22	1.570E-27	2.217E-32	7.568E-39
SM147	1.418E-08	1.656E-08	1.719E-08	1.736E-08	1.741E-08	1.742E-08	1.742E-08	1.742E-08	1.742E-08	1.742E-08
SM151	5.445E+00	5.239E+00	5.042E+00	4.851E+00	4.668E+00	4.322E+00	3.850E+00	3.430E+00	3.056E+00	2.620E+00
EU152	7.184E-02	5.568E-02	4.315E-02	3.345E-02	2.593E-02	1.557E-02	7.250E-03	3.375E-03	1.571E-03	5.671E-04
EU154	2.401E+00	1.604E+00	1.072E+00	7.166E-01	4.789E-01	2.140E-01	6.386E-02	1.907E-02	5.691E-03	1.135E-03

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
EU155	1.047E+01	5.206E+00	2.588E+00	1.287E+00	6.397E-01	1.581E-01	1.943E-02	2.388E-03	2.934E-04	1.792E-05
EU156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	1.962E-04	1.050E-06	5.619E-09	3.006E-11	1.609E-13	4.605E-18	7.055E-25	1.081E-31	1.656E-38	1.357E-47
TB160	1.330E-08	3.314E-16	8.258E-24	2.057E-31	5.127E-39	3.184E-54	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	4.953E-12	4.953E-12	4.953E-12	4.953E-12	4.953E-12	4.953E-12	4.953E-12	4.953E-12	4.953E-12	4.953E-12
TL207	3.320E-05	5.457E-05	7.281E-05	8.838E-05	1.017E-04	1.226E-04	1.439E-04	1.572E-04	1.656E-04	1.720E-04
TL208	1.981E-03	2.113E-03	2.053E-03	1.964E-03	1.874E-03	1.703E-03	1.476E-03	1.279E-03	1.109E-03	9.179E-04
PB210	1.948E-09	7.501E-09	1.886E-08	3.774E-08	6.563E-08	1.536E-07	3.815E-07	7.438E-07	1.256E-06	2.192E-06
PB211	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
PB212	5.512E-03	5.882E-03	5.714E-03	5.467E-03	5.216E-03	4.739E-03	4.107E-03	3.560E-03	3.087E-03	2.555E-03
BI211	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
BI212	5.512E-03	5.882E-03	5.714E-03	5.467E-03	5.216E-03	4.739E-03	4.107E-03	3.560E-03	3.087E-03	2.555E-03
PO212	3.532E-03	3.769E-03	3.661E-03	3.503E-03	3.342E-03	3.037E-03	2.632E-03	2.281E-03	1.978E-03	1.637E-03
PO215	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
PO216	5.512E-03	5.882E-03	5.714E-03	5.467E-03	5.216E-03	4.739E-03	4.107E-03	3.560E-03	3.087E-03	2.555E-03
RN219	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
RN220	5.512E-03	5.882E-03	5.714E-03	5.467E-03	5.216E-03	4.739E-03	4.107E-03	3.560E-03	3.087E-03	2.555E-03
FR223	4.592E-07	7.543E-07	1.006E-06	1.221E-06	1.404E-06	1.695E-06	1.989E-06	2.173E-06	2.288E-06	2.378E-06
RA223	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
RA224	5.512E-03	5.882E-03	5.714E-03	5.467E-03	5.216E-03	4.739E-03	4.107E-03	3.560E-03	3.087E-03	2.555E-03
RA226	2.309E-08	6.006E-08	1.146E-07	1.869E-07	2.773E-07	5.133E-07	1.009E-06	1.678E-06	2.527E-06	3.943E-06
RA228	2.118E-05	2.782E-05	3.178E-05	3.414E-05	3.555E-05	3.689E-05	3.747E-05	3.760E-05	3.762E-05	3.763E-05
AC227	3.327E-05	5.466E-05	7.291E-05	8.848E-05	1.018E-04	1.228E-04	1.442E-04	1.575E-04	1.658E-04	1.723E-04
TH227	3.283E-05	5.397E-05	7.201E-05	8.741E-05	1.005E-04	1.213E-04	1.423E-04	1.555E-04	1.637E-04	1.701E-04
TH228	5.511E-03	5.877E-03	5.709E-03	5.462E-03	5.211E-03	4.739E-03	4.107E-03	3.560E-03	3.086E-03	2.555E-03
TH229	1.363E-05	2.428E-05	3.493E-05	4.558E-05	5.622E-05	7.749E-05	1.093E-04	1.412E-04	1.729E-04	2.152E-04
TH230	1.308E-05	2.116E-05	2.938E-05	3.773E-05	4.623E-05	6.359E-05	9.051E-05	1.184E-04	1.471E-04	1.865E-04
TH231	7.574E-04	7.575E-04	7.576E-04	7.578E-04	7.579E-04	7.581E-04	7.585E-04	7.589E-04	7.593E-04	7.598E-04
TH232	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05
TH234	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05
PA231	1.786E-04	1.786E-04	1.787E-04	1.788E-04	1.788E-04	1.789E-04	1.791E-04	1.793E-04	1.795E-04	1.797E-04
PA233	1.544E-03	1.908E-03	2.400E-03	2.992E-03	3.661E-03	5.160E-03	7.643E-03	1.025E-02	1.287E-02	1.634E-02
PA234M	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05
PA234	1.286E-07	1.286E-07	1.286E-07	1.286E-07	1.286E-07	1.286E-07	1.286E-07	1.286E-07	1.286E-07	1.286E-07
U232	6.108E-03	5.822E-03	5.549E-03	5.288E-03	5.040E-03	4.577E-03	3.962E-03	3.429E-03	2.968E-03	2.448E-03

DECAY TIMES (years out of core)
(Activities* in Ci/element)

Radionuclide	5	10	15	20	25	35	50	65	80	100
U233	2.259E-02	2.259E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02
U234	1.778E-01	1.811E-01	1.842E-01	1.872E-01	1.902E-01	1.956E-01	2.031E-01	2.097E-01	2.156E-01	2.225E-01
U235	7.574E-04	7.575E-04	7.576E-04	7.578E-04	7.579E-04	7.581E-04	7.585E-04	7.589E-04	7.593E-04	7.598E-04
U236	3.196E-03	3.199E-03	3.201E-03	3.204E-03	3.207E-03	3.212E-03	3.220E-03	3.229E-03	3.237E-03	3.247E-03
U237	3.165E-03	2.488E-03	1.955E-03	1.537E-03	1.208E-03	7.467E-04	3.627E-04	1.762E-04	8.557E-05	3.268E-05
U238	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05	9.890E-05
NP237	1.544E-03	1.908E-03	2.400E-03	2.992E-03	3.661E-03	5.160E-03	7.643E-03	1.025E-02	1.287E-02	1.634E-02
PU236	3.763E-05	1.116E-05	3.309E-06	9.811E-07	2.910E-07	2.568E-08	7.713E-10	1.218E-10	1.049E-10	1.044E-10
PU237	5.975E-15	5.252E-27	4.616E-39	4.057E-51	3.566E-63	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU238	2.358E+02	2.268E+02	2.180E+02	2.096E+02	2.015E+02	1.863E+02	1.656E+02	1.471E+02	1.308E+02	1.118E+02
PU239	2.605E+01	2.605E+01	2.604E+01	2.604E+01	2.604E+01	2.603E+01	2.602E+01	2.601E+01	2.600E+01	2.598E+01
PU240	1.828E+01	1.829E+01	1.829E+01	1.829E+01	1.829E+01	1.829E+01	1.827E+01	1.825E+01	1.822E+01	1.819E+01
PU241	1.290E+04	1.014E+04	7.971E+03	6.266E+03	4.926E+03	3.044E+03	1.478E+03	7.181E+02	3.488E+02	1.332E+02
PU242	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01
PU244	4.492E-09	4.492E-09	4.492E-09	4.492E-09	4.492E-09	4.492E-09	4.492E-09	4.492E-09	4.492E-09	4.492E-09
AM241	1.775E+02	2.676E+02	3.374E+02	3.913E+02	4.326E+02	4.879E+02	5.278E+02	5.402E+02	5.395E+02	5.295E+02
AM242M	1.207E+00	1.180E+00	1.153E+00	1.127E+00	1.102E+00	1.053E+00	9.830E-01	9.180E-01	8.573E-01	7.826E-01
AM242	1.201E+00	1.174E+00	1.147E+00	1.122E+00	1.096E+00	1.047E+00	9.781E-01	9.135E-01	8.531E-01	7.787E-01
AM243	1.023E+00	1.022E+00	1.022E+00	1.021E+00	1.021E+00	1.020E+00	1.018E+00	1.017E+00	1.015E+00	1.013E+00
CM242	1.485E+00	9.714E-01	9.493E-01	9.279E-01	9.070E-01	8.662E-01	8.089E-01	7.554E-01	7.055E-01	6.440E-01
CM243	1.123E-01	9.944E-02	8.805E-02	7.797E-02	6.904E-02	5.414E-02	3.759E-02	2.610E-02	1.812E-02	1.114E-02
CM244	3.320E+01	2.741E+01	2.264E+01	1.870E+01	1.544E+01	1.053E+01	5.930E+00	3.340E+00	1.881E+00	8.749E-01
CM245	1.982E-03	1.982E-03	1.981E-03	1.980E-03	1.979E-03	1.977E-03	1.975E-03	1.973E-03	1.970E-03	1.967E-03
CM246	2.010E-05	2.008E-05	2.007E-05	2.005E-05	2.004E-05	2.001E-05	1.996E-05	1.992E-05	1.988E-05	1.982E-05
CM247	1.442E-11	1.442E-11	1.442E-11	1.442E-11	1.442E-11	1.442E-11	1.442E-11	1.442E-11	1.442E-11	1.442E-11
SUBTOTAL**	1.427E+04	1.125E+04	9.043E+03	7.318E+03	5.961E+03	4.042E+03	2.413E+03	1.589E+03	1.163E+03	8.834E+02
TOTAL***	1.427E+04	1.126E+04	9.044E+03	7.319E+03	5.962E+03	4.043E+03	2.414E+03	1.591E+03	1.164E+03	8.844E+02

* Four decimal places of accuracy are as reported by ORIGEN2 output and are not significant for many radionuclides.
** Subtotal: total activity of the 145 isotopes listed in the table.
*** Total: total activity of the ORIGEN2 output isotopes.

Worst-Case Template 29

This analysis was focused on creating a bounding source term estimate. The hypothetical fuel template was created to maximize the source term for all radionuclides, but radionuclide production and decay is a complex multivariable process. It is impossible to maximize all radionuclides. Consequently, Template 29 was created by normalizing all the completed templates to the same basis (Ci per MWd per kg) and selecting the highest curie content for each radionuclide. This template, shown below, is used to conservatively estimate source terms when sufficient information is not known to select one of the other templates. It is expected to be extremely conservative for any credible fuel. This worst-case template was used in the analysis for spent fuels that didn't fit any of the other completed templates. The hypothetical template was not used in the analysis (other than to derive this Worst-Case Template 29).

	DECAY TIMES (years)									
	5	10	15	20	25	35	50	65	80	100
Ac-227	3.327E-05	5.466E-05	7.291E-05	8.848E-05	1.018E-04	1.228E-04	1.442E-04	1.575E-04	1.658E-04	1.723E-04
Ag-110	2.572E-03	1.622E-05	1.024E-07	6.458E-10	4.074E-12	1.621E-16	4.072E-23	0.000E+00	0.000E+00	0.000E+00
Ag-110m	1.933E-01	1.219E-03	7.699E-06	4.855E-08	3.063E-10	1.219E-14	3.062E-21	0.000E+00	0.000E+00	0.000E+00
Ag-111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Am-241	1.775E+02	2.676E+02	3.374E+02	3.913E+02	4.326E+02	4.879E+02	5.278E+02	5.402E+02	5.395E+02	5.295E+02
Am-242	1.201E+00	1.174E+00	1.147E+00	1.122E+00	1.096E+00	1.047E+00	9.781E-01	9.135E-01	8.531E-01	7.787E-01
Am-242m	1.207E+00	1.180E+00	1.153E+00	1.127E+00	1.102E+00	1.053E+00	9.830E-01	9.180E-01	8.573E-01	7.826E-01
Am-243	1.023E+00	1.022E+00	1.022E+00	1.021E+00	1.021E+00	1.020E+00	1.018E+00	1.017E+00	1.015E+00	1.013E+00
Ba-136m	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ba-137m	2.488E+03	2.216E+03	1.975E+03	1.759E+03	1.567E+03	1.245E+03	8.802E+02	6.226E+02	4.403E+02	2.774E+02
Ba-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Be-10	1.527E-05	1.527E-05	1.527E-05	1.527E-05	1.527E-05	1.527E-05	1.527E-05	1.527E-05	1.527E-05	1.527E-05
Bi-211	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
Bi-212	1.870E-02	1.912E-02	1.843E-02	1.760E-02	1.678E-02	1.524E-02	1.319E-02	1.141E-02	9.880E-03	8.157E-03
C-14	7.583E+00	7.577E+00	7.570E+00	7.570E+00	7.563E+00	7.556E+00	7.543E+00	7.529E+00	7.515E+00	7.495E+00
Cd-113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cd-113m	2.758E-01	2.174E-01	1.715E-01	1.353E-01	1.067E-01	6.636E-02	3.255E-02	1.598E-02	7.834E-03	3.031E-03
Cd-115m	2.291E-11	1.099E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ce-141	2.889E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ce-142	1.276E-06	1.276E-06	1.276E-06	1.276E-06	1.276E-06	1.276E-06	1.276E-06	1.276E-06	1.276E-06	1.276E-06
Ce-144	8.500E+02	9.926E+00	1.159E-01	1.353E-03	1.581E-05	8.425E-07	3.430E-15	2.939E-18	1.679E-18	0.000E+00
Cl-36	1.429E-01	1.429E-01	1.429E-01	1.429E-01	1.428E-01	1.428E-01	1.428E-01	1.428E-01	1.428E-01	1.428E-01
Cm-242	1.485E+00	9.714E-01	9.493E-01	9.279E-01	9.070E-01	8.662E-01	8.089E-01	7.554E-01	7.055E-01	6.440E-01
Cm-243	1.123E-01	9.944E-02	8.805E-02	7.797E-02	6.904E-02	5.414E-02	3.759E-02	2.610E-02	1.812E-02	1.114E-02
Cm-244	3.320E+01	2.741E+01	2.264E+01	1.870E+01	1.544E+01	1.053E+01	5.930E+00	3.340E+00	1.881E+00	8.749E-01
Cm-245	1.982E-03	1.982E-03	1.981E-03	1.980E-03	1.979E-03	1.977E-03	1.975E-03	1.973E-03	1.970E-03	1.967E-03
Cm-246	1.915E-04	1.914E-04	1.912E-04	1.911E-04	1.909E-04	1.906E-04	1.902E-04	1.898E-04	1.893E-04	1.888E-04
Cm-247	6.671E-10	6.671E-10	6.671E-10	6.671E-10	6.671E-10	6.671E-10	6.671E-10	6.671E-10	6.671E-10	6.671E-10
Co-60	9.084E+04	4.704E+04	2.437E+04	1.262E+04	6.541E+03	1.755E+03	2.441E+02	3.393E+01	4.719E+00	3.399E-01
Cr-51	1.652E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-134	5.083E+02	9.478E+01	1.767E+01	3.296E+00	6.143E-01	2.134E-02	1.384E-04	8.966E-07	1.838E-07	7.020E-12

	DECAY TIMES (years)									
	5	**10**	**15**	**20**	**25**	**35**	**50**	**65**	**80**	**100**
Cs-135	2.749E-02	2.749E-02	2.749E-02	2.749E-02	2.749E-02	2.749E-02	2.749E-02	2.749E-02	2.749E-02	2.749E-02
Cs-136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Cs-137	2.629E+03	2.343E+03	2.088E+03	1.860E+03	1.658E+03	1.316E+03	9.305E+02	6.580E+02	4.654E+02	2.933E+02
Eu-152	5.555E+00	4.306E+00	3.338E+00	2.588E+00	2.006E+00	1.206E+00	5.615E-01	2.615E-01	1.219E-01	4.398E-02
Eu-154	8.753E+02	5.851E+02	3.912E+02	2.615E+02	1.748E+02	7.812E+01	2.334E+01	6.972E+00	2.083E+00	4.160E-01
Eu-155	2.847E+02	1.416E+02	7.045E+01	3.504E+01	1.743E+01	4.312E+00	5.306E-01	6.528E-02	8.035E-03	4.918E-04
Eu-156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Fe-55	5.450E+04	1.437E+04	3.789E+03	9.991E+02	2.634E+02	1.832E+01	3.359E-01	6.159E-03	1.129E-04	5.460E-07
Fe-59	1.215E-08	7.372E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Fr-223	4.592E-07	7.543E-07	1.006E-06	1.221E-06	1.404E-06	1.695E-06	1.989E-06	2.173E-06	2.288E-06	2.378E-06
Gd-153	3.031E-02	1.622E-04	8.681E-07	4.644E-09	2.484E-11	7.113E-16	1.090E-22	0.000E+00	0.000E+00	0.000E+00
H-3	8.177E+01	6.180E+01	4.667E+01	3.526E+01	2.662E+01	1.519E+01	6.545E+00	2.820E+00	1.215E+00	3.953E-01
I-129	6.636E-04	6.636E-04	6.636E-04	6.636E-04	6.636E-04	6.636E-04	6.636E-04	6.636E-04	6.636E-04	6.636E-04
I-131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
In-114	1.140E-11	8.988E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
In-114m	1.191E-11	9.391E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
In-115m	1.608E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Kr-85	2.601E+02	1.883E+02	1.363E+02	9.864E+01	7.141E+01	3.743E+01	1.420E+01	5.387E+00	2.044E+00	5.613E-01
La-140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MN-54	4.195E+01	7.304E-01	1.271E-02	2.213E-04	3.853E-06	3.147E-07	6.162E-15	1.229E-17	7.023E-18	0.000E+00
Mo-93	4.926E-02	4.921E-02	4.916E-02	4.912E-02	4.907E-02	4.897E-02	4.882E-02	4.868E-02	4.854E-02	4.834E-02
Nb-93m	2.169E-02	3.679E-02	4.849E-02	5.757E-02	6.460E-02	7.427E-02	8.204E-02	8.566E-02	8.736E-02	8.832E-02
Nb-94	6.799E-02	6.797E-02	6.797E-02	6.795E-02	6.794E-02	6.792E-02	6.788E-02	6.785E-02	6.782E-02	6.777E-02
Nb-95	1.113E-03	2.884E-12	7.473E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nb-95m	3.720E-06	9.638E-15	2.497E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Nd-144	3.807E-11	3.838E-11	3.839E-11	3.839E-11	3.839E-11	3.839E-11	3.839E-11	3.839E-11	3.839E-11	3.839E-11
Nd-147	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ni-59	2.130E+01	2.130E+01	2.130E+01	2.130E+01	2.130E+01	2.130E+01	2.129E+01	2.129E+01	2.128E+01	2.128E+01
Ni-63	3.064E+03	2.951E+03	2.842E+03	2.737E+03	2.636E+03	2.444E+03	2.183E+03	1.950E+03	1.742E+03	1.498E+03
Np-237	9.759E-03	9.760E-03	9.762E-03	9.766E-03	9.770E-03	9.779E-03	9.792E-03	1.025E-02	1.287E-02	1.634E-02
Pa-231	1.786E-04	1.786E-04	1.787E-04	1.788E-04	1.788E-04	1.789E-04	1.791E-04	1.793E-04	1.795E-04	1.797E-04

	DECAY TIMES (years)									
	5	10	15	20	25	35	50	65	80	100
Pa-233	9.759E-03	9.760E-03	9.762E-03	9.766E-03	9.770E-03	9.779E-03	9.792E-03	1.025E-02	1.287E-02	1.634E-02
Pa-234	9.541E-06	9.541E-06	9.541E-06	9.541E-06	9.541E-06	9.541E-06	9.541E-06	9.541E-06	9.541E-06	9.541E-06
Pa-234m	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03
Pb-210	7.042E-09	1.980E-08	5.865E-08	1.278E-07	2.341E-07	5.798E-07	1.495E-06	2.957E-06	5.017E-06	8.743E-06
Pb-211	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
Pb-212	1.870E-02	1.912E-02	1.843E-02	1.760E-02	1.678E-02	1.524E-02	1.319E-02	1.141E-02	9.880E-03	8.157E-03
Pd-107	1.013E-03	1.013E-03	1.013E-03	1.013E-03	1.013E-03	1.013E-03	1.013E-03	1.013E-03	1.013E-03	1.013E-03
Pm-145	8.675E-01	7.207E-01	5.928E-01	4.875E-01	4.008E-01	2.710E-01	1.507E-01	8.378E-02	4.659E-02	2.130E-02
Pm-147	2.910E+03	7.770E+02	2.076E+02	5.544E+01	1.481E+01	1.056E+00	2.012E-02	3.835E-04	1.606E-05	3.718E-08
Pm-148	3.534E-12	1.757E-25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pm-148m	6.275E-11	3.121E-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Po-212	1.198E-02	1.225E-02	1.181E-02	1.128E-02	1.076E-02	9.757E-03	8.447E-03	7.310E-03	6.330E-03	5.226E-03
Po-215	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
Po-216	1.870E-02	1.912E-02	1.843E-02	1.760E-02	1.678E-02	1.524E-02	1.319E-02	1.141E-02	9.880E-03	8.157E-03
Pr-143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pr-144	8.500E+02	9.926E+00	1.159E-01	1.353E-03	1.581E-05	8.425E-07	3.430E-15	2.939E-18	1.679E-18	0.000E+00
Pr-144m	1.020E+01	1.191E-01	1.391E-03	1.625E-05	1.896E-07	1.012E-08	4.117E-17	3.524E-20	2.014E-20	0.000E+00
Pu-236	9.558E-04	2.836E-04	8.417E-05	2.498E-05	7.422E-06	6.624E-07	2.676E-08	1.014E-08	9.710E-09	9.692E-09
Pu-237	4.701E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Pu-238	2.358E+02	2.268E+02	2.180E+02	2.096E+02	2.015E+02	1.863E+02	1.656E+02	1.471E+02	1.308E+02	1.118E+02
Pu-239	2.605E+01	2.605E+01	2.604E+01	2.604E+01	2.604E+01	2.603E+01	2.602E+01	2.601E+01	2.600E+01	2.598E+01
Pu-240	1.828E+01	1.829E+01	1.829E+01	1.829E+01	1.829E+01	1.829E+01	1.827E+01	1.825E+01	1.822E+01	1.819E+01
Pu-241	1.290E+04	1.014E+04	7.971E+03	6.266E+03	4.926E+03	3.044E+03	1.478E+03	7.181E+02	3.488E+02	1.332E+02
Pu-242	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01	1.535E-01
Pu-244	5.307E-09	5.307E-09	5.307E-09	5.307E-09	5.307E-09	5.307E-09	5.307E-09	5.307E-09	5.307E-09	5.307E-09
Ra-223	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
Ra-224	1.870E-02	1.912E-02	1.843E-02	1.760E-02	1.678E-02	1.524E-02	1.319E-02	1.141E-02	9.880E-03	8.157E-03
Ra-226	5.641E-08	1.889E-07	3.989E-07	6.861E-07	1.051E-06	2.010E-06	4.025E-06	6.725E-06	1.011E-05	1.566E-05
Ra-228	2.118E-05	2.782E-05	3.178E-05	3.414E-05	3.555E-05	3.689E-05	3.747E-05	3.760E-05	3.762E-05	3.763E-05
Rb-87	8.187E-07	8.187E-07	8.187E-07	8.187E-07	8.187E-07	8.187E-07	8.187E-07	8.187E-07	8.187E-07	8.187E-07
Rh-103m	1.067E-09	1.104E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

	DECAY TIMES (years)									
	5	10	15	20	25	35	50	65	80	100
Rh-106	2.298E+02	7.379E+00	2.371E-01	7.618E-03	2.446E-04	5.345E-05	8.368E-12	8.227E-14	4.701E-14	0.000E+00
Rn-219	3.329E-05	5.473E-05	7.302E-05	8.863E-05	1.019E-04	1.230E-04	1.443E-04	1.577E-04	1.660E-04	1.725E-04
Rn-220	1.870E-02	1.912E-02	1.843E-02	1.760E-02	1.678E-02	1.524E-02	1.319E-02	1.141E-02	9.880E-03	8.157E-03
Ru-103	1.184E-09	1.224E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Ru-106	2.298E+02	7.379E+00	2.371E-01	7.618E-03	2.446E-04	5.345E-05	8.368E-12	8.227E-14	4.701E-14	0.000E+00
Sb-124	2.081E-06	1.533E-15	1.129E-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sb-125	1.176E+02	3.366E+01	9.629E+00	2.756E+00	7.884E-01	6.457E-02	1.513E-03	3.545E-05	4.220E-06	5.569E-09
Sb-126	1.459E-03	1.459E-03	1.459E-03	1.459E-03	1.459E-03	1.459E-03	1.458E-03	1.458E-03	1.458E-03	1.458E-03
Sb-126M	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.041E-02	1.041E-02
Se-79	1.199E-02	1.199E-02	1.199E-02	1.199E-02	1.199E-02	1.199E-02	1.199E-02	1.199E-02	1.198E-02	1.198E-02
Sm-145	1.665E-01	4.034E-03	9.776E-05	2.369E-06	5.741E-08	3.371E-11	4.797E-16	6.826E-21	0.000E+00	0.000E+00
Sm-147	6.263E-06	6.287E-06	6.294E-06	6.295E-06	6.296E-06	6.296E-06	6.296E-06	6.296E-06	6.296E-06	6.296E-06
Sm-151	1.766E+02	1.700E+02	1.635E+02	1.573E+02	1.514E+02	1.402E+02	1.249E+02	1.113E+02	9.913E+01	8.499E+01
Sn-119m	8.272E+00	4.719E-02	2.692E-04	1.536E-06	8.763E-09	2.853E-13	5.300E-20	0.000E+00	0.000E+00	0.000E+00
Sn-121m	1.457E-01	1.360E-01	1.269E-01	1.184E-01	1.104E-01	9.616E-02	7.809E-02	6.341E-02	5.150E-02	3.902E-02
Sn-123	2.085E-02	1.156E-06	6.408E-11	3.553E-15	1.970E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sn-125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sn-126	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.042E-02	1.041E-02	1.041E-02
Sr-89	2.098E-06	2.771E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Sr-90	2.525E+03	2.243E+03	1.991E+03	1.768E+03	1.570E+03	1.237E+03	8.662E+02	6.063E+02	4.243E+02	2.637E+02
Tb-160	8.938E-06	2.254E-13	5.683E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Tc-99	4.230E-01	4.230E-01	4.230E-01	4.230E-01	4.230E-01	4.230E-01	4.230E-01	4.228E-01	4.228E-01	4.228E-01
Te-123m	4.057E-04	1.035E-08	2.635E-13	6.717E-18	1.712E-22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Te-125m	2.870E+01	8.211E+00	2.350E+00	6.724E-01	1.924E-01	1.575E-02	3.691E-04	8.647E-06	1.028E-06	1.359E-09
Te-127	4.862E-03	4.435E-08	4.044E-13	3.690E-18	3.366E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	#VALUE!
Te-127m	4.965E-03	4.527E-08	4.130E-13	3.767E-18	3.435E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	#VALUE!
Te-129	1.130E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Te-129m	1.736E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Th-227	3.283E-05	5.397E-05	7.201E-05	8.741E-05	1.005E-04	1.213E-04	1.423E-04	1.555E-04	1.637E-04	1.701E-04
Th-228	1.869E-02	1.911E-02	1.842E-02	1.759E-02	1.677E-02	1.523E-02	1.319E-02	1.141E-02	9.880E-03	8.157E-03
Th-229	1.730E-05	2.623E-05	3.517E-05	4.558E-05	5.622E-05	7.749E-05	1.093E-04	1.412E-04	1.729E-04	2.152E-04

	DECAY TIMES (years)									
	5	10	15	20	25	35	50	65	80	100
Th-230	4.329E-05	7.924E-05	1.152E-04	1.512E-04	1.871E-04	2.590E-04	3.669E-04	4.747E-04	5.825E-04	7.263E-04
Th-231	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02
Th-232	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05	3.763E-05
Th-234	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03
Tl-206	1.647E-10	1.647E-10	1.647E-10	1.647E-10	1.647E-10	1.647E-10	1.647E-10	1.647E-10	1.647E-10	1.647E-10
Tl-207	3.320E-05	5.457E-05	7.281E-05	8.838E-05	1.017E-04	1.226E-04	1.439E-04	1.572E-04	1.656E-04	1.720E-04
Tl-208	6.719E-03	6.870E-03	6.624E-03	6.325E-03	6.030E-03	5.473E-03	4.737E-03	4.100E-03	3.549E-03	2.931E-03
U-232	1.978E-02	1.885E-02	1.796E-02	1.712E-02	1.631E-02	1.482E-02	1.283E-02	1.110E-02	9.605E-03	7.925E-03
U-233	2.259E-02	2.259E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02	2.258E-02
U-234	7.986E-01	7.993E-01	7.993E-01	7.993E-01	7.993E-01	7.993E-01	7.993E-01	7.993E-01	7.993E-01	7.993E-01
U-235	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02	3.673E-02
U-236	1.468E-02	1.468E-02	1.468E-02	1.468E-02	1.468E-02	1.468E-02	1.468E-02	1.468E-02	1.468E-02	1.468E-02
U-237	3.165E-03	2.488E-03	1.955E-03	1.537E-03	1.208E-03	7.467E-04	3.627E-04	1.762E-04	8.557E-05	3.268E-05
U-238	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03	7.338E-03
Xe-131M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Xe-133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y-90	2.527E+03	2.243E+03	1.991E+03	1.768E+03	1.570E+03	1.238E+03	8.663E+02	6.064E+02	4.243E+02	2.637E+02
Y-91	7.517E-05	3.062E-14	1.248E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Zn-65	1.670E+00	9.328E-03	5.211E-05	2.912E-07	1.627E-09	5.080E-14	8.859E-21	0.000E+00	0.000E+00	0.000E+00
Zr-93	9.350E-02	9.350E-02	9.350E-02	9.350E-02	9.350E-02	9.350E-02	9.350E-02	9.350E-02	9.350E-02	9.350E-02
Zr-95	5.014E-04	1.299E-12	3.366E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Appendix B

Index to DOE Spent Nuclear Fuels

					Source Term Est.	
					Page #	
Fuel Name	SNF ID	TSPA Category	DBE Category		2010	2030
ACRR (PULSED CORE)	757	T8: U Oxide	Non-Metals	Intact	C-1	D-1
AMERICIUM TARGETS	776	T10: Misc	Other	Not Intact	C-2	D-2
ANLJ	5	T9: Aluminum-based	Stable Metals	Intact	C-3	D-3
ANP	451	T8: U Oxide	Non-Metals	Not Intact	C-4	D-4
APPR (AGE-2)	6	T8: U Oxide	Non-Metals	Intact	C-5	D-5
ARKANSAS	7	T8: U Oxide	Non-Metals	Not Intact	C-6	D-6
ARMF (PLATES)	8	T9: Aluminum-based	Stable Metals	Intact	C-7	D-7
ARMF/CFRMF MARK I	9	T9: Aluminum-based	Stable Metals	Intact	C-8	D-8
ARMF/CFRMF MARK I LL	10	T9: Aluminum-based	Stable Metals	Intact	C-9	D-9
ARMF/CFRMF MARK II	11	T9: Aluminum-based	Stable Metals	Intact	C-10	D-10
ARMF/CFRMF MARK III	12	T9: Aluminum-based	Stable Metals	Intact	C-11	D-11
ASTRA (AUSTRIA)	1058	T9: Aluminum-based	Stable Metals	Intact	C-12	D-12
ASTRA (AUSTRIA)	646	T9: Aluminum-based	Stable Metals	Intact	C-13	D-13
ASTRA (AUSTRIA)	712	T9: Aluminum-based	Stable Metals	Intact	C-14	D-14
ASTRA (AUSTRIA)	566	T9: Aluminum-based	Stable Metals	Intact	C-15	D-15
ATR	843	T9: Aluminum-based	Stable Metals	Intact	C-16	D-16
ATR	16	T9: Aluminum-based	Stable Metals	Intact	C-17	D-17
ATR	15	T9: Aluminum-based	Stable Metals	Intact	C-18	D-18
ATSR	17	T9: Aluminum-based	Stable Metals	Intact	C-19	D-19
BABCOCK & WILCOX SCRAP	18	T4: MOX	Non-Metals	Not Intact	C-20	D-20
BCD B-17 (TURKEY POINT 3)	19	T8: U Oxide	Non-Metals	Intact	C-21	D-21
BER-II [HMI] (END BOXES) (GERMANY)	892	T9: Aluminum-based	Stable Metals	Intact	C-22	D-22
BER-II [HMI] (GERMANY)	758	T9: Aluminum-based	Stable Metals	Intact	C-23	D-23
BER-II TRIGA (GERMANY)	236	T11: U-ZrHx	Non-Metals	Intact	C-24	D-24
BMI (CPI-24)	774	T8: U Oxide	Non-Metals	Not Intact	C-25	D-25
BMI (CPI-38)	20	T8: U Oxide	Non-Metals	Not Intact	C-26	D-26
BNL MEDICAL RX (BMRR)	21	T9: Aluminum-based	Stable Metals	Intact	C-27	D-27
BORAX V (SUPERHEATER)	22	T8: U Oxide	Non-Metals	Intact	C-28	D-28
BR-3	927	T8: U Oxide	Non-Metals	Intact	C-29	D-29

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BR-3 FUEL	340	T8: U Oxide	Non-Metals	Intact	C-30	D-30
BRP-B	23	T8: U Oxide	Non-Metals	Intact	C-31	D-31
BRP-C	24	T8: U Oxide	Non-Metals	Intact	C-32	D-32
BRP-D1	25	T8: U Oxide	Non-Metals	Intact	C-33	D-33
BRP-D2	26	T8: U Oxide	Non-Metals	Intact	C-34	D-34
BRP-E	27	T8: U Oxide	Non-Metals	Intact	C-35	D-35
BRP-EG	28	T8: U Oxide	Non-Metals	Intact	C-36	D-36
BRP-EG/F	1081	T8: U Oxide	Non-Metals	Intact	C-37	D-37
BRP-EP	29	T4: MOX	Non-Metals	Intact	C-38	D-38
BRP-F	30	T8: U Oxide	Non-Metals	Intact	C-39	D-39
BRP-F-PU	1082	T8: U Oxide	Non-Metals	Intact	C-40	D-40
BSR	31	T9: Aluminum-based	Stable Metals	Intact	C-41	D-41
CALVERT CLIFFS 1	307	T8: U Oxide	Non-Metals	Intact	C-42	D-42
CANDU	979	T8: U Oxide	Non-Metals	Intact	C-43	D-43
COMMERCIAL BWR & PWR SNF	1089	T8: U Oxide	Non-Metals	Not Intact	C-44	D-44
CONNECTICUT YANKEE (S004)	34	T8: U Oxide	Non-Metals	Intact	C-45	D-45
COOPER NUCLEAR	308	T8: U Oxide	Non-Metals	Intact	C-46	D-46
CP-5 CONVERTER CYLINDERS	36	T2: Pu/U Alloy	Other	Intact	C-47	D-47
CVTR FUEL	37	T8: U Oxide	Non-Metals	Intact	C-48	D-48
DR-3 (DENMARK)	714	T9: Aluminum-based	Stable Metals	Intact	C-49	D-49
DR-3 (DENMARK)	759	T9: Aluminum-based	Stable Metals	Intact	C-50	D-50
DR-3 (DENMARK)	1059	T9: Aluminum-based	Stable Metals	Intact	C-51	D-51
DRCT	701	T8: U Oxide	Non-Metals	Intact	C-52	D-52
DRCT	756	T8: U Oxide	Non-Metals	Intact	C-53	D-53
DRESDEN I	44	T6: U/Th Oxide	Non-Metals	Intact	C-54	D-54
DRESDEN I (E00161)	928	T8: U Oxide	Non-Metals	Intact	C-55	D-55
DRESDEN I (UN0064)	47	T8: U Oxide	Non-Metals	Intact	C-56	D-56
DRESII, HBR, BR-3, BRP, TMI	50	T8: U Oxide	Non-Metals	Not Intact	C-57	D-57
EBR-II & TREAT EXPERIMENTS	858	T4: MOX	Non-Metals	Not Intact	C-58	D-58

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Fuel Name	SNF ID	TSPA Category	DBE Category		2010	2030
EBR-II NITRIDE FUEL EXPER	363	T10: Misc	Other	Intact	C-59	D-59
EBR-II OXIDE FUEL EXPER	364	T4: MOX	Non-Metals	Intact	C-60	D-60
EBR-II OXIDE FUEL EXPER	345	T4: MOX	Non-Metals	Intact	C-61	D-61
EBR-II, FFTF & MTR EXPERIMENTS	42	T3: U/Pu Carbide	Non-Metals	Not Intact	C-62	D-62
EBR-II, TREAT, MTR EXPER. & IPNS TARGET	1088	T7: U Metal	Other	Not Intact	C-63	D-63
EBWR	65	T8: U Oxide	Non-Metals	Intact	C-64	D-64
EBWR	63	T4: MOX	Non-Metals	Intact	C-65	D-65
EBWR	60	T8: U Oxide	Non-Metals	Intact	C-66	D-66
EBWR (FUEL FOLLOWER)	740	T8: U Oxide	Non-Metals	Not Intact	C-67	D-67
EBWR (SPIKES)	891	T8: U Oxide	Non-Metals	Intact	C-68	D-68
EBWR ENRICHED HEAVY	64	T7: U Metal	Other	Intact	C-69	D-69
EBWR ENRICHED THIN	887	T7: U Metal	Other	Intact	C-70	D-70
EBWR ET-11	888	T7: U Metal	Other	Intact	C-71	D-71
EBWR NORMAL HEAVY	889	T7: U Metal	Other	Intact	C-72	D-72
EBWR NORMAL THIN	890	T7: U Metal	Other	Intact	C-73	D-73
ENEA SALUGGIA (ITALY)	574	T9: Aluminum-based	Stable Metals	Intact	C-74	D-74
ENEA SALUGGIA (ITALY)	760	T9: Aluminum-based	Stable Metals	Intact	C-75	D-75
EPRI	67	T4: MOX	Non-Metals	Not Intact	C-76	D-76
ERR	1057	T6: U/Th Oxide	Non-Metals	Intact	C-77	D-77
ERR	68	T6: U/Th Oxide	Non-Metals	Intact	C-78	D-78
ESSOR (ITALY)	762	T9: Aluminum-based	Stable Metals	Intact	C-79	D-79
FAST REACTOR FUEL	1029	T3: U/Pu Carbide	Non-Metals	Not Intact	C-80	D-80
FAST REACTOR FUEL	906	T6: U/Th Oxide	Non-Metals	Not Intact	C-81	D-81
FERMI CORE 1 & 2 (CORE FOIL)	457	T2: Pu/U Alloy	Other	Intact	C-82	D-82
FERMI CORE 1 & 2 (CORE SHIM)	69	T2: Pu/U Alloy	Other	Intact	C-83	D-83
FERMI CORE 1 & 2 (DECLAD)	453	T2: Pu/U Alloy	Other	Not Intact	C-84	D-84
FERMI CORE 1 & 2 (SECTIONED)	454	T2: Pu/U Alloy	Other	Intact	C-85	D-85
FERMI CORE 1 & 2 (SODIUM WORTH)	455	T2: Pu/U Alloy	Other	Intact	C-86	D-86
FERMI CORE 1 & 2 (STD FUEL SUBASSEMBLY)	456	T2: Pu/U Alloy	Other	Intact	C-87	D-87

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FFTF CARBIDE FUEL EXPER.	347	T3: U/Pu Carbide	Non-Metals	Intact	C-88	D-88
FFTF OXIDE EXPERIMENTS	349	T4: MOX	Non-Metals	Intact	C-89	D-89
FFTF-DFA/TDFA	71	T4: MOX	Non-Metals	Intact	C-90	D-90
FFTF-DFA/TDFA PINS	323	T4: MOX	Non-Metals	Intact	C-91	D-91
FFTF-TFA PINS	320	T4: MOX	Non-Metals	Intact	C-92	D-92
FFTF-TFA PINS (AC-3)	1046	T3: U/Pu Carbide	Non-Metals	Intact	C-93	D-93
FFTF-TFA-AB-1	317	T4: MOX	Non-Metals	Intact	C-94	D-94
FFTF-TFA-ABA-1 THRU 6	318	T8: U Oxide	Non-Metals	Intact	C-95	D-95
FFTF-TFA-ACN-1 PINS	321	T4: MOX	Non-Metals	Intact	C-96	D-96
FFTF-TFA-ACN-1 RODS	865	T3: U/Pu Carbide	Non-Metals	Intact	C-97	D-97
FFTF-TFA-ACO-2, 4 THRU 16	329	T4: MOX	Non-Metals	Intact	C-98	D-98
FFTF-TFA-CRBR-3 & CRBR-5	322	T4: MOX	Non-Metals	Intact	C-99	D-99
FFTF-TFA-DEA-2	324	T4: MOX	Non-Metals	Intact	C-100	D-100
FFTF-TFA-FC-1	325	T3: U/Pu Carbide	Non-Metals	Intact	C-101	D-101
FFTF-TFA-MFF-1 & 1A (CDE)	330	T4: MOX	Non-Metals	Intact	C-102	D-102
FFTF-TFA-P0-2,4 & 5	333	T4: MOX	Non-Metals	Intact	C-103	D-103
FFTF-TFA-SRF-3&4	334	T4: MOX	Non-Metals	Intact	C-104	D-104
FFTF-TFA-UO-1	335	T4: MOX	Non-Metals	Intact	C-105	D-105
FFTF-TFA-WBO18 & WBO42	336	T8: U Oxide	Non-Metals	Intact	C-106	D-106
FMRB (GERMANY)	577	T9: Aluminum-based	Stable Metals	Intact	C-107	D-107
FRG-1 (GERMANY)	741	T9: Aluminum-based	Stable Metals	Intact	C-108	D-108
FRG-1 (GERMANY)	581	T9: Aluminum-based	Stable Metals	Intact	C-109	D-109
FRG-1 (GERMANY)	742	T9: Aluminum-based	Stable Metals	Intact	C-110	D-110
FRJ (GERMANY)	933	T9: Aluminum-based	Stable Metals	Intact	C-111	D-111
FRJ (GERMANY)	1000	T9: Aluminum-based	Stable Metals	Intact	C-112	D-112
FRJ TUBES (GERMANY)	999	T9: Aluminum-based	Stable Metals	Intact	C-113	D-113
FRM (GERMANY)	805	T9: Aluminum-based	Stable Metals	Intact	C-114	D-114
FRM (GERMANY)	806	T9: Aluminum-based	Stable Metals	Intact	C-115	D-115
FRR ASTRA (AUSTRIA)	654	T9: Aluminum-based	Stable Metals	Intact	C-116	D-116

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FRR ASTRA (AUSTRIA)	556	T9: Aluminum-based	Stable Metals	Intact	C-117	D-117
FRR ASTRA (AUSTRIA)	515	T9: Aluminum-based	Stable Metals	Intact	C-118	D-118
FRR ASTRA (AUSTRIA)	738	T9: Aluminum-based	Stable Metals	Intact	C-119	D-119
FRR FMRB (GERMANY)	1066	T9: Aluminum-based	Stable Metals	Intact	C-120	D-120
FRR MTR (ARGENTINA)	547	T9: Aluminum-based	Stable Metals	Intact	C-121	D-121
FRR MTR (AUSTRALIA)	649	T9: Aluminum-based	Stable Metals	Intact	C-122	D-122
FRR MTR (CANADA)	294	T9: Aluminum-based	Stable Metals	Intact	C-123	D-123
FRR MTR (JAPAN)	551	T9: Aluminum-based	Stable Metals	Intact	C-124	D-124
FRR MTR (JAPAN)	565	T9: Aluminum-based	Stable Metals	Intact	C-125	D-125
FRR MTR (JAPAN)	603	T9: Aluminum-based	Stable Metals	Intact	C-126	D-126
FRR MTR (JAPAN)	605	T9: Aluminum-based	Stable Metals	Intact	C-127	D-127
FRR MTR (NETHERLANDS)	609	T9: Aluminum-based	Stable Metals	Intact	C-128	D-128
FRR MTR (TAIWAN)	628	T9: Aluminum-based	Stable Metals	Intact	C-129	D-129
FRR MTR (TAIWAN)	555	T9: Aluminum-based	Stable Metals	Intact	C-130	D-130
FRR MTR (VENEZUELA)	559	T9: Aluminum-based	Stable Metals	Intact	C-131	D-131
FRR MTR-C (ARGENTINA)	635	T9: Aluminum-based	Stable Metals	Intact	C-132	D-132
FRR MTR-C (CANADA)	512	T9: Aluminum-based	Stable Metals	Intact	C-133	D-133
FRR MTR-C (CANADA)	612	T9: Aluminum-based	Stable Metals	Intact	C-134	D-134
FRR MTR-C (GERMANY)	517	T9: Aluminum-based	Stable Metals	Intact	C-135	D-135
FRR MTR-C (GERMANY)	579	T9: Aluminum-based	Stable Metals	Intact	C-136	D-136
FRR MTR-C (GREECE)	531	T9: Aluminum-based	Stable Metals	Intact	C-137	D-137
FRR MTR-C (JAPAN)	289	T9: Aluminum-based	Stable Metals	Intact	C-138	D-138
FRR MTR-C (JAPAN)	552	T9: Aluminum-based	Stable Metals	Intact	C-139	D-139
FRR MTR-C (JAPAN)	600	T9: Aluminum-based	Stable Metals	Intact	C-140	D-140
FRR MTR-C (NETHERLANDS)	509	T9: Aluminum-based	Stable Metals	Intact	C-141	D-141
FRR MTR-C (PERU)	503	T9: Aluminum-based	Stable Metals	Intact	C-142	D-142
FRR MTR-C (PORTUGAL)	540	T9: Aluminum-based	Stable Metals	Intact	C-143	D-143
FRR MTR-C (PORTUGAL)	631	T9: Aluminum-based	Stable Metals	Intact	C-144	D-144
FRR MTR-C (SWEDEN)	523	T9: Aluminum-based	Stable Metals	Intact	C-145	D-145

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Fuel Name	SNF ID	TSPA Category	DBE Category		2010	2030
FRR MTR-C (TURKEY)	643	T9: Aluminum-based	Stable Metals	Intact	C-146	D-146
FRR MTR-C1 (SWITZERLAND)	656	T9: Aluminum-based	Stable Metals	Intact	C-147	D-147
FRR MTR-C2 (SWITZERLAND)	657	T9: Aluminum-based	Stable Metals	Intact	C-148	D-148
FRR MTR-C2 (TURKEY)	527	T9: Aluminum-based	Stable Metals	Intact	C-149	D-149
FRR MTR-O (PORTUGAL)	541	T9: Aluminum-based	Stable Metals	Intact	C-150	D-150
FRR MTR-O (TURKEY)	642	T9: Aluminum-based	Stable Metals	Intact	C-151	D-151
FRR MTR-S (CANADA)	720	T9: Aluminum-based	Stable Metals	Intact	C-152	D-152
FRR MTR-S (CANADA)	513	T9: Aluminum-based	Stable Metals	Intact	C-153	D-153
FRR MTR-S (GERMANY)	588	T9: Aluminum-based	Stable Metals	Intact	C-154	D-154
FRR MTR-S (GERMANY)	584	T9: Aluminum-based	Stable Metals	Intact	C-155	D-155
FRR MTR-S (GERMANY)	582	T9: Aluminum-based	Stable Metals	Intact	C-156	D-156
FRR MTR-S (GERMANY)	1068	T9: Aluminum-based	Stable Metals	Intact	C-157	D-157
FRR MTR-S (GERMANY)	519	T9: Aluminum-based	Stable Metals	Intact	C-158	D-158
FRR MTR-S (GERMANY)	585	T9: Aluminum-based	Stable Metals	Intact	C-159	D-159
FRR MTR-S (GERMANY)	1067	T9: Aluminum-based	Stable Metals	Intact	C-160	D-160
FRR MTR-S (GREECE)	532	T9: Aluminum-based	Stable Metals	Intact	C-161	D-161
FRR MTR-S (INDONESIA)	502	T9: Aluminum-based	Stable Metals	Intact	C-162	D-162
FRR MTR-S (JAPAN)	602	T9: Aluminum-based	Stable Metals	Intact	C-163	D-163
FRR MTR-S (JAPAN)	553	T9: Aluminum-based	Stable Metals	Intact	C-164	D-164
FRR MTR-S (JAPAN)	506	T9: Aluminum-based	Stable Metals	Intact	C-165	D-165
FRR MTR-S (JAPAN)	508	T9: Aluminum-based	Stable Metals	Intact	C-166	D-166
FRR MTR-S (NETHERLANDS)	608	T9: Aluminum-based	Stable Metals	Intact	C-167	D-167
FRR MTR-S (NETHERLANDS)	510	T9: Aluminum-based	Stable Metals	Intact	C-168	D-168
FRR MTR-S (NETHERLANDS)	607	T9: Aluminum-based	Stable Metals	Intact	C-169	D-169
FRR MTR-S (PERU)	504	T9: Aluminum-based	Stable Metals	Intact	C-170	D-170
FRR MTR-S (PORTUGAL)	632	T9: Aluminum-based	Stable Metals	Intact	C-171	D-171
FRR MTR-S (PORTUGAL)	542	T9: Aluminum-based	Stable Metals	Intact	C-172	D-172
FRR MTR-S (SWITZERLAND)	658	T9: Aluminum-based	Stable Metals	Intact	C-173	D-173
FRR MTR-S (TURKEY)	644	T9: Aluminum-based	Stable Metals	Intact	C-174	D-174

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Fuel Name	SNF ID	TSPA Category	DBE Category		2010	2030
FRR MTR-S (TURKEY)	528	T9: Aluminum-based	Stable Metals	Intact	C-175	D-175
FRR PIN CLUSTER (CANADA)	660	T9: Aluminum-based	Stable Metals	Intact	C-176	D-176
FRR PIN CLUSTER (CANADA)	662	T9: Aluminum-based	Stable Metals	Intact	C-177	D-177
FRR PIN CLUSTER (CANADA)	663	T9: Aluminum-based	Stable Metals	Intact	C-178	D-178
FRR PIN CLUSTER (CANADA)	661	T9: Aluminum-based	Stable Metals	Intact	C-179	D-179
FRR PIN CLUSTER (SO. KOREA)	293	T9: Aluminum-based	Stable Metals	Intact	C-180	D-180
FRR PIN CLUSTER (SO. KOREA)	659	T9: Aluminum-based	Stable Metals	Intact	C-181	D-181
FRR SLOWPOKE (CANADA)	665	T9: Aluminum-based	Stable Metals	Intact	C-182	D-182
FRR SLOWPOKE (CANADA)	669	T9: Aluminum-based	Stable Metals	Intact	C-183	D-183
FRR SLOWPOKE (CANADA)	668	T9: Aluminum-based	Stable Metals	Intact	C-184	D-184
FRR SLOWPOKE (CANADA)	666	T9: Aluminum-based	Stable Metals	Intact	C-185	D-185
FRR SLOWPOKE (MONTREAL)	667	T9: Aluminum-based	Stable Metals	Intact	C-186	D-186
FRR TARGET (ARGENTINA)	297	T8: U Oxide	Non-Metals	Not Intact	C-187	D-187
FRR TARGET (CANADA)	671	T8: U Oxide	Non-Metals	Not Intact	C-188	D-188
FRR TARGET (INDONESIA)	672	T8: U Oxide	Non-Metals	Not Intact	C-189	D-189
FRR TUBES (AUSTRALIA)	684	T9: Aluminum-based	Stable Metals	Intact	C-190	D-190
FRR TUBES (AUSTRALIA)	300	T9: Aluminum-based	Stable Metals	Intact	C-191	D-191
FRR TUBES (AUSTRALIA)	299	T9: Aluminum-based	Stable Metals	Intact	C-192	D-192
FRR TUBES (DENMARK)	298	T9: Aluminum-based	Stable Metals	Intact	C-193	D-193
FRR TUBES (DENMARK)	678	T9: Aluminum-based	Stable Metals	Intact	C-194	D-194
FRR TUBES (DENMARK)	676	T9: Aluminum-based	Stable Metals	Intact	C-195	D-195
FRR TUBES (GERMANY)	674	T9: Aluminum-based	Stable Metals	Intact	C-196	D-196
FRR TUBES (GERMANY)	675	T9: Aluminum-based	Stable Metals	Intact	C-197	D-197
FRR TUBES (GERMANY)	685	T9: Aluminum-based	Stable Metals	Intact	C-198	D-198
FRR TUBES (GERMANY)	673	T9: Aluminum-based	Stable Metals	Intact	C-199	D-199
FRR TUBES (GERMANY)	683	T9: Aluminum-based	Stable Metals	Intact	C-200	D-200
FSVR	86	T5: U/Th Carbide	Non-Metals	Intact	C-201	D-201
FSVR	85	T5: U/Th Carbide	Non-Metals	Intact	C-202	D-202
GA HTGR FUEL	89	T5: U/Th Carbide	Non-Metals	Not Intact	C-203	D-203

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GA RERTR	90	T11: U-ZrHx	Non-Metals	Not Intact	C-204	D-204
GCRE (1B SERIES)	745	T8: U Oxide	Non-Metals	Intact	C-205	D-205
GCRE (1Z SERIES)	916	T8: U Oxide	Non-Metals	Intact	C-206	D-206
GCRE CAN (1B-8T 1&2)	94	T8: U Oxide	Non-Metals	Not Intact	C-207	D-207
GCRE PELLETS (1B-7T-1)	95	T8: U Oxide	Non-Metals	Not Intact	C-208	D-208
GE TEST	96	T4: MOX	Non-Metals	Not Intact	C-209	D-209
GENTR	97	T9: Aluminum-based	Stable Metals	Intact	C-210	D-210
GETR FILTERS	98	T8: U Oxide	Non-Metals	Not Intact	C-211	D-211
GRR (GREECE)	1069	T9: Aluminum-based	Stable Metals	Intact	C-212	D-212
GRR (GREECE)	440	T9: Aluminum-based	Stable Metals	Intact	C-213	D-213
GTRR	87	T9: Aluminum-based	Stable Metals	Intact	C-214	D-214
H. B. ROBINSON	99	T4: MOX	Non-Metals	Not Intact	C-215	D-215
H. B. ROBINSON (ASSEMBLY)	383	T8: U Oxide	Non-Metals	Intact	C-216	D-216
H. B. ROBINSON RODS	864	T8: U Oxide	Non-Metals	Not Intact	C-217	D-217
HFBR	102	T9: Aluminum-based	Stable Metals	Intact	C-218	D-218
HFBR	961	T9: Aluminum-based	Stable Metals	Intact	C-219	D-219
HFBR	706	T9: Aluminum-based	Stable Metals	Intact	C-220	D-220
HFEF FISSION CHAMBERS	894	T7: U Metal	Other	Not Intact	C-221	D-221
HFIR (INNER)	103	T9: Aluminum-based	Stable Metals	Intact	C-222	D-222
HFIR (INNER)	1083	T9: Aluminum-based	Stable Metals	Intact	C-223	D-223
HFIR (OUTER)	1084	T9: Aluminum-based	Stable Metals	Intact	C-224	D-224
HFIR (OUTER)	707	T9: Aluminum-based	Stable Metals	Intact	C-225	D-225
HIFAR (AUSTRALIA)	680	T9: Aluminum-based	Stable Metals	Intact	C-226	D-226
HOR (NETHERLANDS)	713	T9: Aluminum-based	Stable Metals	Intact	C-227	D-227
HTGR (PEACH BOTTOM SCRAP)	935	T5: U/Th Carbide	Non-Metals	Intact	C-228	D-228
HTRE (ANP)	105	T8: U Oxide	Non-Metals	Not Intact	C-229	D-229
HWCTR 3EMT-2	118	T2: Pu/U Alloy	Other	Intact	C-230	D-230
HWCTR DRIVER	117	T2: Pu/U Alloy	Other	Intact	C-231	D-231
HWCTR ETWO	867	T7: U Metal	Other	Intact	C-232	D-232

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HWCTR IMT	113	T7: U Metal	Other	Intact	C-233	D-233
HWCTR IRO	976	T8: U Oxide	Non-Metals	Intact	C-234	D-234
HWCTR IS	977	T2: Pu/U Alloy	Other	Intact	C-235	D-235
HWCTR OT	283	T8: U Oxide	Non-Metals	Intact	C-236	D-236
HWCTR RMT & SMT	790	T7: U Metal	Other	Intact	C-237	D-237
HWCTR SOT	120	T8: U Oxide	Non-Metals	Intact	C-238	D-238
HWCTR SPR	783	T2: Pu/U Alloy	Other	Intact	C-239	D-239
HWCTR SPRO	115	T8: U Oxide	Non-Metals	Intact	C-240	D-240
HWCTR SPRO	978	T8: U Oxide	Non-Metals	Intact	C-241	D-241
HWCTR SPRO	772	T8: U Oxide	Non-Metals	Intact	C-242	D-242
HWCTR TFEN	880	T2: Pu/U Alloy	Other	Intact	C-243	D-243
HWCTR TMT-1-2 & 1-3	112	T10: Misc	Other	Intact	C-244	D-244
HWCTR TWNT	791	T7: U Metal	Other	Intact	C-245	D-245
IAN-R1 (COLUMBIA)	596	T9: Aluminum-based	Stable Metals	Intact	C-246	D-246
IAN-R1 (COLUMBIA)	803	T9: Aluminum-based	Stable Metals	Intact	C-247	D-247
IEA-R1 (BRAZIL)	954	T9: Aluminum-based	Stable Metals	Intact	C-248	D-248
IEA-R1 (BRAZIL)	1076	T9: Aluminum-based	Stable Metals	Intact	C-249	D-249
IEA-R1 (BRAZIL)	545	T9: Aluminum-based	Stable Metals	Intact	C-250	D-250
IOWA ST. UNIV.	953	T9: Aluminum-based	Stable Metals	Intact	C-251	D-251
IOWA ST. UNIV.	792	T9: Aluminum-based	Stable Metals	Intact	C-252	D-252
JEN-1 (SPAIN)	749	T9: Aluminum-based	Stable Metals	Intact	C-253	D-253
JEN-1 (SPAIN)	795	T9: Aluminum-based	Stable Metals	Intact	C-254	D-254
JMTR (JAPAN)	507	T9: Aluminum-based	Stable Metals	Intact	C-255	D-255
JMTR (JAPAN)	886	T9: Aluminum-based	Stable Metals	Intact	C-256	D-256
JMTR (JAPAN)	123	T9: Aluminum-based	Stable Metals	Intact	C-257	D-257
JRR-2 (JAPAN)	885	T9: Aluminum-based	Stable Metals	Intact	C-258	D-258
JRR-2 (JAPAN)	606	T9: Aluminum-based	Stable Metals	Intact	C-259	D-259
JRR-3M (JAPAN)	1056	T9: Aluminum-based	Stable Metals	Intact	C-260	D-260
JRR-4 (JAPAN)	1071	T9: Aluminum-based	Stable Metals	Intact	C-261	D-261

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JRR-4 (JAPAN)	1070	T9: Aluminum-based	Stable Metals	Intact	C-262	D-262
JRR-4 (JAPAN)	505	T9: Aluminum-based	Stable Metals	Intact	C-263	D-263
KEMA	861	T10: Misc	Other	Not Intact	C-264	D-264
KURR (JAPAN)	601	T9: Aluminum-based	Stable Metals	Intact	C-265	D-265
LOFT CENTER FUEL MODULE (A1,A2,A3,F1)	127	T8: U Oxide	Non-Metals	Intact	C-266	D-266
LOFT CENTER FUEL MODULE (FP-1)	1061	T8: U Oxide	Non-Metals	Intact	C-267	D-267
LOFT CENTER FUEL MODULE FP-2 REMAINS	923	T8: U Oxide	Non-Metals	Not Intact	C-268	D-268
LOFT CORNER FUEL MODULE	128	T8: U Oxide	Non-Metals	Intact	C-269	D-269
LOFT FUEL RODS	924	T8: U Oxide	Non-Metals	Not Intact	C-270	D-270
LOFT SQUARE FUEL MODULE	129	T8: U Oxide	Non-Metals	Intact	C-271	D-271
LOOSE FUEL ROD STORAGE BASKET (LFRSB)	126	T8: U Oxide	Non-Metals	Not Intact	C-272	D-272
LWR COMMERCIAL FUEL	130	T8: U Oxide	Non-Metals	Not Intact	C-273	D-273
LWR SAMPLES	134	T4: MOX	Non-Metals	Not Intact	C-274	D-274
LWR SCRAP	309	T8: U Oxide	Non-Metals	Not Intact	C-275	D-275
LWR SNF SCRAP	940	T8: U Oxide	Non-Metals	Not Intact	C-276	D-276
MACMASTER (CANADA)	614	T9: Aluminum-based	Stable Metals	Intact	C-277	D-277
MISCELLANEOUS RSWF FUEL	366	T7: U Metal	Other	Intact	C-278	D-278
MISCELLANEOUS TREAT FUEL	369	T4: MOX	Non-Metals	Not Intact	C-279	D-279
MISCELLANEOUS TREAT FUEL	905	T10: Misc	Other	Not Intact	C-280	D-280
MIT	135	T9: Aluminum-based	Stable Metals	Intact	C-281	D-281
MIT	136	T9: Aluminum-based	Stable Metals	Intact	C-282	D-282
ML-1 (GCRE)	137	T8: U Oxide	Non-Metals	Intact	C-283	D-283
MNR (CANADA)	1064	T9: Aluminum-based	Stable Metals	Intact	C-284	D-284
MOX SCRAP SNF	368	T4: MOX	Non-Metals	Not Intact	C-285	D-285
MTR CANAL SCRAP	1062	T8: U Oxide	Non-Metals	Not Intact	C-286	D-286
MURR (COLUMBIA)	142	T9: Aluminum-based	Stable Metals	Intact	C-287	D-287
MURR (COLUMBIA)	144	T9: Aluminum-based	Stable Metals	Intact	C-288	D-288
MURR (COLUMBIA)	143	T9: Aluminum-based	Stable Metals	Intact	C-289	D-289
MURR (COLUMBIA)	962	T9: Aluminum-based	Stable Metals	Intact	C-290	D-290

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N REACTOR	991	T7: U Metal	Other	Not Intact	C-291	D-291
N.S. SAVANNAH	854	T8: U Oxide	Non-Metals	Intact	C-292	D-292
NEREIDE (FRANCE)	751	T9: Aluminum-based	Stable Metals	Intact	C-293	D-293
NIST	154	T9: Aluminum-based	Stable Metals	Intact	C-294	D-294
NIST	752	T9: Aluminum-based	Stable Metals	Intact	C-295	D-295
OCONEE	156	T8: U Oxide	Non-Metals	Intact	C-296	D-296
OHIO STATE	157	T9: Aluminum-based	Stable Metals	Intact	C-297	D-297
OHIO STATE	158	T9: Aluminum-based	Stable Metals	Intact	C-298	D-298
OMEGA WEST (204)	406	T9: Aluminum-based	Stable Metals	Intact	C-299	D-299
OMEGA WEST (236)	407	T9: Aluminum-based	Stable Metals	Intact	C-300	D-300
OMEGA WEST (250)	408	T9: Aluminum-based	Stable Metals	Intact	C-301	D-301
ORR	944	T9: Aluminum-based	Stable Metals	Intact	C-302	D-302
ORR	461	T9: Aluminum-based	Stable Metals	Intact	C-303	D-303
ORR	850	T9: Aluminum-based	Stable Metals	Intact	C-304	D-304
ORR	753	T9: Aluminum-based	Stable Metals	Intact	C-305	D-305
ORR	903	T9: Aluminum-based	Stable Metals	Intact	C-306	D-306
ORR	165	T9: Aluminum-based	Stable Metals	Intact	C-307	D-307
ORR EXPERIMENTS	1086	T9: Aluminum-based	Stable Metals	Not Intact	C-308	D-308
ORR SPECIAL	163	T9: Aluminum-based	Stable Metals	Intact	C-309	D-309
ORR-BW-1	160	T4: MOX	Non-Metals	Intact	C-310	D-310
PATHFINDER (SUPERHEATER)	166	T8: U Oxide	Non-Metals	Intact	C-311	D-311
PATHFINDER (SUPERHEATER)	814	T8: U Oxide	Non-Metals	Intact	C-312	D-312
PBF DRIVER CORE	167	T8: U Oxide	Non-Metals	Intact	C-313	D-313
PEACH BOTTOM (ASSEMBLY)	385	T8: U Oxide	Non-Metals	Intact	C-314	D-314
PEACH BOTTOM RODS	386	T8: U Oxide	Non-Metals	Not Intact	C-315	D-315
PEACH BOTTOM UNIT I CORE I	170	T5: U/Th Carbide	Non-Metals	Not Intact	C-316	D-316
PEACH BOTTOM UNIT I CORE I	169	T5: U/Th Carbide	Non-Metals	Not Intact	C-317	D-317
PEACH BOTTOM UNIT I CORE I (PTE-1)	1085	T5: U/Th Carbide	Non-Metals	Not Intact	C-318	D-318
PEACH BOTTOM UNIT I CORE II	171	T5: U/Th Carbide	Non-Metals	Intact	C-319	D-319

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PEACH BOTTOM UNIT I CORE II (INTACT)	206	T5: U/Th Carbide	Non-Metals	Intact	C-320	D-320
PNL MIXED MATERIAL EXP.DCC-1	430	T8: U Oxide	Non-Metals	Not Intact	C-321	D-321
PNL MIXED MATERIAL EXP.DCC-2	431	T8: U Oxide	Non-Metals	Not Intact	C-322	D-322
PNL MIXED MATERIAL EXP.DCC-3	432	T8: U Oxide	Non-Metals	Not Intact	C-323	D-323
PNL MOX FUEL	414	T4: MOX	Non-Metals	Not Intact	C-324	D-324
PNL MOX FUEL (7010)	415	T4: MOX	Non-Metals	Not Intact	C-325	D-325
PNL MOX FUEL (7055)	416	T4: MOX	Non-Metals	Not Intact	C-326	D-326
PNL MOX FUEL (7057)	417	T4: MOX	Non-Metals	Not Intact	C-327	D-327
PNL MOX PELLETS (7057)	418	T4: MOX	Non-Metals	Not Intact	C-328	D-328
PNL MOX PINS (7057)	419	T4: MOX	Non-Metals	Not Intact	C-329	D-329
PNL MOX STAR 3	433	T4: MOX	Non-Metals	Not Intact	C-330	D-330
PNL MOX STAR 4	434	T4: MOX	Non-Metals	Not Intact	C-331	D-331
PNL MOX STAR 5	435	T4: MOX	Non-Metals	Not Intact	C-332	D-332
PNL MOX STAR 6	436	T4: MOX	Non-Metals	Not Intact	C-333	D-333
PNL MOX STAR 7	422	T4: MOX	Non-Metals	Intact	C-334	D-334
PNL-3	420	T4: MOX	Non-Metals	Intact	C-335	D-335
POINT BEACH	311	T8: U Oxide	Non-Metals	Intact	C-336	D-336
PRR-1 (PHILIPPIINES)	638	T9: Aluminum-based	Stable Metals	Intact	C-337	D-337
PRR-1 (PHILLIPPINES)	558	T9: Aluminum-based	Stable Metals	Intact	C-338	D-338
PULSTAR - BUFFALO	174	T8: U Oxide	Non-Metals	Intact	C-339	D-339
PULSTAR-N.C. STATE UNIV.	175	T8: U Oxide	Non-Metals	Intact	C-340	D-340
PULSTAR-SUNY-BUFFALO	176	T8: U Oxide	Non-Metals	Intact	C-341	D-341
PURDUE UNIVERSITY	177	T9: Aluminum-based	Stable Metals	Intact	C-342	D-342
PURDUE UNIVERSITY	178	T9: Aluminum-based	Stable Metals	Intact	C-343	D-343
R-2 SVTR (SWEDEN)	801	T9: Aluminum-based	Stable Metals	Intact	C-344	D-344
R-2 SVTR (SWEDEN)	942	T9: Aluminum-based	Stable Metals	Intact	C-345	D-345
RA-3 (ARGENTINA)	636	T9: Aluminum-based	Stable Metals	Intact	C-346	D-346
RA-3 (ARGENTINA)	634	T9: Aluminum-based	Stable Metals	Intact	C-347	D-347
RECH-1 (CHILE)	708	T9: Aluminum-based	Stable Metals	Intact	C-348	D-348

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RERTR MINIPLATES	1090	T10: Misc	Other	Not Intact	C-349	D-349
RESIDUE FAILED PBF RODS	381	T8: U Oxide	Non-Metals	Not Intact	C-350	D-350
RHF (FRANCE)	179	T9: Aluminum-based	Stable Metals	Intact	C-351	D-351
RINSC	180	T9: Aluminum-based	Stable Metals	Intact	C-352	D-352
RINSC	181	T9: Aluminum-based	Stable Metals	Intact	C-353	D-353
ROBERT E. GINNA	182	T8: U Oxide	Non-Metals	Intact	C-354	D-354
ROVER (UBM)	840	T8: U Oxide	Non-Metals	Not Intact	C-355	D-355
RPI (PORTUGAL)	943	T9: Aluminum-based	Stable Metals	Intact	C-356	D-356
RSG-GAS (INDONESIA)	288	T9: Aluminum-based	Stable Metals	Intact	C-357	D-357
RU-1 (URAGUAY)	557	T9: Aluminum-based	Stable Metals	Intact	C-358	D-358
RU-1 (URAGUAY)	1073	T9: Aluminum-based	Stable Metals	Intact	C-359	D-359
RV-1 (VENEZUELA)	816	T9: Aluminum-based	Stable Metals	Intact	C-360	D-360
SAPHIR (SWITZERLAND)	444	T9: Aluminum-based	Stable Metals	Intact	C-361	D-361
SAPHIR (SWITZERLAND)	443	T9: Aluminum-based	Stable Metals	Intact	C-362	D-362
SAPHIR (SWITZERLAND)	945	T9: Aluminum-based	Stable Metals	Intact	C-363	D-363
SAXTON	882	T8: U Oxide	Non-Metals	Intact	C-364	D-364
SAXTON	787	T4: MOX	Non-Metals	Not Intact	C-365	D-365
SAXTON	883	T4: MOX	Non-Metals	Not Intact	C-366	D-366
SAXTON	788	T8: U Oxide	Non-Metals	Intact	C-367	D-367
SHIPPINGPORT (MET MOUNTS)	1087	T6: U/Th Oxide	Non-Metals	Not Intact	C-368	D-368
SHIPPINGPORT LWBR BLKT I	374	T6: U/Th Oxide	Non-Metals	Intact	C-369	D-369
SHIPPINGPORT LWBR BLKT II	375	T6: U/Th Oxide	Non-Metals	Intact	C-370	D-370
SHIPPINGPORT LWBR BLKT III	376	T6: U/Th Oxide	Non-Metals	Intact	C-371	D-371
SHIPPINGPORT LWBR REFLCT. IV	371	T6: U/Th Oxide	Non-Metals	Intact	C-372	D-372
SHIPPINGPORT LWBR REFLCT. V	372	T6: U/Th Oxide	Non-Metals	Intact	C-373	D-373
SHIPPINGPORT LWBR SCRAP	377	T6: U/Th Oxide	Non-Metals	Not Intact	C-374	D-374
SHIPPINGPORT LWBR SCRAP (LINER 15718)	379	T6: U/Th Oxide	Non-Metals	Not Intact	C-375	D-375
SHIPPINGPORT LWBR SEED	380	T6: U/Th Oxide	Non-Metals	Intact	C-376	D-376
SHIPPINGPORT PWR C1 BLKT	191	T8: U Oxide	Non-Metals	Intact	C-377	D-377

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SHIPPINGPORT PWR C1 BLKT (RODS)	189	T8: U Oxide	Non-Metals	Intact	C-378	D-378
SHIPPINGPORT PWR C2 BLKT	193	T8: U Oxide	Non-Metals	Intact	C-379	D-379
SHIPPINGPORT PWR C2 BLKT	192	T8: U Oxide	Non-Metals	Intact	C-380	D-380
SHIPPINGPORT PWR-C1-S4	194	T2: Pu/U Alloy	Other	Intact	C-381	D-381
SHIPPINGPORT PWR-C2-S1	195	T8: U Oxide	Non-Metals	Intact	C-382	D-382
SHIPPINGPORT PWR-C2-S2	196	T8: U Oxide	Non-Metals	Intact	C-383	D-383
SINGLE PASS REACTOR FUEL	198	T7: U Metal	Other	Not Intact	C-384	D-384
SINGLE PASS REACTOR FUEL	197	T7: U Metal	Other	Not Intact	C-385	D-385
SLOWPOKE (CANADA)	296	T9: Aluminum-based	Stable Metals	Intact	C-386	D-386
SLOWPOKE (CANADA)	1065	T9: Aluminum-based	Stable Metals	Intact	C-387	D-387
SM-1A	201	T8: U Oxide	Non-Metals	Not Intact	C-388	D-388
SNAP	203	T11: U-ZrHx	Non-Metals	Not Intact	C-389	D-389
SODIUM LOOP SAFETY FAC.	352	T4: MOX	Non-Metals	Not Intact	C-390	D-390
SODIUM LOOP SAFETY FAC.	367	T4: MOX	Non-Metals	Not Intact	C-391	D-391
SP-100 FUEL	777	T8: U Oxide	Non-Metals	Not Intact	C-392	D-392
SPEC (ORME)	208	T2: Pu/U Alloy	Other	Not Intact	C-393	D-393
SPERT-III	209	T8: U Oxide	Non-Metals	Not Intact	C-394	D-394
SPSS (SPERT)	213	T8: U Oxide	Non-Metals	Not Intact	C-395	D-395
THOR (TAIWAN)	629	T9: Aluminum-based	Stable Metals	Intact	C-396	D-396
TMI-2	228	T8: U Oxide	Non-Metals	Not Intact	C-397	D-397
TMI-2 CORE DEBRIS	914	T8: U Oxide	Non-Metals	Not Intact	C-398	D-398
TMI-2 CORE DEBRIS (D-153 & 388)	229	T8: U Oxide	Non-Metals	Not Intact	C-399	D-399
TORY-IIA	230	T8: U Oxide	Non-Metals	Not Intact	C-400	D-400
TORY-IIC	231	T8: U Oxide	Non-Metals	Not Intact	C-401	D-401
TREAT DRIVER	232	T8: U Oxide	Non-Metals	Intact	C-402	D-402
TRIGA FFCR (AFRRI)	969	T11: U-ZrHx	Non-Metals	Intact	C-403	D-403
TRIGA FFCR (UC-IRVINE)	1050	T11: U-ZrHx	Non-Metals	Intact	C-404	D-404
TRIGA FFCR (UC-IRVINE)	1052	T11: U-ZrHx	Non-Metals	Intact	C-405	D-405
TRIGA STD (HANFORD)	316	T11: U-ZrHx	Non-Metals	Intact	C-406	D-406

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TRIGA (DEMOUNTABLE) (U OF AZ)	971	T11: U-ZrHx	Non-Metals	Intact	C-407	D-407
TRIGA 20/30 (GA)	995	T11: U-ZrHx	Non-Metals	Intact	C-408	D-408
TRIGA ACPR (SLOVENIA)	932	T11: U-ZrHx	Non-Metals	Intact	C-409	D-409
TRIGA ACPR (JAPAN)	480	T11: U-ZrHx	Non-Metals	Intact	C-410	D-410
TRIGA ACPR (ROMANIA)	1077	T11: U-ZrHx	Non-Metals	Intact	C-411	D-411
TRIGA ACPR PENN. STATE UNIV.	1002	T11: U-ZrHx	Non-Metals	Intact	C-412	D-412
TRIGA FFCR	448	T11: U-ZrHx	Non-Metals	Intact	C-413	D-413
TRIGA FFCR (DORF)	315	T11: U-ZrHx	Non-Metals	Intact	C-414	D-414
TRIGA FFCR (ENGLAND)	987	T11: U-ZrHx	Non-Metals	Intact	C-415	D-415
TRIGA FFCR (GA)	1003	T11: U-ZrHx	Non-Metals	Intact	C-416	D-416
TRIGA FFCR (HEIDELBERG)	1045	T11: U-ZrHx	Non-Metals	Intact	C-417	D-417
TRIGA FFCR (ITALY)	730	T11: U-ZrHx	Non-Metals	Intact	C-418	D-418
TRIGA FFCR (MNRC)	737	T11: U-ZrHx	Non-Metals	Intact	C-419	D-419
TRIGA FFCR (MNRC)	703	T11: U-ZrHx	Non-Metals	Intact	C-420	D-420
TRIGA FFCR (MNRC)	1055	T11: U-ZrHx	Non-Metals	Intact	C-421	D-421
TRIGA FFCR (OSU)	1041	T11: U-ZrHx	Non-Metals	Intact	C-422	D-422
TRIGA FFCR (OSU)	1039	T11: U-ZrHx	Non-Metals	Intact	C-423	D-423
TRIGA FFCR (PENN. STATE UNIV.)	815	T11: U-ZrHx	Non-Metals	Intact	C-424	D-424
TRIGA FFCR (SLOVENIA)	941	T11: U-ZrHx	Non-Metals	Intact	C-425	D-425
TRIGA FFCR (SO. KOREA)	734	T11: U-ZrHx	Non-Metals	Intact	C-426	D-426
TRIGA FFCR (U OF AZ)	974	T11: U-ZrHx	Non-Metals	Intact	C-427	D-427
TRIGA FFCR (U OF TX AUSTIN)	825	T11: U-ZrHx	Non-Metals	Intact	C-428	D-428
TRIGA FFCR (ZAIRE)	735	T11: U-ZrHx	Non-Metals	Intact	C-429	D-429
TRIGA FLIP	354	T11: U-ZrHx	Non-Metals	Intact	C-430	D-430
TRIGA FLIP	241	T11: U-ZrHx	Non-Metals	Intact	C-431	D-431
TRIGA FLIP	242	T11: U-ZrHx	Non-Metals	Intact	C-432	D-432
TRIGA FLIP	243	T11: U-ZrHx	Non-Metals	Intact	C-433	D-433
TRIGA FLIP	240	T11: U-ZrHx	Non-Metals	Intact	C-434	D-434
TRIGA FLIP	239	T11: U-ZrHx	Non-Metals	Intact	C-435	D-435

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TRIGA FLIP (AUSTRIA)	492	T11: U-ZrHx	Non-Metals	Intact	C-436	D-436
TRIGA FLIP (BANGLADESH)	470	T11: U-ZrHx	Non-Metals	Intact	C-437	D-437
TRIGA FLIP (DAMAGED) (SO. KOREA)	819	T11: U-ZrHx	Non-Metals	Intact	C-438	D-438
TRIGA FLIP (GA)	729	T11: U-ZrHx	Non-Metals	Intact	C-439	D-439
TRIGA FLIP (MALAYSIA)	497	T11: U-ZrHx	Non-Metals	Intact	C-440	D-440
TRIGA FLIP (MEXICO)	493	T11: U-ZrHx	Non-Metals	Intact	C-441	D-441
TRIGA FLIP (PHILIPPINES)	499	T11: U-ZrHx	Non-Metals	Intact	C-442	D-442
TRIGA FLIP (SLOVENIA)	495	T11: U-ZrHx	Non-Metals	Intact	C-443	D-443
TRIGA FLIP (SO. KOREA)	494	T11: U-ZrHx	Non-Metals	Intact	C-444	D-444
TRIGA FLIP (TAIWAN)	498	T11: U-ZrHx	Non-Metals	Intact	C-445	D-445
TRIGA FLIP (THAILAND)	496	T11: U-ZrHx	Non-Metals	Intact	C-446	D-446
TRIGA FLIP [DAMAGED] (TEXAS A&M)	844	T11: U-ZrHx	Non-Metals	Intact	C-447	D-447
TRIGA FLIP ANL-W (NRAD)	884	T11: U-ZrHx	Non-Metals	Intact	C-448	D-448
TRIGA FLIP FFCR (GA)	996	T11: U-ZrHx	Non-Metals	Intact	C-449	D-449
TRIGA FLIP FFCR (OSU)	702	T11: U-ZrHx	Non-Metals	Intact	C-450	D-450
TRIGA FLIP FFCR (SO. KOREA)	733	T11: U-ZrHx	Non-Metals	Intact	C-451	D-451
TRIGA FLIP UNIV OF WISCONSIN	1035	T11: U-ZrHx	Non-Metals	Intact	C-452	D-452
TRIGA HIGH POWER (GA)	998	T11: U-ZrHx	Non-Metals	Intact	C-453	D-453
TRIGA HIGH POWER (ROMANIA)	930	T11: U-ZrHx	Non-Metals	Intact	C-454	D-454
TRIGA HIGH POWER (ROMANIA)	302	T11: U-ZrHx	Non-Metals	Intact	C-455	D-455
TRIGA STD	261	T11: U-ZrHx	Non-Metals	Intact	C-456	D-456
TRIGA STD	314	T11: U-ZrHx	Non-Metals	Intact	C-457	D-457
TRIGA STD	256	T11: U-ZrHx	Non-Metals	Intact	C-458	D-458
TRIGA STD	233	T11: U-ZrHx	Non-Metals	Intact	C-459	D-459
TRIGA STD	258	T11: U-ZrHx	Non-Metals	Intact	C-460	D-460
TRIGA STD	237	T11: U-ZrHx	Non-Metals	Intact	C-461	D-461
TRIGA STD	353	T11: U-ZrHx	Non-Metals	Intact	C-462	D-462
TRIGA STD	264	T11: U-ZrHx	Non-Metals	Intact	C-463	D-463
TRIGA STD	262	T11: U-ZrHx	Non-Metals	Intact	C-464	D-464

					Source Term Est.	
					Page #	
Fuel Name	SNF ID	TSPA Category	DBE Category		2010	2030
TRIGA STD	265	T11: U-ZrHx	Non-Metals	Intact	C-465	D-465
TRIGA STD	268	T11: U-ZrHx	Non-Metals	Intact	C-466	D-466
TRIGA STD	370	T11: U-ZrHx	Non-Metals	Intact	C-467	D-467
TRIGA STD	252	T11: U-ZrHx	Non-Metals	Intact	C-468	D-468
TRIGA STD	447	T11: U-ZrHx	Non-Metals	Intact	C-469	D-469
TRIGA STD	238	T11: U-ZrHx	Non-Metals	Intact	C-470	D-470
TRIGA STD	253	T11: U-ZrHx	Non-Metals	Intact	C-471	D-471
TRIGA STD	251	T11: U-ZrHx	Non-Metals	Intact	C-472	D-472
TRIGA STD	235	T11: U-ZrHx	Non-Metals	Intact	C-473	D-473
TRIGA STD	246	T11: U-ZrHx	Non-Metals	Intact	C-474	D-474
TRIGA STD	244	T11: U-ZrHx	Non-Metals	Not Intact	C-475	D-475
TRIGA STD	250	T11: U-ZrHx	Non-Metals	Intact	C-476	D-476
TRIGA STD	254	T11: U-ZrHx	Non-Metals	Intact	C-477	D-477
TRIGA STD	267	T11: U-ZrHx	Non-Metals	Intact	C-478	D-478
TRIGA STD	260	T11: U-ZrHx	Non-Metals	Intact	C-479	D-479
TRIGA STD (ACPR)	895	T11: U-ZrHx	Non-Metals	Intact	C-480	D-480
TRIGA STD (ARRR)	780	T11: U-ZrHx	Non-Metals	Intact	C-481	D-481
TRIGA STD (AUSTRIA)	469	T11: U-ZrHx	Non-Metals	Intact	C-482	D-482
TRIGA STD (AUSTRIA)	462	T11: U-ZrHx	Non-Metals	Intact	C-483	D-483
TRIGA STD (BRAZIL)	1063	T11: U-ZrHx	Non-Metals	Intact	C-484	D-484
TRIGA STD (BRAZIL)	471	T11: U-ZrHx	Non-Metals	Intact	C-485	D-485
TRIGA STD (CORNELL)	1047	T11: U-ZrHx	Non-Metals	Intact	C-486	D-486
TRIGA STD (DOW)	970	T11: U-ZrHx	Non-Metals	Intact	C-487	D-487
TRIGA STD (ENGLAND)	485	T11: U-ZrHx	Non-Metals	Intact	C-488	D-488
TRIGA STD (FINLAND)	472	T11: U-ZrHx	Non-Metals	Intact	C-489	D-489
TRIGA STD (FINLAND)	463	T11: U-ZrHx	Non-Metals	Intact	C-490	D-490
TRIGA STD (GA)	728	T11: U-ZrHx	Non-Metals	Intact	C-491	D-491
TRIGA STD (GA)	870	T11: U-ZrHx	Non-Metals	Intact	C-492	D-492
TRIGA STD (GERMANY)	465	T11: U-ZrHx	Non-Metals	Intact	C-493	D-493

					Source Term Est.	
					Page #	
Fuel Name	SNF ID	TSPA Category	DBE Category		2010	2030
TRIGA STD (GERMANY)	474	T11: U-ZrHx	Non-Metals	Intact	C-494	D-494
TRIGA STD (GERMANY)	305	T11: U-ZrHx	Non-Metals	Intact	C-495	D-495
TRIGA STD (HANFORD)	876	T11: U-ZrHx	Non-Metals	Intact	C-496	D-496
TRIGA STD (HANNOVER)	303	T11: U-ZrHx	Non-Metals	Intact	C-497	D-497
TRIGA STD (HANNOVER)	473	T11: U-ZrHx	Non-Metals	Intact	C-498	D-498
TRIGA STD (HEIDELBERG)	1044	T11: U-ZrHx	Non-Metals	Intact	C-499	D-499
TRIGA STD (HEIDELBERG)	464	T11: U-ZrHx	Non-Metals	Intact	C-500	D-500
TRIGA STD (IFE) (ENGLAND)	1043	T11: U-ZrHx	Non-Metals	Intact	C-501	D-501
TRIGA STD (IFE) (ITALY)	929	T11: U-ZrHx	Non-Metals	Intact	C-502	D-502
TRIGA STD (IFE) (OSU)	1040	T11: U-ZrHx	Non-Metals	Intact	C-503	D-503
TRIGA STD (IFE) (U OF AZ)	972	T11: U-ZrHx	Non-Metals	Intact	C-504	D-504
TRIGA STD (IFE) (U OF AZ)	973	T11: U-ZrHx	Non-Metals	Intact	C-505	D-505
TRIGA STD (IFE) (U OF IL)	1048	T11: U-ZrHx	Non-Metals	Intact	C-506	D-506
TRIGA STD (IFE) (UC-IRVINE)	824	T11: U-ZrHx	Non-Metals	Intact	C-507	D-507
TRIGA STD (IFE) (UC-IRVINE)	1051	T11: U-ZrHx	Non-Metals	Intact	C-508	D-508
TRIGA STD (INDONESIA)	475	T11: U-ZrHx	Non-Metals	Intact	C-509	D-509
TRIGA STD (INDONESIA)	476	T11: U-ZrHx	Non-Metals	Intact	C-510	D-510
TRIGA STD (ITALY)	467	T11: U-ZrHx	Non-Metals	Intact	C-511	D-511
TRIGA STD (ITALY)	478	T11: U-ZrHx	Non-Metals	Intact	C-512	D-512
TRIGA STD (ITALY)	466	T11: U-ZrHx	Non-Metals	Intact	C-513	D-513
TRIGA STD (ITALY)	1080	T11: U-ZrHx	Non-Metals	Intact	C-514	D-514
TRIGA STD (ITALY)	477	T11: U-ZrHx	Non-Metals	Intact	C-515	D-515
TRIGA STD (JAPAN)	481	T11: U-ZrHx	Non-Metals	Intact	C-516	D-516
TRIGA STD (JAPAN)	479	T11: U-ZrHx	Non-Metals	Intact	C-517	D-517
TRIGA STD (KSU)	804	T11: U-ZrHx	Non-Metals	Intact	C-518	D-518
TRIGA STD (KSU)	871	T11: U-ZrHx	Non-Metals	Intact	C-519	D-519
TRIGA STD (MEXICO)	482	T11: U-ZrHx	Non-Metals	Intact	C-520	D-520
TRIGA STD (MNRC)	704	T11: U-ZrHx	Non-Metals	Intact	C-521	D-521
TRIGA STD (MNRC)	1053	T11: U-ZrHx	Non-Metals	Intact	C-522	D-522

					Source Term Est.	
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Fuel Name	SNF ID	TSPA Category	DBE Category		2010	2030
TRIGA STD (MNRC)	1054	T11: U-ZrHx	Non-Metals	Intact	C-523	D-523
TRIGA STD (MSU)	873	T11: U-ZrHx	Non-Metals	Not Intact	C-524	D-524
TRIGA STD (MSU)	878	T11: U-ZrHx	Non-Metals	Intact	C-525	D-525
TRIGA STD (REED COLLEGE)	775	T11: U-ZrHx	Non-Metals	Intact	C-526	D-526
TRIGA STD (ROMANIA)	1078	T11: U-ZrHx	Non-Metals	Intact	C-527	D-527
TRIGA STD (SLOVENIA)	468	T11: U-ZrHx	Non-Metals	Intact	C-528	D-528
TRIGA STD (SLOVENIA)	488	T11: U-ZrHx	Non-Metals	Intact	C-529	D-529
TRIGA STD (SLOVENIA)	1079	T11: U-ZrHx	Non-Metals	Intact	C-530	D-530
TRIGA STD (SO. KOREA)	484	T11: U-ZrHx	Non-Metals	Intact	C-531	D-531
TRIGA STD (SO. KOREA)	483	T11: U-ZrHx	Non-Metals	Intact	C-532	D-532
TRIGA STD (SOLVENIA)	731	T11: U-ZrHx	Non-Metals	Intact	C-533	D-533
TRIGA STD (THAILAND)	489	T11: U-ZrHx	Non-Metals	Intact	C-534	D-534
TRIGA STD (TURKEY)	490	T11: U-ZrHx	Non-Metals	Intact	C-535	D-535
TRIGA STD (U OF AZ)	59	T11: U-ZrHx	Non-Metals	Intact	C-536	D-536
TRIGA STD (U OF AZ)	975	T11: U-ZrHx	Non-Metals	Intact	C-537	D-537
TRIGA STD (U OF ILL)	449	T11: U-ZrHx	Non-Metals	Intact	C-538	D-538
TRIGA STD (U OF UTAH)	699	T11: U-ZrHx	Non-Metals	Intact	C-539	D-539
TRIGA STD (UC BERKLEY)	874	T11: U-ZrHx	Non-Metals	Not Intact	C-540	D-540
TRIGA STD (UNIV. OF TEXAS)	877	T11: U-ZrHx	Non-Metals	Intact	C-541	D-541
TRIGA STD (USGS)	964	T11: U-ZrHx	Non-Metals	Intact	C-542	D-542
TRIGA STD (ZAIRE)	486	T11: U-ZrHx	Non-Metals	Intact	C-543	D-543
TRIGA STD (ZAIRE)	487	T11: U-ZrHx	Non-Metals	Intact	C-544	D-544
TRR-1 (THAILAND)	633	T9: Aluminum-based	Stable Metals	Intact	C-545	D-545
TRU SCRAP SNF	904	T10: Misc	Other	Not Intact	C-546	D-546
TURKEY POINT	271	T8: U Oxide	Non-Metals	Intact	C-547	D-547
UMRR (ROLLA)	146	T9: Aluminum-based	Stable Metals	Intact	C-548	D-548
UMRR (ROLLA)	881	T9: Aluminum-based	Stable Metals	Intact	C-549	D-549
UNIV OF FLORIDA (ARGONAUT)	273	T9: Aluminum-based	Stable Metals	Intact	C-550	D-550
UNIV OF FLORIDA (ARGONAUT)	272	T9: Aluminum-based	Stable Metals	Intact	C-551	D-551

					Source Term Est.	
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Fuel Name	SNF ID	TSPA Category	DBE Category		2010	2030
UNIV OF MASS-LOWELL	275	T9: Aluminum-based	Stable Metals	Intact	C-552	D-552
UNIV OF MASS-LOWELL	274	T9: Aluminum-based	Stable Metals	Intact	C-553	D-553
UNIV OF MICHIGAN	276	T9: Aluminum-based	Stable Metals	Intact	C-554	D-554
UNIV OF MICHIGAN	277	T9: Aluminum-based	Stable Metals	Intact	C-555	D-555
UNIV OF MICHIGAN (CONTROL)	1005	T9: Aluminum-based	Stable Metals	Intact	C-556	D-556
UNIV OF VIRGINIA	279	T9: Aluminum-based	Stable Metals	Intact	C-557	D-557
UNIV OF VIRGINIA	952	T9: Aluminum-based	Stable Metals	Intact	C-558	D-558
US/UK FUEL PINS	356	T4: MOX	Non-Metals	Not Intact	C-559	D-559
VBWR	855	T8: U Oxide	Non-Metals	Intact	C-560	D-560
VBWR (GENEVA)	285	T8: U Oxide	Non-Metals	Not Intact	C-561	D-561
VEPCO	700	T8: U Oxide	Non-Metals	Intact	C-562	D-562
VEPCO	286	T8: U Oxide	Non-Metals	Intact	C-563	D-563
VEPCO (T-11 ASSEMBLY)	993	T8: U Oxide	Non-Metals	Intact	C-564	D-564
VEPCO (T-11 RODS)	1049	T8: U Oxide	Non-Metals	Intact	C-565	D-565
VEPCO (T-11)	994	T8: U Oxide	Non-Metals	Intact	C-566	D-566
WORCESTER POLY INSTITUTE	287	T9: Aluminum-based	Stable Metals	Intact	C-567	D-567
ZPRL (TAIWAN)	554	T9: Aluminum-based	Stable Metals	Intact	C-568	D-568

Appendix C

Source Term Estimates for the Year 2010

(See Volume II)

Appendix D

Source Term Estimates for the Year 2030

(See Volume III)

Appendix E

Uncertainty Estimates

Appendix E

Uncertainty Estimates

Spent nuclear fuel (SNF) source terms generated using the template methodology are estimates based on reasonable assumptions, conservative analyses, and available characterization data. Each assumption, analysis, and piece of data introduces some level of uncertainty into the final source estimate. Uncertainties are introduced by (1) uncertainty within the calculational methodology (i.e., ORIGEN) used to generate the radionuclide inventories for the template fuels, (2) uncertainty in the ORIGEN input data used to generate the radionuclide inventories for the template fuels, and (3) the information relied on for selecting and scaling a template (i.e., precalculated results from a similar fuel) including the effects of estimating the burnup and of using the linear approximation to estimate the radionuclide inventories. These uncertainties may enter the approximation in association with each of the terms used in the estimate. Recall that the template methodology estimates the inventory for each radionuclide by using a linear approximation of the form

$$y = mx + b$$

where

y	=	estimated radionuclide inventory
m	=	generation (or depletion) rate of the radionuclide per MWd and is determined by the change in the template inventory divided by the template burnup
x	=	burnup associated with the fuel whose radionuclide inventory is being estimated
b	=	initial radionuclide inventory (i.e., prior to any burnup).

The radionuclide generation rate, "m," is determined from the precalculated template results and is affected by the uncertainty inherent in the ORIGEN calculation, $U_{ORIGEN\ calc}$ (see Section E-1). This term is also affected by the degree to which the ORIGEN inputs match the fuel whose radionuclide inventory is being estimated. When the fuel being estimated is in fact the fuel used to generate the template (i.e., the template fuel), this uncertainty is termed $U_{ORIGEN\ input}$ (see Section E-2). When a template must be selected from a similar fuel, this uncertainty is referred to as $U_{temp\ sel}$ (see Section E-3.1).

The accuracy of the burnup, "x," of the fuel being estimated also contributes to the uncertainty. This uncertainty is referred to as U_{BU}, and its value varies based on whether the burnup came directly (or was calculated directly) from information in the Spent Fuel Database or whether it was estimated using the fuel's end-of-life (EOL) heavy metal content. The uncertainty associated with the burnup is discussed in Section E-3.2.1.

The accuracy of the initial inventory, "b," is not explicitly considered in this uncertainty analysis. This is because "b" is zero for all radionuclides except those present in fresh fuel (e.g., U-235 and U-238). Consequently, radionuclides with nonzero initial values are not significant contributors to the overall source term.

Lastly, uncertainty is introduced by the methodology itself because it relies on a linear approximation to model radionuclide production as a function of burnup. This uncertainty, termed $U_{lin\ scal}$, is discussed in Section E-3.2.2.

The following discussion is intended to help the reader better understand the limitations and sources of these uncertainties. In Sections E-1 through E-3, each of these sources of uncertainties in the template-generated source term estimates are identified and assigned a quantitative value. These values are based on validation studies that provide a confidence level on how well the calculations compare to measured assay data and by engineering judgment based on the logic imbedded within the template methodology. As such, the quantitative values assigned are based on SNF experience and are themselves estimates. In Section E-4, after making a number of simplifying assumptions, these uncertainties are combined to derive an expression that can be used to estimate a confidence level associated with the radionuclide inventories calculated on each of the Fuel Radionuclide Inventory Worksheets.

E-1. UNCERTAINTY IN CALCULATIONAL METHODOLOGY, $U_{ORIGEN\ CALC}$

The ORIGEN computer code is the primary calculational tool used in the development of the radionuclide inventories or source term for each of the template fuels. The ORIGEN code is widely used and accepted throughout the nuclear industry to perform depletion calculations for predicting radionuclide inventories. Much effort has gone into validating the ORIGEN computer code over the years with the primary focus on commercial oxide SNFs. The DOE-owned nuclear reactor spent fuels, on the other hand, span the gamut of the fuel element designs, uranium enrichment and loading, and neutron spectrum. Validation of the ORIGEN code for these fuels required a special effort to demonstrate ORIGEN's capability to predict inventories other than commercial SNF.

A limited number of validation studies have been performed for the ORIGEN code in support of the template methodology on both commercial and noncommercial DOE SNFs. Two commercial fuels were included to give the validation studies a reference base with the main intention to test a variety of unusual spent fuels and thereby demonstrate the ORIGEN code's capability for predicting spent fuel nuclide concentrations and other spent fuel parameters for any SNF. Specifically, these validation studies included the spent fuels from the following nuclear reactors:

- H. B. Robinson (commercial low-enriched uranium [LEU])
- Turkey Point (commercial LEU)
- Advanced Test Reactor (light water highly-enriched uranium [HEU])
- Advanced Reactivity Measurement Facility Reactor (light water HEU)
- Light Water Breeder Reactor (light water HEU-U233)
- N-Reactor (graphite, light water LEU)
- Fort St. Vrain (graphite HEU)
- TRIGA (light water medium-enriched uranium).

The main goal of these validation studies was to demonstrate the accuracy of the code and develop a level of understanding of what the expected uncertainties might be for the calculational methodology for commercial and noncommercial SNF types. In these validation studies, the calculation input is assumed to be exact, and the calculated source terms are then compared against measured data. Based on these comparisons between calculated and measured data, the uncertainty or level of confidence bands can be determined on a radionuclide-by-radionuclide basis. Integrated values, such as decay heats and gross gamma dose rates, are also compared in order to draw conclusions relative to total inventories. However, because the input data can never be exact, a portion of the uncertainty identified by the validation studies must be attributed to uncertainty in the input data.

In order to understand the magnitude of expected uncertainty under the best input data conditions, validation studies were performed for specific fuel types used in the template methodology.[1–5] These studies compare measured radionuclide concentrations, isotopic ratios, decay heats, or gamma dose rates with calculated values. The input data for the calculation is based on measured values that include burnup data, power or irradiation history information, beginning-of-life (BOL) fuel element heavy metal loadings, and material constituent impurity concentrations. As with any computer code prediction, there is an uncertainty associated with the calculated values relative to the experimentally measured values. And although the comparison of calculated versus measured values is the generally accepted means to validate a computer code, one needs to be cognizant of any associated experimental error in the measured values too. Based on experience, the template methodology and computer codes used to estimate radionuclide depletion, buildup, and decay are, however, quite accurate given accurate input and library data.

The following uncertainty estimates are based on generalized results from template validation studies and represent expected calculated uncertainties for various radionuclides for EOL conditions:

1. ±1–5% for U-235, U-238, Pu-239, Th-232 concentrations
2. ±10–30% for U-233, U-234, U-236, Np-237, Pu-240 concentrations
3. ±30–50% for other significant concentration higher-order actinides (Pu-238, Pu-241, Pu-242, etc.)
4. ±50–400% for other insignificant concentration higher order actinides and daughter decay products
5. ±1–5% for direct yield fission products
6. ±5–50% for indirect yield and transmutation fission products
7. ±5–50% for major constituent activation products
8. ± factor of 2–3 for activation product impurities (Co-60, C-14, etc.)
9. ±5–10% for decay heat
10. ± factor of 1.2–2.0 gross gamma dose rates.

Based on the validation studies, uncertainties of this magnitude can be expected from the ORIGEN code using the best available or most accurate experimental input data for a particular spent fuel prediction. Based on these generalized validation results, the following values are considered appropriate to represent the calculational uncertainty for fission products and for significant nonfission products, respectively.

$$U_{\text{ORIGEN calc}} = \pm 5\% \quad \text{fission products}$$
$$\pm 40\% \quad \text{nonfission products.}$$

E-2. UNCERTAINTY IN ORIGEN INPUT DATA, $U_{\text{ORIGEN INPUT}}$

The key ORIGEN input data parameters that have associated uncertainties include the following: (1) burnup (MWD, MWD/MT, fissions/cc, %FIMA, etc.), (2) BOL heavy metal and structural mass loadings, and (3) neutron cross sections. The next three subsections address the potential uncertainties associated with each of these parameters and their influence on the ORIGEN calculation results. Based on these discussions, it was concluded that

$$U_{\text{ORIGEN input}} = \pm 5\% \quad \text{fission products}$$
$$\pm 20\% \quad \text{nonfission products.}$$

These uncertainties are sufficient to conservatively account for that associated with the both BOL mass loadings and the neutron cross sections. They apply only when the template methodology is used to estimate radionuclide inventories for fuels that are in fact the template fuels. When the fuel being estimated is not the same fuel as the template fuel, the effects of the uncertainties associated with the ORIGEN input data are accounted for by the uncertainties associated with selecting an appropriate template ($U_{\text{temp sel}}$ discussed in Section E-3.1).

These uncertainties (i.e., $U_{\text{ORIGEN input}}$ and $U_{\text{temp sel}}$) are also considered sufficient to account for any error associated with the updates to the ORIGEN data libraries that have occurred since the 1980 version of the ORIGEN2 code used to generate the template results.

E-2.1 Burnup

Spent fuel radionuclide concentrations of activation products, actinides/daughter decay nuclides, and fission products are all functions of the spent fuel burnup. In fact, uncertainty in the spent fuel burnup is the principal factor in predicting activation, actinide, and fission product radionuclide concentrations. The burnup is, therefore, the major contributor to uncertainty in the resulting source term. However, the template methodology scales the template fuel's ORIGEN results to account for differences between the burnup used to generate the template and the burnup of the particular fuel being estimated. Consequently, the error associated with the burnup is not attributable to the accuracy of the burnup inputs for the template calculation but rather the accuracy of the burnup value for the fuel being estimated. The remainder of this section illustrates the importance of burnup in predicting the source term. The error associated with uncertainty in the burnup of the fuel being estimated is discussed in Section E-3.2.1.

The burnup is the key parameter in predicting radionuclide inventories because many radionuclides are directly dependent on the burnup. For example, all fission product radionuclides are directly dependent on the burnup or the number of fission events. And because each fission event yields a distribution of fission products that are quite well known, the accuracy of the estimated fission product concentration is tightly coupled to the accuracy of the burnup. U-235 and U-238 concentrations are also directly dependent on the burnup. Indirect-yield and transmutation fission products, although typically very low concentrations in SNFs, have a cross-sectional dependency and, therefore, a cross-sectional uncertainty from the calculation.

The following discussion is provided to help one understand the relative importance of activation, actinide, and fission products on source term for a fixed burnup. The source term may be used for a variety of purposes such as shielding or thermal analyses, i.e., gamma-ray energy emissions or decay heat generation, respectively. First consider the source term in terms of its gamma energy emission rates. The gamma energy for the high burnup Advanced Test Reactor and Fort St. Vrain fuel elements (Tables 1 and 2) show that the fission products dominate the gamma energy emission rate across the 5 to 100-year decay time span addressed by the template methodology. A similar analysis shows that the decay heat (beta-gamma emission energy) is also dominated by the fission products, particularly at early times (see Tables 3 and 4).

Table 1. Gamma radiation energy emission by component for high burnup Advanced Test Reactor as a function of decay time.

Component	5-Year Decay	35-Year Decay	100-Year Decay
Activation products	0.02%	0.0002%	4E-6%
Actinides/daughters	0.002%	0.01%	0.04%
Fission products	99.98%	99.99%	99.96%

Table 2. Gamma radiation energy emission by component for high burnup FSV SNF as a function of decay time.

Component	5-Year Decay	35-Year Decay	100-Year Decay
Activation products	1.69%	0.124%	5.68E-3%
Actinides/daughters	0.1%	0.319%	0.82%
Fission products	98.21%	99.56%	99.17%

Table 3. Advanced Test Reactor SNF decay heat partitions as a function of decay time.

Component	5-Year Decay	35-Year Decay	100-Year Decay
Activation products	0.027%	0.0005%	0.0012%
Actinides/daughters	1.44%	3.84%	11.11%
Fission products	98.53%	96.16%	88.89%

Table 4. Fort St. Vrain SNF decay heat partitions as a function of decay time.

Component	5-Year Decay	35-Year Decay	100-Year Decay
Activation products	0.756%	0.0366%	0.0016%
Actinides/daughters	15.77%	29.07%	52.99%
Fission products	83.47%	70.89%	47.0%

Thus, accuracy in predicting the concentrations of fission products is key to reducing uncertainty in the source term estimates. Fission product concentrations are dependent on the accuracy of the burnup used to determine the scaling factor applied to the template results. The uncertainties associated with this scaling factor are discussed in Section E-3.1.

E-2.2 Beginning-of-Life Mass Loadings

The BOL heavy metal masses for most SNF elements are usually well known and well documented. The as-fabricated fuel elements typically have uranium or other heavy metal mass loading that have been measured to a relatively high degree of accuracy. This is especially true for the spent fuels in the validation studies and many of the template fuels where typical uncertainties range from ±1–2 percent, or less, for the major heavy metal components (U-235, U-238, Pu-239). For the minor BOL actinides (U-234, U-236, etc.), the uncertainties may be in the range of 5 to 10%. Other fuel constituents are, in general, equally well characterized for the purpose of inclusion into a fuel depletion calculation.

In addition to the heavy metal mass loading, the fuel element structural material masses also contribute to the source term (i.e., activation products). BOL concentration uncertainties in the structural materials are typically on the order of ±2 to 10% for the major constituents. Structural materials also contain impurities that can contribute significantly to the source term. Impurities with concentrations in the 0–500 ppm range can have uncertainties in the range of ±10 to 200%. In order to reduce these uncertainties, the BOL impurity concentration would have to actually be measured. The structural material masses and impurity concentrations are provided and referenced for each of the template calculations. For conservatism, the templates are based on the upper limit of ppm concentrations for each impurity. The impurity mass is also assumed to be additional mass relative to the major structural material components and the total mass of structural materials is slightly overestimated in order to be conservative, particularly for fuel elements with complex fabrication features (grooves, holes, slots, tapers, etc.).

For some of the DOE spent fuels, i.e., nonvalidation or nontemplate fuels, the BOL heavy metal mass and even the exact fuel type may not be well known. This of course presents a problem in scaling the template inventories for these fuels, and perhaps even in selecting the appropriate template for the fuel. In addition, the BOL masses can influence the neutron cross sections used in the depletion calculation. However, this effect is minimized in the template selection process by choosing the template with the most similar properties and, therefore, the most similar neutron spectral characteristics as well. The template selection process and associated uncertainties are discussed in Section E-3.1.

E-2.3 Neutron Reaction Cross Sections

Neutron cross sections are also part of the input data used in the ORIGEN calculations to predict radionuclide inventories. The neutron cross sections can change as a complex function of core burnup, BOL heavy metal mass loading, location in the core relative to targets, safety rods, etc., shim control rod/drum movement, and other neutron spatial and spectral effects. Although the neutron cross section can be difficult to calculate and change as a function of many variables, experience has shown that using calculated BOL neutron cross sections results in very good radionuclide estimates for the activation and actinide nuclides. The fission products, as mentioned in Section E-2.1, are primarily a function of the spent fuel burnup only. Use of the calculated BOL neutron cross sections for the template fuels is the approach taken for the template methodology.

For each template fuel, BOL neutron cross sections are calculated with the intent to refine or increase the accuracy of the predicted radionuclide inventory for each template. The template fuel was selected to represent all fuel assigned to a particular fuel group. The fuels in each group are carefully placed in a particular group based on similarity in moderator, fuel compound, enrichment, and cladding. Therefore, fuels in a particular group can be expected to have similar spectra characteristics and similar BOL cross sections. Cross sections were specifically developed to represent each of the template fuels and those nontemplate fuels in each template group. Template fuel cross sections were developed for 37 different actinides and 77 different fission products. For the actinides, cross section for the (n,γ), $(n,2n)$, $(n,3n)$, and (n,f) nuclear reactions were specifically developed. The statistical uncertainty in these cross sections at BOL were typically less than 1% for the (n,γ) and (n,f) nuclear reactions, approximately 5 to 10% for the $(n,2n)$, >10% for the $(n,3n)$ reaction cross sections.

E-3. UNCERTAINTY FROM SELECTING AND SCALING TEMPLATES

When applying the template methodology to estimate an SNF source term, the precalculated results from the selected template fuel are scaled to account for differences in burnup between the template fuel and the fuel being estimated. Consequently, the fidelity with which the ORIGEN input data matches the template fuel is not a significant source of the uncertainty within the template methodology. The primary source of uncertainty results from (1) template selection—how well the input parameters for the ORIGEN calculation that generated the selected template represent those of the fuel being estimated,

(2) the accuracy of the burnup information of the fuel being estimated, and (3) the linear scaling to account for the difference between the burnup of the fuel and the template fuel.

Information used to select an appropriate template and to determine the proper scaling factor is taken directly from the License Application version of the National Spent Nuclear Fuel Program (NSNFP) SFD when available. The SFD is maintained in accordance with NSNFP procedure PSO 19.02 and contains the best currently available information with respect to DOE SNFs. Information within the SFD has been drawn from documented historical records including manufacturing data, operational histories, and shipping and subsequent storage records. When SFD information is not available, the template methodology applies conservative assumptions to provide a high level of confidence that the resulting estimate will be conservative. The uncertainty associated with the SFD data as well as any assumptions employed to compensate for missing data are discussed in the appropriate sections below.

E-3.1 Template Selection, $U_{temp\ sel}$

When the template methodology is used to estimate radionuclide inventories for fuels other than the fuel used to generate the template, the uncertainty associated with the ORIGEN input data (see Section E-2) is replaced by the uncertainty associated with template selection uncertainty. In this case, the uncertainty does not represent the fidelity with which the ORIGEN inputs model the template fuel, but the fidelity with which the ORIGEN inputs model the fuel being estimated. Templates are selected based on matching the reactor moderator and the fuel compound, cladding, and enrichment. Matching these parameters ensures selection of a template that was calculated using ORIGEN inputs (i.e., BOL constituents and relative masses and cross sections) similar to the fuel being estimated. The cross sections for the actinides of a particular SNF may not coincide exactly with cross sections of the template. However, because the template uses a moderator, clad, fuel compound, and enrichment similar to the SNF, they should be within a factor of 2. For high burnup fuels, the cross section can change significantly with burnup, and differences of factors of 2–3 might be possible. Activation products from particle threshold reactions (high energy neutrons) will be relatively independent of cross section and a very small cross-section uncertainty could be expected (<20%). Activation products produced from thermal reactions will be cross-section dependent and may vary by a factor of 2 or more from the template-generated cross sections.

The four parameters used to select a template are generally available from the SFD. When fuel-specific information is not available for one or more of these parameters, conservative assumptions are made as shown in Table 1 of report DOE/SNF/REP-078. Use of these assumptions biases the uncertainty such that, although not explicitly known, the resulting estimate will tend to overpredict the radionuclide inventories and thus increase confidence that the resulting estimate envelopes the actual source term. The uncertainty applied when selecting a template using Table 1 assumptions reflects this conservatism.

In the event that an appropriate template cannot be identified, a worst case template is provided that is composed of the highest normalized radionuclide production rates (i.e., Ci/MWd/MTIHM) for each radionuclide from each of the other templates. Use of this worst case template thus maximizes the radionuclide production as a function of burnup and produces an extremely conservative estimate. The error associated with use of the worst case template cannot be quantified in a general way. However, because the 15 other templates represent a wide variety of existing fuel types, use of the worst case template provides a very high degree of confidence that, for a given burnup, the resulting radionuclide estimate will bound virtually any fuel's actual radionuclide content.

From the discussion above, the range of uncertainty associated with selecting a template is estimated as shown.

	Source of Template Selection Parameters
$U_{temp\ sel}$ = -50% to +100%	from the SFD (i.e., within a factor of 2)
$U_{temp\ sel}$ = -75% to + 50%	assumptions per Table 1 of DOE/SNF/REP-078
$U_{temp\ sel}$ = -90% to +10%	used worst case template

Although these uncertainties associated with template selection have a much smaller effect on fission products, they are conservatively applied to all radionuclides.

E-3.2 Scaling a Template

In the template methodology, burnup is addressed by scaling the precalculated results for the template fuel by the ratio of the burnup between the template fuel and the fuel being estimated. This scaling introduces uncertainty both as a result of the uncertainty associated with the burnup of the fuel being estimated and from the linear scaling used to account for the difference between the fuel burnup and that of the template. Each of these sources of uncertainty are addressed separately below.

E-3.2.1 Burnup, U_{BU}

The burnup values used to determine the scaling factors used in the estimates come directly (or are calculated directly) from information in the SFD. The burnups provided in the SFD are documented and are typically derived from calculations (or in a small number of cases derived from measurements). The calculations are typically based on actual reactor power histories and estimated fuel element burnups appropriately partitioned based on a total core power output over the known burnup period. An estimate for the uncertainty associated with a calculated burnup value would be approximately ±10%. This uncertainty would also envelop the uncertainty associated with a measured burnup value. Therefore, an error band of ±10% is used to account for the uncertainty in the burnups provided in the SFD.

When available, the SFD provides a minimum, a nominal, and a maximum burnup value. The difference between these burnups provides some insight into the distribution of burnups within the individual fuel elements associated with the SFD fuel record. The radionuclide estimates, which were produced using the template methodology and included as Appendixes C and D, include an estimate based on both a nominal and a maximum (i.e., bounding) burnup value. The estimates based on the bounding burnup value are intended to show the upper range of the radionuclide concentrations that can be expected due to the variation of burnup within all the fuels associated with that SFD record. If a maximum burnup value is not provided by the SFD, it is estimated using the logic shown in Figure 1 of report DOE/SNF/REP-078. The radionuclides estimated using this maximum burnup value are appropriate when assessing the highest potential impacts associated with a single canister or package of fuel. Use of the bounding values is expected to significantly overpredict the impacts if used to represent the composite source term for all the fuel elements included within the fuel record.

Although the SFD contains fields for both the nominal and maximum (i.e., bounding) burnup, these fields are not populated for a significant number of fuels. When burnup information is not available from the SFD, it is estimated using the logic shown in Figure 1 of the report. As noted in Figure 1, the nominal burnup is calculated from the heavy metal that is depleted when both BOL and EOL are available in the SFD. The accuracy of the resulting estimate is proportional to the accuracy of the mass values in the SFD. Because the EOL values in the SFD are checked against material accountability records and the BOL values are normally from vendor specifications and/or measurements, the calculated nominal burnups are also expected to have an accuracy within ±10%. When neither the burnup nor the BOL heavy metal is known, the BOL heavy metal is determined using very conservative assumptions (i.e., 100% depletion of all fissile material if BOL enrichment is known or that BOL heavy metal was equal to twice the EOL heavy metal). Use of these assumptions biases the resulting estimates to predict higher radionuclide inventories and, as explained below, skews the uncertainty sharply.

Assuming that BOL heavy metal mass was twice the EOL heavy metal mass will result in overestimating burnup for fuels where the material fissioned is less than one half of the original heavy metal mass. Consequently, this assumption could be nonconservative only for highly enriched, highly burned fuels. The percentage of initial heavy metal mass depleted (fissioned) can be approximated as the product of the percent enrichment and the percent burnup. Because DOE SNFs are primarily the products of research, test, and materials production programs, most fuels are not highly enriched. Burnups approaching 50% are very uncommon. Consequently, fuels with greater than 50% of the initial heavy metal mass depleted are not expected.

The SFD version 5.0.1 data were reviewed to evaluate both the need for and the conservatism of estimating burnup by assuming BOL heavy metal mass to be twice the EOL heavy metal mass. Of 568 records for repository-bound SNF, the BOL heavy metal mass is not known for 97 records. Of these 97 records, 47 have burnup information (i.e., nominal or bounding burnup can be obtained directly from the SFD), resulting in the need to estimate burnup for the other 50 SNF records. The assumption is made that BOL heavy metal mass is twice the EOL heavy metal mass for these 50 of 568 SNF records in the SFD.

The conservatism of this assumption was evaluated by reviewing the 471 SFD records with both BOL and EOL heavy metal mass known. Of these 471 records, estimating the BOL heavy metal mass to be twice the EOL heavy metal mass would have resulted in overestimating the heavy metal mass depleted (i.e., burnup) for 97% (458) of the 471 fuel records (see Figure 1).

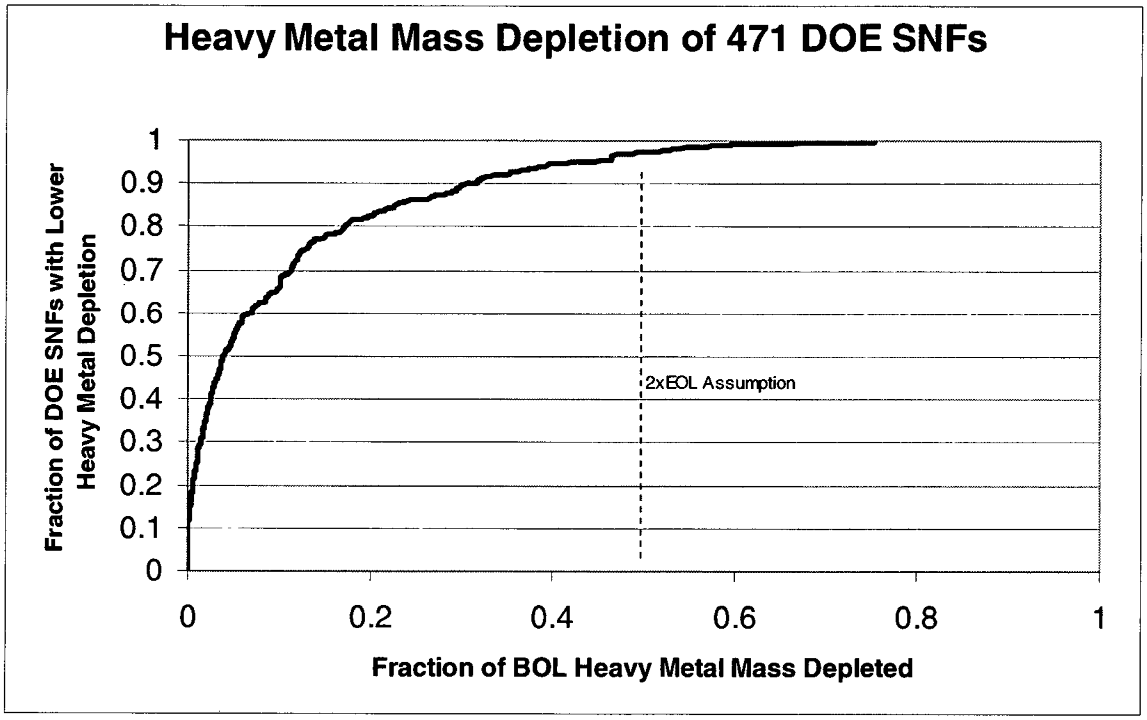

Figure 1. Heavy metal mass depletion of 471 DOE spent nuclear fuels.

The actual EOL heavy metal mass to BOL heavy metal mass was examined for these same 471 SNF records. As shown in Table 5, assuming this ratio to be 0.5 would overestimate the burnup by one to three orders of magnitude for over 97% (all but 13 of 471) of these SNFs. A review of the thirteen fuels, whose present data indicate that BOL heavy metal mass is more than twice the EOL heavy metal mass, reveals that these are primarily foreign research reactor fuels not yet returned to DOE custody. The burnup shown in the database for these fuels conservatively provides the maximum burnup that could be expected for these fuels. Historically, actual burnups, which are provided by the reactor sites when the fuel is returned, have been significantly less than the conservative estimates in the SFD projections.

By assuming that the burnup distribution of the fuels with unknown BOL heavy metal mass is reasonably represented by the 471 fuel records evaluated, one concludes that assuming BOL mass to be twice the EOL mass will produce an extremely conservative burnup estimate. From the above, it can be seen that estimating burnup in this manner skews the uncertainty sharply toward overpredicting the expected radionuclide inventory. In this case, the actual burnup (proportional to radionuclide predictions) is expected to be within the range of 1 to 110% of the estimated burnup.

In summary, uncertainty in the estimated radionuclide inventories that can be associated with the burnup is estimated to be:

	Source of Burnup Value used in Estimate
$U_{BU} = \pm 10\%$	given in(or calculated from) the SFD
$U_{BU} = -99\%$ to $+ 10\%$	estimated by assuming BOL heavy metal mass as twice EOL heavy metal mass

This uncertainty applies to all radionuclides estimated with the template methodology because all radionuclides are scaled by the ratio of the fuel burnup to the template burnup.

Table 5. EOL over BOL heavy metal mass distribution of 471 DOE spent nuclear fuels.

Heavy Metal Mass Ratio (EOL/BOL)	No. of SNFs in Range	Conservatism[a]
0.999 to 1.0	58	>500
0.99 to 0.999	61	>50
0.9 to 0.99	200	>5
0.83 to 0.9	55	>3
0.667 to 0.83	59	>1.5
0.5 to 0.667	25	>1
0.135 to 0.5	13	Nonconservative by a factor of up to 1.7
Total SNF records evaluated	471	

a. This represents the minimum conservatism (i.e., factor of overprediction) by the ratio of the heavy metal mass depletion predicted using the conservative assumption (i.e., 0.5) to the maximum heavy metal mass actually depleted for these fuels.

E-3.2.2 Linear Scaling, $U_{lin\ scal}$

The scaling factor used in the template methodology can also be represented as the product of a burnup multiplier and a mass multiplier (see Section 6 of DOE/SNF/REP-078) where the mass multiplier scales the template results for any difference in mass and the burnup multiplier accounts for the difference in specific burnup (i.e., burnup per unit mass). This decomposition of the scaling factor is useful in understanding uncertainty because all radionuclide inventories scale linearly with the mass multiplier while only fission products scale relatively linear with the burnup multiplier. Thus, the magnitude of the burnup multiplier is an indication of the uncertainty potentially introduced into the inventories of actinide and other transmutation products. The affect of scaling to account for differences in specific burnup on each radionuclide is determined by the slope and curvature of its rate of buildup at the burnup modeled in the template and the magnitude and direction (i.e., scaling up or down) of the burnup multiplier. As illustrated in Figure 2, if the rate of buildup of a radionuclide is positive and increasing with burnup at the template burnup value, an estimate using a burnup multiplier with a value of less than one would overpredict the actual radionuclide inventory while an estimate with a multiplier greater than one would underpredict the actual value.

As a result, the effect of the burnup multiplier on uncertainty may vary for each radionuclide and for each fuel and, therefore, cannot be quantified in any generalized way. However, analysis of the data summarized in Reference 6 confirms that representing radionuclides as a linear function of burnup reasonably models radionuclide production over a broad range of burnups and that, for most radionuclides with nonlinear buildup rates with respect to burnup, the rate is both positive and increasing (i.e., slope and curvature are positive). For purposes of estimating the uncertainty associated with the template methodology, a range of 0.5 to 2 is considered adequate to account for the uncertainty introduced from the linear scaling when using templates other than the worst case template. Because use of the worst case template uses the maximum production rate (with respect to burnup) for each radionuclide, the likelihood that the actual radionuclide inventory will be underestimated is significantly reduced.

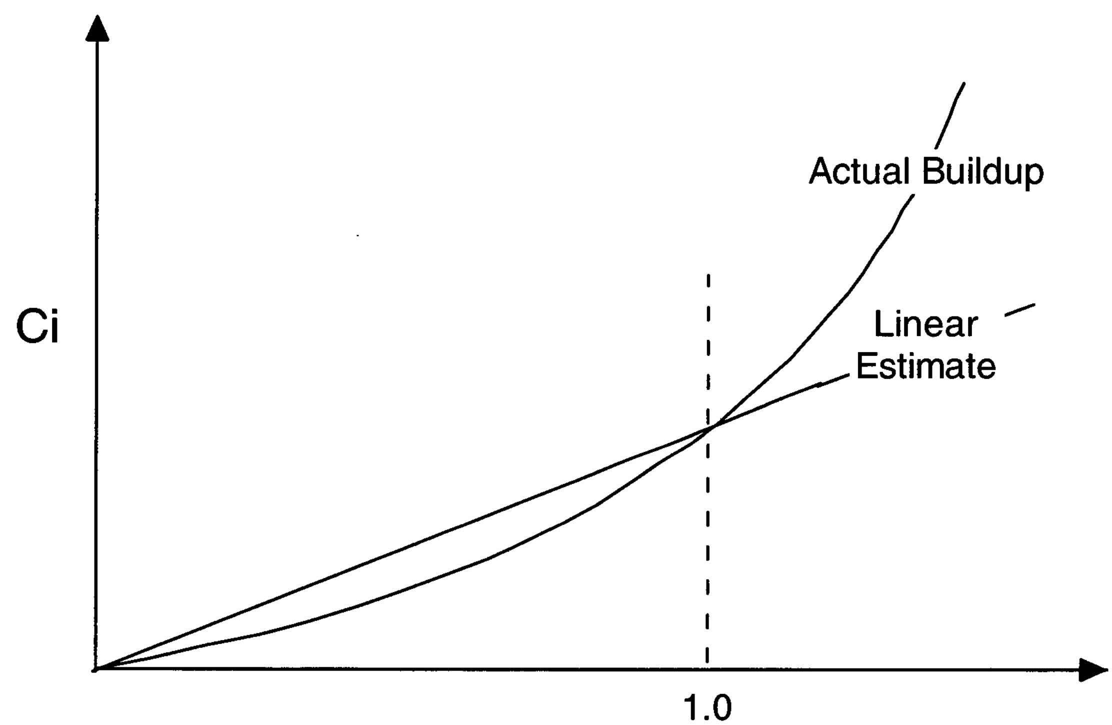

Figure 2. Burnup multiplier.

$U_{lin\ scal}$ = -50% to +100% except when using worst case template
$U_{lin\ scal}$ = -50% to +10% when using worst case template

Because fission products will scale linearly with burnup, $U_{lin\ scale}$ is applied only to nonfission products.

E-4. CONCLUSIONS

Although conservatism is used throughout the template methodology, there can be no absolute guarantee that the final template source term is indeed conservative. This is because of both distribution of uncertainty associated with each of the inputs relied on by the methodology and the additional complexity resulting from the fact that each SNF will have a unique set of uncertainties based on the completeness and accuracy of its available information. The template methodology addresses these uncertainties by adding conservatism throughout the process with the intent of biasing the uncertainty to provide a high degree of confidence that the actual source term will not exceed the estimated value.

The template methodology provides several potential paths for estimating radionuclide inventories depending on the available information. The uncertainty in the result is, therefore, dependent on the path taken. Figure 3 illustrates these paths and the associated path-dependent uncertainties. Figures 4, 5, and 6 illustrate the portion of the total curies estimated using each of the sixteen potential paths.

The uncertainties shown represent a range, about the estimated value of the radionuclide inventory, within which the actual value would be expected to fall. Each uncertainty is given in terms of the contribution it would be expected to make if there were no uncertainty in each of the other parameters. For each uncertainty, the figure refers back to the section of this appendix where it is discussed.

These individual sources of uncertainty can be combined to determine an overall range of uncertainty using accepted error propagation techniques. For purposes of combining these uncertainties, each of the ranges was assumed to have a normal distribution about the estimated value and to represent a 95% confidence level. Thus one half of this confidence interval can be equated to one standard deviation. Because these confidence intervals are not symmetrical in all cases, the positive and negative errors are combined separately in the following approximation.

In the basic linear equation ($Y = mx + b$) used in the estimate, the uncertainties associated with the ORIGEN calculation and the ORIGEN inputs affect the "m" term, and the uncertainty associated with the burnup affects the "x" term. The uncertainty associated with the linear scaling affects the combined "mx" term because it applies to the overall estimate "Y." By assuming each of these uncertainties to be independent, the combined standard deviations (i.e., the positive and negative standard deviations are combined separately) can be estimated as the square root of the sum of the squares of each of the individual standard deviations. This combined standard deviation is shown for each of the potential paths in Table 6 along with the percentage of the total estimated curie inventory associated with each path. A weighted standard deviation is also shown in order to estimate the contribution from each path on the uncertainty in the total estimated radionuclide inventory (i.e., total curies) from all DOE SNFs.

The overall uncertainties determined by the foregoing analyses are still expected to provide a very conservative estimate. This is because it was presumed that the value estimated using the template methodology is in fact the expected value. However, additional conservatism is implicit in the template methodology. Because of the conservative nature of the assumptions used to compensate for insufficient fuel information, the methodology sharply skews the radionuclide inventory estimates toward overpredicting the actual values for these fuels. The total radionuclide inventory is likely to be

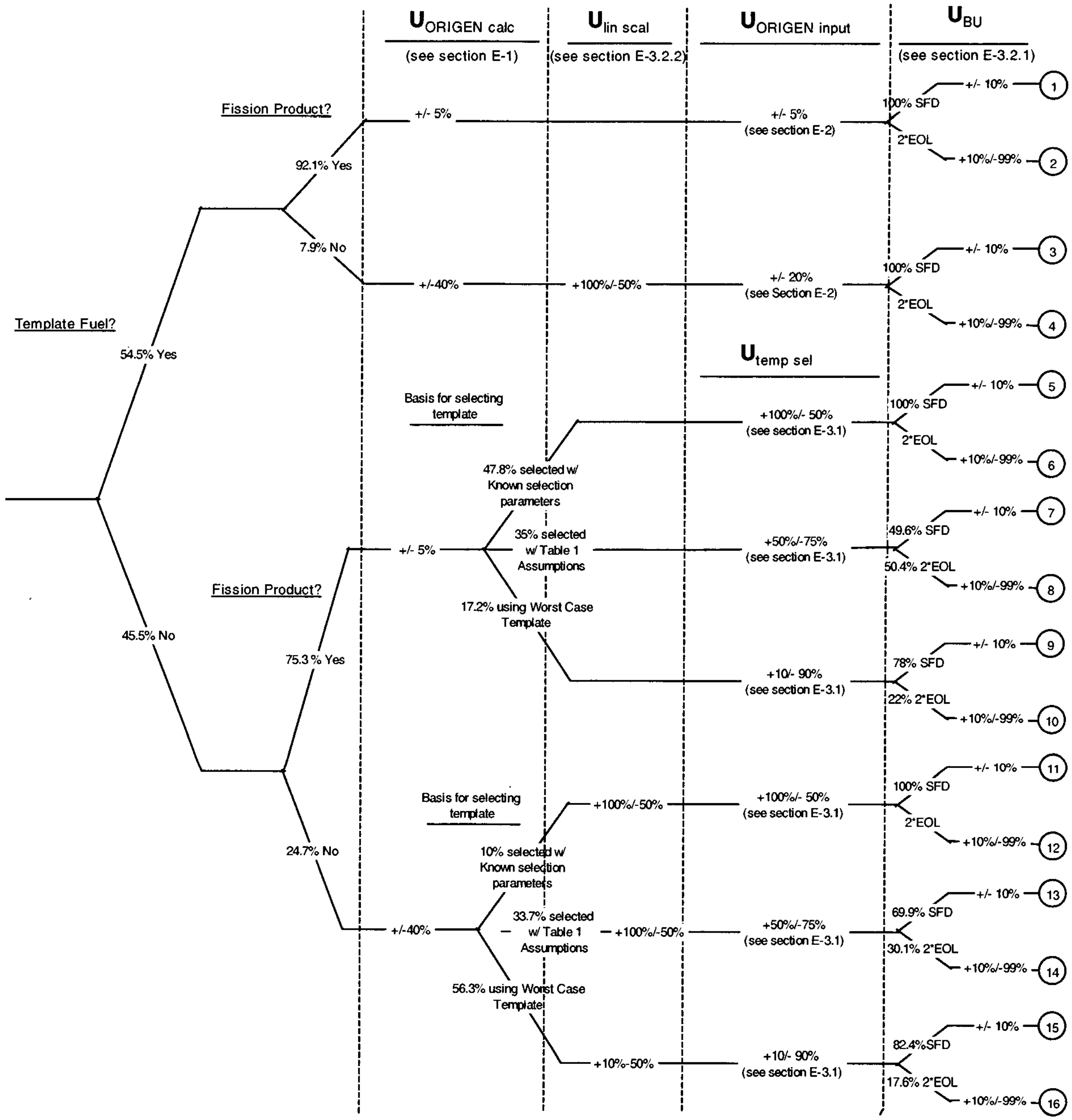

Figure 3. Path-dependent sources of uncertainty.

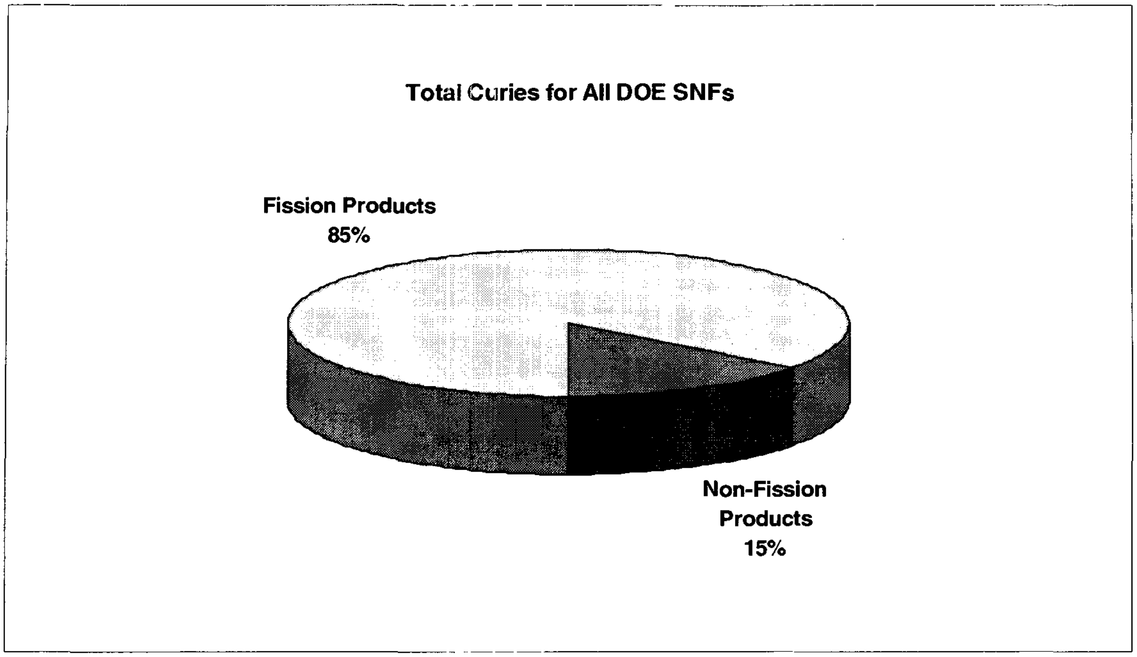

Figure 4. Percent of total curies between fission products and other radionuclides.

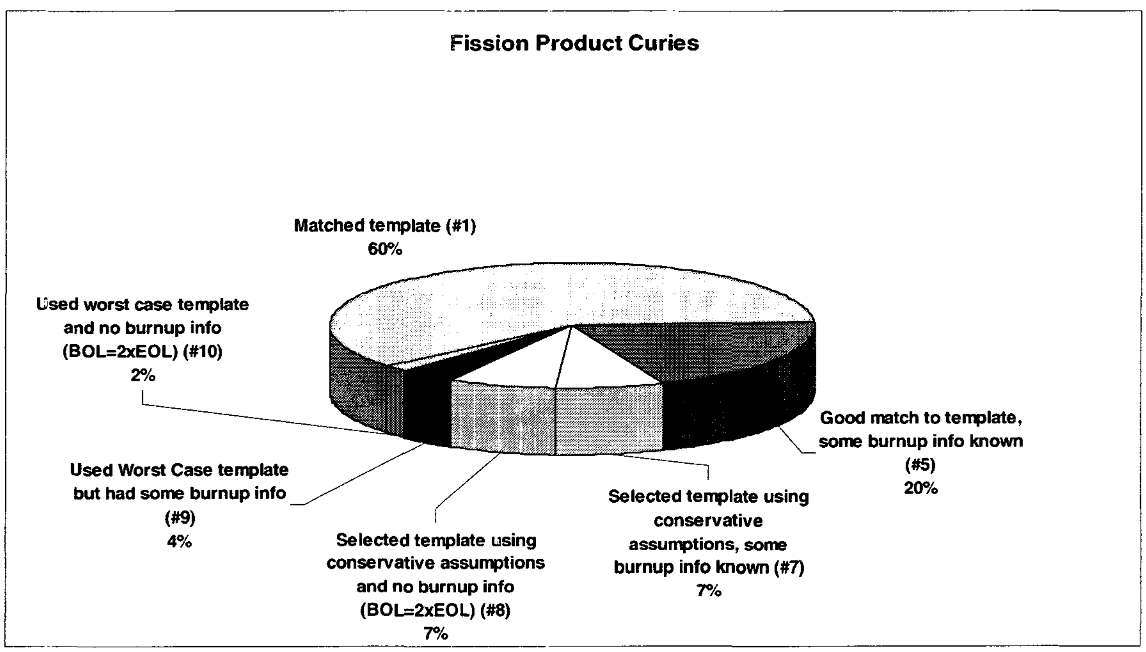

Figure 5. Breakdown of fission product curies.

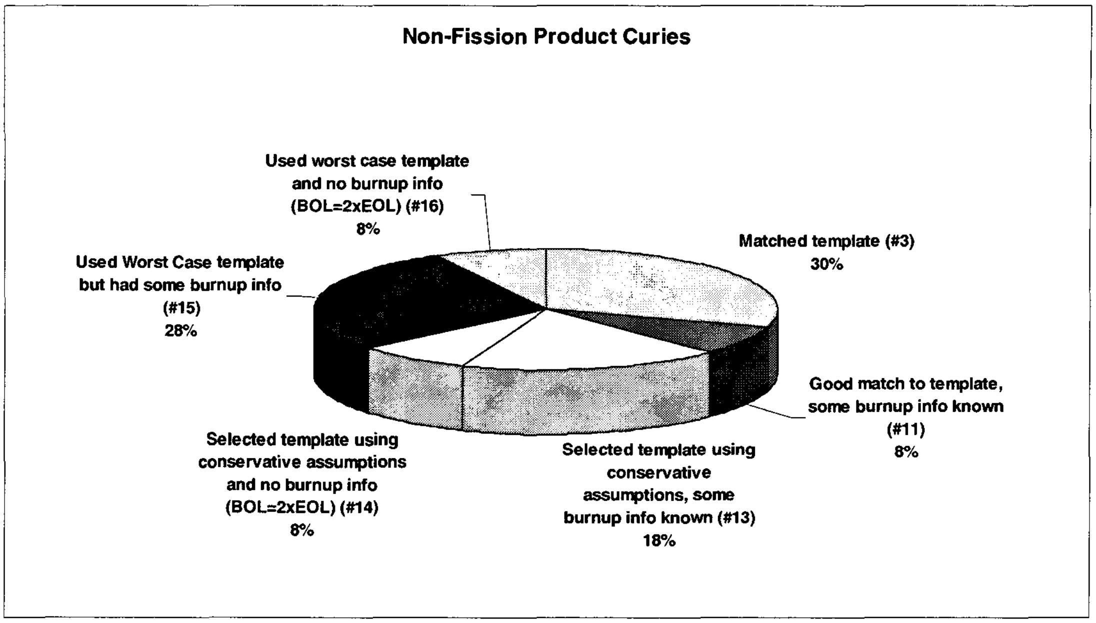

Figure 6. Breakdown of nonfission product curies.

Table 6. Overall standard deviations.

Case #	Template Fuel	Radionuclide	Template Selection Basis	Burnup Basis	Standard Deviation lower	Standard Deviation upper	% of Ci	Standard Deviation (weighted) lower	Standard Deviation (weighted) upper
1	yes	fission product	NA--Template Fuel	SFD Information	-6.12%	6.12%	51.49%	-3.15%	3.15%
2	yes	fission product	NA--Template Fuel	Assumed BOL=2*EOL	-49.63%	6.12%	0.00%	0.00%	0.00%
3	yes	non fission product	NA--Template Fuel	SFD Information	-33.91%	55.00%	4.40%	-1.49%	2.42%
4	yes	non fission product	NA--Template Fuel	Assumed BOL=2*EOL	-59.79%	55.00%	0.00%	0.00%	0.00%
5	no	fission product	SFD Information	SFD Information	-25.62%	50.31%	16.81%	-4.31%	8.46%
6	no	fission product	SFD Information	Assumed BOL=2*EOL	-55.51%	50.31%	0.00%	0.00%	0.00%
7	no	fission product	Table 1 assumptions	SFD Information	-37.91%	25.62%	6.11%	-2.32%	1.57%
8	no	fission product	Table 1 assumptions	Assumed BOL=2*EOL	-62.15%	25.62%	6.21%	-3.86%	1.59%
9	no	fission product	worst case template	SFD Information	-45.35%	7.50%	3.29%	-1.49%	0.25%
10	no	fission product	worst case template	Assumed BOL=2*EOL	-66.94%	7.50%	1.33%	-0.89%	0.10%
11	no	non-fission product	SFD Information	SFD Information	-40.93%	73.65%	1.15%	-0.47%	0.85%
12	no	non-fission product	SFD Information	Assumed BOL=2*EOL	-64.03%	73.65%	0.00%	0.00%	0.00%
13	no	non-fission product	Table 1 assumptions	SFD Information	-49.56%	59.58%	2.71%	-1.34%	1.61%
14	no	non-fission product	Table 1 assumptions	Assumed BOL=2*EOL	-69.87%	59.58%	1.17%	-0.82%	0.70%
15	no	non-fission product	worst case template	SFD Information	-55.45%	21.79%	4.20%	-2.33%	0.92%
16	no	non-fission product	worst case template	Assumed BOL=2*EOL	-74.16%	21.79%	1.13%	-0.84%	0.25%
							100.00%	-23%	22%

overestimated because of a relatively small quantity of fuels for which the estimates were based on conservative assumptions (e.g., worst case template and/or estimating burnup by assuming the BOL heavy metal mass was twice the EOL mass). The following discussion illustrates the effects of these conservative assumptions by examining their effects on the predicted radionuclide concentrations in terms of Ci/MTHM.

In terms of MTHM, the source term estimate for about 91% of the DOE SNF inventory is based on a validated ORIGEN output that was developed for that fuel type (i.e., Paths 1 through 4). As an example, the N-Reactor template was developed specifically to model the N-Reactor fuel and was validated against available N-Reactor fuel data. Thus, applying the N-Reactor template to the N-Reactor fuel introduces minimal uncertainty. This 91% of the MTHM accounts for only 55.9% of the total curies in the estimate.

By MTHM, approximately 5.9% of the DOE SNF inventory uses a template that, although based on another fuel type, shares parameters (i.e., reactor moderator, fuel compound, enrichment, cladding) that dominate the model with respect to generation of radionuclides. An example is the use of the N-Reactor fuel template for a uranium metal fuel such as Single Pass Reactor fuels that have a slightly different configuration (tube type fuel design vs. concentric tubes design for the N-Reactor fuels). These fuels take Paths 5, 6, 11, and 12 of Figure 3. This 5.9% of the fuels account for 18% of the total curies in the estimate.

For about 2.9% of the fuels by MTHM, conservative assumptions were used to select an appropriate template (Paths 7 and 13). For about 0.11% of the fuels, the burnup information is uncertain because of missing or incomplete BOL and burnup values (Paths 8 and 14). For these fuels, BOL heavy metal is assumed to be two times the EOL value, which would overestimate the burnup for 97% of the DOE SNFs (see Section E-3.2.1). This assumption produces a very conservative estimate of the burnup, which results in an increased scaling of the template radionuclide inventories. These 2.9% and 0.11% of the fuels account, respectively, for 8.8% and 7.4% of the total curies in the estimate.

About 0.08% of the DOE SNF by MTHM uses a worst case template that was derived by taking the highest normalized (Ci/MTU) values for each radionuclide from all the available templates. These fuels take Paths 9 and 15 of Figure 3. Although such a fuel does not physically exist, this template is used to bound fuel materials in the DOE SNF inventory for which a template cannot be selected. There are two reasons for this: (1) the unavailability of a template that adequately models the fuel or (2) the unavailability of sufficient information to identify a proper template. About 0.001% of the DOE SNF uses a worst case template and assumes BOL heavy metal is two times the EOL value (Paths 10 and 16). These 0.08% and 0.001% of the fuels account, respectively, for 7.5% and 2.5% of the total curies in the estimate.

Based on the above, it is clear that each of the conservative assumptions employed by the methodology to compensate for insufficient information adds a degree of conservatism. Figure 7 illustrates the effects of these conservative assumptions. This figure clearly shows an inverse correlation between the available information used in the methodology and the resulting radionuclide concentrations estimated. This phenomenon is evident in Figure 8, which shows the radionuclide concentrations (Ci/MTHM). Figure 8 provides clear evidence that the assumptions employed within the methodology are indeed conservative.

As shown in Figure 7, 17.4% (7.4% + 7.5% + 2.5%) of the radionuclide inventory comes from the result of 0.2% of the total fuel. This 0.2% of the mass relied heavily on conservative assumptions to compensate for missing information. Consequently by assuming this 0.2% of fuel with sufficient information can be reasonably represented by the 99.8% of fuels with sufficient information, one may conclude that the expected value for the total radionuclide inventory associated with DOE SNF is more reasonably about 83% of the nominal inventory estimated.

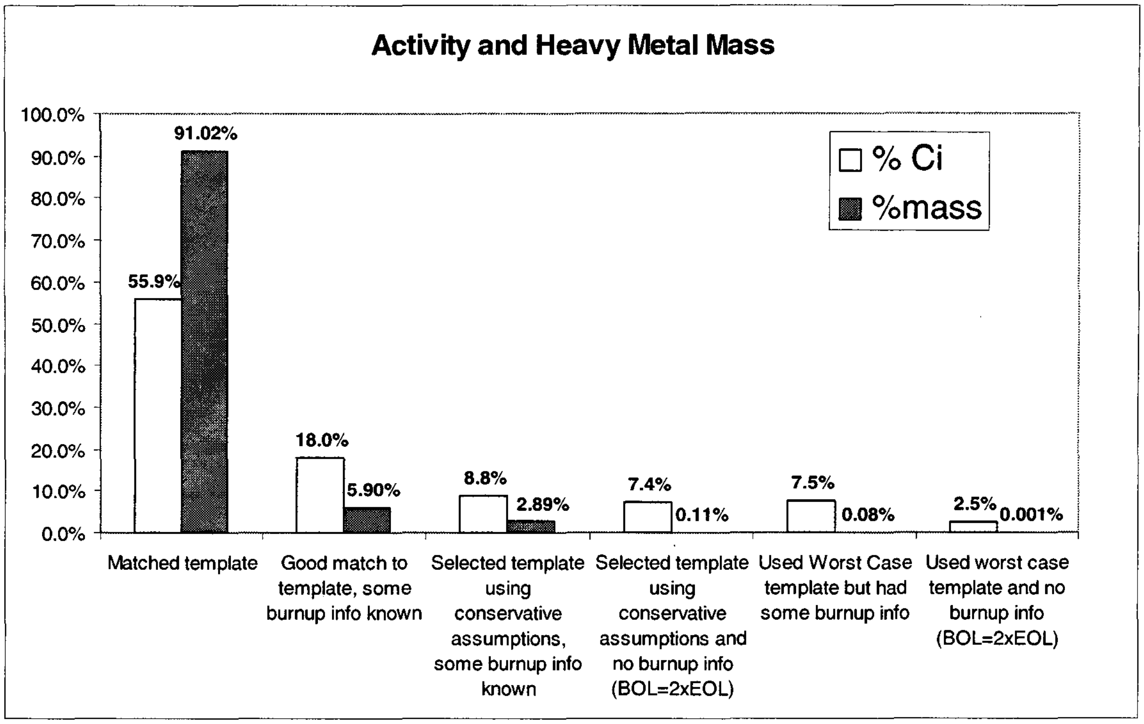

Figure 7. Activity and quantity of SNF relating to known information about SNF.

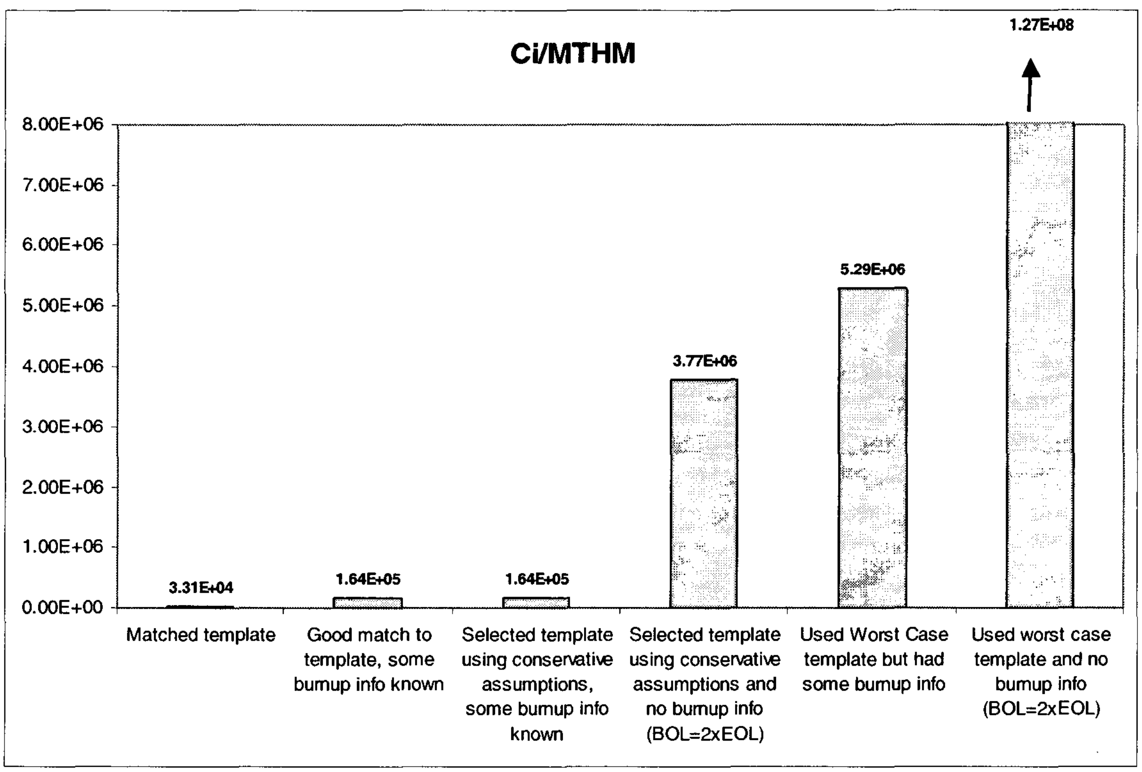

Figure 8. Activity per MTHM relating to known information about SNF.

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Appendix F

DOE SNF Canister Count

Appendix F

DOE SNF Canister Count

INTRODUCTION

The Spent Fuel Database (SFD) (See Reference 1) provides point estimates of the number of U.S. Department of Energy (DOE) spent nuclear fuel (SNF) canisters required for all DOE SNF) except the SNF identified for placement into high integrity cans (HICs). This appendix provides an estimate of the number of standardized canisters required for HICs.

It is projected that there will be about 3,500 DOE SNF canisters. This projected number of canisters could be affected by numerous uncertainties. Some examples of uncertainties that could affect the number of canisters include the following:

- Canister and basket designs—The point-estimates are based on specific canister and basket designs. As evidenced by the proposed Idaho Dry Storage Project canister and basket design, it is possible that the final canister or basket designs will be different than those currently planned. Different designs could affect the number of canisters.

- Canisters and baskets used—The current estimates are based on the selection of a specific canister size for each fuel. It is possible that different canister sizes will be used for some fuels. Use of different canisters will likely affect the number of canisters.

- Mixing of SNF—The point-estimates are based on the assumption that different types of SNF can be mixed in canisters. If different SNFs are not mixed in canisters, then there will be several hundred additional canisters.

- Loading of HICs—It is planned that some DOE SNF will be placed in HICs prior to loading into canisters. Placing more or fewer HICs into canisters affects the number of standardized canisters.

- Treatment options—The decision to implement or not to implement the melt and dilute treatment of aluminum SNF results in a difference about 1,000 standard canisters. The decision regarding treatment of the sodium-bonded fuel also affects the total number of standard canisters.

- Projections—The SFD estimates include projections for the generation of domestic research reactor SNF and receipt of foreign research reactor SNF. The projections are considered conservative at this time because some domestic reactors may shut down earlier than expected and not all foreign research reactor SNF is likely to be shipped to the U.S.

This appendix provides a range on the estimated number of DOE SNF canisters to account for these ranges. Details of both the standardized canisters required for HICs and the range of DOE SNF canisters are provided in Reference 2.

STANDARDIZED CANISTERS REQUIRED FOR HIGH INTEGRITY CANS

DOE SNF whose condition does not allow it to be placed directly into a DOE SNF canister is first placed into an inner container referred to as a HIC. The HICs have an inner diameter of 4-7/8 in. with a length that is adjusted as needed for the specific DOE SNF (see Reference 3). SFD projects that about 172 HICs will be required for DOE SNF. At least 5 HICs can be placed into an 18-in.-diameter standardized canister, so 35 standardized canisters are required for the HICs. Only two types of SNF requiring HICs have been identified to be longer than 10 ft. Therefore, the 172 HICs will be placed into two 18 in. × 15 ft standardized canisters and thirty-three 18 in. × 10 ft standardized canisters.

RANGE OF DOE SNF CANISTERS

The estimated DOE SNF canister range is based on an assumed maximum and minimum overall packing efficiencies of 33.3 and 66.7%, respectively. The average packing efficiency for the SFD point-estimate is 49%. These assumed overall packing efficiencies are not intended to be bounding values for all individual canisters but are considered reasonable overall assumptions based on the evaluation of the packing efficiencies for Boiling Water Reactor waste packages, Pressurized Water Reactor waste packages, TRIGA SNF in a standardized canister and three theoretical configurations. Based on the assumed maximum and minimum overall packing efficiencies, the estimated range of DOE SNF canisters is 2,500 to 5,000. Table E-1 reports the point-estimate, minimum, and maximum number of DOE SNF canisters of each size in each Total System Performance Assessment group.

Table F-1. DOE SNF Canister Count.

Group	Minimum	Point-Estimate	Maximum
T01 Naval (Evaluated by NNPP)	—	—	—
T02 Pu/U A24 in. × 15 ft oy	18 in. × 10 ft = 6.5 18 in. × 15 ft = 5.5	18 in. × 10 ft = 9.1 18 in. × 15 ft = 7.6	18 in. × 10 ft = 13.0 18 in. × 15 ft = 11.0
T03 U/Pu Carbide	18 in. × 10 ft = 1.0 18 in. × 15 ft = 1.6	18 in. × 10 ft = 1.4 18 in. × 15 ft = 2.3	18 in. × 10 ft = 1.9 18 in. × 15 ft = 3.3
T04 MOX	18 in. × 10 ft = 10.2 18 in. × 15 ft = 91.4	18 in. × 10 ft = 14.3 18 in. × 15 ft = 127.5	18 in. × 10 ft = 20.4 18 in. × 15 ft = 182.8
T05 U/Th Carbide	18 in. × 10 ft = 0.1 18 in. × 15 ft = 406.8	18 in. × 10 ft = 0.2 18 in. × 15 ft = 567.3	18 in. × 10 ft = 0.3 18 in. × 15 ft = 813.5
T06 U/Th Oxide	18 in. × 10 ft = 9.0 18 in. × 15 ft = 9.3 24 in. × 15 ft = 19.4	18 in. × 10 ft = 12.5 18 in. × 15 ft = 13 24 in. × 15 ft = 27.0	18 in. × 10 ft = 18.0 18 in. × 15 ft = 18.6 24 in. × 15 ft = 38.7
T07 U Metal	18 in. × 10 ft = 10.1 18 in. × 15 ft = 1.0 MCO = 287.5	18 in. × 10 ft = 14.1 18 in. × 15 ft = 1.4 MCO = 401.0	18 in. × 10 ft = 20.2 18 in. × 15 ft = 2.0 MCO = 575.1
T08 U Oxide	18 in. × 10 ft = 198.2 18 in. × 15 ft = 350.4 MCO = 12.9	18 in. × 10 ft = 276.4 18 in. × 15 ft = 488.7 MCO = 18.0	18 in. × 10 ft = 396.3 18 in. × 15 ft = 700.9 MCO = 25.8
T09 Aluminum-based	18 in. × 10 ft = 726.1 18 in. × 15 ft = 169.1 24 in. × 10 ft = 118.5	18 in. × 10 ft = 1,012.6 18 in. × 15 ft = 235.8 24 in. × 10 ft = 165.3	18 in. × 10 ft = 1,452.1 18 in. × 15 ft = 338.2 24 in. × 10 ft = 237.1
T10 Misc	18 in. × 10 ft = 2.1 18 in. × 15 ft = 0.1	18 in. × 10 ft = 2.9 18 in. × 15 ft = 0.1	18 in. × 10 ft = 4.1 18 in. × 15 ft = 0.1
T11 U-ZrHx	18 in. × 10 ft = 63.2	18 in. × 10 ft = 88.2	18 in. × 10 ft = 126.4
Total by canister size	18 in. × 10 ft = 1,026.4 18 in. × 15 ft = 1,035.2 24 in. × 10 ft = 118.5 24 in. × 15 ft = 19.4 MCO = 300.4 Total = 2,500.0	18 in. × 10 ft = 1,431.5 18 in. × 15 ft = 1,443.8 24 in. × 10 ft = 165.3 24 in. × 15 ft = 27.0 MCO = 419.0 Total = 3,486.7	18 in. × 10 ft = 2,052.9 18 in. × 15 ft = 2,070.4 24 in. × 10 ft = 237.1 24 in. × 15 ft = 38.7 MCO = 600.9 Total = 5,000.0

The point-estimate reported in Table F-1 differs from the SFD estimate reported in the summary tables of Appendix C of DOE/SNF/REP-078 because it includes the number of canisters required for HICs. The SFD point-estimate number of canisters plus the canisters required for HICs (i.e., 3,486.7) is rounded to 3,500.

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DOE/SNF/REP-078
Rev. 1

United States Department of Energy

National Spent Nuclear Fuel Program

Source Term Estimates for DOE Spent Nuclear Fuels
Appendix C
Source Term Estimates for the Year 2010
Volume II

490

January 2004

U.S. Department of Energy
Assistant Secretary for Environmental Management
Office of Nuclear Material and Spent Fuel

See Volume I of DOE/SNF/REP-078 for approvals.

This document was developed and is controlled in accordance with NSNFP procedures. Unless noted otherwise, information must be evaluated for adequacy relative to its specific use if relied on to support design or decisions important to safety or waste isolation.

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Rev. 1

Source Term Estimates for DOE Spent Nuclear Fuels
Appendix C
Source Term Estimates for the Year 2010
Volume II

January 2004

WBS# A.1.01.00.03.0B

Idaho National Engineering and Environmental Laboratory
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
Under DOE Idaho Operations Office
Contract DE-AC07-99ID13727

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ACRR (PULSED CORE)
SNF ID #: 757
Fuel Units & Descr: 251 - ELEMENT
Heavy Metal Mass: BOL=120.83kg ; EOL=120.83kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 2035
Estimates as of: 2010
Template: Pathfinder (Light Water, SST, 60 to 100%, U)
[2]**Template Burnup(MWd):** 6.01
Template BOL Heavy Metal Mass (MT): 0.00012882
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
2.26

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	1.9667E-09	2,282.862	4,565.724	0.00E+00	4.49E-06	8.98E-06
Am-241	4.9468E-05	2,282.862	4,565.724	0.00E+00	1.13E-01	2.26E-01
Am-242m	9.7537E-09	2,282.862	4,565.724	0.00E+00	2.23E-05	4.45E-05
Am-243	9.8802E-10	2,282.862	4,565.724	0.00E+00	2.26E-06	4.51E-06
C-14	2.3095E-04	2,282.862	4,565.724	0.00E+00	5.27E-01	1.05E+00
Cl-36	1.2261E-06	2,282.862	4,565.724	0.00E+00	2.80E-03	5.60E-03
Cm-243	5.1581E-10	2,282.862	4,565.724	0.00E+00	1.18E-06	2.36E-06
Cm-244	7.3012E-09	2,282.862	4,565.724	0.00E+00	1.67E-05	3.33E-05
Co-60	3.6556E+00	2,282.862	4,565.724	0.00E+00	8.35E+03	1.67E+04
Cs-134	7.2063E-02	2,282.862	4,565.724	0.00E+00	1.65E+02	3.29E+02
Cs-135	3.0316E-05	2,282.862	4,565.724	0.00E+00	6.92E-02	1.38E-01
Cs-137	2.9002E+00	2,282.862	4,565.724	0.00E+00	6.62E+03	1.32E+04
Eu-154	7.5025E-03	2,282.862	4,565.724	0.00E+00	1.71E+01	3.43E+01
Eu-155	4.6123E-02	2,282.862	4,565.724	0.00E+00	1.05E+02	2.11E+02
Fe-55	3.6439E+00	2,282.862	4,565.724	0.00E+00	8.32E+03	1.66E+04
H-3	1.3524E-02	2,282.862	4,565.724	0.00E+00	3.09E+01	6.17E+01
I-129	7.3195E-07	2,282.862	4,565.724	0.00E+00	1.67E-03	3.34E-03
Kr-85	2.8686E-01	2,282.862	4,565.724	0.00E+00	6.55E+02	1.31E+03
Np-237	1.1478E-06	2,282.862	4,565.724	0.00E+00	2.62E-03	5.24E-03
Pa-231	1.0990E-08	2,282.862	4,565.724	0.00E+00	2.51E-05	5.02E-05
Pb-210	8.0782E-15	2,282.862	4,565.724	0.00E+00	1.84E-11	3.69E-11
Pm-147	3.2097E+00	2,282.862	4,565.724	0.00E+00	7.33E+03	1.47E+04
Pu-238	3.7404E-04	2,282.862	4,565.724	0.00E+00	8.54E-01	1.71E+00
Pu-239	6.6839E-04	2,282.862	4,565.724	0.00E+00	1.53E+00	3.05E+00
Pu-240	8.7121E-05	2,282.862	4,565.724	0.00E+00	1.99E-01	3.98E-01
Pu-241	3.0283E-03	2,282.862	4,565.724	0.00E+00	6.91E+00	1.38E+01
Pu-242	1.9717E-09	2,282.862	4,565.724	0.00E+00	4.50E-06	9.00E-06
Ra-226	7.3527E-14	2,282.862	4,565.724	0.00E+00	1.68E-10	3.36E-10
Ra-228	6.0965E-12	2,282.862	4,565.724	0.00E+00	1.39E-08	2.78E-08
Ru-106	1.6531E-01	2,282.862	4,565.724	0.00E+00	3.77E+02	7.55E+02
Se-79	1.3228E-05	2,282.862	4,565.724	0.00E+00	3.02E-02	6.04E-02
Sn-126	1.1494E-05	2,282.862	4,565.724	0.00E+00	2.62E-02	5.25E-02
Sr-90	2.7854E+00	2,282.862	4,565.724	0.00E+00	6.36E+03	1.27E+04
Tc-99	4.6656E-04	2,282.862	4,565.724	0.00E+00	1.07E+00	2.13E+00
Th-229	2.9368E-12	2,282.862	4,565.724	0.00E+00	6.70E-09	1.34E-08
Th-230	3.2662E-11	2,282.862	4,565.724	0.00E+00	7.46E-08	1.49E-07
Th-232	8.3045E-12	2,282.862	4,565.724	0.00E+00	1.90E-08	3.79E-08
Tl-208	2.6722E-08	2,282.862	4,565.724	0.00E+00	6.10E-05	1.22E-04
U-232	7.7720E-08	2,282.862	4,565.724	0.00E+00	1.77E-04	3.55E-04
U-233	2.9834E-09	2,282.862	4,565.724	0.00E+00	6.81E-06	1.36E-05
U-234	3.5275E-07	2,282.862	4,565.724	0.00E+00	8.05E-04	1.61E-03
U-235	-2.7761E-06	2,282.862	0.000	5.51E-02	4.88E-02	5.51E-02
U-236	1.6190E-05	2,282.862	4,565.724	0.00E+00	3.70E-02	7.39E-02
U-238	-2.8547E-09	2,282.862	0.000	3.20E-02	3.20E-02	3.20E-02
Y-90	2.7870E+00	2,282.862	4,565.724	0.00E+00	6.36E+03	1.27E+04
Other Radionuclides					1.20E+04	2.40E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	8.978E+14
0.0250	1.915E+14
0.0375	1.709E+14
0.0575	1.718E+14
0.0850	1.089E+14
0.1250	8.686E+13
0.2250	9.015E+13
0.3750	4.376E+13
0.5750	5.305E+14
0.8500	2.568E+13
1.2500	1.240E+15
1.7500	4.379E+11
2.2500	1.253E+12
2.7500	7.109E+09
3.5000	7.849E+08
5.0000	1.891E+02
7.0000	2.123E+01
11.0000	2.406E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.42E+02	**4.85E+02**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	SST	SST
BOL HM Constituents:	U02-BeO2	U
BOL Enrichment %:	21.10367543	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		2,282.862
Bounding:	199.976	4,565.724

Basis for burnup used in estimate:
Nominal burnup assumed to be 2% of BOL heavy metal mass.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.40	
Bounding:	0.81	22.83

Estimated EOL HM/Given EOL HM
0.98

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: AMERICIUM TARGETS
SNF ID #: 776
Fuel Units & Desc: 12 - ROD
Heavy Metal Mass: BOL=.15kg : EOL=.12kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1970
Estimates as of: 2010
Template: (Worst Case)
[2]Template Burnup(MWd): 62.5
Template BOL Heavy Metal Mass (MT): 0.00186865
Template Decay Time: 35 years

Estimated Canister usage:

HIC
3.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.3072E-06	30.563	61.127	0.00E+00	7.05E-05	1.41E-04
Am-241	8.4448E+00	30.563	61.127	0.00E+00	2.58E+02	5.16E+02
Am-242m	1.6848E-02	30.563	61.127	0.00E+00	5.15E-01	1.03E+00
Am-243	1.6320E-02	30.563	61.127	9.57E+00	1.01E+01	1.06E+01
C-14	1.2090E-01	30.563	61.127	0.00E+00	3.70E+00	7.39E+00
Cl-36	2.2849E-03	30.563	61.127	0.00E+00	6.98E-02	1.40E-01
Cm-243	8.6624E-04	30.563	61.127	0.00E+00	2.65E-02	5.30E-02
Cm-244	1.6848E-01	30.563	61.127	0.00E+00	5.15E+00	1.03E+01
Co-60	2.8086E+01	30.563	61.127	0.00E+00	8.58E+02	1.72E+03
Cs-134	3.4148E-04	30.563	61.127	0.00E+00	1.04E-02	2.09E-02
Cs-135	4.3976E-04	30.563	61.127	0.00E+00	1.34E-02	2.69E-02
Cs-137	2.1049E+01	30.563	61.127	0.00E+00	6.43E+02	1.29E+03
Eu-154	1.2500E+00	30.563	61.127	0.00E+00	3.82E+01	7.64E+01
Eu-155	6.8986E-02	30.563	61.127	0.00E+00	2.11E+00	4.22E+00
Fe-55	2.9308E-01	30.563	61.127	0.00E+00	8.96E+00	1.79E+01
H-3	2.4311E-01	30.563	61.127	0.00E+00	7.43E+00	1.49E+01
I-129	1.0618E-05	30.563	61.127	0.00E+00	3.25E-04	6.49E-04
Kr-85	5.9882E-01	30.563	61.127	0.00E+00	1.83E+01	3.66E+01
Np-237	1.5668E-04	30.563	61.127	0.00E+00	4.79E-03	9.58E-03
Pa-231	2.8656E-06	30.563	61.127	0.00E+00	8.76E-05	1.75E-04
Pb-210	2.3918E-08	30.563	61.127	0.00E+00	7.31E-07	1.46E-06
Pm-147	1.6900E-02	30.563	61.127	0.00E+00	5.17E-01	1.03E+00
Pu-238	-8.6123E-01	30.563	0.000	1.93E+01	0.00E+00	1.93E+01
Pu-239	-4.8440E-02	30.563	0.000	2.33E+00	8.52E-01	2.33E+00
Pu-240	-3.0095E-01	30.563	0.000	2.98E+00	0.00E+00	2.98E+00
Pu-241	-1.0411E+02	30.563	0.000	7.67E+02	0.00E+00	7.67E+02
Pu-242	-1.1381E-04	30.563	0.000	1.29E-02	9.41E-03	1.29E-02
Ra-226	6.4400E-08	30.563	61.127	0.00E+00	1.97E-06	3.94E-06
Ra-228	5.9952E-07	30.563	61.127	0.00E+00	1.83E-05	3.66E-05
Ru-106	8.5526E-07	30.563	61.127	0.00E+00	2.61E-05	5.23E-05
Se-79	1.9181E-04	30.563	61.127	0.00E+00	5.86E-03	1.17E-02
Sn-126	1.6671E-04	30.563	61.127	0.00E+00	5.10E-03	1.02E-02
Sr-90	1.9799E+01	30.563	61.127	0.00E+00	6.05E+02	1.21E+03
Tc-99	6.7678E-03	30.563	61.127	0.00E+00	2.07E-01	4.14E-01
Th-229	1.7488E-06	30.563	61.127	0.00E+00	5.34E-05	1.07E-04
Th-230	5.8704E-06	30.563	61.127	0.00E+00	1.79E-04	3.59E-04
Th-232	-4.2431E-09	30.563	0.000	3.04E-06	2.91E-06	3.04E-06
Tl-208	8.7573E-05	30.563	61.127	0.00E+00	2.68E-03	5.35E-03
U-232	2.3706E-04	30.563	61.127	0.00E+00	7.25E-03	1.45E-02
U-233	3.6128E-04	30.563	61.127	0.00E+00	1.10E-02	2.21E-02
U-234	1.2788E-02	30.563	61.127	0.00E+00	3.91E-01	7.82E-01
U-235	5.7486E-04	30.563	61.127	6.45E-05	1.76E-02	3.52E-02
U-236	2.3485E-04	30.563	61.127	0.00E+00	7.18E-03	1.44E-02
U-238	1.1581E-04	30.563	61.127	8.03E-06	3.55E-03	7.09E-03
Y-90	1.9804E+01	30.563	61.127	0.00E+00	6.05E+02	1.21E+03
Other Radionuclides					1.88E+03	3.77E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.501E+13
0.0250	1.491E+13
0.0375	1.304E+13
0.0575	2.049E+13
0.0850	8.203E+12
0.1250	6.270E+12
0.2250	6.928E+12
0.3750	2.963E+12
0.5750	4.818E+13
0.8500	1.841E+12
1.2500	1.287E+14
1.7500	5.694E+10
2.2500	6.750E+08
2.7500	1.902E+08
3.5000	1.527E+05
5.0000	6.484E+04
7.0000	7.425E+03
11.0000	8.495E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.05E+01	6.14E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	GRAPHITE	(Worst Case)
Fuel Cladding:	ALUM (1100)	SST/Inconel
BOL HM Constituents:	Am2O3	U, Th, & Pu
BOL Enrichment %:		0 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel didn't closely match any existing templates, therefore the worst case template was used.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		30.563
Bounding:		61.127

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	6.09	
Bounding:	12.18	

Estimated EOL HM/Given EOL HM
160.66

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	ANLJ	[1]Fuel decay start date:	1966
SNF ID #:	5	Estimates as of:	2010
Fuel Units & Descr:	19 - ELEMENT	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=2.79kg ; EOL=2.79kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	35 years

Estimated Canister usage: 18"x10'

0.79

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.0068E-09	3.599	7.197	0.00E+00	7.22E-09	1.44E-08
Am-241	2.5251E-03	3.599	7.197	0.00E+00	9.09E-03	1.82E-02
Am-242m	3.9624E-07	3.599	7.197	0.00E+00	1.43E-06	2.85E-06
Am-243	1.4880E-06	3.599	7.197	0.00E+00	5.35E-06	1.07E-05
C-14	5.7053E-09	3.599	7.197	0.00E+00	2.05E-08	4.11E-08
Cl-36	1.3124E-32	3.599	7.197	0.00E+00	4.72E-32	9.45E-32
Cm-243	1.1419E-07	3.599	7.197	0.00E+00	4.11E-07	8.22E-07
Cm-244	1.6522E-05	3.599	7.197	0.00E+00	5.95E-05	1.19E-04
Co-60	7.4047E-07	3.599	7.197	0.00E+00	2.66E-06	5.33E-06
Cs-134	2.0455E-05	3.599	7.197	0.00E+00	7.36E-05	1.47E-04
Cs-135	3.4477E-06	3.599	7.197	0.00E+00	1.24E-05	2.48E-05
Cs-137	1.4365E+00	3.599	7.197	0.00E+00	5.17E+00	1.03E+01
Eu-154	7.3230E-03	3.599	7.197	0.00E+00	2.64E-02	5.27E-02
Eu-155	5.9259E-04	3.599	7.197	0.00E+00	2.13E-03	4.27E-03
Fe-55	2.2791E-06	3.599	7.197	0.00E+00	8.20E-06	1.64E-05
H-3	1.9698E-03	3.599	7.197	0.00E+00	7.09E-03	1.42E-02
I-129	7.5300E-07	3.599	7.197	0.00E+00	2.71E-06	5.42E-06
Kr-85	4.1176E-02	3.599	7.197	0.00E+00	1.48E-01	2.96E-01
Np-237	9.5752E-06	3.599	7.197	0.00E+00	3.45E-05	6.89E-05
Pa-231	3.9379E-09	3.599	7.197	0.00E+00	1.42E-08	2.83E-08
Pb-210	3.3115E-10	3.599	7.197	0.00E+00	1.19E-09	2.38E-09
Pm-147	9.2402E-04	3.599	7.197	0.00E+00	3.33E-03	6.65E-03
Pu-238	1.6217E-02	3.599	7.197	0.00E+00	5.84E-02	1.17E-01
Pu-239	4.2810E-04	3.599	7.197	0.00E+00	1.54E-03	3.08E-03
Pu-240	2.4333E-04	3.599	7.197	0.00E+00	8.76E-04	1.75E-03
Pu-241	1.6242E-02	3.599	7.197	0.00E+00	5.84E-02	1.17E-01
Pu-242	3.6329E-07	3.599	7.197	0.00E+00	1.31E-06	2.61E-06
Ra-226	9.0114E-10	3.599	7.197	0.00E+00	3.24E-09	6.49E-09
Ra-228	3.1019E-14	3.599	7.197	0.00E+00	1.12E-13	2.23E-13
Ru-106	2.1225E-10	3.599	7.197	0.00E+00	7.64E-10	1.53E-09
Se-79	1.2930E-05	3.599	7.197	0.00E+00	4.65E-05	9.31E-05
Sn-126	1.1571E-05	3.599	7.197	0.00E+00	4.16E-05	8.33E-05
Sr-90	1.3472E+00	3.599	7.197	0.00E+00	4.85E+00	9.70E+00
Tc-99	4.2239E-04	3.599	7.197	0.00E+00	1.52E-03	3.04E-03
Th-229	1.2407E-11	3.599	7.197	0.00E+00	4.47E-11	8.93E-11
Th-230	8.3497E-08	3.599	7.197	0.00E+00	3.00E-07	6.01E-07
Th-232	3.8371E-14	3.599	7.197	0.00E+00	1.38E-13	2.76E-13
Tl-208	4.0414E-08	3.599	7.197	0.00E+00	1.45E-07	2.91E-07
U-232	1.0948E-07	3.599	7.197	0.00E+00	3.94E-07	7.88E-07
U-233	3.6275E-09	3.599	7.197	0.00E+00	1.31E-08	2.61E-08
U-234	1.8562E-04	3.599	7.197	0.00E+00	6.68E-04	1.34E-03
U-235	-2.7235E-06	3.599	0.000	5.63E-03	5.62E-03	5.63E-03
U-236	1.5493E-05	3.599	7.197	0.00E+00	5.58E-05	1.12E-04
U-238	-4.2851E-09	3.599	0.000	6.39E-05	6.38E-05	6.39E-05
Y-90	1.3475E+00	3.599	7.197	0.00E+00	4.85E+00	9.70E+00
Other Radionuclides					4.92E+00	9.85E+00

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	5.302E+11
0.0250	1.101E+11
0.0375	9.568E+10
0.0575	1.030E+11
0.0850	6.207E+10
0.1250	4.102E+10
0.2250	5.368E+10
0.3750	2.330E+10
0.5750	3.852E+11
0.8500	4.705E+09
1.2500	2.276E+09
1.7500	1.281E+08
2.2500	1.071E+04
2.7500	1.022E+04
3.5000	6.449E+00
5.0000	2.641E+00
7.0000	2.898E-01
11.0000	3.236E-02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.04E-02	1.21E-01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.19727891	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		3.599	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		7.197	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	
Bounding:	0.01	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ARKANSAS
SNF ID #: 7
Fuel Units & Descr: 3 - SCRAP
Heavy Metal Mass: BOL=12.60kg ; EOL=11.90kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1986
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]**Template Burnup(MWd):** 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 20 years

Estimated Canister usage:
18"x10'
0.17

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	5.0630E-10	670.422	1,340.843	0.00E+00	3.39E-07	6.79E-07
Am-241	1.1489E-01	670.422	1,340.843	0.00E+00	7.70E+01	1.54E+02
Am-242m	3.0733E-04	670.422	1,340.843	0.00E+00	2.06E-01	4.12E-01
Am-243	6.2661E-04	670.422	1,340.843	0.00E+00	4.20E-01	8.40E-01
C-14	4.7997E-05	670.422	1,340.843	0.00E+00	3.22E-02	6.44E-02
Cl-36	8.0313E-07	670.422	1,340.843	0.00E+00	5.38E-04	1.08E-03
Cm-243	3.6127E-04	670.422	1,340.843	0.00E+00	2.42E-01	4.84E-01
Cm-244	8.6999E-02	670.422	1,340.843	0.00E+00	5.83E+01	1.17E+02
Co-60	1.8379E-02	670.422	1,340.843	0.00E+00	1.23E+01	2.46E+01
Cs-134	6.2548E-03	670.422	1,340.843	0.00E+00	4.19E+00	8.39E+00
Cs-135	1.4433E-05	670.422	1,340.843	0.00E+00	9.68E-03	1.94E-02
Cs-137	1.9767E+00	670.422	1,340.843	0.00E+00	1.33E+03	2.65E+03
Eu-154	6.7603E-02	670.422	1,340.843	0.00E+00	4.53E+01	9.06E+01
Eu-155	1.4373E-02	670.422	1,340.843	0.00E+00	9.64E+00	1.93E+01
Fe-55	2.3466E-03	670.422	1,340.843	0.00E+00	1.57E+00	3.15E+00
H-3	4.8143E-02	670.422	1,340.843	0.00E+00	3.23E+01	6.46E+01
I-129	9.8288E-07	670.422	1,340.843	0.00E+00	6.59E-04	1.32E-03
Kr-85	7.4386E-02	670.422	1,340.843	0.00E+00	4.99E+01	9.97E+01
Np-237	1.0145E-05	670.422	1,340.843	0.00E+00	6.80E-03	1.36E-02
Pa-231	1.0258E-09	670.422	1,340.843	0.00E+00	6.88E-07	1.38E-06
Pb-210	1.4163E-11	670.422	1,340.843	0.00E+00	9.50E-09	1.90E-08
Pm-147	1.9170E-02	670.422	1,340.843	0.00E+00	1.29E+01	2.57E+01
Pu-238	8.3915E-02	670.422	1,340.843	0.00E+00	5.63E+01	1.13E+02
Pu-239	1.1628E-02	670.422	1,340.843	0.00E+00	7.80E+00	1.56E+01
Pu-240	1.5050E-02	670.422	1,340.843	0.00E+00	1.01E+01	2.02E+01
Pu-241	1.8524E+00	670.422	1,340.843	0.00E+00	1.24E+03	2.48E+03
Pu-242	6.4260E-05	670.422	1,340.843	0.00E+00	4.31E-02	8.62E-02
Ra-226	6.0562E-11	670.422	1,340.843	0.00E+00	4.06E-08	8.12E-08
Ra-228	4.9919E-12	670.422	1,340.843	0.00E+00	3.35E-09	6.69E-09
Ru-106	1.8330E-05	670.422	1,340.843	0.00E+00	1.23E-02	2.46E-02
Se-79	1.2379E-05	670.422	1,340.843	0.00E+00	8.30E-03	1.66E-02
Sn-126	2.5210E-05	670.422	1,340.843	0.00E+00	1.69E-02	3.38E-02
Sr-90	1.3098E+00	670.422	1,340.843	0.00E+00	8.78E+02	1.76E+03
Tc-99	3.9357E-04	670.422	1,340.843	0.00E+00	2.64E-01	5.28E-01
Th-229	6.2968E-11	670.422	1,340.843	0.00E+00	4.22E-08	8.44E-08
Th-230	1.0362E-08	670.422	1,340.843	0.00E+00	6.95E-06	1.39E-05
Th-232	5.2891E-12	670.422	1,340.843	0.00E+00	3.55E-09	7.09E-09
Tl-208	1.9977E-07	670.422	1,340.843	0.00E+00	1.34E-04	2.68E-04
U-232	5.4490E-07	670.422	1,340.843	0.00E+00	3.65E-04	7.31E-04
U-233	2.3934E-08	670.422	1,340.843	0.00E+00	1.60E-05	3.21E-05
U-234	4.4816E-05	670.422	1,340.843	0.00E+00	3.00E-02	6.01E-02
U-235	-1.4492E-06	670.422	0.000	7.90E-04	0.00E+00	7.90E-04
U-236	7.5711E-06	670.422	1,340.843	0.00E+00	5.08E-03	1.02E-02
U-238	-2.6129E-07	670.422	0.000	4.11E-03	3.94E-03	4.11E-03
Y-90	1.3101E+00	670.422	1,340.843	0.00E+00	8.78E+02	1.76E+03
Other Radionuclides					1.27E+03	2.54E+03

Gamma Sources

Photon Energy Group (Avg. MeV)	Total Photons/sec (bounding)
0.0150	1.026E+14
0.0250	2.089E+13
0.0375	2.041E+13
0.0575	2.144E+13
0.0850	1.175E+13
0.1250	8.898E+12
0.2250	1.007E+13
0.3750	4.341E+12
0.5750	9.858E+13
0.8500	2.554E+12
1.2500	3.836E+12
1.7500	7.063E+10
2.2500	1.637E+07
2.7500	1.149E+07
3.5000	1.701E+06
5.0000	7.164E+05
7.0000	8.260E+04
11.0000	9.488E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.01E+01	4.02E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-4	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	2.9	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	592.200	670.422
Bounding:		1,340.843

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.52	1.13
Bounding:	3.04	

Estimated EOL HM/Given EOL HM: 1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	ARMF (PLATES)	[1]Fuel decay start date:	1987
SNF ID #:	8	Estimates as of:	2010
Fuel Units & Descr:	15 - FLAT PLATES IN CAN	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=.20kg ; EOL=.20kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	20 years

Estimated Canister usage: 18"x10'

1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	6.6313E-10	0.023	0.046	0.00E+00	1.51E-11	3.02E-11
Am-241	2.0060E-03	0.023	0.046	0.00E+00	4.57E-05	9.14E-05
Am-242m	4.2429E-07	0.023	0.046	0.00E+00	9.66E-09	1.93E-08
Am-243	1.4899E-06	0.023	0.046	0.00E+00	3.39E-08	6.79E-08
C-14	5.7135E-09	0.023	0.046	0.00E+00	1.30E-10	2.60E-10
Cl-36	1.3124E-32	0.023	0.046	0.00E+00	2.99E-34	5.98E-34
Cm-243	1.6443E-07	0.023	0.046	0.00E+00	3.74E-09	7.49E-09
Cm-244	2.9330E-05	0.023	0.046	0.00E+00	6.68E-07	1.34E-06
Co-60	5.3186E-06	0.023	0.046	0.00E+00	1.21E-07	2.42E-07
Cs-134	3.1563E-03	0.023	0.046	0.00E+00	7.19E-05	1.44E-04
Cs-135	3.4477E-06	0.023	0.046	0.00E+00	7.85E-08	1.57E-07
Cs-137	2.0313E+00	0.023	0.046	0.00E+00	4.63E-02	9.25E-02
Eu-154	2.4513E-02	0.023	0.046	0.00E+00	5.58E-04	1.12E-03
Eu-155	4.8175E-03	0.023	0.046	0.00E+00	1.10E-04	2.19E-04
Fe-55	1.2397E-04	0.023	0.046	0.00E+00	2.82E-06	5.65E-06
H-3	4.5697E-03	0.023	0.046	0.00E+00	1.04E-04	2.08E-04
I-129	7.5300E-07	0.023	0.046	0.00E+00	1.71E-08	3.43E-08
Kr-85	1.0850E-01	0.023	0.046	0.00E+00	2.47E-03	4.94E-03
Np-237	9.5561E-06	0.023	0.046	0.00E+00	2.18E-07	4.35E-07
Pa-231	2.0359E-09	0.023	0.046	0.00E+00	4.64E-11	9.27E-11
Pb-210	4.9728E-11	0.023	0.046	0.00E+00	1.13E-12	2.26E-12
Pm-147	4.8502E-02	0.023	0.046	0.00E+00	1.10E-03	2.21E-03
Pu-238	1.8254E-02	0.023	0.046	0.00E+00	4.16E-04	8.31E-04
Pu-239	4.2810E-04	0.023	0.046	0.00E+00	9.75E-06	1.95E-05
Pu-240	2.4368E-04	0.023	0.046	0.00E+00	5.55E-06	1.11E-05
Pu-241	3.3415E-02	0.023	0.046	0.00E+00	7.61E-04	1.52E-03
Pu-242	3.6329E-07	0.023	0.046	0.00E+00	8.27E-09	1.65E-08
Ra-226	2.2854E-10	0.023	0.046	0.00E+00	5.20E-12	1.04E-11
Ra-228	1.2426E-14	0.023	0.046	0.00E+00	2.83E-16	5.66E-16
Ru-106	6.3589E-06	0.023	0.046	0.00E+00	1.45E-07	2.90E-07
Se-79	1.2933E-05	0.023	0.046	0.00E+00	2.94E-07	5.89E-07
Sn-126	1.1574E-05	0.023	0.046	0.00E+00	2.64E-07	5.27E-07
Sr-90	1.9248E+00	0.023	0.046	0.00E+00	4.38E-02	8.77E-02
Tc-99	4.2239E-04	0.023	0.046	0.00E+00	9.62E-06	1.92E-05
Th-229	5.0953E-12	0.023	0.046	0.00E+00	1.16E-13	2.32E-13
Th-230	4.1885E-08	0.023	0.046	0.00E+00	9.54E-10	1.91E-09
Th-232	1.9270E-14	0.023	0.046	0.00E+00	4.39E-16	8.78E-16
Tl-208	4.6024E-08	0.023	0.046	0.00E+00	1.05E-09	2.10E-09
U-232	1.2582E-07	0.023	0.046	0.00E+00	2.86E-09	5.73E-09
U-233	2.5825E-09	0.023	0.046	0.00E+00	5.88E-11	1.18E-10
U-234	1.8450E-04	0.023	0.046	0.00E+00	4.20E-06	8.40E-06
U-235	-2.7235E-06	0.023	0.000	3.93E-04	3.93E-04	3.93E-04
U-236	1.5493E-05	0.023	0.046	0.00E+00	3.53E-07	7.06E-07
U-238	-4.2851E-09	0.023	0.000	5.39E-06	5.39E-06	5.39E-06
Y-90	1.9254E+00	0.023	0.046	0.00E+00	4.38E-02	8.77E-02
Other Radionuclides					4.40E-02	8.81E-02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.816E+09
0.0250	9.996E+08
0.0375	8.719E+08
0.0575	9.339E+08
0.0850	5.654E+08
0.1250	3.841E+08
0.2250	4.949E+08
0.3750	2.120E+08
0.5750	3.458E+09
0.8500	5.845E+07
1.2500	3.338E+07
1.7500	1.532E+06
2.2500	1.345E+02
2.7500	7.601E+01
3.5000	3.911E-01
5.0000	3.743E-02
7.0000	4.178E-03
11.0000	4.716E-04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.53E-04	1.10E-03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM (1100)	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	91.89393939	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	0.023	
Bounding:		0.046

Basis for burnup used in estimate:

Nominal burnup taken directly from SFD (converted to MWd).
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	0.00
Bounding:	0.00	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ARMF/CFRMF MARK II
SNF ID #: 11
Fuel Units & Descr: 8 - 15 FLAT PLATES
Heavy Metal Mass: BOL=1.16kg ; EOL=1.16kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1991
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 15 years

Estimated Canister usage: 18"x10'
0.33

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	4.5861E-10	0.134	1.417	0.00E+00	6.14E-11	6.50E-10
Am-241	1.7832E-03	0.134	1.417	0.00E+00	2.39E-04	2.53E-03
Am-242m	4.3410E-07	0.134	1.417	0.00E+00	5.81E-08	6.15E-07
Am-243	1.4907E-06	0.134	1.417	0.00E+00	2.00E-07	2.11E-06
C-14	5.7162E-09	0.134	1.417	0.00E+00	7.65E-10	8.10E-09
Cl-36	1.3124E-32	0.134	1.417	0.00E+00	1.76E-33	1.86E-32
Cm-243	1.8568E-07	0.134	1.417	0.00E+00	2.49E-08	2.63E-07
Cm-244	3.5512E-05	0.134	1.417	0.00E+00	4.75E-06	5.03E-05
Co-60	1.0261E-05	0.134	1.417	0.00E+00	1.37E-06	1.45E-05
Cs-134	1.6931E-02	0.134	1.417	0.00E+00	2.27E-03	2.40E-02
Cs-135	3.4477E-06	0.134	1.417	0.00E+00	4.62E-07	4.88E-06
Cs-137	2.2800E+00	0.134	1.417	0.00E+00	3.05E-01	3.23E+00
Eu-154	3.6656E-02	0.134	1.417	0.00E+00	4.91E-03	5.19E-02
Eu-155	9.6841E-03	0.134	1.417	0.00E+00	1.30E-03	1.37E-02
Fe-55	4.6977E-04	0.134	1.417	0.00E+00	6.29E-05	6.65E-04
H-3	6.0485E-03	0.134	1.417	0.00E+00	8.10E-04	8.57E-03
I-129	7.5300E-07	0.134	1.417	0.00E+00	1.01E-07	1.07E-06
Kr-85	1.4989E-01	0.134	1.417	0.00E+00	2.01E-02	2.12E-01
Np-237	9.5534E-06	0.134	1.417	0.00E+00	1.28E-06	1.35E-05
Pa-231	1.6550E-09	0.134	1.417	0.00E+00	2.22E-10	2.34E-09
Pb-210	2.6631E-11	0.134	1.417	0.00E+00	3.56E-12	3.77E-11
Pm-147	1.8156E-01	0.134	1.417	0.00E+00	2.43E-02	2.57E-01
Pu-238	1.8990E-02	0.134	1.417	0.00E+00	2.54E-03	2.69E-02
Pu-239	4.2838E-04	0.134	1.417	0.00E+00	5.73E-05	6.07E-04
Pu-240	2.4379E-04	0.134	1.417	0.00E+00	3.26E-05	3.45E-04
Pu-241	4.2511E-02	0.134	1.417	0.00E+00	5.69E-03	6.02E-02
Pu-242	3.6329E-07	0.134	1.417	0.00E+00	4.86E-08	5.15E-07
Ra-226	1.4725E-10	0.134	1.417	0.00E+00	1.97E-11	2.09E-10
Ra-228	8.9760E-15	0.134	1.417	0.00E+00	1.20E-15	1.27E-14
Ru-106	1.9752E-04	0.134	1.417	0.00E+00	2.64E-05	2.80E-04
Se-79	1.2933E-05	0.134	1.417	0.00E+00	1.73E-06	1.83E-05
Sn-126	1.1574E-05	0.134	1.417	0.00E+00	1.55E-06	1.64E-05
Sr-90	2.1680E+00	0.134	1.417	0.00E+00	2.90E-01	3.07E+00
Tc-99	4.2239E-04	0.134	1.417	0.00E+00	5.65E-05	5.98E-04
Th-229	3.9270E-12	0.134	1.417	0.00E+00	5.26E-13	5.56E-12
Th-230	3.3578E-08	0.134	1.417	0.00E+00	4.49E-09	4.76E-08
Th-232	1.5452E-14	0.134	1.417	0.00E+00	2.07E-15	2.19E-14
Tl-208	4.6705E-08	0.134	1.417	0.00E+00	6.25E-09	6.62E-08
U-232	1.3045E-07	0.134	1.417	0.00E+00	1.75E-08	1.85E-07
U-233	2.3739E-09	0.134	1.417	0.00E+00	3.18E-10	3.36E-09
U-234	1.8423E-04	0.134	1.417	0.00E+00	2.47E-05	2.61E-04
U-235	-2.7235E-06	0.134	0.000	2.34E-03	2.34E-03	2.34E-03
U-236	1.5493E-05	0.134	1.417	0.00E+00	2.07E-06	2.19E-05
U-238	-4.2851E-09	0.134	0.000	2.69E-05	2.69E-05	2.69E-05
Y-90	2.1686E+00	0.134	1.417	0.00E+00	2.90E-01	3.07E+00
Other Radionuclides					2.91E-01	3.08E+00

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.690E+11
0.0250	3.524E+10
0.0375	3.077E+10
0.0575	3.281E+10
0.0850	1.988E+10
0.1250	1.364E+10
0.2250	1.717E+10
0.3750	7.501E+09
0.5750	1.218E+11
0.8500	2.892E+09
1.2500	1.461E+09
1.7500	6.123E+07
2.2500	7.660E+04
2.7500	4.603E+03
3.5000	2.929E+02
5.0000	7.699E-01
7.0000	8.546E-02
11.0000	9.608E-03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.68E-03	3.84E-02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM (1100)	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.12714777	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	0.134	
Bounding:	1.417	

Basis for burnup used in estimate:

Nominal burnup taken directly from SFD (converted to MWd).
Bounding burnup taken directly from SFD (converted to MWd).

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	0.00
Bounding:	0.00	0.00

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	ARMF/CFRMF MARK III	**Fuel decay start date:**[1]	1991
SNF ID #:	12	**Estimates as of:**	2010
Fuel Units & Descr:	4 - 15 FLAT PLATES	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=.10kg ; EOL=.10kg	**Template Burnup(MWd):**[2]	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	15 years

Estimated Canister usage: 18"x10'

0.17

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	4.5861E-10	0.011	0.117	0.00E+00	5.06E-12	5.36E-11
Am-241	1.7832E-03	0.011	0.117	0.00E+00	1.97E-05	2.08E-04
Am-242m	4.3410E-07	0.011	0.117	0.00E+00	4.79E-09	5.07E-08
Am-243	1.4907E-06	0.011	0.117	0.00E+00	1.65E-08	1.74E-07
C-14	5.7162E-09	0.011	0.117	0.00E+00	6.31E-11	6.68E-10
Cl-36	1.3124E-32	0.011	0.117	0.00E+00	1.45E-34	1.53E-33
Cm-243	1.8568E-07	0.011	0.117	0.00E+00	2.05E-09	2.17E-08
Cm-244	3.5512E-05	0.011	0.117	0.00E+00	3.92E-07	4.15E-06
Co-60	1.0261E-05	0.011	0.117	0.00E+00	1.13E-07	1.20E-06
Cs-134	1.6931E-02	0.011	0.117	0.00E+00	1.87E-04	1.98E-03
Cs-135	3.4477E-06	0.011	0.117	0.00E+00	3.81E-08	4.03E-07
Cs-137	2.2800E+00	0.011	0.117	0.00E+00	2.52E-02	2.66E-01
Eu-154	3.6656E-02	0.011	0.117	0.00E+00	4.05E-04	4.28E-03
Eu-155	9.6841E-03	0.011	0.117	0.00E+00	1.07E-04	1.13E-03
Fe-55	4.6977E-04	0.011	0.117	0.00E+00	5.19E-06	5.49E-05
H-3	6.0485E-03	0.011	0.117	0.00E+00	6.68E-05	7.07E-04
I-129	7.5300E-07	0.011	0.117	0.00E+00	8.31E-09	8.80E-08
Kr-85	1.4989E-01	0.011	0.117	0.00E+00	1.65E-03	1.75E-02
Np-237	9.5534E-06	0.011	0.117	0.00E+00	1.05E-07	1.12E-06
Pa-231	1.6550E-09	0.011	0.117	0.00E+00	1.83E-11	1.93E-10
Pb-210	2.6631E-11	0.011	0.117	0.00E+00	2.94E-13	3.11E-12
Pm-147	1.8156E-01	0.011	0.117	0.00E+00	2.00E-03	2.12E-02
Pu-238	1.8990E-02	0.011	0.117	0.00E+00	2.10E-04	2.22E-03
Pu-239	4.2838E-04	0.011	0.117	0.00E+00	4.73E-06	5.00E-05
Pu-240	2.4379E-04	0.011	0.117	0.00E+00	2.69E-06	2.85E-05
Pu-241	4.2511E-02	0.011	0.117	0.00E+00	4.69E-04	4.97E-03
Pu-242	3.6329E-07	0.011	0.117	0.00E+00	4.01E-09	4.24E-08
Ra-226	1.4725E-10	0.011	0.117	0.00E+00	1.63E-12	1.72E-11
Ra-228	8.9760E-15	0.011	0.117	0.00E+00	9.91E-17	1.05E-15
Ru-106	1.9752E-04	0.011	0.117	0.00E+00	2.18E-06	2.31E-05
Se-79	1.2933E-05	0.011	0.117	0.00E+00	1.43E-07	1.51E-06
Sn-126	1.1574E-05	0.011	0.117	0.00E+00	1.28E-07	1.35E-06
Sr-90	2.1680E+00	0.011	0.117	0.00E+00	2.39E-02	2.53E-01
Tc-99	4.2239E-04	0.011	0.117	0.00E+00	4.66E-06	4.93E-05
Th-229	3.9270E-12	0.011	0.117	0.00E+00	4.34E-14	4.59E-13
Th-230	3.3578E-08	0.011	0.117	0.00E+00	3.71E-10	3.92E-09
Th-232	1.5452E-14	0.011	0.117	0.00E+00	1.71E-16	1.81E-15
Tl-208	4.6705E-08	0.011	0.117	0.00E+00	5.16E-10	5.46E-09
U-232	1.3045E-07	0.011	0.117	0.00E+00	1.44E-09	1.52E-08
U-233	2.3739E-09	0.011	0.117	0.00E+00	2.62E-11	2.77E-10
U-234	1.8423E-04	0.011	0.117	0.00E+00	2.03E-06	2.15E-05
U-235	-2.7235E-06	0.011	0.000	1.90E-04	1.90E-04	1.90E-04
U-236	1.5493E-05	0.011	0.117	0.00E+00	1.71E-07	1.81E-06
U-238	-4.2851E-09	0.011	0.000	2.69E-06	2.69E-06	2.69E-06
Y-90	2.1686E+00	0.011	0.117	0.00E+00	2.39E-02	2.53E-01
Other Radionuclides					2.40E-02	2.54E-01

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.394E+10
0.0250	2.907E+09
0.0375	2.538E+09
0.0575	2.706E+09
0.0850	1.640E+09
0.1250	1.125E+09
0.2250	1.416E+09
0.3750	6.187E+08
0.5750	1.004E+10
0.8500	2.385E+08
1.2500	1.205E+08
1.7500	5.050E+06
2.2500	6.317E+03
2.7500	3.796E+02
3.5000	2.416E+01
5.0000	6.453E-02
7.0000	7.168E-03
11.0000	8.062E-04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.04E-04	3.17E-03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM (1100)	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	91.66666667	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	0.011	
Bounding:	0.117	

Basis for burnup used in estimate:

Nominal burnup taken directly from SFD (converted to MWd).

Bounding burnup taken directly from SFD (converted to MWd).

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	0.00
Bounding:	0.00	0.00

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	ASTRA (AUSTRIA)	[1]Fuel decay start date:	1985
SNF ID #:	646	Estimates as of:	2010
Fuel Units & Descr:	33 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=9.03kg ; EOL=4.36kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	25 years

Estimated Canister usage: 18"x10'

0.92

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.1465E-09	4,418.982	8,547.324	0.00E+00	5.07E-06	9.80E-06
Am-241	2.3056E-03	4,418.982	8,547.324	0.00E+00	1.02E+01	1.97E+01
Am-242m	4.1476E-07	4,418.982	8,547.324	0.00E+00	1.83E-03	3.55E-03
Am-243	1.4894E-06	4,418.982	8,547.324	0.00E+00	6.58E-03	1.27E-02
C-14	5.7108E-09	4,418.982	8,547.324	0.00E+00	2.52E-05	4.88E-05
Cl-36	1.3124E-32	4,418.982	8,547.324	0.00E+00	5.80E-29	1.12E-28
Cm-243	1.4562E-07	4,418.982	8,547.324	0.00E+00	6.43E-04	1.24E-03
Cm-244	2.4221E-05	4,418.982	8,547.324	0.00E+00	1.07E-01	2.07E-01
Co-60	2.7560E-06	4,418.982	8,547.324	0.00E+00	1.22E-02	2.36E-02
Cs-134	5.8851E-04	4,418.982	8,547.324	0.00E+00	2.60E+00	5.03E+00
Cs-135	3.4477E-06	4,418.982	8,547.324	0.00E+00	1.52E-02	2.95E-02
Cs-137	1.8099E+00	4,418.982	8,547.324	0.00E+00	8.00E+03	1.55E+04
Eu-154	1.6386E-02	4,418.982	8,547.324	0.00E+00	7.24E+01	1.40E+02
Eu-155	2.3957E-03	4,418.982	8,547.324	0.00E+00	1.06E+01	2.05E+01
Fe-55	3.2707E-05	4,418.982	8,547.324	0.00E+00	1.45E-01	2.80E-01
H-3	3.4504E-03	4,418.982	8,547.324	0.00E+00	1.52E+01	2.95E+01
I-129	7.5300E-07	4,418.982	8,547.324	0.00E+00	3.33E-03	6.44E-03
Kr-85	7.8540E-02	4,418.982	8,547.324	0.00E+00	3.47E+02	6.71E+02
Np-237	9.5615E-06	4,418.982	8,547.324	0.00E+00	4.23E-02	8.17E-02
Pa-231	2.7968E-09	4,418.982	8,547.324	0.00E+00	1.24E-05	2.39E-05
Pb-210	1.2612E-10	4,418.982	8,547.324	0.00E+00	5.57E-07	1.08E-06
Pm-147	1.2952E-02	4,418.982	8,547.324	0.00E+00	5.72E+01	1.11E+02
Pu-238	1.7549E-02	4,418.982	8,547.324	0.00E+00	7.75E+01	1.50E+02
Pu-239	4.2810E-04	4,418.982	8,547.324	0.00E+00	1.89E+00	3.66E+00
Pu-240	2.4357E-04	4,418.982	8,547.324	0.00E+00	1.08E+00	2.08E+00
Pu-241	2.6277E-02	4,418.982	8,547.324	0.00E+00	1.16E+02	2.25E+02
Pu-242	3.6329E-07	4,418.982	8,547.324	0.00E+00	1.61E-03	3.11E-03
Ra-226	4.4444E-10	4,418.982	8,547.324	0.00E+00	1.96E-06	3.80E-06
Ra-228	1.9714E-14	4,418.982	8,547.324	0.00E+00	8.71E-11	1.69E-10
Ru-106	2.0477E-07	4,418.982	8,547.324	0.00E+00	9.05E-04	1.75E-03
Se-79	1.2933E-05	4,418.982	8,547.324	0.00E+00	5.72E-02	1.11E-01
Sn-126	1.1574E-05	4,418.982	8,547.324	0.00E+00	5.11E-02	9.89E-02
Sr-90	1.7092E+00	4,418.982	8,547.324	0.00E+00	7.55E+03	1.46E+04
Tc-99	4.2239E-04	4,418.982	8,547.324	0.00E+00	1.87E+00	3.61E+00
Th-229	7.7260E-12	4,418.982	8,547.324	0.00E+00	3.41E-08	6.60E-08
Th-230	5.8497E-08	4,418.982	8,547.324	0.00E+00	2.58E-04	5.00E-04
Th-232	2.6906E-14	4,418.982	8,547.324	0.00E+00	1.19E-10	2.30E-10
Tl-208	4.4336E-08	4,418.982	8,547.324	0.00E+00	1.96E-04	3.79E-04
U-232	1.2037E-07	4,418.982	8,547.324	0.00E+00	5.32E-04	1.03E-03
U-233	3.0011E-09	4,418.982	8,547.324	0.00E+00	1.33E-05	2.57E-05
U-234	1.8497E-04	4,418.982	8,547.324	0.00E+00	8.17E-01	1.58E+00
U-235	-2.7235E-06	4,418.982	0.000	1.82E-02	6.12E-03	1.82E-02
U-236	1.5493E-05	4,418.982	8,547.324	0.00E+00	6.85E-02	1.32E-01
U-238	-4.2851E-09	4,418.982	0.000	2.10E-04	1.91E-04	2.10E-04
Y-90	1.7094E+00	4,418.982	8,547.324	0.00E+00	7.55E+03	1.46E+04
Other Radionuclides					7.61E+03	1.47E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.998E+14
0.0250	1.662E+14
0.0375	1.447E+14
0.0575	1.554E+14
0.0850	9.376E+13
0.1250	6.280E+13
0.2250	8.094E+13
0.3750	3.519E+13
0.5750	5.769E+14
0.8500	8.313E+12
1.2500	4.623E+12
1.7500	2.284E+11
2.2500	1.628E+07
2.7500	1.333E+07
3.5000	1.006E+04
5.0000	3.382E+03
7.0000	3.723E+02
11.0000	4.164E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.35E+01	1.81E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.07350223	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		4,418.982	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		8,547.324	Bounding burnup calculated assuming all BOL heavy metal burned.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.56	
Bounding:	3.01	

Estimated EOL HM/Given EOL HM

1.06

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ASTRA (AUSTRIA)
SNF ID #: 712
Fuel Units & Descr: 39 - 19 FLAT PLATES
Heavy Metal Mass: BOL=72.24kg ; EOL=66.18kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1985
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 25 years

Estimated Canister usage: 18"x10'
1.08

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.1465E-09	5,732.119	11,464.238	0.00E+00	6.57E-06	1.31E-05
Am-241	2.3056E-03	5,732.119	11,464.238	0.00E+00	1.32E+01	2.64E+01
Am-242m	4.1476E-07	5,732.119	11,464.238	0.00E+00	2.38E-03	4.75E-03
Am-243	1.4894E-06	5,732.119	11,464.238	0.00E+00	8.54E-03	1.71E-02
C-14	5.7108E-09	5,732.119	11,464.238	0.00E+00	3.27E-05	6.55E-05
Cl-36	1.3124E-32	5,732.119	11,464.238	0.00E+00	7.52E-29	1.50E-28
Cm-243	1.4562E-07	5,732.119	11,464.238	0.00E+00	8.35E-04	1.67E-03
Cm-244	2.4221E-05	5,732.119	11,464.238	0.00E+00	1.39E-01	2.78E-01
Co-60	2.7560E-06	5,732.119	11,464.238	0.00E+00	1.58E-02	3.16E-02
Cs-134	5.8851E-04	5,732.119	11,464.238	0.00E+00	3.37E+00	6.75E+00
Cs-135	3.4477E-06	5,732.119	11,464.238	0.00E+00	1.98E-02	3.95E-02
Cs-137	1.8099E+00	5,732.119	11,464.238	0.00E+00	1.04E+04	2.07E+04
Eu-154	1.6386E-02	5,732.119	11,464.238	0.00E+00	9.39E+01	1.88E+02
Eu-155	2.3957E-03	5,732.119	11,464.238	0.00E+00	1.37E+01	2.75E+01
Fe-55	3.2707E-05	5,732.119	11,464.238	0.00E+00	1.87E-01	3.75E-01
H-3	3.4504E-03	5,732.119	11,464.238	0.00E+00	1.98E+01	3.96E+01
I-129	7.5300E-07	5,732.119	11,464.238	0.00E+00	4.32E-03	8.63E-03
Kr-85	7.8540E-02	5,732.119	11,464.238	0.00E+00	4.50E+02	9.00E+02
Np-237	9.5615E-06	5,732.119	11,464.238	0.00E+00	5.48E-02	1.10E-01
Pa-231	2.7968E-09	5,732.119	11,464.238	0.00E+00	1.60E-05	3.21E-05
Pb-210	1.2612E-10	5,732.119	11,464.238	0.00E+00	7.23E-07	1.45E-06
Pm-147	1.2952E-02	5,732.119	11,464.238	0.00E+00	7.42E+01	1.48E+02
Pu-238	1.7549E-02	5,732.119	11,464.238	0.00E+00	1.01E+02	2.01E+02
Pu-239	4.2810E-04	5,732.119	11,464.238	0.00E+00	2.45E+00	4.91E+00
Pu-240	2.4357E-04	5,732.119	11,464.238	0.00E+00	1.40E+00	2.79E+00
Pu-241	2.6277E-02	5,732.119	11,464.238	0.00E+00	1.51E+02	3.01E+02
Pu-242	3.6329E-07	5,732.119	11,464.238	0.00E+00	2.08E-03	4.16E-03
Ra-226	4.4444E-10	5,732.119	11,464.238	0.00E+00	2.55E-06	5.10E-06
Ra-228	1.9714E-14	5,732.119	11,464.238	0.00E+00	1.13E-10	2.26E-10
Ru-106	2.0477E-07	5,732.119	11,464.238	0.00E+00	1.17E-03	2.35E-03
Se-79	1.2933E-05	5,732.119	11,464.238	0.00E+00	7.41E-02	1.48E-01
Sn-126	1.1574E-05	5,732.119	11,464.238	0.00E+00	6.63E-02	1.33E-01
Sr-90	1.7092E+00	5,732.119	11,464.238	0.00E+00	9.80E+03	1.96E+04
Tc-99	4.2239E-04	5,732.119	11,464.238	0.00E+00	2.42E+00	4.84E+00
Th-229	7.7260E-12	5,732.119	11,464.238	0.00E+00	4.43E-08	8.86E-08
Th-230	5.8497E-08	5,732.119	11,464.238	0.00E+00	3.35E-04	6.71E-04
Th-232	2.6906E-14	5,732.119	11,464.238	0.00E+00	1.54E-10	3.08E-10
Tl-208	4.4336E-08	5,732.119	11,464.238	0.00E+00	2.54E-04	5.08E-04
U-232	1.2037E-07	5,732.119	11,464.238	0.00E+00	6.90E-04	1.38E-03
U-233	3.0011E-09	5,732.119	11,464.238	0.00E+00	1.72E-05	3.44E-05
U-234	1.8497E-04	5,732.119	11,464.238	0.00E+00	1.06E+00	2.12E+00
U-235	-2.7235E-06	5,732.119	0.000	3.10E-02	1.54E-02	3.10E-02
U-236	1.5493E-05	5,732.119	11,464.238	0.00E+00	8.88E-02	1.78E-01
U-238	-4.2851E-09	5,732.119	0.000	1.95E-02	1.94E-02	1.95E-02
Y-90	1.7094E+00	5,732.119	11,464.238	0.00E+00	9.80E+03	1.96E+04
Other Radionuclides					9.88E+03	1.98E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.073E+15
0.0250	2.229E+14
0.0375	1.941E+14
0.0575	2.084E+14
0.0850	1.258E+14
0.1250	8.423E+13
0.2250	1.086E+14
0.3750	4.720E+13
0.5750	7.738E+14
0.8500	1.115E+13
1.2500	6.201E+12
1.7500	3.064E+11
2.2500	2.184E+07
2.7500	1.788E+07
3.5000	1.359E+04
5.0000	4.581E+03
7.0000	5.044E+02
11.0000	5.643E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.21E+02	2.42E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	19.83800556	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		5,732.119
Bounding:		11,464.238

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.25	
Bounding:	0.50	

Estimated EOL HM/Given EOL HM
1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ASTRA (AUSTRIA)
SNF ID #: 1058
Fuel Units & Descr: 3 - 19 FLAT PLATES
Heavy Metal Mass: BOL=5.38kg ; EOL=4.82kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1985
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 25 years

Estimated Canister usage: 18"x10'

0.08

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.1465E-09	530.994	1,061.988	0.00E+00	6.09E-07	1.22E-06
Am-241	2.3056E-03	530.994	1,061.988	0.00E+00	1.22E+00	2.45E+00
Am-242m	4.1476E-07	530.994	1,061.988	0.00E+00	2.20E-04	4.40E-04
Am-243	1.4894E-06	530.994	1,061.988	0.00E+00	7.91E-04	1.58E-03
C-14	5.7108E-09	530.994	1,061.988	0.00E+00	3.03E-06	6.06E-06
Cl-36	1.3124E-32	530.994	1,061.988	0.00E+00	6.97E-30	1.39E-29
Cm-243	1.4562E-07	530.994	1,061.988	0.00E+00	7.73E-05	1.55E-04
Cm-244	2.4221E-05	530.994	1,061.988	0.00E+00	1.29E-02	2.57E-02
Co-60	2.7560E-06	530.994	1,061.988	0.00E+00	1.46E-03	2.93E-03
Cs-134	5.8851E-04	530.994	1,061.988	0.00E+00	3.12E-01	6.25E-01
Cs-135	3.4477E-06	530.994	1,061.988	0.00E+00	1.83E-03	3.66E-03
Cs-137	1.8099E+00	530.994	1,061.988	0.00E+00	9.61E+02	1.92E+03
Eu-154	1.6386E-02	530.994	1,061.988	0.00E+00	8.70E+00	1.74E+01
Eu-155	2.3957E-03	530.994	1,061.988	0.00E+00	1.27E+00	2.54E+00
Fe-55	3.2707E-05	530.994	1,061.988	0.00E+00	1.74E-02	3.47E-02
H-3	3.4504E-03	530.994	1,061.988	0.00E+00	1.83E+00	3.66E+00
I-129	7.5300E-07	530.994	1,061.988	0.00E+00	4.00E-04	8.00E-04
Kr-85	7.8540E-02	530.994	1,061.988	0.00E+00	4.17E+01	8.34E+01
Np-237	9.5615E-06	530.994	1,061.988	0.00E+00	5.08E-03	1.02E-02
Pa-231	2.7968E-09	530.994	1,061.988	0.00E+00	1.49E-06	2.97E-06
Pb-210	1.2612E-10	530.994	1,061.988	0.00E+00	6.70E-08	1.34E-07
Pm-147	1.2952E-02	530.994	1,061.988	0.00E+00	6.88E+00	1.38E+01
Pu-238	1.7549E-02	530.994	1,061.988	0.00E+00	9.32E+00	1.86E+01
Pu-239	4.2810E-04	530.994	1,061.988	0.00E+00	2.27E-01	4.55E-01
Pu-240	2.4357E-04	530.994	1,061.988	0.00E+00	1.29E-01	2.59E-01
Pu-241	2.6277E-02	530.994	1,061.988	0.00E+00	1.40E+01	2.79E+01
Pu-242	3.6329E-07	530.994	1,061.988	0.00E+00	1.93E-04	3.86E-04
Ra-226	4.4444E-10	530.994	1,061.988	0.00E+00	2.36E-07	4.72E-07
Ra-228	1.9714E-14	530.994	1,061.988	0.00E+00	1.05E-11	2.09E-11
Ru-106	2.0477E-07	530.994	1,061.988	0.00E+00	1.09E-04	2.17E-04
Se-79	1.2933E-05	530.994	1,061.988	0.00E+00	6.87E-03	1.37E-02
Sn-126	1.1574E-05	530.994	1,061.988	0.00E+00	6.15E-03	1.23E-02
Sr-90	1.7092E+00	530.994	1,061.988	0.00E+00	9.08E+02	1.82E+03
Tc-99	4.2239E-04	530.994	1,061.988	0.00E+00	2.24E-01	4.49E-01
Th-229	7.7260E-12	530.994	1,061.988	0.00E+00	4.10E-09	8.20E-09
Th-230	5.8497E-08	530.994	1,061.988	0.00E+00	3.11E-05	6.21E-05
Th-232	2.6906E-14	530.994	1,061.988	0.00E+00	1.43E-11	2.86E-11
Tl-208	4.4336E-08	530.994	1,061.988	0.00E+00	2.35E-05	4.71E-05
U-232	1.2037E-07	530.994	1,061.988	0.00E+00	6.39E-05	1.28E-04
U-233	3.0011E-09	530.994	1,061.988	0.00E+00	1.59E-06	3.19E-06
U-234	1.8497E-04	530.994	1,061.988	0.00E+00	9.82E-02	1.96E-01
U-235	-2.7235E-06	530.994	0.000	2.27E-03	8.21E-04	2.27E-03
U-236	1.5493E-05	530.994	1,061.988	0.00E+00	8.23E-03	1.65E-02
U-238	-4.2851E-09	530.994	0.000	1.46E-03	1.45E-03	1.46E-03
Y-90	1.7094E+00	530.994	1,061.988	0.00E+00	9.08E+02	1.82E+03
Other Radionuclides					9.15E+02	1.83E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	9.937E+13
0.0250	2.064E+13
0.0375	1.798E+13
0.0575	1.931E+13
0.0850	1.165E+13
0.1250	7.802E+12
0.2250	1.006E+13
0.3750	4.372E+12
0.5750	7.168E+13
0.8500	1.033E+12
1.2500	5.744E+11
1.7500	2.838E+10
2.2500	2.023E+06
2.7500	1.656E+06
3.5000	1.257E+03
5.0000	4.235E+02
7.0000	4.663E+01
11.0000	5.217E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.12E+01	2.25E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3O8	U
BOL Enrichment %:	19.50065847	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		530.994
Bounding:		1,061.988

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.31	
Bounding:	0.63	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	ASTRA (AUSTRIA)	**Fuel decay start date:**[1]	1985
SNF ID #:	566	**Estimates as of:**	2010
Fuel Units & Descr:	5 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=3.62kg ; EOL=2.77kg	**Template Burnup(MWd):**[2]	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	25 years

Estimated Canister usage:

18"x10'
0.14

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.1465E-09	807.808	1,615.615	0.00E+00	9.26E-07	1.85E-06
Am-241	2.3056E-03	807.808	1,615.615	0.00E+00	1.86E+00	3.72E+00
Am-242m	4.1476E-07	807.808	1,615.615	0.00E+00	3.35E-04	6.70E-04
Am-243	1.4894E-06	807.808	1,615.615	0.00E+00	1.20E-03	2.41E-03
C-14	5.7108E-09	807.808	1,615.615	0.00E+00	4.61E-06	9.23E-06
Cl-36	1.3124E-32	807.808	1,615.615	0.00E+00	1.06E-29	2.12E-29
Cm-243	1.4562E-07	807.808	1,615.615	0.00E+00	1.18E-04	2.35E-04
Cm-244	2.4221E-05	807.808	1,615.615	0.00E+00	1.96E-02	3.91E-02
Co-60	2.7560E-06	807.808	1,615.615	0.00E+00	2.23E-03	4.45E-03
Cs-134	5.8851E-04	807.808	1,615.615	0.00E+00	4.75E-01	9.51E-01
Cs-135	3.4477E-06	807.808	1,615.615	0.00E+00	2.79E-03	5.57E-03
Cs-137	1.8099E+00	807.808	1,615.615	0.00E+00	1.46E+03	2.92E+03
Eu-154	1.6386E-02	807.808	1,615.615	0.00E+00	1.32E+01	2.65E+01
Eu-155	2.3957E-03	807.808	1,615.615	0.00E+00	1.94E+00	3.87E+00
Fe-55	3.2707E-05	807.808	1,615.615	0.00E+00	2.64E-02	5.28E-02
H-3	3.4504E-03	807.808	1,615.615	0.00E+00	2.79E+00	5.57E+00
I-129	7.5300E-07	807.808	1,615.615	0.00E+00	6.08E-04	1.22E-03
Kr-85	7.8540E-02	807.808	1,615.615	0.00E+00	6.34E+01	1.27E+02
Np-237	9.5615E-06	807.808	1,615.615	0.00E+00	7.72E-03	1.54E-02
Pa-231	2.7968E-09	807.808	1,615.615	0.00E+00	2.26E-06	4.52E-06
Pb-210	1.2612E-10	807.808	1,615.615	0.00E+00	1.02E-07	2.04E-07
Pm-147	1.2952E-02	807.808	1,615.615	0.00E+00	1.05E+01	2.09E+01
Pu-238	1.7549E-02	807.808	1,615.615	0.00E+00	1.42E+01	2.84E+01
Pu-239	4.2810E-04	807.808	1,615.615	0.00E+00	3.46E-01	6.92E-01
Pu-240	2.4357E-04	807.808	1,615.615	0.00E+00	1.97E-01	3.94E-01
Pu-241	2.6277E-02	807.808	1,615.615	0.00E+00	2.12E+01	4.25E+01
Pu-242	3.6329E-07	807.808	1,615.615	0.00E+00	2.93E-04	5.87E-04
Ra-226	4.4444E-10	807.808	1,615.615	0.00E+00	3.59E-07	7.18E-07
Ra-228	1.9714E-14	807.808	1,615.615	0.00E+00	1.59E-11	3.19E-11
Ru-106	2.0477E-07	807.808	1,615.615	0.00E+00	1.65E-04	3.31E-04
Se-79	1.2933E-05	807.808	1,615.615	0.00E+00	1.04E-02	2.09E-02
Sn-126	1.1574E-05	807.808	1,615.615	0.00E+00	9.35E-03	1.87E-02
Sr-90	1.7092E+00	807.808	1,615.615	0.00E+00	1.38E+03	2.76E+03
Tc-99	4.2239E-04	807.808	1,615.615	0.00E+00	3.41E-01	6.82E-01
Th-229	7.7260E-12	807.808	1,615.615	0.00E+00	6.24E-09	1.25E-08
Th-230	5.8497E-08	807.808	1,615.615	0.00E+00	4.73E-05	9.45E-05
Th-232	2.6906E-14	807.808	1,615.615	0.00E+00	2.17E-11	4.35E-11
Tl-208	4.4336E-08	807.808	1,615.615	0.00E+00	3.58E-05	7.16E-05
U-232	1.2037E-07	807.808	1,615.615	0.00E+00	9.72E-05	1.94E-04
U-233	3.0011E-09	807.808	1,615.615	0.00E+00	2.42E-06	4.85E-06
U-234	1.8497E-04	807.808	1,615.615	0.00E+00	1.49E-01	2.99E-01
U-235	-2.7235E-06	807.808	0.000	3.48E-03	1.28E-03	3.48E-03
U-236	1.5493E-05	807.808	1,615.615	0.00E+00	1.25E-02	2.50E-02
U-238	-4.2851E-09	807.808	0.000	6.76E-04	6.72E-04	6.76E-04
Y-90	1.7094E+00	807.808	1,615.615	0.00E+00	1.38E+03	2.76E+03
Other Radionuclides					1.39E+03	2.78E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.512E+14
0.0250	3.141E+13
0.0375	2.735E+13
0.0575	2.937E+13
0.0850	1.772E+13
0.1250	1.187E+13
0.2250	1.530E+13
0.3750	6.651E+12
0.5750	1.091E+14
0.8500	1.571E+12
1.2500	8.739E+11
1.7500	4.318E+10
2.2500	3.078E+06
2.7500	2.519E+06
3.5000	1.905E+03
5.0000	6.408E+02
7.0000	7.053E+01
11.0000	7.890E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.71E+01	**3.42E+01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	44.43904151	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		807.808	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,615.615	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.71	
Bounding:	1.42	

Estimated EOL HM/Given EOL HM

1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ATR
SNF ID #: 15
Fuel Units & Descr: 1760 - 19 CURVED PLATES
Heavy Metal Mass: BOL=2031.04kg ; EOL=1477.70kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1985
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 25 years

Estimated Canister usage:
18"x10'
88.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.1465E-09	524,027.503	1,048,055.006	0.00E+00	6.01E-04	1.20E-03
Am-241	2.3056E-03	524,027.503	1,048,055.006	0.00E+00	1.21E+03	2.42E+03
Am-242m	4.1476E-07	524,027.503	1,048,055.006	0.00E+00	2.17E-01	4.35E-01
Am-243	1.4894E-06	524,027.503	1,048,055.006	0.00E+00	7.80E-01	1.56E+00
C-14	5.7108E-09	524,027.503	1,048,055.006	0.00E+00	2.99E-03	5.99E-03
Cl-36	1.3124E-32	524,027.503	1,048,055.006	0.00E+00	6.88E-27	1.38E-26
Cm-243	1.4562E-07	524,027.503	1,048,055.006	0.00E+00	7.63E-02	1.53E-01
Cm-244	2.4221E-05	524,027.503	1,048,055.006	0.00E+00	1.27E+01	2.54E+01
Co-60	2.7560E-06	524,027.503	1,048,055.006	0.00E+00	1.44E+00	2.89E+00
Cs-134	5.8851E-04	524,027.503	1,048,055.006	0.00E+00	3.08E+02	6.17E+02
Cs-135	3.4477E-06	524,027.503	1,048,055.006	0.00E+00	1.81E+00	3.61E+00
Cs-137	1.8099E+00	524,027.503	1,048,055.006	0.00E+00	9.48E+05	1.90E+06
Eu-154	1.6386E-02	524,027.503	1,048,055.006	0.00E+00	8.59E+03	1.72E+04
Eu-155	2.3957E-03	524,027.503	1,048,055.006	0.00E+00	1.26E+03	2.51E+03
Fe-55	3.2707E-05	524,027.503	1,048,055.006	0.00E+00	1.71E+01	3.43E+01
H-3	3.4504E-03	524,027.503	1,048,055.006	0.00E+00	1.81E+03	3.62E+03
I-129	7.5300E-07	524,027.503	1,048,055.006	0.00E+00	3.95E-01	7.89E-01
Kr-85	7.8540E-02	524,027.503	1,048,055.006	0.00E+00	4.12E+04	8.23E+04
Np-237	9.5615E-06	524,027.503	1,048,055.006	0.00E+00	5.01E+00	1.00E+01
Pa-231	2.7968E-09	524,027.503	1,048,055.006	0.00E+00	1.47E-03	2.93E-03
Pb-210	1.2612E-10	524,027.503	1,048,055.006	0.00E+00	6.61E-05	1.32E-04
Pm-147	1.2952E-02	524,027.503	1,048,055.006	0.00E+00	6.79E+03	1.36E+04
Pu-238	1.7549E-02	524,027.503	1,048,055.006	0.00E+00	9.20E+03	1.84E+04
Pu-239	4.2810E-04	524,027.503	1,048,055.006	0.00E+00	2.24E+02	4.49E+02
Pu-240	2.4357E-04	524,027.503	1,048,055.006	0.00E+00	1.28E+02	2.55E+02
Pu-241	2.6277E-02	524,027.503	1,048,055.006	0.00E+00	1.38E+04	2.75E+04
Pu-242	3.6329E-07	524,027.503	1,048,055.006	0.00E+00	1.90E-01	3.81E-01
Ra-226	4.4444E-10	524,027.503	1,048,055.006	0.00E+00	2.33E-04	4.66E-04
Ra-228	1.9714E-14	524,027.503	1,048,055.006	0.00E+00	1.03E-08	2.07E-08
Ru-106	2.0477E-07	524,027.503	1,048,055.006	0.00E+00	1.07E-01	2.15E-01
Se-79	1.2933E-05	524,027.503	1,048,055.006	0.00E+00	6.78E+00	1.36E+01
Sn-126	1.1574E-05	524,027.503	1,048,055.006	0.00E+00	6.07E+00	1.21E+01
Sr-90	1.7092E+00	524,027.503	1,048,055.006	0.00E+00	8.96E+05	1.79E+06
Tc-99	4.2239E-04	524,027.503	1,048,055.006	0.00E+00	2.21E+02	4.43E+02
Th-229	7.7260E-12	524,027.503	1,048,055.006	0.00E+00	4.05E-06	8.10E-06
Th-230	5.8497E-08	524,027.503	1,048,055.006	0.00E+00	3.07E-02	6.13E-02
Th-232	2.6906E-14	524,027.503	1,048,055.006	0.00E+00	1.41E-08	2.82E-08
Tl-208	4.4336E-08	524,027.503	1,048,055.006	0.00E+00	2.32E-02	4.65E-02
U-232	1.2037E-07	524,027.503	1,048,055.006	0.00E+00	6.31E-02	1.26E-01
U-233	3.0011E-09	524,027.503	1,048,055.006	0.00E+00	1.57E-03	3.15E-03
U-234	1.8497E-04	524,027.503	1,048,055.006	0.00E+00	9.69E+01	1.94E+02
U-235	-2.7235E-06	524,027.503	0.000	4.09E+00	2.66E+00	4.09E+00
U-236	1.5493E-05	524,027.503	1,048,055.006	0.00E+00	8.12E+00	1.62E+01
U-238	-4.2851E-09	524,027.503	0.000	4.67E-02	4.45E-02	4.67E-02
Y-90	1.7094E+00	524,027.503	1,048,055.006	0.00E+00	8.96E+05	1.79E+06
Other Radionuclides					9.03E+05	1.81E+06

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	9.807E+16
0.0250	2.037E+16
0.0375	1.774E+16
0.0575	1.905E+16
0.0850	1.150E+16
0.1250	7.700E+15
0.2250	9.925E+15
0.3750	4.315E+15
0.5750	7.074E+16
0.8500	1.019E+15
1.2500	5.669E+14
1.7500	2.801E+13
2.2500	1.997E+09
2.7500	1.634E+09
3.5000	1.234E+06
5.0000	4.148E+05
7.0000	4.565E+04
11.0000	5.107E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.11E+04	2.22E+04
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM (6061-T6)	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.1542461	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	510,485.656	524,027.503	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	868,779.391	1,048,055.006	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.82	1.03
Bounding:	1.64	1.21

Estimated EOL HM/Given EOL HM: 1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	ATR	[1]Fuel decay start date:	2035
SNF ID #:	16	Estimates as of:	2010
Fuel Units & Descr:	3948 - 19 CURVED PLATES	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=4555.99kg ; EOL=3489.64kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:
18"x10'
197.40

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	1,145,112.141	2,019,717.366	0.00E+00	1.67E-04	2.94E-04
Am-241	1.1190E-03	1,145,112.141	2,019,717.366	0.00E+00	1.28E+03	2.26E+03
Am-242m	4.5425E-07	1,145,112.141	2,019,717.366	0.00E+00	5.20E-01	9.17E-01
Am-243	1.4921E-06	1,145,112.141	2,019,717.366	0.00E+00	1.71E+00	3.01E+00
C-14	5.7244E-09	1,145,112.141	2,019,717.366	0.00E+00	6.56E-03	1.16E-02
Cl-36	1.3124E-32	1,145,112.141	2,019,717.366	0.00E+00	1.50E-26	2.65E-26
Cm-243	2.3676E-07	1,145,112.141	2,019,717.366	0.00E+00	2.71E-01	4.78E-01
Cm-244	5.2042E-05	1,145,112.141	2,019,717.366	0.00E+00	5.96E+01	1.05E+02
Co-60	3.8208E-05	1,145,112.141	2,019,717.366	0.00E+00	4.38E+01	7.72E+01
Cs-134	4.8693E-01	1,145,112.141	2,019,717.366	0.00E+00	5.58E+05	9.83E+05
Cs-135	3.4477E-06	1,145,112.141	2,019,717.366	0.00E+00	3.95E+00	6.96E+00
Cs-137	2.8731E+00	1,145,112.141	2,019,717.366	0.00E+00	3.29E+06	5.80E+06
Eu-154	8.2053E-02	1,145,112.141	2,019,717.366	0.00E+00	9.40E+04	1.66E+05
Eu-155	3.9134E-02	1,145,112.141	2,019,717.366	0.00E+00	4.48E+04	7.90E+04
Fe-55	6.7429E-03	1,145,112.141	2,019,717.366	0.00E+00	7.72E+03	1.36E+04
H-3	1.0599E-02	1,145,112.141	2,019,717.366	0.00E+00	1.21E+04	2.14E+04
I-129	7.5300E-07	1,145,112.141	2,019,717.366	0.00E+00	8.62E-01	1.52E+00
Kr-85	2.8595E-01	1,145,112.141	2,019,717.366	0.00E+00	3.27E+05	5.78E+05
Np-237	9.5479E-06	1,145,112.141	2,019,717.366	0.00E+00	1.09E+01	1.93E+01
Pa-231	8.9297E-10	1,145,112.141	2,019,717.366	0.00E+00	1.02E-03	1.80E-03
Pb-210	3.7609E-12	1,145,112.141	2,019,717.366	0.00E+00	4.31E-06	7.60E-06
Pm-147	2.5452E+00	1,145,112.141	2,019,717.366	0.00E+00	2.91E+06	5.14E+06
Pu-238	2.0550E-02	1,145,112.141	2,019,717.366	0.00E+00	2.35E+04	4.15E+04
Pu-239	4.2838E-04	1,145,112.141	2,019,717.366	0.00E+00	4.91E+02	8.65E+02
Pu-240	2.4401E-04	1,145,112.141	2,019,717.366	0.00E+00	2.79E+02	4.93E+02
Pu-241	6.8764E-02	1,145,112.141	2,019,717.366	0.00E+00	7.87E+04	1.39E+05
Pu-242	3.6329E-07	1,145,112.141	2,019,717.366	0.00E+00	4.16E-01	7.34E-01
Ra-226	3.8045E-11	1,145,112.141	2,019,717.366	0.00E+00	4.36E-05	7.68E-05
Ra-228	2.9902E-15	1,145,112.141	2,019,717.366	0.00E+00	3.42E-09	6.04E-09
Ru-106	1.9055E-01	1,145,112.141	2,019,717.366	0.00E+00	2.18E+05	3.85E+05
Se-79	1.2936E-05	1,145,112.141	2,019,717.366	0.00E+00	1.48E+01	2.61E+01
Sn-126	1.1574E-05	1,145,112.141	2,019,717.366	0.00E+00	1.33E+01	2.34E+01
Sr-90	2.7505E+00	1,145,112.141	2,019,717.366	0.00E+00	3.15E+06	5.56E+06
Tc-99	4.2239E-04	1,145,112.141	2,019,717.366	0.00E+00	4.84E+02	8.53E+02
Th-229	1.8848E-12	1,145,112.141	2,019,717.366	0.00E+00	2.16E-06	3.81E-06
Th-230	1.7042E-08	1,145,112.141	2,019,717.366	0.00E+00	1.95E-02	3.44E-02
Th-232	7.8132E-15	1,145,112.141	2,019,717.366	0.00E+00	8.95E-09	1.58E-08
Tl-208	4.4063E-08	1,145,112.141	2,019,717.366	0.00E+00	5.05E-02	8.90E-02
U-232	1.3151E-07	1,145,112.141	2,019,717.366	0.00E+00	1.51E-01	2.66E-01
U-233	1.9564E-09	1,145,112.141	2,019,717.366	0.00E+00	2.24E-03	3.95E-03
U-234	1.8371E-04	1,145,112.141	2,019,717.366	0.00E+00	2.10E+02	3.71E+02
U-235	-2.7235E-06	1,145,112.141	0.000	9.17E+00	6.05E+00	9.17E+00
U-236	1.5493E-05	1,145,112.141	2,019,717.366	0.00E+00	1.77E+01	3.13E+01
U-238	-4.2851E-09	1,145,112.141	0.000	1.05E-01	9.99E-02	1.05E-01
Y-90	2.7505E+00	1,145,112.141	2,019,717.366	0.00E+00	3.15E+06	5.56E+06
Other Radionuclides					5.89E+06	1.04E+07

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.897E+17
0.0250	8.395E+16
0.0375	7.747E+16
0.0575	7.617E+16
0.0850	4.856E+16
0.1250	4.205E+16
0.2250	4.116E+16
0.3750	1.992E+16
0.5750	2.736E+17
0.8500	3.832E+16
1.2500	7.130E+15
1.7500	2.990E+14
2.2500	6.272E+14
2.7500	3.608E+12
3.5000	4.003E+11
5.0000	1.196E+06
7.0000	1.334E+05
11.0000	1.503E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.81E+04	1.02E+05
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM (6061-T6)	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.1542461	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	1,145,112.141	1,009,858.683
Bounding:	1,948,830.134	2,019,717.366

Basis for burnup used in estimate:

Nominal burnup taken directly from SFD (converted to MWd).

Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.80	0.88
Bounding:	1.41	1.04

Estimated EOL HM/Given EOL HM: 0.98

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	ATR	[1]Fuel decay start date:	1985
SNF ID #:	843	Estimates as of:	2010
Fuel Units & Descr:	128 - 19 CURVED PLATES	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=147.71kg ; EOL=99.39kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	25 years

Estimated Canister usage:

18"x10'
6.40

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.1465E-09	45,759.977	91,519.955	0.00E+00	5.25E-05	1.05E-04
Am-241	2.3056E-03	45,759.977	91,519.955	0.00E+00	1.06E+02	2.11E+02
Am-242m	4.1476E-07	45,759.977	91,519.955	0.00E+00	1.90E-02	3.80E-02
Am-243	1.4894E-06	45,759.977	91,519.955	0.00E+00	6.82E-02	1.36E-01
C-14	5.7108E-09	45,759.977	91,519.955	0.00E+00	2.61E-04	5.23E-04
Cl-36	1.3124E-32	45,759.977	91,519.955	0.00E+00	6.01E-28	1.20E-27
Cm-243	1.4562E-07	45,759.977	91,519.955	0.00E+00	6.66E-03	1.33E-02
Cm-244	2.4221E-05	45,759.977	91,519.955	0.00E+00	1.11E+00	2.22E+00
Co-60	2.7560E-06	45,759.977	91,519.955	0.00E+00	1.26E-01	2.52E-01
Cs-134	5.8851E-04	45,759.977	91,519.955	0.00E+00	2.69E+01	5.39E+01
Cs-135	3.4477E-06	45,759.977	91,519.955	0.00E+00	1.58E-01	3.16E-01
Cs-137	1.8099E+00	45,759.977	91,519.955	0.00E+00	8.28E+04	1.66E+05
Eu-154	1.6386E-02	45,759.977	91,519.955	0.00E+00	7.50E+02	1.50E+03
Eu-155	2.3957E-03	45,759.977	91,519.955	0.00E+00	1.10E+02	2.19E+02
Fe-55	3.2707E-05	45,759.977	91,519.955	0.00E+00	1.50E+00	2.99E+00
H-3	3.4504E-03	45,759.977	91,519.955	0.00E+00	1.58E+02	3.16E+02
I-129	7.5300E-07	45,759.977	91,519.955	0.00E+00	3.45E-02	6.89E-02
Kr-85	7.8540E-02	45,759.977	91,519.955	0.00E+00	3.59E+03	7.19E+03
Np-237	9.5615E-06	45,759.977	91,519.955	0.00E+00	4.38E-01	8.75E-01
Pa-231	2.7968E-09	45,759.977	91,519.955	0.00E+00	1.28E-04	2.56E-04
Pb-210	1.2612E-10	45,759.977	91,519.955	0.00E+00	5.77E-06	1.15E-05
Pm-147	1.2952E-02	45,759.977	91,519.955	0.00E+00	5.93E+02	1.19E+03
Pu-238	1.7549E-02	45,759.977	91,519.955	0.00E+00	8.03E+02	1.61E+03
Pu-239	4.2810E-04	45,759.977	91,519.955	0.00E+00	1.96E+01	3.92E+01
Pu-240	2.4357E-04	45,759.977	91,519.955	0.00E+00	1.11E+01	2.23E+01
Pu-241	2.6277E-02	45,759.977	91,519.955	0.00E+00	1.20E+03	2.40E+03
Pu-242	3.6329E-07	45,759.977	91,519.955	0.00E+00	1.66E-02	3.32E-02
Ra-226	4.4444E-10	45,759.977	91,519.955	0.00E+00	2.03E-05	4.07E-05
Ra-228	1.9714E-14	45,759.977	91,519.955	0.00E+00	9.02E-10	1.80E-09
Ru-106	2.0477E-07	45,759.977	91,519.955	0.00E+00	9.37E-03	1.87E-02
Se-79	1.2933E-05	45,759.977	91,519.955	0.00E+00	5.92E-01	1.18E+00
Sn-126	1.1574E-05	45,759.977	91,519.955	0.00E+00	5.30E-01	1.06E+00
Sr-90	1.7092E+00	45,759.977	91,519.955	0.00E+00	7.82E+04	1.56E+05
Tc-99	4.2239E-04	45,759.977	91,519.955	0.00E+00	1.93E+01	3.87E+01
Th-229	7.7260E-12	45,759.977	91,519.955	0.00E+00	3.54E-07	7.07E-07
Th-230	5.8497E-08	45,759.977	91,519.955	0.00E+00	2.68E-03	5.35E-03
Th-232	2.6906E-14	45,759.977	91,519.955	0.00E+00	1.23E-09	2.46E-09
Tl-208	4.4336E-08	45,759.977	91,519.955	0.00E+00	2.03E-03	4.06E-03
U-232	1.2037E-07	45,759.977	91,519.955	0.00E+00	5.51E-03	1.10E-02
U-233	3.0011E-09	45,759.977	91,519.955	0.00E+00	1.37E-04	2.75E-04
U-234	1.8497E-04	45,759.977	91,519.955	0.00E+00	8.46E+00	1.69E+01
U-235	-2.7235E-06	45,759.977	0.000	2.97E-01	1.73E-01	2.97E-01
U-236	1.5493E-05	45,759.977	91,519.955	0.00E+00	7.09E-01	1.42E+00
U-238	-4.2851E-09	45,759.977	0.000	3.40E-03	3.20E-03	3.40E-03
Y-90	1.7094E+00	45,759.977	91,519.955	0.00E+00	7.82E+04	1.56E+05
Other Radionuclides					7.88E+04	1.58E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	8.564E+15
0.0250	1.779E+15
0.0375	1.549E+15
0.0575	1.664E+15
0.0850	1.004E+15
0.1250	6.724E+14
0.2250	8.667E+14
0.3750	3.768E+14
0.5750	6.178E+15
0.8500	8.901E+13
1.2500	4.950E+13
1.7500	2.446E+12
2.2500	1.744E+08
2.7500	1.427E+08
3.5000	1.077E+05
5.0000	3.622E+04
7.0000	3.986E+03
11.0000	4.459E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.68E+02	1.94E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM (6061-T6)	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.1542461	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	37,126.230	45,759.977	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	63,183.956	91,519.955	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.98	1.23
Bounding:	1.97	1.45

Estimated EOL HM/Given EOL HM: 1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ATSR
SNF ID #: 17
Fuel Units & Descr: 20 - 19 FLAT PLATES
Heavy Metal Mass: BOL= ; EOL=3.21kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 1988
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 20 years

Estimated Canister usage:

18"x10'
0.56

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	6.6313E-10	3,039.932	3,039.932	0.00E+00	2.02E-06	2.02E-06
Am-241	2.0060E-03	3,039.932	3,039.932	0.00E+00	6.10E+00	6.10E+00
Am-242m	4.2429E-07	3,039.932	3,039.932	0.00E+00	1.29E-03	1.29E-03
Am-243	1.4899E-06	3,039.932	3,039.932	0.00E+00	4.53E-03	4.53E-03
C-14	5.7135E-09	3,039.932	3,039.932	0.00E+00	1.74E-05	1.74E-05
Cl-36	1.3124E-32	3,039.932	3,039.932	0.00E+00	3.99E-29	3.99E-29
Cm-243	1.6443E-07	3,039.932	3,039.932	0.00E+00	5.00E-04	5.00E-04
Cm-244	2.9330E-05	3,039.932	3,039.932	0.00E+00	8.92E-02	8.92E-02
Co-60	5.3186E-06	3,039.932	3,039.932	0.00E+00	1.62E-02	1.62E-02
Cs-134	3.1563E-03	3,039.932	3,039.932	0.00E+00	9.59E+00	9.59E+00
Cs-135	3.4477E-06	3,039.932	3,039.932	0.00E+00	1.05E-02	1.05E-02
Cs-137	2.0313E+00	3,039.932	3,039.932	0.00E+00	6.18E+03	6.18E+03
Eu-154	2.4513E-02	3,039.932	3,039.932	0.00E+00	7.45E+01	7.45E+01
Eu-155	4.8175E-03	3,039.932	3,039.932	0.00E+00	1.46E+01	1.46E+01
Fe-55	1.2397E-04	3,039.932	3,039.932	0.00E+00	3.77E-01	3.77E-01
H-3	4.5697E-03	3,039.932	3,039.932	0.00E+00	1.39E+01	1.39E+01
I-129	7.5300E-07	3,039.932	3,039.932	0.00E+00	2.29E-03	2.29E-03
Kr-85	1.0850E-01	3,039.932	3,039.932	0.00E+00	3.30E+02	3.30E+02
Np-237	9.5561E-06	3,039.932	3,039.932	0.00E+00	2.90E-02	2.90E-02
Pa-231	2.0359E-09	3,039.932	3,039.932	0.00E+00	6.19E-06	6.19E-06
Pb-210	4.9728E-11	3,039.932	3,039.932	0.00E+00	1.51E-07	1.51E-07
Pm-147	4.8502E-02	3,039.932	3,039.932	0.00E+00	1.47E+02	1.47E+02
Pu-238	1.8254E-02	3,039.932	3,039.932	0.00E+00	5.55E+01	5.55E+01
Pu-239	4.2810E-04	3,039.932	3,039.932	0.00E+00	1.30E+00	1.30E+00
Pu-240	2.4368E-04	3,039.932	3,039.932	0.00E+00	7.41E-01	7.41E-01
Pu-241	3.3415E-02	3,039.932	3,039.932	0.00E+00	1.02E+02	1.02E+02
Pu-242	3.6329E-07	3,039.932	3,039.932	0.00E+00	1.10E-03	1.10E-03
Ra-226	2.2854E-10	3,039.932	3,039.932	0.00E+00	6.95E-07	6.95E-07
Ra-228	1.2426E-14	3,039.932	3,039.932	0.00E+00	3.78E-11	3.78E-11
Ru-106	6.3589E-06	3,039.932	3,039.932	0.00E+00	1.93E-02	1.93E-02
Se-79	1.2933E-05	3,039.932	3,039.932	0.00E+00	3.93E-02	3.93E-02
Sn-126	1.1574E-05	3,039.932	3,039.932	0.00E+00	3.52E-02	3.52E-02
Sr-90	1.9248E+00	3,039.932	3,039.932	0.00E+00	5.85E+03	5.85E+03
Tc-99	4.2239E-04	3,039.932	3,039.932	0.00E+00	1.28E+00	1.28E+00
Th-229	5.0953E-12	3,039.932	3,039.932	0.00E+00	1.55E-08	1.55E-08
Th-230	4.1885E-08	3,039.932	3,039.932	0.00E+00	1.27E-04	1.27E-04
Th-232	1.9270E-14	3,039.932	3,039.932	0.00E+00	5.86E-11	5.86E-11
Tl-208	4.6024E-08	3,039.932	3,039.932	0.00E+00	1.40E-04	1.40E-04
U-232	1.2582E-07	3,039.932	3,039.932	0.00E+00	3.82E-04	3.82E-04
U-233	2.5825E-09	3,039.932	3,039.932	0.00E+00	7.85E-06	7.85E-06
U-234	1.8450E-04	3,039.932	3,039.932	0.00E+00	5.61E-01	5.61E-01
U-235	-2.7235E-06	3,039.932	0.000	1.28E-02	4.50E-03	1.28E-02
U-236	1.5493E-05	3,039.932	3,039.932	0.00E+00	4.71E-02	4.71E-02
U-238	-4.2851E-09	3,039.932	0.000	1.29E-04	1.16E-04	1.29E-04
Y-90	1.9254E+00	3,039.932	3,039.932	0.00E+00	5.85E+03	5.85E+03
Other Radionuclides					5.88E+03	5.88E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.209E+14
0.0250	6.673E+13
0.0375	5.820E+13
0.0575	6.234E+13
0.0850	3.767E+13
0.1250	2.549E+13
0.2250	3.250E+13
0.3750	1.415E+13
0.5750	2.308E+14
0.8500	3.902E+12
1.2500	2.228E+12
1.7500	1.023E+11
2.2500	8.973E+06
2.7500	5.071E+06
3.5000	2.330E+04
5.0000	1.317E+03
7.0000	1.454E+02
11.0000	1.630E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
7.25E+01	7.25E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:		60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		3,039.932	Nominal burnup set equal to bounding burnup.
Bounding:		3,039.932	Bounding burnup estimated by assuming BOL heavy metal mass was twice EOL.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.50	
Bounding:	1.50	

Estimated EOL HM/Given EOL HM

1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BABCOCK & WILCOX SCRAP	[1]Fuel decay start date:	1969
SNF ID #:	18	Estimates as of:	2010
Fuel Units & Desc.:	1 - CANISTER OF SCRAP	Template:	(Worst Case)
Heavy Metal Mass:	BOL= ; EOL=.07kg	[2]Template Burnup(MWd):	62.5
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.00186865
		Template Decay Time:	35 years

Estimated Canister usage:
HIC
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	2.3072E-06	66.525	66.525	0.00E+00	1.53E-04	1.53E-04
Am-241	8.4448E+00	66.525	66.525	0.00E+00	5.62E+02	5.62E+02
Am-242m	1.6848E-02	66.525	66.525	0.00E+00	1.12E+00	1.12E+00
Am-243	1.6320E-02	66.525	66.525	0.00E+00	1.09E+00	1.09E+00
C-14	1.2090E-01	66.525	66.525	0.00E+00	8.04E+00	8.04E+00
Cl-36	2.2849E-03	66.525	66.525	0.00E+00	1.52E-01	1.52E-01
Cm-243	8.6624E-04	66.525	66.525	0.00E+00	5.76E-02	5.76E-02
Cm-244	1.6848E-01	66.525	66.525	0.00E+00	1.12E+01	1.12E+01
Co-60	2.8086E+01	66.525	66.525	0.00E+00	1.87E+03	1.87E+03
Cs-134	3.4148E-04	66.525	66.525	0.00E+00	2.27E-02	2.27E-02
Cs-135	4.3976E-04	66.525	66.525	0.00E+00	2.93E-02	2.93E-02
Cs-137	2.1049E+01	66.525	66.525	0.00E+00	1.40E+03	1.40E+03
Eu-154	1.2500E+00	66.525	66.525	0.00E+00	8.32E+01	8.32E+01
Eu-155	6.8986E-02	66.525	66.525	0.00E+00	4.59E+00	4.59E+00
Fe-55	2.9308E-01	66.525	66.525	0.00E+00	1.95E+01	1.95E+01
H-3	2.4311E-01	66.525	66.525	0.00E+00	1.62E+01	1.62E+01
I-129	1.0618E-05	66.525	66.525	0.00E+00	7.06E-04	7.06E-04
Kr-85	5.9882E-01	66.525	66.525	0.00E+00	3.98E+01	3.98E+01
Np-237	1.5668E-04	66.525	66.525	0.00E+00	1.04E-02	1.04E-02
Pa-231	2.8656E-06	66.525	66.525	0.00E+00	1.91E-04	1.91E-04
Pb-210	2.3918E-08	66.525	66.525	0.00E+00	1.59E-06	1.59E-06
Pm-147	1.6900E-02	66.525	66.525	0.00E+00	1.12E+00	1.12E+00
Pu-238	-8.6123E-01	66.525	0.000	1.80E+01	0.00E+00	1.80E+01
Pu-239	-4.8440E-02	66.525	0.000	2.18E+00	0.00E+00	2.18E+00
Pu-240	-3.0095E-01	66.525	0.000	2.78E+00	0.00E+00	2.78E+00
Pu-241	-1.0411E+02	66.525	0.000	7.16E+02	0.00E+00	7.16E+02
Pu-242	-1.1381E-04	66.525	0.000	1.20E-02	4.46E-03	1.20E-02
Ra-226	6.4400E-08	66.525	66.525	0.00E+00	4.28E-06	4.28E-06
Ra-228	5.9952E-07	66.525	66.525	0.00E+00	3.99E-05	3.99E-05
Ru-106	8.5526E-07	66.525	66.525	0.00E+00	5.69E-05	5.69E-05
Se-79	1.9181E-04	66.525	66.525	0.00E+00	1.28E-02	1.28E-02
Sn-126	1.6671E-04	66.525	66.525	0.00E+00	1.11E-02	1.11E-02
Sr-90	1.9799E+01	66.525	66.525	0.00E+00	1.32E+03	1.32E+03
Tc-99	6.7678E-03	66.525	66.525	0.00E+00	4.50E-01	4.50E-01
Th-229	1.7488E-06	66.525	66.525	0.00E+00	1.16E-04	1.16E-04
Th-230	5.8704E-06	66.525	66.525	0.00E+00	3.91E-04	3.91E-04
Th-232	6.0208E-07	66.525	66.525	0.00E+00	4.01E-05	4.01E-05
Tl-208	8.7573E-05	66.525	66.525	0.00E+00	5.83E-03	5.83E-03
U-232	2.3706E-04	66.525	66.525	0.00E+00	1.58E-02	1.58E-02
U-233	3.6128E-04	66.525	66.525	0.00E+00	2.40E-02	2.40E-02
U-234	1.2788E-02	66.525	66.525	0.00E+00	8.51E-01	8.51E-01
U-235	5.7486E-04	66.525	66.525	6.02E-05	3.83E-02	3.83E-02
U-236	2.3485E-04	66.525	66.525	0.00E+00	1.56E-02	1.56E-02
U-238	1.1581E-04	66.525	66.525	7.49E-06	7.71E-03	7.71E-03
Y-90	1.9804E+01	66.525	66.525	0.00E+00	1.32E+03	1.32E+03
Other Radionuclides					4.10E+03	4.10E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	8.152E+13
0.0250	1.622E+13
0.0375	1.417E+13
0.0575	2.230E+13
0.0850	8.703E+12
0.1250	6.821E+12
0.2250	7.539E+12
0.3750	3.224E+12
0.5750	5.244E+13
0.8500	2.004E+12
1.2500	1.401E+14
1.7500	6.197E+10
2.2500	7.346E+08
2.7500	2.070E+08
3.5000	1.657E+05
5.0000	7.036E+04
7.0000	8.057E+03
11.0000	9.219E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.56E+01	6.63E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	(Worst Case)
Fuel Cladding:	SST	SST/Inconel
BOL HM Constituents:	PuO2-UO2	U, Th, & Pu
BOL Enrichment %:		0 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel didn't closely match any existing templates, therefore the worst case template was used.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		66.525
Bounding:		66.525

Basis for burnup used in estimate:

Nominal burnup set equal to bounding burnup.
Bounding burnup estimated by assuming BOL heavy metal mass was twice EOL.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	14.21	
Bounding:	14.21	

Estimated EOL HM/Given EOL HM
591.64

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BCD B-17 (TURKEY POINT 3)	**[1]Fuel decay start date:**	1975
SNF ID #:	19	**Estimates as of:**	2010
Fuel Units & Descr:	1 - 15 X 15 ROD ARRAY	**Template:**	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=458.98kg ; EOL=411.81kg	**[2]Template Burnup(MWd):**	61.92
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.00176911
		Template Decay Time:	35 years

Estimated Canister usage:

PWR
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	8.7758E-10	44,857.390	89,714.780	0.00E+00	3.94E-05	7.87E-05
Am-241	1.4352E-01	44,857.390	89,714.780	0.00E+00	6.44E+03	1.29E+04
Am-242m	2.8698E-04	44,857.390	89,714.780	0.00E+00	1.29E+01	2.57E+01
Am-243	6.2565E-04	44,857.390	89,714.780	0.00E+00	2.81E+01	5.61E+01
C-14	4.7901E-05	44,857.390	89,714.780	0.00E+00	2.15E+00	4.30E+00
Cl-36	8.0297E-07	44,857.390	89,714.780	0.00E+00	3.60E-02	7.20E-02
Cm-243	2.5081E-04	44,857.390	89,714.780	0.00E+00	1.13E+01	2.25E+01
Cm-244	4.9015E-02	44,857.390	89,714.780	0.00E+00	2.20E+03	4.40E+03
Co-60	2.5581E-03	44,857.390	89,714.780	0.00E+00	1.15E+02	2.30E+02
Cs-134	4.0536E-05	44,857.390	89,714.780	0.00E+00	1.82E+00	3.64E+00
Cs-135	1.4433E-05	44,857.390	89,714.780	0.00E+00	6.47E-01	1.29E+00
Cs-137	1.3979E+00	44,857.390	89,714.780	0.00E+00	6.27E+04	1.25E+05
Eu-154	2.0203E-02	44,857.390	89,714.780	0.00E+00	9.06E+02	1.81E+03
Eu-155	1.7684E-03	44,857.390	89,714.780	0.00E+00	7.93E+01	1.59E+02
Fe-55	4.3136E-05	44,857.390	89,714.780	0.00E+00	1.93E+00	3.87E+00
H-3	2.0769E-02	44,857.390	89,714.780	0.00E+00	9.32E+02	1.86E+03
I-129	9.8288E-07	44,857.390	89,714.780	0.00E+00	4.41E-02	8.82E-02
Kr-85	2.8214E-02	44,857.390	89,714.780	0.00E+00	1.27E+03	2.53E+03
Np-237	1.1218E-05	44,857.390	89,714.780	0.00E+00	5.03E-01	1.01E+00
Pa-231	1.3036E-09	44,857.390	89,714.780	0.00E+00	5.85E-05	1.17E-04
Pb-210	8.5078E-11	44,857.390	89,714.780	0.00E+00	3.82E-06	7.63E-06
Pm-147	3.6531E-04	44,857.390	89,714.780	0.00E+00	1.64E+01	3.28E+01
Pu-238	7.4564E-02	44,857.390	89,714.780	0.00E+00	3.34E+03	6.69E+03
Pu-239	1.1623E-02	44,857.390	89,714.780	0.00E+00	5.21E+02	1.04E+03
Pu-240	1.5132E-02	44,857.390	89,714.780	0.00E+00	6.79E+02	1.36E+03
Pu-241	9.0036E-01	44,857.390	89,714.780	0.00E+00	4.04E+04	8.08E+04
Pu-242	6.4260E-05	44,857.390	89,714.780	0.00E+00	2.88E+00	5.77E+00
Ra-226	2.2804E-10	44,857.390	89,714.780	0.00E+00	1.02E-05	2.05E-05
Ra-228	5.2713E-12	44,857.390	89,714.780	0.00E+00	2.36E-07	4.73E-07
Ru-106	6.1160E-10	44,857.390	89,714.780	0.00E+00	2.74E-05	5.49E-05
Se-79	1.2377E-05	44,857.390	89,714.780	0.00E+00	5.55E-01	1.11E+00
Sn-126	2.5210E-05	44,857.390	89,714.780	0.00E+00	1.13E+00	2.26E+00
Sr-90	9.1667E-01	44,857.390	89,714.780	0.00E+00	4.11E+04	8.22E+04
Tc-99	3.9357E-04	44,857.390	89,714.780	0.00E+00	1.77E+01	3.53E+01
Th-229	1.2057E-10	44,857.390	89,714.780	0.00E+00	5.41E-06	1.08E-05
Th-230	2.1043E-08	44,857.390	89,714.780	0.00E+00	9.44E-04	1.89E-03
Th-232	5.2972E-12	44,857.390	89,714.780	0.00E+00	2.38E-07	4.75E-07
Tl-208	1.7474E-07	44,857.390	89,714.780	0.00E+00	7.84E-03	1.57E-02
U-232	4.7368E-07	44,857.390	89,714.780	0.00E+00	2.12E-02	4.25E-02
U-233	2.5097E-08	44,857.390	89,714.780	0.00E+00	1.13E-03	2.25E-03
U-234	5.0000E-05	44,857.390	89,714.780	0.00E+00	2.24E+00	4.49E+00
U-235	-1.4489E-06	44,857.390	0.000	2.54E-02	0.00E+00	2.54E-02
U-236	7.5824E-06	44,857.390	89,714.780	0.00E+00	3.40E-01	6.80E-01
U-238	-2.6129E-07	44,857.390	0.000	1.50E-01	1.39E-01	1.50E-01
Y-90	9.1699E-01	44,857.390	89,714.780	0.00E+00	4.11E+04	8.23E+04
Other Radionuclides					6.02E+04	1.20E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.827E+15
0.0250	9.734E+14
0.0375	9.284E+14
0.0575	1.073E+15
0.0850	5.401E+14
0.1250	3.748E+14
0.2250	4.632E+14
0.3750	1.992E+14
0.5750	4.632E+15
0.8500	6.408E+13
1.2500	6.295E+13
1.7500	1.885E+12
2.2500	3.036E+08
2.7500	6.218E+08
3.5000	6.404E+07
5.0000	2.738E+07
7.0000	3.155E+06
11.0000	3.624E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.03E+03	2.06E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-4	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	2.560002614	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	11,779.722	44,857.390	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		89,714.780	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	2.79	3.81
Bounding:	5.58	

Estimated EOL HM/Given EOL HM: 1.05

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BER-II [HMI] (END BOXES) (GERMANY)	[1]Fuel decay start date:	1996		Estimated Canister usage:
SNF ID #:	892	Estimates as of:	2010		HIC
Fuel Units & Descr:	6 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)		1.00
Heavy Metal Mass:	BOL=.00kg ; EOL=.00kg	[2]Template Burnup(MWd):	367.2		
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689		
		Template Decay Time:	10 years		

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.8404E-10	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Am-241	1.4935E-03	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Am-242m	4.4390E-07	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Am-243	1.4913E-06	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
C-14	5.7217E-09	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Cl-36	1.3124E-32	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Cm-243	2.0967E-07	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Cm-244	4.3001E-05	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Co-60	1.9798E-05	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Cs-134	9.0795E-02	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Cs-135	3.4477E-06	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Cs-137	2.5588E+00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Eu-154	5.4847E-02	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Eu-155	1.9469E-02	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Fe-55	1.7797E-03	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
H-3	8.0065E-03	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
I-129	7.5300E-07	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Kr-85	2.0705E-01	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Np-237	9.5507E-06	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Pa-231	1.2740E-09	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Pb-210	1.1838E-11	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Pm-147	6.7974E-01	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Pu-238	1.9755E-02	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Pu-239	4.2838E-04	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Pu-240	2.4390E-04	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Pu-241	5.4058E-02	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Pu-242	3.6329E-07	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Ra-226	8.3742E-11	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Ra-228	5.7734E-15	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Ru-106	6.1356E-03	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Se-79	1.2936E-05	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Sn-126	1.1574E-05	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Sr-90	2.4417E+00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Tc-99	4.2239E-04	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Th-229	2.8568E-12	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Th-230	2.5310E-08	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Th-232	1.1631E-14	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Tl-208	4.6705E-08	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
U-232	1.3151E-07	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
U-233	2.1650E-09	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
U-234	1.8399E-04	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
U-235	-2.7235E-06	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
U-236	1.5493E-05	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
U-238	-4.2851E-09	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Y-90	2.4423E+00	0.000	0.000	0.00E+00	0.00E+00	0.00E+00
Other Radionuclides					0.00E+00	0.00E+00

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	0.000E+00
0.0250	0.000E+00
0.0375	0.000E+00
0.0575	0.000E+00
0.0850	0.000E+00
0.1250	0.000E+00
0.2250	0.000E+00
0.3750	0.000E+00
0.5750	0.000E+00
0.8500	0.000E+00
1.2500	0.000E+00
1.7500	0.000E+00
2.2500	0.000E+00
2.7500	0.000E+00
3.5000	0.000E+00
5.0000	0.000E+00
7.0000	0.000E+00
11.0000	0.000E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
0.00E+00	0.00E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	100	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		
Bounding:		

Basis for burnup used in estimate:

Nominal burnup assumed to be 2% of BOL heavy metal mass.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:		
Bounding:		

Estimated EOL HM/Given EOL HM

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BER-II [HMI] (GERMANY)
SNF ID #: 758
Fuel Units & Descr: 112 - 17 FLAT PLATES
Heavy Metal Mass: BOL=20.65kg ; EOL=12.07kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 1996
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 10 years

Estimated Canister usage:

18"x10'
4.67

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.8404E-10	8,124.669	16,249.338	0.00E+00	2.31E-06	4.62E-06
Am-241	1.4935E-03	8,124.669	16,249.338	0.00E+00	1.21E+01	2.43E+01
Am-242m	4.4390E-07	8,124.669	16,249.338	0.00E+00	3.61E-03	7.21E-03
Am-243	1.4913E-06	8,124.669	16,249.338	0.00E+00	1.21E-02	2.42E-02
C-14	5.7217E-09	8,124.669	16,249.338	0.00E+00	4.65E-05	9.30E-05
Cl-36	1.3124E-32	8,124.669	16,249.338	0.00E+00	1.07E-28	2.13E-28
Cm-243	2.0967E-07	8,124.669	16,249.338	0.00E+00	1.70E-03	3.41E-03
Cm-244	4.3001E-05	8,124.669	16,249.338	0.00E+00	3.49E-01	6.99E-01
Co-60	1.9798E-05	8,124.669	16,249.338	0.00E+00	1.61E-01	3.22E-01
Cs-134	9.0795E-02	8,124.669	16,249.338	0.00E+00	7.38E+02	1.48E+03
Cs-135	3.4477E-06	8,124.669	16,249.338	0.00E+00	2.80E-02	5.60E-02
Cs-137	2.5588E+00	8,124.669	16,249.338	0.00E+00	2.08E+04	4.16E+04
Eu-154	5.4847E-02	8,124.669	16,249.338	0.00E+00	4.46E+02	8.91E+02
Eu-155	1.9469E-02	8,124.669	16,249.338	0.00E+00	1.58E+02	3.16E+02
Fe-55	1.7797E-03	8,124.669	16,249.338	0.00E+00	1.45E+01	2.89E+01
H-3	8.0065E-03	8,124.669	16,249.338	0.00E+00	6.51E+01	1.30E+02
I-129	7.5300E-07	8,124.669	16,249.338	0.00E+00	6.12E-03	1.22E-02
Kr-85	2.0705E-01	8,124.669	16,249.338	0.00E+00	1.68E+03	3.36E+03
Np-237	9.5507E-06	8,124.669	16,249.338	0.00E+00	7.76E-02	1.55E-01
Pa-231	1.2740E-09	8,124.669	16,249.338	0.00E+00	1.04E-05	2.07E-05
Pb-210	1.1838E-11	8,124.669	16,249.338	0.00E+00	9.62E-08	1.92E-07
Pm-147	6.7974E-01	8,124.669	16,249.338	0.00E+00	5.52E+03	1.10E+04
Pu-238	1.9755E-02	8,124.669	16,249.338	0.00E+00	1.61E+02	3.21E+02
Pu-239	4.2838E-04	8,124.669	16,249.338	0.00E+00	3.48E+00	6.96E+00
Pu-240	2.4390E-04	8,124.669	16,249.338	0.00E+00	1.98E+00	3.96E+00
Pu-241	5.4058E-02	8,124.669	16,249.338	0.00E+00	4.39E+02	8.78E+02
Pu-242	3.6329E-07	8,124.669	16,249.338	0.00E+00	2.95E-03	5.90E-03
Ra-226	8.3742E-11	8,124.669	16,249.338	0.00E+00	6.80E-07	1.36E-06
Ra-228	5.7734E-15	8,124.669	16,249.338	0.00E+00	4.69E-11	9.38E-11
Ru-106	6.1356E-03	8,124.669	16,249.338	0.00E+00	4.98E+01	9.97E+01
Se-79	1.2936E-05	8,124.669	16,249.338	0.00E+00	1.05E-01	2.10E-01
Sn-126	1.1574E-05	8,124.669	16,249.338	0.00E+00	9.40E-02	1.88E-01
Sr-90	2.4417E+00	8,124.669	16,249.338	0.00E+00	1.98E+04	3.97E+04
Tc-99	4.2239E-04	8,124.669	16,249.338	0.00E+00	3.43E+00	6.86E+00
Th-229	2.8568E-12	8,124.669	16,249.338	0.00E+00	2.32E-08	4.64E-08
Th-230	2.5310E-08	8,124.669	16,249.338	0.00E+00	2.06E-04	4.11E-04
Th-232	1.1631E-14	8,124.669	16,249.338	0.00E+00	9.45E-11	1.89E-10
Tl-208	4.6705E-08	8,124.669	16,249.338	0.00E+00	3.79E-04	7.59E-04
U-232	1.3151E-07	8,124.669	16,249.338	0.00E+00	1.07E-03	2.14E-03
U-233	2.1650E-09	8,124.669	16,249.338	0.00E+00	1.76E-05	3.52E-05
U-234	1.8399E-04	8,124.669	16,249.338	0.00E+00	1.49E+00	2.99E+00
U-235	-2.7235E-06	8,124.669	0.000	4.15E-02	1.94E-02	4.15E-02
U-236	1.5493E-05	8,124.669	16,249.338	0.00E+00	1.26E-01	2.52E-01
U-238	-4.2851E-09	8,124.669	0.000	4.84E-04	4.49E-04	4.84E-04
Y-90	2.4423E+00	8,124.669	16,249.338	0.00E+00	1.98E+04	3.97E+04
Other Radionuclides					2.02E+04	4.04E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.210E+15
0.0250	4.651E+14
0.0375	4.055E+14
0.0575	4.284E+14
0.0850	2.606E+14
0.1250	1.823E+14
0.2250	2.238E+14
0.3750	1.003E+14
0.5750	1.628E+15
0.8500	7.943E+13
1.2500	2.585E+13
1.7500	9.441E+11
2.2500	6.242E+10
2.7500	8.708E+08
3.5000	1.037E+08
5.0000	8.613E+03
7.0000	9.571E+02
11.0000	1.077E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.57E+02	5.14E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.03245367	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		8,124.669	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		16,249.338	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.25	
Bounding:	2.50	

Estimated EOL HM/Given EOL HM

1.04

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BER-II TRIGA (GERMANY)
SNF ID #: 236
Fuel Units & Descr: 21 - 4 X 4 ROD ARRAY
Heavy Metal Mass: BOL=9.20kg ; EOL=9.19kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1982
Estimates as of: 2010
Template: TRIGA-SS (LW/U-Zrx, SST, 10 to 20%, U)
[2]**Template Burnup(MWd):** 6.65
Template BOL Heavy Metal Mass (MT): 0.000195
Template Decay Time: 25 years

Estimated Canister usage:
18"x10'
2.63

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	4.1459E-09	22.401	9.407	0.00E+00	9.29E-08	3.90E-08
Am-241	3.5850E-03	22.401	9.407	0.00E+00	8.03E-02	3.37E-02
Am-242m	1.2899E-06	22.401	9.407	0.00E+00	2.89E-05	1.21E-05
Am-243	1.4747E-07	22.401	9.407	0.00E+00	3.30E-06	1.39E-06
C-14	1.2839E-04	22.401	9.407	0.00E+00	2.88E-03	1.21E-03
Cl-36	2.8120E-06	22.401	9.407	0.00E+00	6.30E-05	2.65E-05
Cm-243	1.1038E-07	22.401	9.407	0.00E+00	2.47E-06	1.04E-06
Cm-244	7.8917E-07	22.401	9.407	0.00E+00	1.77E-05	7.42E-06
Co-60	9.2647E-02	22.401	9.407	0.00E+00	2.08E+00	8.72E-01
Cs-134	1.0940E-04	22.401	9.407	0.00E+00	2.45E-03	1.03E-03
Cs-135	3.2195E-05	22.401	9.407	0.00E+00	7.21E-04	3.03E-04
Cs-137	1.7368E+00	22.401	9.407	0.00E+00	3.89E+01	1.63E+01
Eu-154	3.0677E-03	22.401	9.407	0.00E+00	6.87E-02	2.89E-02
Eu-155	1.7925E-03	22.401	9.407	0.00E+00	4.02E-02	1.69E-02
Fe-55	3.7444E-03	22.401	9.407	0.00E+00	8.39E-02	3.52E-02
H-3	3.6180E-03	22.401	9.407	0.00E+00	8.10E-02	3.40E-02
I-129	7.3684E-07	22.401	9.407	0.00E+00	1.65E-05	6.93E-06
Kr-85	6.9368E-02	22.401	9.407	0.00E+00	1.55E+00	6.53E-01
Np-237	1.2662E-06	22.401	9.407	0.00E+00	2.84E-05	1.19E-05
Pa-231	9.1654E-09	22.401	9.407	0.00E+00	2.05E-07	8.62E-08
Pb-210	1.3728E-13	22.401	9.407	0.00E+00	3.08E-12	1.29E-12
Pm-147	1.0702E-02	22.401	9.407	0.00E+00	2.40E-01	1.01E-01
Pu-238	8.8692E-04	22.401	9.407	0.00E+00	1.99E-02	8.34E-03
Pu-239	5.5263E-03	22.401	9.407	0.00E+00	1.24E-01	5.20E-02
Pu-240	2.1233E-03	22.401	9.407	0.00E+00	4.76E-02	2.00E-02
Pu-241	3.8962E-02	22.401	9.407	0.00E+00	8.73E-01	3.67E-01
Pu-242	2.3128E-07	22.401	9.407	0.00E+00	5.18E-06	2.18E-06
Ra-226	4.6752E-13	22.401	9.407	0.00E+00	1.05E-11	4.40E-12
Ra-228	2.4827E-10	22.401	9.407	0.00E+00	5.56E-09	2.34E-09
Ru-106	9.8526E-08	22.401	9.407	0.00E+00	2.21E-06	9.27E-07
Se-79	1.3015E-05	22.401	9.407	0.00E+00	2.92E-04	1.22E-04
Sn-126	1.2165E-05	22.401	9.407	0.00E+00	2.73E-04	1.14E-04
Sr-90	1.6195E+00	22.401	9.407	0.00E+00	3.63E+01	1.52E+01
Tc-99	4.4241E-04	22.401	9.407	0.00E+00	9.91E-03	4.16E-03
Th-229	4.2451E-10	22.401	9.407	0.00E+00	9.51E-09	3.99E-09
Th-230	6.1398E-11	22.401	9.407	0.00E+00	1.38E-09	5.78E-10
Th-232	2.5278E-10	22.401	9.407	0.00E+00	5.66E-09	2.38E-09
Tl-208	1.5098E-08	22.401	9.407	0.00E+00	3.38E-07	1.42E-07
U-232	4.0662E-08	22.401	9.407	0.00E+00	9.11E-07	3.83E-07
U-233	1.2217E-07	22.401	9.407	0.00E+00	2.74E-06	1.15E-06
U-234	2.2391E-07	22.401	9.407	0.00E+00	5.02E-06	2.11E-06
U-235	-2.6194E-06	22.401	0.000	8.75E-03	8.69E-03	8.75E-03
U-236	1.2695E-05	22.401	9.407	0.00E+00	2.84E-04	1.19E-04
U-238	-3.6331E-08	22.401	0.000	1.73E-03	1.73E-03	1.73E-03
Y-90	1.6195E+00	22.401	9.407	0.00E+00	3.63E+01	1.52E+01
Other Radionuclides					3.85E+01	1.62E+01

Gamma Sources	
Photon Energy Group	**Total Photons/sec (bounding)**
Avg. MeV	
0.0150	8.352E+11
0.0250	1.736E+11
0.0375	1.506E+11
0.0575	1.622E+11
0.0850	9.779E+10
0.1250	6.383E+10
0.2250	8.426E+10
0.3750	3.672E+10
0.5750	6.087E+11
0.8500	6.536E+09
1.2500	6.711E+10
1.7500	1.702E+08
2.2500	3.587E+05
2.7500	6.076E+03
3.5000	2.206E+01
5.0000	8.959E+00
7.0000	1.020E+00
11.0000	1.165E-01

Thermal Power	
Nominal Heat Output (Watts)	**Bounding Heat Output (Watts)**
4.76E-01	**2.00E-01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	LW AND U ZIRC HYDRIDE	LW AND U ZIRC HYDRIDE
Fuel Cladding:	SST (347)	SST
BOL HM Constituents:	U-ZrHX-Er	U
BOL Enrichment %:	44.02590702	10 to 20

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]	From SFD	Estimated
Nominal:	22.401	4.009
Bounding:	9.407	8.019

Basis for burnup used in estimate:
Nominal burnup taken directly from SFD (converted to MWd).
Bounding burnup taken directly from SFD (converted to MWd).

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.07	0.18
Bounding:	0.03	0.85

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BMI (CPI-24)	[1]Fuel decay start date:	1961
SNF ID #:	774	Estimates as of:	2010
Fuel Units & Descr:	2 - CANISTER OF SCRAP	Template:	Pathfinder (Light Water, SST, 60 to 100%, U)
Heavy Metal Mass:	BOL= ; EOL=.56kg	[2]Template Burnup(MWd):	6.01
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.00012882
		Template Decay Time:	35 years

Estimated Canister usage: 18"x10'

0.15

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	2.3344E-08	528.247	528.247	0.00E+00	1.23E-05	1.23E-05
Am-241	1.1135E-04	528.247	528.247	0.00E+00	5.88E-02	5.88E-02
Am-242m	8.5075E-09	528.247	528.247	0.00E+00	4.49E-06	4.49E-06
Am-243	9.8519E-10	528.247	528.247	0.00E+00	5.20E-07	5.20E-07
C-14	2.3012E-04	528.247	528.247	0.00E+00	1.22E-01	1.22E-01
Cl-36	1.2261E-06	528.247	528.247	0.00E+00	6.48E-04	6.48E-04
Cm-243	2.4875E-10	528.247	528.247	0.00E+00	1.31E-07	1.31E-07
Cm-244	2.3178E-09	528.247	528.247	0.00E+00	1.22E-06	1.22E-06
Co-60	7.0849E-02	528.247	528.247	0.00E+00	3.74E+01	3.74E+01
Cs-134	3.0266E-06	528.247	528.247	0.00E+00	1.60E-03	1.60E-03
Cs-135	3.0316E-05	528.247	528.247	0.00E+00	1.60E-02	1.60E-02
Cs-137	1.4511E+00	528.247	528.247	0.00E+00	7.67E+02	7.67E+02
Eu-154	6.6955E-04	528.247	528.247	0.00E+00	3.54E-01	3.54E-01
Eu-155	6.9850E-04	528.247	528.247	0.00E+00	3.69E-01	3.69E-01
Fe-55	1.2318E-03	528.247	528.247	0.00E+00	6.51E-01	6.51E-01
H-3	2.5141E-03	528.247	528.247	0.00E+00	1.33E+00	1.33E+00
I-129	7.3195E-07	528.247	528.247	0.00E+00	3.87E-04	3.87E-04
Kr-85	4.1281E-02	528.247	528.247	0.00E+00	2.18E+01	2.18E+01
Np-237	1.1489E-06	528.247	528.247	0.00E+00	6.07E-04	6.07E-04
Pa-231	4.5241E-08	528.247	528.247	0.00E+00	2.39E-05	2.39E-05
Pb-210	6.4476E-13	528.247	528.247	0.00E+00	3.41E-10	3.41E-10
Pm-147	1.1651E-03	528.247	528.247	0.00E+00	6.15E-01	6.15E-01
Pu-238	2.9517E-04	528.247	528.247	0.00E+00	1.56E-01	1.56E-01
Pu-239	6.6772E-04	528.247	528.247	0.00E+00	3.53E-01	3.53E-01
Pu-240	8.6839E-05	528.247	528.247	0.00E+00	4.59E-02	4.59E-02
Pu-241	7.1514E-04	528.247	528.247	0.00E+00	3.78E-01	3.78E-01
Pu-242	1.9717E-09	528.247	528.247	0.00E+00	1.04E-06	1.04E-06
Ra-226	1.7654E-12	528.247	528.247	0.00E+00	9.33E-10	9.33E-10
Ra-228	8.2928E-12	528.247	528.247	0.00E+00	4.38E-09	4.38E-09
Ru-106	1.8419E-10	528.247	528.247	0.00E+00	9.73E-08	9.73E-08
Se-79	1.3223E-05	528.247	528.247	0.00E+00	6.98E-03	6.98E-03
Sn-126	1.1493E-05	528.247	528.247	0.00E+00	6.07E-03	6.07E-03
Sr-90	1.3649E+00	528.247	528.247	0.00E+00	7.21E+02	7.21E+02
Tc-99	4.6656E-04	528.247	528.247	0.00E+00	2.46E-01	2.46E-01
Th-229	1.4547E-11	528.247	528.247	0.00E+00	7.68E-09	7.68E-09
Th-230	1.6617E-10	528.247	528.247	0.00E+00	8.78E-08	8.78E-08
Th-232	8.3361E-12	528.247	528.247	0.00E+00	4.40E-09	4.40E-09
Tl-208	2.1664E-08	528.247	528.247	0.00E+00	1.14E-05	1.14E-05
U-232	5.8669E-08	528.247	528.247	0.00E+00	3.10E-05	3.10E-05
U-233	3.1847E-09	528.247	528.247	0.00E+00	1.68E-06	1.68E-06
U-234	3.8769E-07	528.247	528.247	0.00E+00	2.05E-04	2.05E-04
U-235	-2.7761E-06	528.247	0.000	2.26E-03	7.92E-04	2.26E-03
U-236	1.6190E-05	528.247	528.247	0.00E+00	8.55E-03	8.55E-03
U-238	-2.8547E-09	528.247	0.000	2.44E-05	2.29E-05	2.44E-05
Y-90	1.3652E+00	528.247	528.247	0.00E+00	7.21E+02	7.21E+02
Other Radionuclides					8.72E+02	8.72E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.943E+13
0.0250	8.193E+12
0.0375	7.087E+12
0.0575	7.639E+12
0.0850	4.615E+12
0.1250	2.997E+12
0.2250	3.973E+12
0.3750	1.733E+12
0.5750	2.854E+13
0.8500	2.889E+11
1.2500	2.872E+12
1.7500	7.455E+09
2.2500	1.547E+07
2.7500	4.473E+05
3.5000	3.154E+01
5.0000	1.297E+01
7.0000	1.432E+00
11.0000	1.607E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.22E+00	9.22E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	SST	SST
BOL HM Constituents:	UO2	U
BOL Enrichment %:		60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		528.247
Bounding:		528.247

Basis for burnup used in estimate:

Nominal burnup set equal to bounding burnup.
Bounding burnup estimated by assuming BOL heavy metal mass was twice EOL.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	10.12	
Bounding:	10.12	

Estimated EOL HM/Given EOL HM

1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BMI (CPI-38)	**[1]Fuel decay start date:**	1961	Estimated
SNF ID #:	20	**Estimates as of:**	2010	Canister usage:
Fuel Units & Descr:	1 - CANISTER OF SCRAP	**Template:**	Pathfinder (Light Water, SST, 60 to 100%, U)	18"x10'
Heavy Metal Mass:	BOL= ; EOL=1.29kg	**[2]Template Burnup(MWd):**	6.01	0.08
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.00012882	
		Template Decay Time:	35 years	

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.3344E-08	1,215.100	1,215.100	0.00E+00	2.84E-05	2.84E-05
Am-241	1.1135E-04	1,215.100	1,215.100	0.00E+00	1.35E-01	1.35E-01
Am-242m	8.5075E-09	1,215.100	1,215.100	0.00E+00	1.03E-05	1.03E-05
Am-243	9.8519E-10	1,215.100	1,215.100	0.00E+00	1.20E-06	1.20E-06
C-14	2.3012E-04	1,215.100	1,215.100	0.00E+00	2.80E-01	2.80E-01
Cl-36	1.2261E-06	1,215.100	1,215.100	0.00E+00	1.49E-03	1.49E-03
Cm-243	2.4875E-10	1,215.100	1,215.100	0.00E+00	3.02E-07	3.02E-07
Cm-244	2.3178E-09	1,215.100	1,215.100	0.00E+00	2.82E-06	2.82E-06
Co-60	7.0849E-02	1,215.100	1,215.100	0.00E+00	8.61E+01	8.61E+01
Cs-134	3.0266E-06	1,215.100	1,215.100	0.00E+00	3.68E-03	3.68E-03
Cs-135	3.0316E-05	1,215.100	1,215.100	0.00E+00	3.68E-02	3.68E-02
Cs-137	1.4511E+00	1,215.100	1,215.100	0.00E+00	1.76E+03	1.76E+03
Eu-154	6.6955E-04	1,215.100	1,215.100	0.00E+00	8.14E-01	8.14E-01
Eu-155	6.9850E-04	1,215.100	1,215.100	0.00E+00	8.49E-01	8.49E-01
Fe-55	1.2318E-03	1,215.100	1,215.100	0.00E+00	1.50E+00	1.50E+00
H-3	2.5141E-03	1,215.100	1,215.100	0.00E+00	3.05E+00	3.05E+00
I-129	7.3195E-07	1,215.100	1,215.100	0.00E+00	8.89E-04	8.89E-04
Kr-85	4.1281E-02	1,215.100	1,215.100	0.00E+00	5.02E+01	5.02E+01
Np-237	1.1489E-06	1,215.100	1,215.100	0.00E+00	1.40E-03	1.40E-03
Pa-231	4.5241E-08	1,215.100	1,215.100	0.00E+00	5.50E-05	5.50E-05
Pb-210	6.4476E-13	1,215.100	1,215.100	0.00E+00	7.83E-10	7.83E-10
Pm-147	1.1651E-03	1,215.100	1,215.100	0.00E+00	1.42E+00	1.42E+00
Pu-238	2.9517E-04	1,215.100	1,215.100	0.00E+00	3.59E-01	3.59E-01
Pu-239	6.6772E-04	1,215.100	1,215.100	0.00E+00	8.11E-01	8.11E-01
Pu-240	8.6839E-05	1,215.100	1,215.100	0.00E+00	1.06E-01	1.06E-01
Pu-241	7.1514E-04	1,215.100	1,215.100	0.00E+00	8.69E-01	8.69E-01
Pu-242	1.9717E-09	1,215.100	1,215.100	0.00E+00	2.40E-06	2.40E-06
Ra-226	1.7654E-12	1,215.100	1,215.100	0.00E+00	2.15E-09	2.15E-09
Ra-228	8.2928E-12	1,215.100	1,215.100	0.00E+00	1.01E-08	1.01E-08
Ru-106	1.8419E-10	1,215.100	1,215.100	0.00E+00	2.24E-07	2.24E-07
Se-79	1.3223E-05	1,215.100	1,215.100	0.00E+00	1.61E-02	1.61E-02
Sn-126	1.1493E-05	1,215.100	1,215.100	0.00E+00	1.40E-02	1.40E-02
Sr-90	1.3649E+00	1,215.100	1,215.100	0.00E+00	1.66E+03	1.66E+03
Tc-99	4.6656E-04	1,215.100	1,215.100	0.00E+00	5.67E-01	5.67E-01
Th-229	1.4547E-11	1,215.100	1,215.100	0.00E+00	1.77E-08	1.77E-08
Th-230	1.6617E-10	1,215.100	1,215.100	0.00E+00	2.02E-07	2.02E-07
Th-232	8.3361E-12	1,215.100	1,215.100	0.00E+00	1.01E-08	1.01E-08
Tl-208	2.1664E-08	1,215.100	1,215.100	0.00E+00	2.63E-05	2.63E-05
U-232	5.8669E-08	1,215.100	1,215.100	0.00E+00	7.13E-05	7.13E-05
U-233	3.1847E-09	1,215.100	1,215.100	0.00E+00	3.87E-06	3.87E-06
U-234	3.8769E-07	1,215.100	1,215.100	0.00E+00	4.71E-04	4.71E-04
U-235	-2.7761E-06	1,215.100	0.000	5.20E-03	1.82E-03	5.20E-03
U-236	1.6190E-05	1,215.100	1,215.100	0.00E+00	1.97E-02	1.97E-02
U-238	-2.8547E-09	1,215.100	0.000	5.62E-05	5.27E-05	5.62E-05
Y-90	1.3652E+00	1,215.100	1,215.100	0.00E+00	1.66E+03	1.66E+03
Other Radionuclides					2.01E+03	2.01E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	9.069E+13
0.0250	1.885E+13
0.0375	1.630E+13
0.0575	1.757E+13
0.0850	1.062E+13
0.1250	6.893E+12
0.2250	9.138E+12
0.3750	3.986E+12
0.5750	6.566E+13
0.8500	6.646E+11
1.2500	6.606E+12
1.7500	1.715E+10
2.2500	3.559E+07
2.7500	1.029E+06
3.5000	7.255E+01
5.0000	2.983E+01
7.0000	3.294E+00
11.0000	3.697E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.12E+01	2.12E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	HASTELLOY	SST
BOL HM Constituents:	UO2	U
BOL Enrichment %:		60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except cladding (SST is conservative) and enrichment (unknown).

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,215.100	Nominal burnup set equal to bounding burnup.
Bounding:		1,215.100	Bounding burnup estimated by assuming BOL heavy metal mass was twice EOL.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	10.12	
Bounding:	10.12	

Estimated EOL HM/Given EOL HM: 1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BNL MEDICAL RX (BMRR)
SNF ID #: 21
Fuel Units & Descr: 40 - CYLINDRICAL SECTIONS
Heavy Metal Mass: BOL=6.19kg ; EOL=5.12kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1989
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 20 years

Estimated Canister usage:

18"x10'
1.11

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6313E-10	1,007.629	2,015.257	0.00E+00	6.68E-07	1.34E-06
Am-241	2.0060E-03	1,007.629	2,015.257	0.00E+00	2.02E+00	4.04E+00
Am-242m	4.2429E-07	1,007.629	2,015.257	0.00E+00	4.28E-04	8.55E-04
Am-243	1.4899E-06	1,007.629	2,015.257	0.00E+00	1.50E-03	3.00E-03
C-14	5.7135E-09	1,007.629	2,015.257	0.00E+00	5.76E-06	1.15E-05
Cl-36	1.3124E-32	1,007.629	2,015.257	0.00E+00	1.32E-29	2.64E-29
Cm-243	1.6443E-07	1,007.629	2,015.257	0.00E+00	1.66E-04	3.31E-04
Cm-244	2.9330E-05	1,007.629	2,015.257	0.00E+00	2.96E-02	5.91E-02
Co-60	5.3186E-06	1,007.629	2,015.257	0.00E+00	5.36E-03	1.07E-02
Cs-134	3.1563E-03	1,007.629	2,015.257	0.00E+00	3.18E+00	6.36E+00
Cs-135	3.4477E-06	1,007.629	2,015.257	0.00E+00	3.47E-03	6.95E-03
Cs-137	2.0313E+00	1,007.629	2,015.257	0.00E+00	2.05E+03	4.09E+03
Eu-154	2.4513E-02	1,007.629	2,015.257	0.00E+00	2.47E+01	4.94E+01
Eu-155	4.8175E-03	1,007.629	2,015.257	0.00E+00	4.85E+00	9.71E+00
Fe-55	1.2397E-04	1,007.629	2,015.257	0.00E+00	1.25E-01	2.50E-01
H-3	4.5697E-03	1,007.629	2,015.257	0.00E+00	4.60E+00	9.21E+00
I-129	7.5300E-07	1,007.629	2,015.257	0.00E+00	7.59E-04	1.52E-03
Kr-85	1.0850E-01	1,007.629	2,015.257	0.00E+00	1.09E+02	2.19E+02
Np-237	9.5561E-06	1,007.629	2,015.257	0.00E+00	9.63E-03	1.93E-02
Pa-231	2.0359E-09	1,007.629	2,015.257	0.00E+00	2.05E-06	4.10E-06
Pb-210	4.9728E-11	1,007.629	2,015.257	0.00E+00	5.01E-08	1.00E-07
Pm-147	4.8502E-02	1,007.629	2,015.257	0.00E+00	4.89E+01	9.77E+01
Pu-238	1.8254E-02	1,007.629	2,015.257	0.00E+00	1.84E+01	3.68E+01
Pu-239	4.2810E-04	1,007.629	2,015.257	0.00E+00	4.31E-01	8.63E-01
Pu-240	2.4368E-04	1,007.629	2,015.257	0.00E+00	2.46E-01	4.91E-01
Pu-241	3.3415E-02	1,007.629	2,015.257	0.00E+00	3.37E+01	6.73E+01
Pu-242	3.6329E-07	1,007.629	2,015.257	0.00E+00	3.66E-04	7.32E-04
Ra-226	2.2854E-10	1,007.629	2,015.257	0.00E+00	2.30E-07	4.61E-07
Ra-228	1.2426E-14	1,007.629	2,015.257	0.00E+00	1.25E-11	2.50E-11
Ru-106	6.3589E-06	1,007.629	2,015.257	0.00E+00	6.41E-03	1.28E-02
Se-79	1.2933E-05	1,007.629	2,015.257	0.00E+00	1.30E-02	2.61E-02
Sn-126	1.1574E-05	1,007.629	2,015.257	0.00E+00	1.17E-02	2.33E-02
Sr-90	1.9248E+00	1,007.629	2,015.257	0.00E+00	1.94E+03	3.88E+03
Tc-99	4.2239E-04	1,007.629	2,015.257	0.00E+00	4.26E-01	8.51E-01
Th-229	5.0953E-12	1,007.629	2,015.257	0.00E+00	5.13E-09	1.03E-08
Th-230	4.1885E-08	1,007.629	2,015.257	0.00E+00	4.22E-05	8.44E-05
Th-232	1.9270E-14	1,007.629	2,015.257	0.00E+00	1.94E-11	3.88E-11
Tl-208	4.6024E-08	1,007.629	2,015.257	0.00E+00	4.64E-05	9.28E-05
U-232	1.2582E-07	1,007.629	2,015.257	0.00E+00	1.27E-04	2.54E-04
U-233	2.5825E-09	1,007.629	2,015.257	0.00E+00	2.60E-06	5.20E-06
U-234	1.8450E-04	1,007.629	2,015.257	0.00E+00	1.86E-01	3.72E-01
U-235	-2.7235E-06	1,007.629	0.000	1.24E-02	9.65E-03	1.24E-02
U-236	1.5493E-05	1,007.629	2,015.257	0.00E+00	1.56E-02	3.12E-02
U-238	-4.2851E-09	1,007.629	0.000	1.53E-04	1.49E-04	1.53E-04
Y-90	1.9254E+00	1,007.629	2,015.257	0.00E+00	1.94E+03	3.88E+03
Other Radionuclides					1.95E+03	3.90E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.127E+14
0.0250	4.424E+13
0.0375	3.859E+13
0.0575	4.133E+13
0.0850	2.497E+13
0.1250	1.690E+13
0.2250	2.155E+13
0.3750	9.379E+12
0.5750	1.530E+14
0.8500	2.587E+12
1.2500	1.477E+12
1.7500	6.780E+10
2.2500	5.948E+06
2.7500	3.362E+06
3.5000	1.545E+04
5.0000	8.733E+02
7.0000	9.643E+01
11.0000	1.081E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.40E+01	4.80E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM (1100)	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.65152255	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,007.629	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		2,015.257	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.52	
Bounding:	1.03	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BORAX V (SUPERHEATER)	[1]Fuel decay start date:	1964
SNF ID #:	22	Estimates as of:	2010
Fuel Units & Descr:	36 - 20 FLAT PLATES	Template:	Pathfinder (Light Water, SST, 60 to 100%, U)
Heavy Metal Mass:	BOL=22.02kg ; EOL=20.83kg	[2]Template Burnup(MWd):	6.01
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.00012882
		Template Decay Time:	35 years

Estimated Canister usage: 18"x10'

2.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.3344E-08	1,122.241	2,244.483	0.00E+00	2.62E-05	5.24E-05
Am-241	1.1135E-04	1,122.241	2,244.483	0.00E+00	1.25E-01	2.50E-01
Am-242m	8.5075E-09	1,122.241	2,244.483	0.00E+00	9.55E-06	1.91E-05
Am-243	9.8519E-10	1,122.241	2,244.483	0.00E+00	1.11E-06	2.21E-06
C-14	2.3012E-04	1,122.241	2,244.483	0.00E+00	2.58E-01	5.16E-01
Cl-36	1.2261E-06	1,122.241	2,244.483	0.00E+00	1.38E-03	2.75E-03
Cm-243	2.4875E-10	1,122.241	2,244.483	0.00E+00	2.79E-07	5.58E-07
Cm-244	2.3178E-09	1,122.241	2,244.483	0.00E+00	2.60E-06	5.20E-06
Co-60	7.0849E-02	1,122.241	2,244.483	0.00E+00	7.95E+01	1.59E+02
Cs-134	3.0266E-06	1,122.241	2,244.483	0.00E+00	3.40E-03	6.79E-03
Cs-135	3.0316E-05	1,122.241	2,244.483	0.00E+00	3.40E-02	6.80E-02
Cs-137	1.4511E+00	1,122.241	2,244.483	0.00E+00	1.63E+03	3.26E+03
Eu-154	6.6955E-04	1,122.241	2,244.483	0.00E+00	7.51E-01	1.50E+00
Eu-155	6.9850E-04	1,122.241	2,244.483	0.00E+00	7.84E-01	1.57E+00
Fe-55	1.2318E-03	1,122.241	2,244.483	0.00E+00	1.38E+00	2.76E+00
H-3	2.5141E-03	1,122.241	2,244.483	0.00E+00	2.82E+00	5.64E+00
I-129	7.3195E-07	1,122.241	2,244.483	0.00E+00	8.21E-04	1.64E-03
Kr-85	4.1281E-02	1,122.241	2,244.483	0.00E+00	4.63E+01	9.27E+01
Np-237	1.1489E-06	1,122.241	2,244.483	0.00E+00	1.29E-03	2.58E-03
Pa-231	4.5241E-08	1,122.241	2,244.483	0.00E+00	5.08E-05	1.02E-04
Pb-210	6.4476E-13	1,122.241	2,244.483	0.00E+00	7.24E-10	1.45E-09
Pm-147	1.1651E-03	1,122.241	2,244.483	0.00E+00	1.31E+00	2.61E+00
Pu-238	2.9517E-04	1,122.241	2,244.483	0.00E+00	3.31E-01	6.63E-01
Pu-239	6.6772E-04	1,122.241	2,244.483	0.00E+00	7.49E-01	1.50E+00
Pu-240	8.6839E-05	1,122.241	2,244.483	0.00E+00	9.75E-02	1.95E-01
Pu-241	7.1514E-04	1,122.241	2,244.483	0.00E+00	8.03E-01	1.61E+00
Pu-242	1.9717E-09	1,122.241	2,244.483	0.00E+00	2.21E-06	4.43E-06
Ra-226	1.7654E-12	1,122.241	2,244.483	0.00E+00	1.98E-09	3.96E-09
Ra-228	8.2928E-12	1,122.241	2,244.483	0.00E+00	9.31E-09	1.86E-08
Ru-106	1.8419E-10	1,122.241	2,244.483	0.00E+00	2.07E-07	4.13E-07
Se-79	1.3223E-05	1,122.241	2,244.483	0.00E+00	1.48E-02	2.97E-02
Sn-126	1.1493E-05	1,122.241	2,244.483	0.00E+00	1.29E-02	2.58E-02
Sr-90	1.3649E+00	1,122.241	2,244.483	0.00E+00	1.53E+03	3.06E+03
Tc-99	4.6656E-04	1,122.241	2,244.483	0.00E+00	5.24E-01	1.05E+00
Th-229	1.4547E-11	1,122.241	2,244.483	0.00E+00	1.63E-08	3.27E-08
Th-230	1.6617E-10	1,122.241	2,244.483	0.00E+00	1.86E-07	3.73E-07
Th-232	8.3361E-12	1,122.241	2,244.483	0.00E+00	9.36E-09	1.87E-08
Tl-208	2.1664E-08	1,122.241	2,244.483	0.00E+00	2.43E-05	4.86E-05
U-232	5.8669E-08	1,122.241	2,244.483	0.00E+00	6.58E-05	1.32E-04
U-233	3.1847E-09	1,122.241	2,244.483	0.00E+00	3.57E-06	7.15E-06
U-234	3.8769E-07	1,122.241	2,244.483	0.00E+00	4.35E-04	8.70E-04
U-235	-2.7761E-06	1,122.241	0.000	4.43E-02	4.12E-02	4.43E-02
U-236	1.6190E-05	1,122.241	2,244.483	0.00E+00	1.82E-02	3.63E-02
U-238	-2.8547E-09	1,122.241	0.000	5.07E-04	5.04E-04	5.07E-04
Y-90	1.3652E+00	1,122.241	2,244.483	0.00E+00	1.53E+03	3.06E+03
Other Radionuclides					1.85E+03	3.71E+03

Gamma Sources

Photon Energy Group (Avg. MeV)	Total Photons/sec (bounding)
0.0150	1.675E+14
0.0250	3.481E+13
0.0375	3.011E+13
0.0575	3.246E+13
0.0850	1.961E+13
0.1250	1.273E+13
0.2250	1.688E+13
0.3750	7.362E+12
0.5750	1.213E+14
0.8500	1.228E+12
1.2500	1.220E+13
1.7500	3.168E+10
2.2500	6.575E+07
2.7500	1.900E+06
3.5000	1.373E+02
5.0000	5.651E+01
7.0000	6.243E+00
11.0000	7.007E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.96E+01	3.92E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	SST (304L)	SST
BOL HM Constituents:	UO2	U
BOL Enrichment %:	93.14999492	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	5.858	1,122.241
Bounding:		2,244.483

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.

Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.09	191.59
Bounding:	2.18	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BR-3
SNF ID #: 927
Fuel Units & Descr: 16 - ROD
Heavy Metal Mass: BOL=5.60kg ; EOL=5.11kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1981
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]Template Burnup(MWd): 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 25 years

Estimated Canister usage:

18"x15'
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6376E-10	465.586	931.173	0.00E+00	3.09E-07	6.18E-07
Am-241	1.3144E-01	465.586	931.173	0.00E+00	6.12E+01	1.22E+02
Am-242m	3.0039E-04	465.586	931.173	0.00E+00	1.40E-01	2.80E-01
Am-243	6.2629E-04	465.586	931.173	0.00E+00	2.92E-01	5.83E-01
C-14	4.7965E-05	465.586	931.173	0.00E+00	2.23E-02	4.47E-02
Cl-36	8.0297E-07	465.586	931.173	0.00E+00	3.74E-04	7.48E-04
Cm-243	3.1993E-04	465.586	931.173	0.00E+00	1.49E-01	2.98E-01
Cm-244	7.1851E-02	465.586	931.173	0.00E+00	3.35E+01	6.69E+01
Co-60	9.5220E-03	465.586	931.173	0.00E+00	4.43E+00	8.87E+00
Cs-134	1.1662E-03	465.586	931.173	0.00E+00	5.43E-01	1.09E+00
Cs-135	1.4433E-05	465.586	931.173	0.00E+00	6.72E-03	1.34E-02
Cs-137	1.7603E+00	465.586	931.173	0.00E+00	8.20E+02	1.64E+03
Eu-154	4.5203E-02	465.586	931.173	0.00E+00	2.10E+01	4.21E+01
Eu-155	7.1479E-03	465.586	931.173	0.00E+00	3.33E+00	6.66E+00
Fe-55	6.1919E-04	465.586	931.173	0.00E+00	2.88E-01	5.77E-01
H-3	3.6386E-02	465.586	931.173	0.00E+00	1.69E+01	3.39E+01
I-129	9.8288E-07	465.586	931.173	0.00E+00	4.58E-04	9.15E-04
Kr-85	5.3844E-02	465.586	931.173	0.00E+00	2.51E+01	5.01E+01
Np-237	1.0546E-05	465.586	931.173	0.00E+00	4.91E-03	9.82E-03
Pa-231	1.1370E-09	465.586	931.173	0.00E+00	5.29E-07	1.06E-06
Pb-210	3.3624E-11	465.586	931.173	0.00E+00	1.57E-08	3.13E-08
Pm-147	5.1211E-03	465.586	931.173	0.00E+00	2.38E+00	4.77E+00
Pu-238	8.0669E-02	465.586	931.173	0.00E+00	3.76E+01	7.51E+01
Pu-239	1.1626E-02	465.586	931.173	0.00E+00	5.41E+00	1.08E+01
Pu-240	1.5097E-02	465.586	931.173	0.00E+00	7.03E+00	1.41E+01
Pu-241	1.4567E+00	465.586	931.173	0.00E+00	6.78E+02	1.36E+03
Pu-242	6.4260E-05	465.586	931.173	0.00E+00	2.99E-02	5.98E-02
Ra-226	1.1392E-10	465.586	931.173	0.00E+00	5.30E-08	1.06E-07
Ra-228	5.1841E-12	465.586	931.173	0.00E+00	2.41E-09	4.83E-09
Ru-106	5.9012E-07	465.586	931.173	0.00E+00	2.75E-04	5.50E-04
Se-79	1.2379E-05	465.586	931.173	0.00E+00	5.76E-03	1.15E-02
Sn-126	2.5210E-05	465.586	931.173	0.00E+00	1.17E-02	2.35E-02
Sr-90	1.1630E+00	465.586	931.173	0.00E+00	5.41E+02	1.08E+03
Tc-99	3.9357E-04	465.586	931.173	0.00E+00	1.83E-01	3.66E-01
Th-229	8.5691E-11	465.586	931.173	0.00E+00	3.99E-08	7.98E-08
Th-230	1.4493E-08	465.586	931.173	0.00E+00	6.75E-06	1.35E-05
Th-232	5.2923E-12	465.586	931.173	0.00E+00	2.46E-09	4.93E-09
Tl-208	1.9202E-07	465.586	931.173	0.00E+00	8.94E-05	1.79E-04
U-232	5.2083E-07	465.586	931.173	0.00E+00	2.42E-04	4.85E-04
U-233	2.4386E-08	465.586	931.173	0.00E+00	1.14E-05	2.27E-05
U-234	4.7012E-05	465.586	931.173	0.00E+00	2.19E-02	4.38E-02
U-235	-1.4492E-06	465.586	0.000	3.46E-03	2.78E-03	3.46E-03
U-236	7.5759E-06	465.586	931.173	0.00E+00	3.53E-03	7.05E-03
U-238	-2.6129E-07	465.586	0.000	1.34E-03	1.22E-03	1.34E-03
Y-90	1.1631E+00	465.586	931.173	0.00E+00	5.42E+02	1.08E+03
Other Radionuclides					7.87E+02	1.57E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	6.332E+13
0.0250	1.283E+13
0.0375	1.241E+13
0.0575	1.354E+13
0.0850	7.175E+12
0.1250	5.241E+12
0.2250	6.159E+12
0.3750	2.643E+12
0.5750	6.073E+13
0.8500	1.199E+12
1.2500	1.619E+12
1.7500	3.548E+10
2.2500	6.553E+06
2.7500	7.364E+06
3.5000	9.652E+05
5.0000	4.124E+05
7.0000	4.755E+04
11.0000	5.462E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.28E+01	2.55E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-4	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	28.57142857	0 to 5

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Bumup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		465.586
Bounding:		931.173

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	2.38	
Bounding:	4.75	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BR-3 FUEL	[1]Fuel decay start date:	1994
SNF ID #:	340	Estimates as of:	2010
Fuel Units & Descr:	16 - ROD	Template:	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=7.54kg ; EOL=7.06kg	[2]Template Burnup(MWd):	61.92
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.00176911
		Template Decay Time:	15 years

Estimated Canister usage: 18"x10'

0.12

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	4.2135E-10	448.850	897.699	0.00E+00	1.89E-07	3.78E-07
Am-241	1.0257E-01	448.850	897.699	0.00E+00	4.60E+01	9.21E+01
Am-242m	3.1444E-04	448.850	897.699	0.00E+00	1.41E-01	2.82E-01
Am-243	6.2694E-04	448.850	897.699	0.00E+00	2.81E-01	5.63E-01
C-14	4.8030E-05	448.850	897.699	0.00E+00	2.16E-02	4.31E-02
Cl-36	8.0313E-07	448.850	897.699	0.00E+00	3.60E-04	7.21E-04
Cm-243	4.0795E-04	448.850	897.699	0.00E+00	1.83E-01	3.66E-01
Cm-244	1.0533E-01	448.850	897.699	0.00E+00	4.73E+01	9.46E+01
Co-60	3.5449E-02	448.850	897.699	0.00E+00	1.59E+01	3.18E+01
Cs-134	3.3543E-02	448.850	897.699	0.00E+00	1.51E+01	3.01E+01
Cs-135	1.4433E-05	448.850	897.699	0.00E+00	6.48E-03	1.30E-02
Cs-137	2.2190E+00	448.850	897.699	0.00E+00	9.96E+02	1.99E+03
Eu-154	1.0111E-01	448.850	897.699	0.00E+00	4.54E+01	9.08E+01
Eu-155	2.8892E-02	448.850	897.699	0.00E+00	1.30E+01	2.59E+01
Fe-55	8.8889E-03	448.850	897.699	0.00E+00	3.99E+00	7.98E+00
H-3	6.3727E-02	448.850	897.699	0.00E+00	2.86E+01	5.72E+01
I-129	9.8288E-07	448.850	897.699	0.00E+00	4.41E-04	8.82E-04
Kr-85	1.0276E-01	448.850	897.699	0.00E+00	4.61E+01	9.22E+01
Np-237	9.9693E-06	448.850	897.699	0.00E+00	4.47E-03	8.95E-03
Pa-231	9.7028E-10	448.850	897.699	0.00E+00	4.36E-07	8.71E-07
Pb-210	8.0862E-12	448.850	897.699	0.00E+00	3.63E-09	7.26E-09
Pm-147	7.1786E-02	448.850	897.699	0.00E+00	3.22E+01	6.44E+01
Pu-238	8.7274E-02	448.850	897.699	0.00E+00	3.92E+01	7.83E+01
Pu-239	1.1630E-02	448.850	897.699	0.00E+00	5.22E+00	1.04E+01
Pu-240	1.5016E-02	448.850	897.699	0.00E+00	6.74E+00	1.35E+01
Pu-241	2.3563E+00	448.850	897.699	0.00E+00	1.06E+03	2.12E+03
Pu-242	6.4260E-05	448.850	897.699	0.00E+00	2.88E-02	5.77E-02
Ra-226	4.0407E-11	448.850	897.699	0.00E+00	1.81E-08	3.63E-08
Ra-228	4.7917E-12	448.850	897.699	0.00E+00	2.15E-09	4.30E-09
Ru-106	5.6928E-04	448.850	897.699	0.00E+00	2.56E-01	5.11E-01
Se-79	1.2380E-05	448.850	897.699	0.00E+00	5.56E-03	1.11E-02
Sn-126	2.5210E-05	448.850	897.699	0.00E+00	1.13E-02	2.26E-02
Sr-90	1.4751E+00	448.850	897.699	0.00E+00	6.62E+02	1.32E+03
Tc-99	3.9357E-04	448.850	897.699	0.00E+00	1.77E-01	3.53E-01
Th-229	5.1744E-11	448.850	897.699	0.00E+00	2.32E-08	4.65E-08
Th-230	8.3721E-09	448.850	897.699	0.00E+00	3.76E-06	7.52E-06
Th-232	5.2859E-12	448.850	897.699	0.00E+00	2.37E-09	4.75E-09
Tl-208	2.0397E-07	448.850	897.699	0.00E+00	9.16E-05	1.83E-04
U-232	5.6638E-07	448.850	897.699	0.00E+00	2.54E-04	5.08E-04
U-233	2.3708E-08	448.850	897.699	0.00E+00	1.06E-05	2.13E-05
U-234	4.3653E-05	448.850	897.699	0.00E+00	1.96E-02	3.92E-02
U-235	-1.4494E-06	448.850	0.000	1.35E-03	6.98E-04	1.35E-03
U-236	7.5694E-06	448.850	897.699	0.00E+00	3.40E-03	6.80E-03
U-238	-2.6129E-07	448.850	0.000	2.32E-03	2.21E-03	2.32E-03
Y-90	1.4755E+00	448.850	897.699	0.00E+00	6.62E+02	1.32E+03
Other Radionuclides					9.60E+02	1.92E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.763E+13
0.0250	1.599E+13
0.0375	1.575E+13
0.0575	1.596E+13
0.0850	9.022E+12
0.1250	7.131E+12
0.2250	7.690E+12
0.3750	3.388E+12
0.5750	7.544E+13
0.8500	3.098E+12
1.2500	4.362E+12
1.7500	6.645E+10
2.2500	5.701E+07
2.7500	1.205E+07
3.5000	1.885E+06
5.0000	5.789E+05
7.0000	6.675E+04
11.0000	7.667E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.51E+01	3.01E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-4	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	8.280254777	0 to 5

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches PWR Template on all but one parameter (enrichment) making PWR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	293.904	448.850
Bounding:	316.512	897.699

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.70	1.53
Bounding:	3.40	2.84

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BRP-B	**[1]Fuel decay start date:**	1972
SNF ID #:	23	**Estimates as of:**	2010
Fuel Units & Descr:	2 - 11 X 11 ROD ARRAY	**Template:**	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=262.68kg ; EOL=250.07kg	**[2]Template Burnup(MWd):**	61.92
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.00176911
		Template Decay Time:	35 years

Estimated Canister usage:

BWR
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	11,990.372	23,980.745	0.00E+00	1.05E-05	2.10E-05
Am-241	1.4352E-01	11,990.372	23,980.745	0.00E+00	1.72E+03	3.44E+03
Am-242m	2.8698E-04	11,990.372	23,980.745	0.00E+00	3.44E+00	6.88E+00
Am-243	6.2565E-04	11,990.372	23,980.745	0.00E+00	7.50E+00	1.50E+01
C-14	4.7901E-05	11,990.372	23,980.745	0.00E+00	5.74E-01	1.15E+00
Cl-36	8.0297E-07	11,990.372	23,980.745	0.00E+00	9.63E-03	1.93E-02
Cm-243	2.5081E-04	11,990.372	23,980.745	0.00E+00	3.01E+00	6.01E+00
Cm-244	4.9015E-02	11,990.372	23,980.745	0.00E+00	5.88E+02	1.18E+03
Co-60	2.5581E-03	11,990.372	23,980.745	0.00E+00	3.07E+01	6.13E+01
Cs-134	4.0536E-05	11,990.372	23,980.745	0.00E+00	4.86E-01	9.72E-01
Cs-135	1.4433E-05	11,990.372	23,980.745	0.00E+00	1.73E-01	3.46E-01
Cs-137	1.3979E+00	11,990.372	23,980.745	0.00E+00	1.68E+04	3.35E+04
Eu-154	2.0203E-02	11,990.372	23,980.745	0.00E+00	2.42E+02	4.84E+02
Eu-155	1.7684E-03	11,990.372	23,980.745	0.00E+00	2.12E+01	4.24E+01
Fe-55	4.3136E-05	11,990.372	23,980.745	0.00E+00	5.17E-01	1.03E+00
H-3	2.0769E-02	11,990.372	23,980.745	0.00E+00	2.49E+02	4.98E+02
I-129	9.8288E-07	11,990.372	23,980.745	0.00E+00	1.18E-02	2.36E-02
Kr-85	2.8214E-02	11,990.372	23,980.745	0.00E+00	3.38E+02	6.77E+02
Np-237	1.1218E-05	11,990.372	23,980.745	0.00E+00	1.35E-01	2.69E-01
Pa-231	1.3036E-09	11,990.372	23,980.745	0.00E+00	1.56E-05	3.13E-05
Pb-210	8.5078E-11	11,990.372	23,980.745	0.00E+00	1.02E-06	2.04E-06
Pm-147	3.6531E-04	11,990.372	23,980.745	0.00E+00	4.38E+00	8.76E+00
Pu-238	7.4564E-02	11,990.372	23,980.745	0.00E+00	8.94E+02	1.79E+03
Pu-239	1.1623E-02	11,990.372	23,980.745	0.00E+00	1.39E+02	2.79E+02
Pu-240	1.5132E-02	11,990.372	23,980.745	0.00E+00	1.81E+02	3.63E+02
Pu-241	9.0036E-01	11,990.372	23,980.745	0.00E+00	1.08E+04	2.16E+04
Pu-242	6.4260E-05	11,990.372	23,980.745	0.00E+00	7.71E-01	1.54E+00
Ra-226	2.2804E-10	11,990.372	23,980.745	0.00E+00	2.73E-06	5.47E-06
Ra-228	5.2713E-12	11,990.372	23,980.745	0.00E+00	6.32E-08	1.26E-07
Ru-106	6.1160E-10	11,990.372	23,980.745	0.00E+00	7.33E-06	1.47E-05
Se-79	1.2377E-05	11,990.372	23,980.745	0.00E+00	1.48E-01	2.97E-01
Sn-126	2.5210E-05	11,990.372	23,980.745	0.00E+00	3.02E-01	6.05E-01
Sr-90	9.1667E-01	11,990.372	23,980.745	0.00E+00	1.10E+04	2.20E+04
Tc-99	3.9357E-04	11,990.372	23,980.745	0.00E+00	4.72E+00	9.44E+00
Th-229	1.2057E-10	11,990.372	23,980.745	0.00E+00	1.45E-06	2.89E-06
Th-230	2.1043E-08	11,990.372	23,980.745	0.00E+00	2.52E-04	5.05E-04
Th-232	5.2972E-12	11,990.372	23,980.745	0.00E+00	6.35E-08	1.27E-07
Tl-208	1.7474E-07	11,990.372	23,980.745	0.00E+00	2.10E-03	4.19E-03
U-232	4.7368E-07	11,990.372	23,980.745	0.00E+00	5.68E-03	1.14E-02
U-233	2.5097E-08	11,990.372	23,980.745	0.00E+00	3.01E-04	6.02E-04
U-234	5.0000E-05	11,990.372	23,980.745	0.00E+00	6.00E-01	1.20E+00
U-235	-1.4489E-06	11,990.372	0.000	1.69E-02	0.00E+00	1.69E-02
U-236	7.5824E-06	11,990.372	23,980.745	0.00E+00	9.09E-02	1.82E-01
U-238	-2.6129E-07	11,990.372	0.000	8.57E-02	8.25E-02	8.57E-02
Y-90	9.1699E-01	11,990.372	23,980.745	0.00E+00	1.10E+04	2.20E+04
Other Radionuclides					1.61E+04	3.22E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.290E+15
0.0250	2.602E+14
0.0375	2.482E+14
0.0575	2.867E+14
0.0850	1.444E+14
0.1250	1.002E+14
0.2250	1.238E+14
0.3750	5.323E+13
0.5750	1.238E+15
0.8500	1.713E+13
1.2500	1.683E+13
1.7500	5.039E+11
2.2500	8.114E+07
2.7500	1.662E+08
3.5000	1.712E+07
5.0000	7.318E+06
7.0000	8.434E+05
11.0000	9.687E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.76E+02	5.52E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	2.982065336	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	5,310.893	11,990.372	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	5,318.510	23,980.745	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.30	2.26
Bounding:	2.61	4.51

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BRP-C
SNF ID #: 24
Fuel Units & Descr: 4 - 11 X 11 ROD ARRAY
Heavy Metal Mass: BOL=468.95kg ; EOL=459.84kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1968
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]Template Burnup(MWd): 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage:
BWR
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	11,298.833	17,314.186	0.00E+00	9.92E-06	1.52E-05
Am-241	1.4352E-01	11,298.833	17,314.186	0.00E+00	1.62E+03	2.48E+03
Am-242m	2.8698E-04	11,298.833	17,314.186	0.00E+00	3.24E+00	4.97E+00
Am-243	6.2565E-04	11,298.833	17,314.186	0.00E+00	7.07E+00	1.08E+01
C-14	4.7901E-05	11,298.833	17,314.186	0.00E+00	5.41E-01	8.29E-01
Cl-36	8.0297E-07	11,298.833	17,314.186	0.00E+00	9.07E-03	1.39E-02
Cm-243	2.5081E-04	11,298.833	17,314.186	0.00E+00	2.83E+00	4.34E+00
Cm-244	4.9015E-02	11,298.833	17,314.186	0.00E+00	5.54E+02	8.49E+02
Co-60	2.5581E-03	11,298.833	17,314.186	0.00E+00	2.89E+01	4.43E+01
Cs-134	4.0536E-05	11,298.833	17,314.186	0.00E+00	4.58E-01	7.02E-01
Cs-135	1.4433E-05	11,298.833	17,314.186	0.00E+00	1.63E-01	2.50E-01
Cs-137	1.3979E+00	11,298.833	17,314.186	0.00E+00	1.58E+04	2.42E+04
Eu-154	2.0203E-02	11,298.833	17,314.186	0.00E+00	2.28E+02	3.50E+02
Eu-155	1.7684E-03	11,298.833	17,314.186	0.00E+00	2.00E+01	3.06E+01
Fe-55	4.3136E-05	11,298.833	17,314.186	0.00E+00	4.87E-01	7.47E-01
H-3	2.0769E-02	11,298.833	17,314.186	0.00E+00	2.35E+02	3.60E+02
I-129	9.8288E-07	11,298.833	17,314.186	0.00E+00	1.11E-02	1.70E-02
Kr-85	2.8214E-02	11,298.833	17,314.186	0.00E+00	3.19E+02	4.88E+02
Np-237	1.1218E-05	11,298.833	17,314.186	0.00E+00	1.27E-01	1.94E-01
Pa-231	1.3036E-09	11,298.833	17,314.186	0.00E+00	1.47E-05	2.26E-05
Pb-210	8.5078E-11	11,298.833	17,314.186	0.00E+00	9.61E-07	1.47E-06
Pm-147	3.6531E-04	11,298.833	17,314.186	0.00E+00	4.13E+00	6.33E+00
Pu-238	7.4564E-02	11,298.833	17,314.186	0.00E+00	8.42E+02	1.29E+03
Pu-239	1.1623E-02	11,298.833	17,314.186	0.00E+00	1.31E+02	2.01E+02
Pu-240	1.5132E-02	11,298.833	17,314.186	0.00E+00	1.71E+02	2.62E+02
Pu-241	9.0036E-01	11,298.833	17,314.186	0.00E+00	1.02E+04	1.56E+04
Pu-242	6.4260E-05	11,298.833	17,314.186	0.00E+00	7.26E-01	1.11E+00
Ra-226	2.2804E-10	11,298.833	17,314.186	0.00E+00	2.58E-06	3.95E-06
Ra-228	5.2713E-12	11,298.833	17,314.186	0.00E+00	5.96E-08	9.13E-08
Ru-106	6.1160E-10	11,298.833	17,314.186	0.00E+00	6.91E-06	1.06E-05
Se-79	1.2377E-05	11,298.833	17,314.186	0.00E+00	1.40E-01	2.14E-01
Sn-126	2.5210E-05	11,298.833	17,314.186	0.00E+00	2.85E-01	4.36E-01
Sr-90	9.1667E-01	11,298.833	17,314.186	0.00E+00	1.04E+04	1.59E+04
Tc-99	3.9357E-04	11,298.833	17,314.186	0.00E+00	4.45E+00	6.81E+00
Th-229	1.2057E-10	11,298.833	17,314.186	0.00E+00	1.36E-06	2.09E-06
Th-230	2.1043E-08	11,298.833	17,314.186	0.00E+00	2.38E-04	3.64E-04
Th-232	5.2972E-12	11,298.833	17,314.186	0.00E+00	5.99E-08	9.17E-08
Tl-208	1.7474E-07	11,298.833	17,314.186	0.00E+00	1.97E-03	3.03E-03
U-232	4.7368E-07	11,298.833	17,314.186	0.00E+00	5.35E-03	8.20E-03
U-233	2.5097E-08	11,298.833	17,314.186	0.00E+00	2.84E-04	4.35E-04
U-234	5.0000E-05	11,298.833	17,314.186	0.00E+00	5.65E-01	8.66E-01
U-235	-1.4489E-06	11,298.833	0.000	3.67E-02	2.04E-02	3.67E-02
U-236	7.5824E-06	11,298.833	17,314.186	0.00E+00	8.57E-02	1.31E-01
U-238	-2.6129E-07	11,298.833	0.000	1.52E-01	1.49E-01	1.52E-01
Y-90	9.1699E-01	11,298.833	17,314.186	0.00E+00	1.04E+04	1.59E+04
Other Radionuclides					1.52E+04	2.32E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	9.316E+14
0.0250	1.879E+14
0.0375	1.792E+14
0.0575	2.070E+14
0.0850	1.042E+14
0.1250	7.233E+13
0.2250	8.939E+13
0.3750	3.843E+13
0.5750	8.940E+14
0.8500	1.237E+13
1.2500	1.215E+13
1.7500	3.638E+11
2.2500	5.859E+07
2.7500	1.200E+08
3.5000	1.236E+07
5.0000	5.284E+06
7.0000	6.090E+05
11.0000	6.994E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.60E+02	3.98E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	3.626092666	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	11,298.833	8,657.093	Nominal burnup taken directly from SFD (converted to MWd).
Bounding:	11,722.293	17,314.186	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.69	0.77
Bounding:	1.05	1.48

Estimated EOL HM/Given EOL HM
0.99

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BRP-D1
SNF ID #: 25
Fuel Units & Descr: 4 - 9 X 9 ROD ARRAY
Heavy Metal Mass: BOL=548.28kg ; EOL=508.34kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1968
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]Template Burnup(MWd): 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage:
BWR
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	37,986.376	75,972.752	0.00E+00	3.33E-05	6.67E-05
Am-241	1.4352E-01	37,986.376	75,972.752	0.00E+00	5.45E+03	1.09E+04
Am-242m	2.8698E-04	37,986.376	75,972.752	0.00E+00	1.09E+01	2.18E+01
Am-243	6.2565E-04	37,986.376	75,972.752	0.00E+00	2.38E+01	4.75E+01
C-14	4.7901E-05	37,986.376	75,972.752	0.00E+00	1.82E+00	3.64E+00
Cl-36	8.0297E-07	37,986.376	75,972.752	0.00E+00	3.05E-02	6.10E-02
Cm-243	2.5081E-04	37,986.376	75,972.752	0.00E+00	9.53E+00	1.91E+01
Cm-244	4.9015E-02	37,986.376	75,972.752	0.00E+00	1.86E+03	3.72E+03
Co-60	2.5581E-03	37,986.376	75,972.752	0.00E+00	9.72E+01	1.94E+02
Cs-134	4.0536E-05	37,986.376	75,972.752	0.00E+00	1.54E+00	3.08E+00
Cs-135	1.4433E-05	37,986.376	75,972.752	0.00E+00	5.48E-01	1.10E+00
Cs-137	1.3979E+00	37,986.376	75,972.752	0.00E+00	5.31E+04	1.06E+05
Eu-154	2.0203E-02	37,986.376	75,972.752	0.00E+00	7.67E+02	1.53E+03
Eu-155	1.7684E-03	37,986.376	75,972.752	0.00E+00	6.72E+01	1.34E+02
Fe-55	4.3136E-05	37,986.376	75,972.752	0.00E+00	1.64E+00	3.28E+00
H-3	2.0769E-02	37,986.376	75,972.752	0.00E+00	7.89E+02	1.58E+03
I-129	9.8288E-07	37,986.376	75,972.752	0.00E+00	3.73E-02	7.47E-02
Kr-85	2.8214E-02	37,986.376	75,972.752	0.00E+00	1.07E+03	2.14E+03
Np-237	1.1218E-05	37,986.376	75,972.752	0.00E+00	4.26E-01	8.52E-01
Pa-231	1.3036E-09	37,986.376	75,972.752	0.00E+00	4.95E-05	9.90E-05
Pb-210	8.5078E-11	37,986.376	75,972.752	0.00E+00	3.23E-06	6.46E-06
Pm-147	3.6531E-04	37,986.376	75,972.752	0.00E+00	1.39E+01	2.78E+01
Pu-238	7.4564E-02	37,986.376	75,972.752	0.00E+00	2.83E+03	5.66E+03
Pu-239	1.1623E-02	37,986.376	75,972.752	0.00E+00	4.42E+02	8.83E+02
Pu-240	1.5132E-02	37,986.376	75,972.752	0.00E+00	5.75E+02	1.15E+03
Pu-241	9.0036E-01	37,986.376	75,972.752	0.00E+00	3.42E+04	6.84E+04
Pu-242	6.4260E-05	37,986.376	75,972.752	0.00E+00	2.44E+00	4.88E+00
Ra-226	2.2804E-10	37,986.376	75,972.752	0.00E+00	8.66E-06	1.73E-05
Ra-228	5.2713E-12	37,986.376	75,972.752	0.00E+00	2.00E-07	4.00E-07
Ru-106	6.1160E-10	37,986.376	75,972.752	0.00E+00	2.32E-05	4.65E-05
Se-79	1.2377E-05	37,986.376	75,972.752	0.00E+00	4.70E-01	9.40E-01
Sn-126	2.5210E-05	37,986.376	75,972.752	0.00E+00	9.58E-01	1.92E+00
Sr-90	9.1667E-01	37,986.376	75,972.752	0.00E+00	3.48E+04	6.96E+04
Tc-99	3.9357E-04	37,986.376	75,972.752	0.00E+00	1.50E+01	2.99E+01
Th-229	1.2057E-10	37,986.376	75,972.752	0.00E+00	4.58E-06	9.16E-06
Th-230	2.1043E-08	37,986.376	75,972.752	0.00E+00	7.99E-04	1.60E-03
Th-232	5.2972E-12	37,986.376	75,972.752	0.00E+00	2.01E-07	4.02E-07
Tl-208	1.7474E-07	37,986.376	75,972.752	0.00E+00	6.64E-03	1.33E-02
U-232	4.7368E-07	37,986.376	75,972.752	0.00E+00	1.80E-02	3.60E-02
U-233	2.5097E-08	37,986.376	75,972.752	0.00E+00	9.53E-04	1.91E-03
U-234	5.0000E-05	37,986.376	75,972.752	0.00E+00	1.90E+00	3.80E+00
U-235	-1.4489E-06	37,986.376	0.000	3.40E-02	0.00E+00	3.40E-02
U-236	7.5824E-06	37,986.376	75,972.752	0.00E+00	2.88E-01	5.76E-01
U-238	-2.6129E-07	37,986.376	0.000	1.79E-01	1.69E-01	1.79E-01
Y-90	9.1699E-01	37,986.376	75,972.752	0.00E+00	3.48E+04	6.97E+04
Other Radionuclides					5.10E+04	1.02E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.088E+15
0.0250	8.243E+14
0.0375	7.862E+14
0.0575	9.084E+14
0.0850	4.574E+14
0.1250	3.174E+14
0.2250	3.922E+14
0.3750	1.686E+14
0.5750	3.923E+15
0.8500	5.426E+13
1.2500	5.331E+13
1.7500	1.597E+12
2.2500	2.571E+08
2.7500	5.266E+08
3.5000	5.423E+07
5.0000	2.318E+07
7.0000	2.672E+06
11.0000	3.069E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.74E+02	1.75E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	2.873465935	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	900.827	37,986.376
Bounding:	926.596	75,972.752

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.98	42.17
Bounding:	3.96	81.99

Estimated EOL HM/Given EOL HM
1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BRP-D2	**[1]Fuel decay start date:**	1968
SNF ID #:	26	**Estimates as of:**	2010
Fuel Units & Desc.:	2 - 7 X 7 ROD ARRAY	**Template:**	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=233.59kg ; EOL=217.10kg	**[2]Template Burnup(MWd):**	61.92
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.00176911
		Template Decay Time:	35 years

Estimated Canister usage:

BWR
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	15,685.204	31,370.408	0.00E+00	1.38E-05	2.75E-05
Am-241	1.4352E-01	15,685.204	31,370.408	0.00E+00	2.25E+03	4.50E+03
Am-242m	2.8698E-04	15,685.204	31,370.408	0.00E+00	4.50E+00	9.00E+00
Am-243	6.2565E-04	15,685.204	31,370.408	0.00E+00	9.81E+00	1.96E+01
C-14	4.7901E-05	15,685.204	31,370.408	0.00E+00	7.51E-01	1.50E+00
Cl-36	8.0297E-07	15,685.204	31,370.408	0.00E+00	1.26E-02	2.52E-02
Cm-243	2.5081E-04	15,685.204	31,370.408	0.00E+00	3.93E+00	7.87E+00
Cm-244	4.9015E-02	15,685.204	31,370.408	0.00E+00	7.69E+02	1.54E+03
Co-60	2.5581E-03	15,685.204	31,370.408	0.00E+00	4.01E+01	8.02E+01
Cs-134	4.0536E-05	15,685.204	31,370.408	0.00E+00	6.36E-01	1.27E+00
Cs-135	1.4433E-05	15,685.204	31,370.408	0.00E+00	2.26E-01	4.53E-01
Cs-137	1.3979E+00	15,685.204	31,370.408	0.00E+00	2.19E+04	4.39E+04
Eu-154	2.0203E-02	15,685.204	31,370.408	0.00E+00	3.17E+02	6.34E+02
Eu-155	1.7684E-03	15,685.204	31,370.408	0.00E+00	2.77E+01	5.55E+01
Fe-55	4.3136E-05	15,685.204	31,370.408	0.00E+00	6.77E-01	1.35E+00
H-3	2.0769E-02	15,685.204	31,370.408	0.00E+00	3.26E+02	6.52E+02
I-129	9.8288E-07	15,685.204	31,370.408	0.00E+00	1.54E-02	3.08E-02
Kr-85	2.8214E-02	15,685.204	31,370.408	0.00E+00	4.43E+02	8.85E+02
Np-237	1.1218E-05	15,685.204	31,370.408	0.00E+00	1.76E-01	3.52E-01
Pa-231	1.3036E-09	15,685.204	31,370.408	0.00E+00	2.04E-05	4.09E-05
Pb-210	8.5078E-11	15,685.204	31,370.408	0.00E+00	1.33E-06	2.67E-06
Pm-147	3.6531E-04	15,685.204	31,370.408	0.00E+00	5.73E+00	1.15E+01
Pu-238	7.4564E-02	15,685.204	31,370.408	0.00E+00	1.17E+03	2.34E+03
Pu-239	1.1623E-02	15,685.204	31,370.408	0.00E+00	1.82E+02	3.65E+02
Pu-240	1.5132E-02	15,685.204	31,370.408	0.00E+00	2.37E+02	4.75E+02
Pu-241	9.0036E-01	15,685.204	31,370.408	0.00E+00	1.41E+04	2.82E+04
Pu-242	6.4260E-05	15,685.204	31,370.408	0.00E+00	1.01E+00	2.02E+00
Ra-226	2.2804E-10	15,685.204	31,370.408	0.00E+00	3.58E-06	7.15E-06
Ra-228	5.2713E-12	15,685.204	31,370.408	0.00E+00	8.27E-08	1.65E-07
Ru-106	6.1160E-10	15,685.204	31,370.408	0.00E+00	9.59E-06	1.92E-05
Se-79	1.2377E-05	15,685.204	31,370.408	0.00E+00	1.94E-01	3.88E-01
Sn-126	2.5210E-05	15,685.204	31,370.408	0.00E+00	3.95E-01	7.91E-01
Sr-90	9.1667E-01	15,685.204	31,370.408	0.00E+00	1.44E+04	2.88E+04
Tc-99	3.9357E-04	15,685.204	31,370.408	0.00E+00	6.17E+00	1.23E+01
Th-229	1.2057E-10	15,685.204	31,370.408	0.00E+00	1.89E-06	3.78E-06
Th-230	2.1043E-08	15,685.204	31,370.408	0.00E+00	3.30E-04	6.60E-04
Th-232	5.2972E-12	15,685.204	31,370.408	0.00E+00	8.31E-08	1.66E-07
Tl-208	1.7474E-07	15,685.204	31,370.408	0.00E+00	2.74E-03	5.48E-03
U-232	4.7368E-07	15,685.204	31,370.408	0.00E+00	7.43E-03	1.49E-02
U-233	2.5097E-08	15,685.204	31,370.408	0.00E+00	3.94E-04	7.87E-04
U-234	5.0000E-05	15,685.204	31,370.408	0.00E+00	7.84E-01	1.57E+00
U-235	-1.4489E-06	15,685.204	0.000	1.42E-02	0.00E+00	1.42E-02
U-236	7.5824E-06	15,685.204	31,370.408	0.00E+00	1.19E-01	2.38E-01
U-238	-2.6129E-07	15,685.204	0.000	7.63E-02	7.22E-02	7.63E-02
Y-90	9.1699E-01	15,685.204	31,370.408	0.00E+00	1.44E+04	2.88E+04
Other Radionuclides					2.11E+04	4.21E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.688E+15
0.0250	3.404E+14
0.0375	3.246E+14
0.0575	3.751E+14
0.0850	1.889E+14
0.1250	1.311E+14
0.2250	1.620E+14
0.3750	6.964E+13
0.5750	1.620E+15
0.8500	2.241E+13
1.2500	2.201E+13
1.7500	6.592E+11
2.2500	1.061E+08
2.7500	2.174E+08
3.5000	2.239E+07
5.0000	9.573E+06
7.0000	1.103E+06
11.0000	1.267E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.61E+02	7.22E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	2.810841528	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	1,061.912	15,685.204	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	1,641.455	31,370.408	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.92	14.77
Bounding:	3.84	19.11

Estimated EOL HM/Given EOL HM

1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BRP-E
SNF ID #: 27
Fuel Units & Descr: 18 - 9 X 9 ROD ARRAY
Heavy Metal Mass: BOL=2443.47kg ; EOL=2420.59kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1972
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]Template Burnup(MWd): 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage:
BWR
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	29,160.321	43,511.792	0.00E+00	2.56E-05	3.82E-05
Am-241	1.4352E-01	29,160.321	43,511.792	0.00E+00	4.19E+03	6.24E+03
Am-242m	2.8698E-04	29,160.321	43,511.792	0.00E+00	8.37E+00	1.25E+01
Am-243	6.2565E-04	29,160.321	43,511.792	0.00E+00	1.82E+01	2.72E+01
C-14	4.7901E-05	29,160.321	43,511.792	0.00E+00	1.40E+00	2.08E+00
Cl-36	8.0297E-07	29,160.321	43,511.792	0.00E+00	2.34E-02	3.49E-02
Cm-243	2.5081E-04	29,160.321	43,511.792	0.00E+00	7.31E+00	1.09E+01
Cm-244	4.9015E-02	29,160.321	43,511.792	0.00E+00	1.43E+03	2.13E+03
Co-60	2.5581E-03	29,160.321	43,511.792	0.00E+00	7.46E+01	1.11E+02
Cs-134	4.0536E-05	29,160.321	43,511.792	0.00E+00	1.18E+00	1.76E+00
Cs-135	1.4433E-05	29,160.321	43,511.792	0.00E+00	4.21E-01	6.28E-01
Cs-137	1.3979E+00	29,160.321	43,511.792	0.00E+00	4.08E+04	6.08E+04
Eu-154	2.0203E-02	29,160.321	43,511.792	0.00E+00	5.89E+02	8.79E+02
Eu-155	1.7684E-03	29,160.321	43,511.792	0.00E+00	5.16E+01	7.69E+01
Fe-55	4.3136E-05	29,160.321	43,511.792	0.00E+00	1.26E+00	1.88E+00
H-3	2.0769E-02	29,160.321	43,511.792	0.00E+00	6.06E+02	9.04E+02
I-129	9.8288E-07	29,160.321	43,511.792	0.00E+00	2.87E-02	4.28E-02
Kr-85	2.8214E-02	29,160.321	43,511.792	0.00E+00	8.23E+02	1.23E+03
Np-237	1.1218E-05	29,160.321	43,511.792	0.00E+00	3.27E-01	4.88E-01
Pa-231	1.3036E-09	29,160.321	43,511.792	0.00E+00	3.80E-05	5.67E-05
Pb-210	8.5078E-11	29,160.321	43,511.792	0.00E+00	2.48E-06	3.70E-06
Pm-147	3.6531E-04	29,160.321	43,511.792	0.00E+00	1.07E+01	1.59E+01
Pu-238	7.4564E-02	29,160.321	43,511.792	0.00E+00	2.17E+03	3.24E+03
Pu-239	1.1623E-02	29,160.321	43,511.792	0.00E+00	3.39E+02	5.06E+02
Pu-240	1.5132E-02	29,160.321	43,511.792	0.00E+00	4.41E+02	6.58E+02
Pu-241	9.0036E-01	29,160.321	43,511.792	0.00E+00	2.63E+04	3.92E+04
Pu-242	6.4260E-05	29,160.321	43,511.792	0.00E+00	1.87E+00	2.80E+00
Ra-226	2.2804E-10	29,160.321	43,511.792	0.00E+00	6.65E-06	9.92E-06
Ra-228	5.2713E-12	29,160.321	43,511.792	0.00E+00	1.54E-07	2.29E-07
Ru-106	6.1160E-10	29,160.321	43,511.792	0.00E+00	1.78E-05	2.66E-05
Se-79	1.2377E-05	29,160.321	43,511.792	0.00E+00	3.61E-01	5.39E-01
Sn-126	2.5210E-05	29,160.321	43,511.792	0.00E+00	7.35E-01	1.10E+00
Sr-90	9.1667E-01	29,160.321	43,511.792	0.00E+00	2.67E+04	3.99E+04
Tc-99	3.9357E-04	29,160.321	43,511.792	0.00E+00	1.15E+01	1.71E+01
Th-229	1.2057E-10	29,160.321	43,511.792	0.00E+00	3.52E-06	5.25E-06
Th-230	2.1043E-08	29,160.321	43,511.792	0.00E+00	6.14E-04	9.16E-04
Th-232	5.2972E-12	29,160.321	43,511.792	0.00E+00	1.54E-07	2.30E-07
Tl-208	1.7474E-07	29,160.321	43,511.792	0.00E+00	5.10E-03	7.60E-03
U-232	4.7368E-07	29,160.321	43,511.792	0.00E+00	1.38E-02	2.06E-02
U-233	2.5097E-08	29,160.321	43,511.792	0.00E+00	7.32E-04	1.09E-03
U-234	5.0000E-05	29,160.321	43,511.792	0.00E+00	1.46E+00	2.18E+00
U-235	-1.4489E-06	29,160.321	0.000	1.58E-01	1.16E-01	1.58E-01
U-236	7.5824E-06	29,160.321	43,511.792	0.00E+00	2.21E-01	3.30E-01
U-238	-2.6129E-07	29,160.321	0.000	7.97E-01	7.89E-01	7.97E-01
Y-90	9.1699E-01	29,160.321	43,511.792	0.00E+00	2.67E+04	3.99E+04
Other Radionuclides					3.91E+04	5.84E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.341E+15
0.0250	4.721E+14
0.0375	4.503E+14
0.0575	5.202E+14
0.0850	2.620E+14
0.1250	1.818E+14
0.2250	2.246E+14
0.3750	9.659E+13
0.5750	2.247E+15
0.8500	3.108E+13
1.2500	3.053E+13
1.7500	9.144E+11
2.2500	1.472E+08
2.7500	3.016E+08
3.5000	3.107E+07
5.0000	1.328E+07
7.0000	1.531E+06
11.0000	1.758E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.71E+02	1.00E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	2.995467825	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	29,160.321	21,755.896	Nominal burnup taken directly from SFD (converted to MWd).
Bounding:	33,700.280	43,511.792	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.34	0.75
Bounding:	0.51	1.29

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BRP-EG	[1]Fuel decay start date:	1973
SNF ID #:	28	Estimates as of:	2010
Fuel Units & Descr:	33 - 9 X 9 ROD ARRAY	Template:	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=4566.96kg ; EOL=4419.28kg	[2]Template Burnup(MWd):	61.92
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.00176911
		Template Decay Time:	35 years

Estimated Canister usage:
BWR
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	140,435.078	280,870.156	0.00E+00	1.23E-04	2.46E-04
Am-241	1.4352E-01	140,435.078	280,870.156	0.00E+00	2.02E+04	4.03E+04
Am-242m	2.8698E-04	140,435.078	280,870.156	0.00E+00	4.03E+01	8.06E+01
Am-243	6.2565E-04	140,435.078	280,870.156	0.00E+00	8.79E+01	1.76E+02
C-14	4.7901E-05	140,435.078	280,870.156	0.00E+00	6.73E+00	1.35E+01
Cl-36	8.0297E-07	140,435.078	280,870.156	0.00E+00	1.13E-01	2.26E-01
Cm-243	2.5081E-04	140,435.078	280,870.156	0.00E+00	3.52E+01	7.04E+01
Cm-244	4.9015E-02	140,435.078	280,870.156	0.00E+00	6.88E+03	1.38E+04
Co-60	2.5581E-03	140,435.078	280,870.156	0.00E+00	3.59E+02	7.19E+02
Cs-134	4.0536E-05	140,435.078	280,870.156	0.00E+00	5.69E+00	1.14E+01
Cs-135	1.4433E-05	140,435.078	280,870.156	0.00E+00	2.03E+00	4.05E+00
Cs-137	1.3979E+00	140,435.078	280,870.156	0.00E+00	1.96E+05	3.93E+05
Eu-154	2.0203E-02	140,435.078	280,870.156	0.00E+00	2.84E+03	5.67E+03
Eu-155	1.7684E-03	140,435.078	280,870.156	0.00E+00	2.48E+02	4.97E+02
Fe-55	4.3136E-05	140,435.078	280,870.156	0.00E+00	6.06E+00	1.21E+01
H-3	2.0769E-02	140,435.078	280,870.156	0.00E+00	2.92E+03	5.83E+03
I-129	9.8288E-07	140,435.078	280,870.156	0.00E+00	1.38E-01	2.76E-01
Kr-85	2.8214E-02	140,435.078	280,870.156	0.00E+00	3.96E+03	7.92E+03
Np-237	1.1218E-05	140,435.078	280,870.156	0.00E+00	1.58E+00	3.15E+00
Pa-231	1.3036E-09	140,435.078	280,870.156	0.00E+00	1.83E-04	3.66E-04
Pb-210	8.5078E-11	140,435.078	280,870.156	0.00E+00	1.19E-05	2.39E-05
Pm-147	3.6531E-04	140,435.078	280,870.156	0.00E+00	5.13E+01	1.03E+02
Pu-238	7.4564E-02	140,435.078	280,870.156	0.00E+00	1.05E+04	2.09E+04
Pu-239	1.1623E-02	140,435.078	280,870.156	0.00E+00	1.63E+03	3.26E+03
Pu-240	1.5132E-02	140,435.078	280,870.156	0.00E+00	2.13E+03	4.25E+03
Pu-241	9.0036E-01	140,435.078	280,870.156	0.00E+00	1.26E+05	2.53E+05
Pu-242	6.4260E-05	140,435.078	280,870.156	0.00E+00	9.02E+00	1.80E+01
Ra-226	2.2804E-10	140,435.078	280,870.156	0.00E+00	3.20E-05	6.40E-05
Ra-228	5.2713E-12	140,435.078	280,870.156	0.00E+00	7.40E-07	1.48E-06
Ru-106	6.1160E-10	140,435.078	280,870.156	0.00E+00	8.59E-05	1.72E-04
Se-79	1.2377E-05	140,435.078	280,870.156	0.00E+00	1.74E+00	3.48E+00
Sn-126	2.5210E-05	140,435.078	280,870.156	0.00E+00	3.54E+00	7.08E+00
Sr-90	9.1667E-01	140,435.078	280,870.156	0.00E+00	1.29E+05	2.57E+05
Tc-99	3.9357E-04	140,435.078	280,870.156	0.00E+00	5.53E+01	1.11E+02
Th-229	1.2057E-10	140,435.078	280,870.156	0.00E+00	1.69E-05	3.39E-05
Th-230	2.1043E-08	140,435.078	280,870.156	0.00E+00	2.96E-03	5.91E-03
Th-232	5.2972E-12	140,435.078	280,870.156	0.00E+00	7.44E-07	1.49E-06
Tl-208	1.7474E-07	140,435.078	280,870.156	0.00E+00	2.45E-02	4.91E-02
U-232	4.7368E-07	140,435.078	280,870.156	0.00E+00	6.65E-02	1.33E-01
U-233	2.5097E-08	140,435.078	280,870.156	0.00E+00	3.52E-03	7.05E-03
U-234	5.0000E-05	140,435.078	280,870.156	0.00E+00	7.02E+00	1.40E+01
U-235	-1.4489E-06	140,435.078	0.000	3.47E-01	1.43E-01	3.47E-01
U-236	7.5824E-06	140,435.078	280,870.156	0.00E+00	1.06E+00	2.13E+00
U-238	-2.6129E-07	140,435.078	0.000	1.48E+00	1.44E+00	1.48E+00
Y-90	9.1699E-01	140,435.078	280,870.156	0.00E+00	1.29E+05	2.58E+05
Other Radionuclides					1.89E+05	3.77E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.511E+16
0.0250	3.047E+15
0.0375	2.907E+15
0.0575	3.358E+15
0.0850	1.691E+15
0.1250	1.173E+15
0.2250	1.450E+15
0.3750	6.235E+14
0.5750	1.450E+16
0.8500	2.006E+14
1.2500	1.971E+14
1.7500	5.902E+12
2.2500	9.504E+08
2.7500	1.947E+09
3.5000	2.005E+08
5.0000	8.571E+07
7.0000	9.879E+06
11.0000	1.135E+06

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.23E+03	6.46E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	3.513472006	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	60,840.985	140,435.078
Bounding:	83,858.442	280,870.156

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.88	2.31
Bounding:	1.76	3.35

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BRP-EG/F
SNF ID #: 1081
Fuel Units & Descr: 4 - 9 X 9 ROD ARRAY
Heavy Metal Mass: BOL=553.69kg ; EOL=541.11kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1973
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]**Template Burnup(MWd):** 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage:

BWR
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	11,962.224	23,924.448	0.00E+00	1.05E-05	2.10E-05
Am-241	1.4352E-01	11,962.224	23,924.448	0.00E+00	1.72E+03	3.43E+03
Am-242m	2.8698E-04	11,962.224	23,924.448	0.00E+00	3.43E+00	6.87E+00
Am-243	6.2565E-04	11,962.224	23,924.448	0.00E+00	7.48E+00	1.50E+01
C-14	4.7901E-05	11,962.224	23,924.448	0.00E+00	5.73E-01	1.15E+00
Cl-36	8.0297E-07	11,962.224	23,924.448	0.00E+00	9.61E-03	1.92E-02
Cm-243	2.5081E-04	11,962.224	23,924.448	0.00E+00	3.00E+00	6.00E+00
Cm-244	4.9015E-02	11,962.224	23,924.448	0.00E+00	5.86E+02	1.17E+03
Co-60	2.5581E-03	11,962.224	23,924.448	0.00E+00	3.06E+01	6.12E+01
Cs-134	4.0536E-05	11,962.224	23,924.448	0.00E+00	4.85E-01	9.70E-01
Cs-135	1.4433E-05	11,962.224	23,924.448	0.00E+00	1.73E-01	3.45E-01
Cs-137	1.3979E+00	11,962.224	23,924.448	0.00E+00	1.67E+04	3.34E+04
Eu-154	2.0203E-02	11,962.224	23,924.448	0.00E+00	2.42E+02	4.83E+02
Eu-155	1.7684E-03	11,962.224	23,924.448	0.00E+00	2.12E+01	4.23E+01
Fe-55	4.3136E-05	11,962.224	23,924.448	0.00E+00	5.16E-01	1.03E+00
H-3	2.0769E-02	11,962.224	23,924.448	0.00E+00	2.48E+02	4.97E+02
I-129	9.8288E-07	11,962.224	23,924.448	0.00E+00	1.18E-02	2.35E-02
Kr-85	2.8214E-02	11,962.224	23,924.448	0.00E+00	3.38E+02	6.75E+02
Np-237	1.1218E-05	11,962.224	23,924.448	0.00E+00	1.34E-01	2.68E-01
Pa-231	1.3036E-09	11,962.224	23,924.448	0.00E+00	1.56E-05	3.12E-05
Pb-210	8.5078E-11	11,962.224	23,924.448	0.00E+00	1.02E-06	2.04E-06
Pm-147	3.6531E-04	11,962.224	23,924.448	0.00E+00	4.37E+00	8.74E+00
Pu-238	7.4564E-02	11,962.224	23,924.448	0.00E+00	8.92E+02	1.78E+03
Pu-239	1.1623E-02	11,962.224	23,924.448	0.00E+00	1.39E+02	2.78E+02
Pu-240	1.5132E-02	11,962.224	23,924.448	0.00E+00	1.81E+02	3.62E+02
Pu-241	9.0036E-01	11,962.224	23,924.448	0.00E+00	1.08E+04	2.15E+04
Pu-242	6.4260E-05	11,962.224	23,924.448	0.00E+00	7.69E-01	1.54E+00
Ra-226	2.2804E-10	11,962.224	23,924.448	0.00E+00	2.73E-06	5.46E-06
Ra-228	5.2713E-12	11,962.224	23,924.448	0.00E+00	6.31E-08	1.26E-07
Ru-106	6.1160E-10	11,962.224	23,924.448	0.00E+00	7.32E-06	1.46E-05
Se-79	1.2377E-05	11,962.224	23,924.448	0.00E+00	1.48E-01	2.96E-01
Sn-126	2.5210E-05	11,962.224	23,924.448	0.00E+00	3.02E-01	6.03E-01
Sr-90	9.1667E-01	11,962.224	23,924.448	0.00E+00	1.10E+04	2.19E+04
Tc-99	3.9357E-04	11,962.224	23,924.448	0.00E+00	4.71E+00	9.42E+00
Th-229	1.2057E-10	11,962.224	23,924.448	0.00E+00	1.44E-06	2.88E-06
Th-230	2.1043E-08	11,962.224	23,924.448	0.00E+00	2.52E-04	5.03E-04
Th-232	5.2972E-12	11,962.224	23,924.448	0.00E+00	6.34E-08	1.27E-07
Tl-208	1.7474E-07	11,962.224	23,924.448	0.00E+00	2.09E-03	4.18E-03
U-232	4.7368E-07	11,962.224	23,924.448	0.00E+00	5.67E-03	1.13E-02
U-233	2.5097E-08	11,962.224	23,924.448	0.00E+00	3.00E-04	6.00E-04
U-234	5.0000E-05	11,962.224	23,924.448	0.00E+00	5.98E-01	1.20E+00
U-235	-1.4489E-06	11,962.224	0.000	4.16E-02	2.43E-02	4.16E-02
U-236	7.5824E-06	11,962.224	23,924.448	0.00E+00	9.07E-02	1.81E-01
U-238	-2.6129E-07	11,962.224	0.000	1.80E-01	1.76E-01	1.80E-01
Y-90	9.1699E-01	11,962.224	23,924.448	0.00E+00	1.10E+04	2.19E+04
Other Radionuclides					1.61E+04	3.21E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.287E+15
0.0250	2.596E+14
0.0375	2.476E+14
0.0575	2.860E+14
0.0850	1.440E+14
0.1250	9.995E+13
0.2250	1.235E+14
0.3750	5.311E+13
0.5750	1.235E+15
0.8500	1.709E+13
1.2500	1.679E+13
1.7500	5.028E+11
2.2500	8.095E+07
2.7500	1.658E+08
3.5000	1.708E+07
5.0000	7.301E+06
7.0000	8.415E+05
11.0000	9.665E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.75E+02	5.50E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	3.477706364	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	8,552.788	11,962.224	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	8,583.240	23,924.448	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.62	1.40
Bounding:	1.23	2.79

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BRP-EP
SNF ID #: 29
Fuel Units & Descr: 3 - 9 X 9 ROD ARRAY
Heavy Metal Mass: BOL=369.99kg ; EOL=351.85kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1974
Estimates as of: 2010
Template: (Worst Case)
[2]**Template Burnup(MWd):** 62.5
Template BOL Heavy Metal Mass (MT): 0.00186865
Template Decay Time: 35 years

Estimated Canister usage:

BWR
1.00

II. Estimates

Radionuclide	m: Ci/MWd From Template	x_n: Nominal Fuel Burnup (MWd)[2]	x_b: Bounding Fuel Burnup (MWd)[2]	b: Initial Activity (Ci)	y_n: Nominal Fuel Inventories(Ci)	y_b: Bounding Fuel Inventories(Ci)
Ac-227	2.3072E-06	17,236.638	34,473.277	0.00E+00	3.98E-02	7.95E-02
Am-241	8.4448E+00	17,236.638	34,473.277	0.00E+00	1.46E+05	2.91E+05
Am-242m	1.6848E-02	17,236.638	34,473.277	0.00E+00	2.90E+02	5.81E+02
Am-243	1.6320E-02	17,236.638	34,473.277	0.00E+00	2.81E+02	5.63E+02
C-14	1.2090E-01	17,236.638	34,473.277	0.00E+00	2.08E+03	4.17E+03
Cl-36	2.2849E-03	17,236.638	34,473.277	0.00E+00	3.94E+01	7.88E+01
Cm-243	8.6624E-04	17,236.638	34,473.277	0.00E+00	1.49E+01	2.99E+01
Cm-244	1.6848E-01	17,236.638	34,473.277	0.00E+00	2.90E+03	5.81E+03
Co-60	2.8086E+01	17,236.638	34,473.277	0.00E+00	4.84E+05	9.68E+05
Cs-134	3.4148E-04	17,236.638	34,473.277	0.00E+00	5.89E+00	1.18E+01
Cs-135	4.3976E-04	17,236.638	34,473.277	0.00E+00	7.58E+00	1.52E+01
Cs-137	2.1049E+01	17,236.638	34,473.277	0.00E+00	3.63E+05	7.26E+05
Eu-154	1.2500E+00	17,236.638	34,473.277	0.00E+00	2.15E+04	4.31E+04
Eu-155	6.8986E-02	17,236.638	34,473.277	0.00E+00	1.19E+03	2.38E+03
Fe-55	2.9308E-01	17,236.638	-34,473.277	0.00E+00	5.05E+03	1.01E+04
H-3	2.4311E-01	17,236.638	34,473.277	0.00E+00	4.19E+03	8.38E+03
I-129	1.0618E-05	17,236.638	34,473.277	0.00E+00	1.83E-01	3.66E-01
Kr-85	5.9882E-01	17,236.638	34,473.277	0.00E+00	1.03E+04	2.06E+04
Np-237	1.5668E-04	17,236.638	34,473.277	0.00E+00	2.70E+00	5.40E+00
Pa-231	2.8656E-06	17,236.638	34,473.277	0.00E+00	4.94E-02	9.88E-02
Pb-210	2.3918E-08	17,236.638	34,473.277	0.00E+00	4.12E-04	8.25E-04
Pm-147	1.6900E-02	17,236.638	34,473.277	0.00E+00	2.91E+02	5.83E+02
Pu-238	-8.6123E-01	17,236.638	0.000	4.75E+04	3.27E+04	4.75E+04
Pu-239	-4.8440E-02	17,236.638	0.000	5.75E+03	4.92E+03	5.75E+03
Pu-240	-3.0095E-01	17,236.638	0.000	7.35E+03	2.16E+03	7.35E+03
Pu-241	-1.0411E+02	17,236.638	0.000	1.89E+06	9.65E+04	1.89E+06
Pu-242	-1.1381E-04	17,236.638	0.000	3.18E+01	2.98E+01	3.18E+01
Ra-226	6.4400E-08	17,236.638	34,473.277	0.00E+00	1.11E-03	2.22E-03
Ra-228	5.9952E-07	17,236.638	34,473.277	0.00E+00	1.03E-02	2.07E-02
Ru-106	8.5526E-07	17,236.638	34,473.277	0.00E+00	1.47E-02	2.95E-02
Se-79	1.9181E-04	17,236.638	34,473.277	0.00E+00	3.31E+00	6.61E+00
Sn-126	1.6671E-04	17,236.638	34,473.277	0.00E+00	2.87E+00	5.75E+00
Sr-90	1.9799E+01	17,236.638	34,473.277	0.00E+00	3.41E+05	6.83E+05
Tc-99	6.7678E-03	17,236.638	34,473.277	0.00E+00	1.17E+02	2.33E+02
Th-229	1.7488E-06	17,236.638	34,473.277	0.00E+00	3.01E-02	6.03E-02
Th-230	5.8704E-06	17,236.638	34,473.277	0.00E+00	1.01E-01	2.02E-01
Th-232	6.0208E-07	17,236.638	34,473.277	0.00E+00	1.04E-02	2.08E-02
Tl-208	8.7573E-05	17,236.638	34,473.277	0.00E+00	1.51E+00	3.02E+00
U-232	2.3706E-04	17,236.638	34,473.277	0.00E+00	4.09E+00	8.17E+00
U-233	3.6128E-04	17,236.638	34,473.277	0.00E+00	6.23E+00	1.25E+01
U-234	1.2788E-02	17,236.638	34,473.277	0.00E+00	2.20E+02	4.41E+02
U-235	5.7486E-04	17,236.638	34,473.277	1.59E-01	1.01E+01	2.00E+01
U-236	2.3485E-04	17,236.638	34,473.277	0.00E+00	4.05E+00	8.10E+00
U-238	1.1581E-04	17,236.638	34,473.277	1.98E-02	2.02E+00	4.01E+00
Y-90	1.9804E+01	17,236.638	34,473.277	0.00E+00	3.41E+05	6.83E+05
Other Radionuclides					1.06E+06	2.13E+06

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.255E+16
0.0250	8.407E+15
0.0375	7.344E+15
0.0575	1.155E+16
0.0850	4.510E+15
0.1250	3.535E+15
0.2250	3.907E+15
0.3750	1.671E+15
0.5750	2.717E+16
0.8500	1.038E+15
1.2500	7.259E+16
1.7500	3.211E+13
2.2500	3.807E+11
2.7500	1.073E+11
3.5000	9.149E+07
5.0000	3.883E+07
7.0000	4.444E+06
11.0000	5.083E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.83E+04	3.60E+04
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	(Worst Case)
Fuel Cladding:	ZIRC-2	SST/Inconel
BOL HM Constituents:	PuO2-UO2	U, Th, & Pu
BOL Enrichment %:	0.7	0 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel didn't closely match any existing templates, therefore the worst case template was used.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	6,607.651	17,236.638
Bounding:	7,131.557	34,473.277

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.39	2.61
Bounding:	2.79	4.83

Estimated EOL HM/Given EOL HM

31.12

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BRP-F	**[1]Fuel decay start date:**	1974
SNF ID #:	30	**Estimates as of:**	2010
Fuel Units & Descr:	13 - 9 X 9 ROD ARRAY	**Template:**	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=1799.10kg ; EOL=1756.76kg	**[2]Template Burnup(MWd):**	61.92
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.00176911
		Template Decay Time:	35 years

Estimated Canister usage: **BWR** 1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	40,267.997	80,535.994	0.00E+00	3.53E-05	7.07E-05
Am-241	1.4352E-01	40,267.997	80,535.994	0.00E+00	5.78E+03	1.16E+04
Am-242m	2.8698E-04	40,267.997	80,535.994	0.00E+00	1.16E+01	2.31E+01
Am-243	6.2565E-04	40,267.997	80,535.994	0.00E+00	2.52E+01	5.04E+01
C-14	4.7901E-05	40,267.997	80,535.994	0.00E+00	1.93E+00	3.86E+00
Cl-36	8.0297E-07	40,267.997	80,535.994	0.00E+00	3.23E-02	6.47E-02
Cm-243	2.5081E-04	40,267.997	80,535.994	0.00E+00	1.01E+01	2.02E+01
Cm-244	4.9015E-02	40,267.997	80,535.994	0.00E+00	1.97E+03	3.95E+03
Co-60	2.5581E-03	40,267.997	80,535.994	0.00E+00	1.03E+02	2.06E+02
Cs-134	4.0536E-05	40,267.997	80,535.994	0.00E+00	1.63E+00	3.26E+00
Cs-135	1.4433E-05	40,267.997	80,535.994	0.00E+00	5.81E-01	1.16E+00
Cs-137	1.3979E+00	40,267.997	80,535.994	0.00E+00	5.63E+04	1.13E+05
Eu-154	2.0203E-02	40,267.997	80,535.994	0.00E+00	8.14E+02	1.63E+03
Eu-155	1.7684E-03	40,267.997	80,535.994	0.00E+00	7.12E+01	1.42E+02
Fe-55	4.3136E-05	40,267.997	80,535.994	0.00E+00	1.74E+00	3.47E+00
H-3	2.0769E-02	40,267.997	80,535.994	0.00E+00	8.36E+02	1.67E+03
I-129	9.8288E-07	40,267.997	80,535.994	0.00E+00	3.96E-02	7.92E-02
Kr-85	2.8214E-02	40,267.997	80,535.994	0.00E+00	1.14E+03	2.27E+03
Np-237	1.1218E-05	40,267.997	80,535.994	0.00E+00	4.52E-01	9.03E-01
Pa-231	1.3036E-09	40,267.997	80,535.994	0.00E+00	5.25E-05	1.05E-04
Pb-210	8.5078E-11	40,267.997	80,535.994	0.00E+00	3.43E-06	6.85E-06
Pm-147	3.6531E-04	40,267.997	80,535.994	0.00E+00	1.47E+01	2.94E+01
Pu-238	7.4564E-02	40,267.997	80,535.994	0.00E+00	3.00E+03	6.01E+03
Pu-239	1.1623E-02	40,267.997	80,535.994	0.00E+00	4.68E+02	9.36E+02
Pu-240	1.5132E-02	40,267.997	80,535.994	0.00E+00	6.09E+02	1.22E+03
Pu-241	9.0036E-01	40,267.997	80,535.994	0.00E+00	3.63E+04	7.25E+04
Pu-242	6.4260E-05	40,267.997	80,535.994	0.00E+00	2.59E+00	5.18E+00
Ra-226	2.2804E-10	40,267.997	80,535.994	0.00E+00	9.18E-06	1.84E-05
Ra-228	5.2713E-12	40,267.997	80,535.994	0.00E+00	2.12E-07	4.25E-07
Ru-106	6.1160E-10	40,267.997	80,535.994	0.00E+00	2.46E-05	4.93E-05
Se-79	1.2377E-05	40,267.997	80,535.994	0.00E+00	4.98E-01	9.97E-01
Sn-126	2.5210E-05	40,267.997	80,535.994	0.00E+00	1.02E+00	2.03E+00
Sr-90	9.1667E-01	40,267.997	80,535.994	0.00E+00	3.69E+04	7.38E+04
Tc-99	3.9357E-04	40,267.997	80,535.994	0.00E+00	1.58E+01	3.17E+01
Th-229	1.2057E-10	40,267.997	80,535.994	0.00E+00	4.86E-06	9.71E-06
Th-230	2.1043E-08	40,267.997	80,535.994	0.00E+00	8.47E-04	1.69E-03
Th-232	5.2972E-12	40,267.997	80,535.994	0.00E+00	2.13E-07	4.27E-07
Tl-208	1.7474E-07	40,267.997	80,535.994	0.00E+00	7.04E-03	1.41E-02
U-232	4.7368E-07	40,267.997	80,535.994	0.00E+00	1.91E-02	3.81E-02
U-233	2.5097E-08	40,267.997	80,535.994	0.00E+00	1.01E-03	2.02E-03
U-234	5.0000E-05	40,267.997	80,535.994	0.00E+00	2.01E+00	4.03E+00
U-235	-1.4489E-06	40,267.997	0.000	1.37E-01	7.83E-02	1.37E-01
U-236	7.5824E-06	40,267.997	80,535.994	0.00E+00	3.05E-01	6.11E-01
U-238	-2.6129E-07	40,267.997	0.000	5.83E-01	5.73E-01	5.83E-01
Y-90	9.1699E-01	40,267.997	80,535.994	0.00E+00	3.69E+04	7.39E+04
Other Radionuclides					5.41E+04	1.08E+05

Gamma Sources

Photon Energy Group (Avg. MeV)	Total Photons/sec (bounding)
0.0150	4.333E+15
0.0250	8.738E+14
0.0375	8.334E+14
0.0575	9.629E+14
0.0850	4.849E+14
0.1250	3.365E+14
0.2250	4.158E+14
0.3750	1.788E+14
0.5750	4.158E+15
0.8500	5.752E+13
1.2500	5.651E+13
1.7500	1.692E+12
2.2500	2.725E+08
2.7500	5.582E+08
3.5000	5.749E+07
5.0000	2.458E+07
7.0000	2.833E+06
11.0000	3.253E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.26E+02	1.85E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	3.514682259	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	18,908.581	40,267.997	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	25,797.349	80,535.994	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.64	2.13
Bounding:	1.28	3.12

Estimated EOL HM/Given EOL HM 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	BRP-F-PU	**[1]Fuel decay start date:**	1974
SNF ID #:	1082	**Estimates as of:**	2010
Fuel Units & Desc.:	2 - 9 X 9 ROD ARRAY	**Template:**	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=269.59kg ; EOL=263.82kg	**[2]Template Burnup(MWd):**	61.92
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.00176911
		Template Decay Time:	35 years

Estimated Canister usage:

BWR
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	5,489.089	10,978.178	0.00E+00	4.82E-06	9.63E-06
Am-241	1.4352E-01	5,489.089	10,978.178	0.00E+00	7.88E+02	1.58E+03
Am-242m	2.8698E-04	5,489.089	10,978.178	0.00E+00	1.58E+00	3.15E+00
Am-243	6.2565E-04	5,489.089	10,978.178	0.00E+00	3.43E+00	6.87E+00
C-14	4.7901E-05	5,489.089	10,978.178	0.00E+00	2.63E-01	5.26E-01
Cl-36	8.0297E-07	5,489.089	10,978.178	0.00E+00	4.41E-03	8.82E-03
Cm-243	2.5081E-04	5,489.089	10,978.178	0.00E+00	1.38E+00	2.75E+00
Cm-244	4.9015E-02	5,489.089	10,978.178	0.00E+00	2.69E+02	5.38E+02
Co-60	2.5581E-03	5,489.089	10,978.178	0.00E+00	1.40E+01	2.81E+01
Cs-134	4.0536E-05	5,489.089	10,978.178	0.00E+00	2.23E-01	4.45E-01
Cs-135	1.4433E-05	5,489.089	10,978.178	0.00E+00	7.92E-02	1.58E-01
Cs-137	1.3979E+00	5,489.089	10,978.178	0.00E+00	7.67E+03	1.53E+04
Eu-154	2.0203E-02	5,489.089	10,978.178	0.00E+00	1.11E+02	2.22E+02
Eu-155	1.7684E-03	5,489.089	10,978.178	0.00E+00	9.71E+00	1.94E+01
Fe-55	4.3136E-05	5,489.089	10,978.178	0.00E+00	2.37E-01	4.74E-01
H-3	2.0769E-02	5,489.089	10,978.178	0.00E+00	1.14E+02	2.28E+02
I-129	9.8288E-07	5,489.089	10,978.178	0.00E+00	5.40E-03	1.08E-02
Kr-85	2.8214E-02	5,489.089	10,978.178	0.00E+00	1.55E+02	3.10E+02
Np-237	1.1218E-05	5,489.089	10,978.178	0.00E+00	6.16E-02	1.23E-01
Pa-231	1.3036E-09	5,489.089	10,978.178	0.00E+00	7.16E-06	1.43E-05
Pb-210	8.5078E-11	5,489.089	10,978.178	0.00E+00	4.67E-07	9.34E-07
Pm-147	3.6531E-04	5,489.089	10,978.178	0.00E+00	2.01E+00	4.01E+00
Pu-238	7.4564E-02	5,489.089	10,978.178	0.00E+00	4.09E+02	8.19E+02
Pu-239	1.1623E-02	5,489.089	10,978.178	0.00E+00	6.38E+01	1.28E+02
Pu-240	1.5132E-02	5,489.089	10,978.178	0.00E+00	8.31E+01	1.66E+02
Pu-241	9.0036E-01	5,489.089	10,978.178	0.00E+00	4.94E+03	9.88E+03
Pu-242	6.4260E-05	5,489.089	10,978.178	0.00E+00	3.53E-01	7.05E-01
Ra-226	2.2804E-10	5,489.089	10,978.178	0.00E+00	1.25E-06	2.50E-06
Ra-228	5.2713E-12	5,489.089	10,978.178	0.00E+00	2.89E-08	5.79E-08
Ru-106	6.1160E-10	5,489.089	10,978.178	0.00E+00	3.36E-06	6.71E-06
Se-79	1.2377E-05	5,489.089	10,978.178	0.00E+00	6.79E-02	1.36E-01
Sn-126	2.5210E-05	5,489.089	10,978.178	0.00E+00	1.38E-01	2.77E-01
Sr-90	9.1667E-01	5,489.089	10,978.178	0.00E+00	5.03E+03	1.01E+04
Tc-99	3.9357E-04	5,489.089	10,978.178	0.00E+00	2.16E+00	4.32E+00
Th-229	1.2057E-10	5,489.089	10,978.178	0.00E+00	6.62E-07	1.32E-06
Th-230	2.1043E-08	5,489.089	10,978.178	0.00E+00	1.16E-04	2.31E-04
Th-232	5.2972E-12	5,489.089	10,978.178	0.00E+00	2.91E-08	5.82E-08
Tl-208	1.7474E-07	5,489.089	10,978.178	0.00E+00	9.59E-04	1.92E-03
U-232	4.7368E-07	5,489.089	10,978.178	0.00E+00	2.60E-03	5.20E-03
U-233	2.5097E-08	5,489.089	10,978.178	0.00E+00	1.38E-04	2.76E-04
U-234	5.0000E-05	5,489.089	10,978.178	0.00E+00	2.74E-01	5.49E-01
U-235	-1.4489E-06	5,489.089	0.000	2.05E-02	1.26E-02	2.05E-02
U-236	7.5824E-06	5,489.089	10,978.178	0.00E+00	4.16E-02	8.32E-02
U-238	-2.6129E-07	5,489.089	0.000	8.74E-02	8.60E-02	8.74E-02
Y-90	9.1699E-01	5,489.089	10,978.178	0.00E+00	5.03E+03	1.01E+04
Other Radionuclides					7.37E+03	1.47E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	5.907E+14
0.0250	1.191E+14
0.0375	1.136E+14
0.0575	1.313E+14
0.0850	6.609E+13
0.1250	4.586E+13
0.2250	5.668E+13
0.3750	2.437E+13
0.5750	5.668E+14
0.8500	7.841E+12
1.2500	7.703E+12
1.7500	2.307E+11
2.2500	3.715E+07
2.7500	7.609E+07
3.5000	7.837E+06
5.0000	3.350E+06
7.0000	3.861E+05
11.0000	4.435E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.26E+02	2.53E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	3.524667186	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	4,154.685	5,489.089	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	4,193.237	10,978.178	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.58	1.32
Bounding:	1.16	2.62

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: BSR
SNF ID #: 31
Fuel Units & Descr: 41 - 19 PLATE MTR ASS'Y
Heavy Metal Mass: BOL=7.86kg ; EOL=6.94kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1991
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 15 years

Estimated Canister usage:
18"x10'
1.71

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Bumup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	4.5861E-10	865.860	1,731.720	0.00E+00	3.97E-07	7.94E-07
Am-241	1.7832E-03	865.860	1,731.720	0.00E+00	1.54E+00	3.09E+00
Am-242m	4.3410E-07	865.860	1,731.720	0.00E+00	3.76E-04	7.52E-04
Am-243	1.4907E-06	865.860	1,731.720	0.00E+00	1.29E-03	2.58E-03
C-14	5.7162E-09	865.860	1,731.720	0.00E+00	4.95E-06	9.90E-06
Cl-36	1.3124E-32	865.860	1,731.720	0.00E+00	1.14E-29	2.27E-29
Cm-243	1.8568E-07	865.860	1,731.720	0.00E+00	1.61E-04	3.22E-04
Cm-244	3.5512E-05	865.860	1,731.720	0.00E+00	3.07E-02	6.15E-02
Co-60	1.0261E-05	865.860	1,731.720	0.00E+00	8.88E-03	1.78E-02
Cs-134	1.6931E-02	865.860	1,731.720	0.00E+00	1.47E+01	2.93E+01
Cs-135	3.4477E-06	865.860	1,731.720	0.00E+00	2.99E-03	5.97E-03
Cs-137	2.2800E+00	865.860	1,731.720	0.00E+00	1.97E+03	3.95E+03
Eu-154	3.6656E-02	865.860	1,731.720	0.00E+00	3.17E+01	6.35E+01
Eu-155	9.6841E-03	865.860	1,731.720	0.00E+00	8.39E+00	1.68E+01
Fe-55	4.6977E-04	865.860	1,731.720	0.00E+00	4.07E-01	8.14E-01
H-3	6.0485E-03	865.860	1,731.720	0.00E+00	5.24E+00	1.05E+01
I-129	7.5300E-07	865.860	1,731.720	0.00E+00	6.52E-04	1.30E-03
Kr-85	1.4989E-01	865.860	1,731.720	0.00E+00	1.30E+02	2.60E+02
Np-237	9.5534E-06	865.860	1,731.720	0.00E+00	8.27E-03	1.65E-02
Pa-231	1.6550E-09	865.860	1,731.720	0.00E+00	1.43E-06	2.87E-06
Pb-210	2.6631E-11	865.860	1,731.720	0.00E+00	2.31E-08	4.61E-08
Pm-147	1.8156E-01	865.860	1,731.720	0.00E+00	1.57E+02	3.14E+02
Pu-238	1.8990E-02	865.860	1,731.720	0.00E+00	1.64E+01	3.29E+01
Pu-239	4.2838E-04	865.860	1,731.720	0.00E+00	3.71E-01	7.42E-01
Pu-240	2.4379E-04	865.860	1,731.720	0.00E+00	2.11E-01	4.22E-01
Pu-241	4.2511E-02	865.860	1,731.720	0.00E+00	3.68E+01	7.36E+01
Pu-242	3.6329E-07	865.860	1,731.720	0.00E+00	3.15E-04	6.29E-04
Ra-226	1.4725E-10	865.860	1,731.720	0.00E+00	1.27E-07	2.55E-07
Ra-228	8.9760E-15	865.860	1,731.720	0.00E+00	7.77E-12	1.55E-11
Ru-106	1.9752E-04	865.860	1,731.720	0.00E+00	1.71E-01	3.42E-01
Se-79	1.2933E-05	865.860	1,731.720	0.00E+00	1.12E-02	2.24E-02
Sn-126	1.1574E-05	865.860	1,731.720	0.00E+00	1.00E-02	2.00E-02
Sr-90	2.1680E+00	865.860	1,731.720	0.00E+00	1.88E+03	3.75E+03
Tc-99	4.2239E-04	865.860	1,731.720	0.00E+00	3.66E-01	7.31E-01
Th-229	3.9270E-12	865.860	1,731.720	0.00E+00	3.40E-09	6.80E-09
Th-230	3.3578E-08	865.860	1,731.720	0.00E+00	2.91E-05	5.81E-05
Th-232	1.5452E-14	865.860	1,731.720	0.00E+00	1.34E-11	2.68E-11
Tl-208	4.6705E-08	865.860	1,731.720	0.00E+00	4.04E-05	8.09E-05
U-232	1.3045E-07	865.860	1,731.720	0.00E+00	1.13E-04	2.26E-04
U-233	2.3739E-09	865.860	1,731.720	0.00E+00	2.06E-06	4.11E-06
U-234	1.8423E-04	865.860	1,731.720	0.00E+00	1.60E-01	3.19E-01
U-235	-2.7235E-06	865.860	0.000	1.58E-02	1.35E-02	1.58E-02
U-236	1.5493E-05	865.860	1,731.720	0.00E+00	1.34E-02	2.68E-02
U-238	-4.2851E-09	865.860	0.000	1.79E-04	1.75E-04	1.79E-04
Y-90	2.1686E+00	865.860	1,731.720	0.00E+00	1.88E+03	3.76E+03
Other Radionuclides					1.88E+03	3.77E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.066E+14
0.0250	4.308E+13
0.0375	3.762E+13
0.0575	4.011E+13
0.0850	2.430E+13
0.1250	1.666E+13
0.2250	2.093E+13
0.3750	9.170E+12
0.5750	1.489E+14
0.8500	3.536E+12
1.2500	1.786E+12
1.7500	7.485E+10
2.2500	9.363E+07
2.7500	5.627E+06
3.5000	3.577E+05
5.0000	8.275E+02
7.0000	9.166E+01
11.0000	1.029E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.34E+01	**4.69E+01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM (6061)	ALUM
BOL HM Constituents:	U3O8	U
BOL Enrichment %:	93.23369049	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		865.860	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,731.720	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.35	
Bounding:	0.70	

Estimated EOL HM/Given EOL HM
1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	CALVERT CLIFFS 1	**[1]Fuel decay start date:**	1980
SNF ID #:	307	**Estimates as of:**	2010
Fuel Units & Descr:	2 - 14 X 14 ROD ARRAY	**Template:**	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=772.00kg ; EOL=675.90kg	**[2]Template Burnup(MWd):**	61.92
ROD Storage Site:	HANFORD	**Template BOL Heavy Metal Mass (MT):**	0.00176911
		Template Decay Time:	25 years

Estimated Canister usage: 18"x15'

1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6376E-10	91,386.554	182,773.109	0.00E+00	6.07E-05	1.21E-04
Am-241	1.3144E-01	91,386.554	182,773.109	0.00E+00	1.20E+04	2.40E+04
Am-242m	3.0039E-04	91,386.554	182,773.109	0.00E+00	2.75E+01	5.49E+01
Am-243	6.2629E-04	91,386.554	182,773.109	0.00E+00	5.72E+01	1.14E+02
C-14	4.7965E-05	91,386.554	182,773.109	0.00E+00	4.38E+00	8.77E+00
Cl-36	8.0297E-07	91,386.554	182,773.109	0.00E+00	7.34E-02	1.47E-01
Cm-243	3.1993E-04	91,386.554	182,773.109	0.00E+00	2.92E+01	5.85E+01
Cm-244	7.1851E-02	91,386.554	182,773.109	0.00E+00	6.57E+03	1.31E+04
Co-60	9.5220E-03	91,386.554	182,773.109	0.00E+00	8.70E+02	1.74E+03
Cs-134	1.1662E-03	91,386.554	182,773.109	0.00E+00	1.07E+02	2.13E+02
Cs-135	1.4433E-05	91,386.554	182,773.109	0.00E+00	1.32E+00	2.64E+00
Cs-137	1.7603E+00	91,386.554	182,773.109	0.00E+00	1.61E+05	3.22E+05
Eu-154	4.5203E-02	91,386.554	182,773.109	0.00E+00	4.13E+03	8.26E+03
Eu-155	7.1479E-03	91,386.554	182,773.109	0.00E+00	6.53E+02	1.31E+03
Fe-55	6.1919E-04	91,386.554	182,773.109	0.00E+00	5.66E+01	1.13E+02
H-3	3.6386E-02	91,386.554	182,773.109	0.00E+00	3.33E+03	6.65E+03
I-129	9.8288E-07	91,386.554	182,773.109	0.00E+00	8.98E-02	1.80E-01
Kr-85	5.3844E-02	91,386.554	182,773.109	0.00E+00	4.92E+03	9.84E+03
Np-237	1.0546E-05	91,386.554	182,773.109	0.00E+00	9.64E-01	1.93E+00
Pa-231	1.1370E-09	91,386.554	182,773.109	0.00E+00	1.04E-04	2.08E-04
Pb-210	3.3624E-11	91,386.554	182,773.109	0.00E+00	3.07E-06	6.15E-06
Pm-147	5.1211E-03	91,386.554	182,773.109	0.00E+00	4.68E+02	9.36E+02
Pu-238	8.0669E-02	91,386.554	182,773.109	0.00E+00	7.37E+03	1.47E+04
Pu-239	1.1626E-02	91,386.554	182,773.109	0.00E+00	1.06E+03	2.12E+03
Pu-240	1.5097E-02	91,386.554	182,773.109	0.00E+00	1.38E+03	2.76E+03
Pu-241	1.4567E+00	91,386.554	182,773.109	0.00E+00	1.33E+05	2.66E+05
Pu-242	6.4260E-05	91,386.554	182,773.109	0.00E+00	5.87E+00	1.17E+01
Ra-226	1.1392E-10	91,386.554	182,773.109	0.00E+00	1.04E-05	2.08E-05
Ra-228	5.1841E-12	91,386.554	182,773.109	0.00E+00	4.74E-07	9.48E-07
Ru-106	5.9012E-07	91,386.554	182,773.109	0.00E+00	5.39E-02	1.08E-01
Se-79	1.2379E-05	91,386.554	182,773.109	0.00E+00	1.13E+00	2.26E+00
Sn-126	2.5210E-05	91,386.554	182,773.109	0.00E+00	2.30E+00	4.61E+00
Sr-90	1.1630E+00	91,386.554	182,773.109	0.00E+00	1.06E+05	2.13E+05
Tc-99	3.9357E-04	91,386.554	182,773.109	0.00E+00	3.60E+01	7.19E+01
Th-229	8.5691E-11	91,386.554	182,773.109	0.00E+00	7.83E-06	1.57E-05
Th-230	1.4493E-08	91,386.554	182,773.109	0.00E+00	1.32E-03	2.65E-03
Th-232	5.2923E-12	91,386.554	182,773.109	0.00E+00	4.84E-07	9.67E-07
Tl-208	1.9202E-07	91,386.554	182,773.109	0.00E+00	1.75E-02	3.51E-02
U-232	5.2083E-07	91,386.554	182,773.109	0.00E+00	4.76E-02	9.52E-02
U-233	2.4386E-08	91,386.554	182,773.109	0.00E+00	2.23E-03	4.46E-03
U-234	4.7012E-05	91,386.554	182,773.109	0.00E+00	4.30E+00	8.59E+00
U-235	-1.4492E-06	91,386.554	0.000	5.00E-02	0.00E+00	5.00E-02
U-236	7.5759E-06	91,386.554	182,773.109	0.00E+00	6.92E-01	1.38E+00
U-238	-2.6129E-07	91,386.554	0.000	2.52E-01	2.28E-01	2.52E-01
Y-90	1.1631E+00	91,386.554	182,773.109	0.00E+00	1.06E+05	2.13E+05
Other Radionuclides					1.54E+05	3.09E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.243E+16
0.0250	2.517E+15
0.0375	2.436E+15
0.0575	2.658E+15
0.0850	1.408E+15
0.1250	1.029E+15
0.2250	1.209E+15
0.3750	5.187E+14
0.5750	1.192E+16
0.8500	2.353E+14
1.2500	3.178E+14
1.7500	6.964E+12
2.2500	1.286E+09
2.7500	1.445E+09
3.5000	1.895E+08
5.0000	8.095E+07
7.0000	9.333E+06
11.0000	1.072E+06

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.51E+03	5.01E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-4	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	2.999999974	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	32,848.600	91,386.554	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	33,041.600	182,773.109	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	3.38	2.78
Bounding:	6.76	5.53

Estimated EOL HM/Given EOL HM

1.06

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: CANDU
SNF ID #: 979
Fuel Units & Descr: 4 - ROD
Heavy Metal Mass: BOL= ; EOL=49.32kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1964
Estimates as of: 2010
Template: HFBR (Heavy Water, Zirc., 0 to 5%, U)
[2]**Template Burnup(MWd):** 5
Template BOL Heavy Metal Mass (MT): 0.00034251
Template Decay Time: 35 years

Estimated Canister usage: 18"x15'
0.14

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	4.6920E-09	47,275.849	47,275.849	0.00E+00	2.22E-04	2.22E-04
Am-241	2.2880E-02	47,275.849	47,275.849	0.00E+00	1.08E+03	1.08E+03
Am-242m	3.5400E-06	47,275.849	47,275.849	0.00E+00	1.67E-01	1.67E-01
Am-243	2.0580E-06	47,275.849	47,275.849	0.00E+00	9.73E-02	9.73E-02
C-14	1.1264E-03	47,275.849	47,275.849	0.00E+00	5.33E+01	5.33E+01
Cl-36	8.3760E-11	47,275.849	47,275.849	0.00E+00	3.96E-06	3.96E-06
Cm-243	5.0340E-07	47,275.849	47,275.849	0.00E+00	2.38E-02	2.38E-02
Cm-244	1.0450E-05	47,275.849	47,275.849	0.00E+00	4.94E-01	4.94E-01
Co-60	6.4420E-02	47,275.849	47,275.849	0.00E+00	3.05E+03	3.05E+03
Cs-134	7.9240E-06	47,275.849	47,275.849	0.00E+00	3.75E-01	3.75E-01
Cs-135	7.9140E-06	47,275.849	47,275.849	0.00E+00	3.74E-01	3.74E-01
Cs-137	1.4316E+00	47,275.849	47,275.849	0.00E+00	6.77E+04	6.77E+04
Eu-154	6.7900E-03	47,275.849	47,275.849	0.00E+00	3.21E+02	3.21E+02
Eu-155	6.2800E-04	47,275.849	47,275.849	0.00E+00	2.97E+01	2.97E+01
Fe-55	5.7480E-05	47,275.849	47,275.849	0.00E+00	2.72E+00	2.72E+00
H-3	2.3800E-02	47,275.849	47,275.849	0.00E+00	1.13E+03	1.13E+03
I-129	7.5020E-07	47,275.849	47,275.849	0.00E+00	3.55E-02	3.55E-02
Kr-85	3.8220E-02	47,275.849	47,275.849	0.00E+00	1.81E+03	1.81E+03
Np-237	5.5780E-06	47,275.849	47,275.849	0.00E+00	2.64E-01	2.64E-01
Pa-231	7.8820E-09	47,275.849	47,275.849	0.00E+00	3.73E-04	3.73E-04
Pb-210	4.3840E-09	47,275.849	47,275.849	0.00E+00	2.07E-04	2.07E-04
Pm-147	9.9500E-04	47,275.849	47,275.849	0.00E+00	4.70E+01	4.70E+01
Pu-238	6.4240E-03	47,275.849	47,275.849	0.00E+00	3.04E+02	3.04E+02
Pu-239	1.8744E-02	47,275.849	47,275.849	0.00E+00	8.86E+02	8.86E+02
Pu-240	8.3540E-03	47,275.849	47,275.849	0.00E+00	3.95E+02	3.95E+02
Pu-241	1.4606E-01	47,275.849	47,275.849	0.00E+00	6.91E+03	6.91E+03
Pu-242	2.0400E-06	47,275.849	47,275.849	0.00E+00	9.64E-02	9.64E-02
Ra-226	1.1804E-08	47,275.849	47,275.849	0.00E+00	5.58E-04	5.58E-04
Ra-228	1.1864E-09	47,275.849	47,275.849	0.00E+00	5.61E-05	5.61E-05
Ru-106	3.2580E-10	47,275.849	47,275.849	0.00E+00	1.54E-05	1.54E-05
Se-79	1.2524E-05	47,275.849	47,275.849	0.00E+00	5.92E-01	5.92E-01
Sn-126	1.2052E-05	47,275.849	47,275.849	0.00E+00	5.70E-01	5.70E-01
Sr-90	1.2638E+00	47,275.849	47,275.849	0.00E+00	5.97E+04	5.97E+04
Tc-99	4.4140E-04	47,275.849	47,275.849	0.00E+00	2.09E+01	2.09E+01
Th-229	4.3480E-09	47,275.849	47,275.849	0.00E+00	2.06E-04	2.06E-04
Th-230	1.0760E-06	47,275.849	47,275.849	0.00E+00	5.09E-02	5.09E-02
Th-232	1.1926E-09	47,275.849	47,275.849	0.00E+00	5.64E-05	5.64E-05
Tl-208	4.6200E-08	47,275.849	47,275.849	0.00E+00	2.18E-03	2.18E-03
U-232	1.2406E-07	47,275.849	47,275.849	0.00E+00	5.87E-03	5.87E-03
U-233	9.1620E-07	47,275.849	47,275.849	0.00E+00	4.33E-02	4.33E-02
U-234	2.3440E-03	47,275.849	47,275.849	0.00E+00	1.11E+02	1.11E+02
U-235	-2.3296E-06	47,275.849	0.000	1.07E-02	0.00E+00	1.07E-02
U-236	2.6620E-05	47,275.849	47,275.849	0.00E+00	1.26E+00	1.26E+00
U-238	-1.3291E-07	47,275.849	0.000	3.12E-02	2.49E-02	3.12E-02
Y-90	1.2642E+00	47,275.849	47,275.849	0.00E+00	5.98E+04	5.98E+04
Other Radionuclides					6.45E+04	6.45E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.298E+15
0.0250	6.832E+14
0.0375	6.010E+14
0.0575	6.508E+14
0.0850	3.837E+14
0.1250	2.532E+14
0.2250	3.306E+14
0.3750	1.438E+14
0.5750	2.516E+15
0.8500	2.904E+13
1.2500	2.393E+14
1.7500	7.873E+11
2.2500	1.261E+09
2.7500	8.066E+07
3.5000	2.433E+05
5.0000	1.021E+05
7.0000	1.148E+04
11.0000	1.303E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.69E+02	8.69E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:		0 to 5

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		47,275.849
Bounding:		47,275.849

Basis for burnup used in estimate:
Nominal burnup set equal to bounding burnup.
Bounding burnup estimated by assuming BOL heavy metal mass was twice EOL.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	32.83	
Bounding:	32.83	

Estimated EOL HM/Given EOL HM
2.59

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: COMMERCIAL BWR & PWR SNF
SNF ID #: 1089
Fuel Units & Descr: 19 - CANISTER OF SCRAP
Heavy Metal Mass: BOL= ; EOL=38.38kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1983
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]Template Burnup(MWd): 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 25 years

Estimated Canister usage:
HIC
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6376E-10	2,457.879	4,915.758	0.00E+00	1.63E-06	3.26E-06
Am-241	1.3144E-01	2,457.879	4,915.758	0.00E+00	3.23E+02	6.46E+02
Am-242m	3.0039E-04	2,457.879	4,915.758	0.00E+00	7.38E-01	1.48E+00
Am-243	6.2629E-04	2,457.879	4,915.758	0.00E+00	1.54E+00	3.08E+00
C-14	4.7965E-05	2,457.879	4,915.758	0.00E+00	1.18E-01	2.36E-01
Cl-36	8.0297E-07	2,457.879	4,915.758	0.00E+00	1.97E-03	3.95E-03
Cm-243	3.1993E-04	2,457.879	4,915.758	0.00E+00	7.86E-01	1.57E+00
Cm-244	7.1851E-02	2,457.879	4,915.758	0.00E+00	1.77E+02	3.53E+02
Co-60	9.5220E-03	2,457.879	4,915.758	0.00E+00	2.34E+01	4.68E+01
Cs-134	1.1662E-03	2,457.879	4,915.758	0.00E+00	2.87E+00	5.73E+00
Cs-135	1.4433E-05	2,457.879	4,915.758	0.00E+00	3.55E-02	7.09E-02
Cs-137	1.7603E+00	2,457.879	4,915.758	0.00E+00	4.33E+03	8.65E+03
Eu-154	4.5203E-02	2,457.879	4,915.758	0.00E+00	1.11E+02	2.22E+02
Eu-155	7.1479E-03	2,457.879	4,915.758	0.00E+00	1.76E+01	3.51E+01
Fe-55	6.1919E-04	2,457.879	4,915.758	0.00E+00	1.52E+00	3.04E+00
H-3	3.6386E-02	2,457.879	4,915.758	0.00E+00	8.94E+01	1.79E+02
I-129	9.8288E-07	2,457.879	4,915.758	0.00E+00	2.42E-03	4.83E-03
Kr-85	5.3844E-02	2,457.879	4,915.758	0.00E+00	1.32E+02	2.65E+02
Np-237	1.0546E-05	2,457.879	4,915.758	0.00E+00	2.59E-02	5.18E-02
Pa-231	1.1370E-09	2,457.879	4,915.758	0.00E+00	2.79E-06	5.59E-06
Pb-210	3.3624E-11	2,457.879	4,915.758	0.00E+00	8.26E-08	1.65E-07
Pm-147	5.1211E-03	2,457.879	4,915.758	0.00E+00	1.26E+01	2.52E+01
Pu-238	8.0669E-02	2,457.879	4,915.758	0.00E+00	1.98E+02	3.97E+02
Pu-239	1.1626E-02	2,457.879	4,915.758	0.00E+00	2.86E+01	5.72E+01
Pu-240	1.5097E-02	2,457.879	4,915.758	0.00E+00	3.71E+01	7.42E+01
Pu-241	1.4567E+00	2,457.879	4,915.758	0.00E+00	3.58E+03	7.16E+03
Pu-242	6.4260E-05	2,457.879	4,915.758	0.00E+00	1.58E-01	3.16E-01
Ra-226	1.1392E-10	2,457.879	4,915.758	0.00E+00	2.80E-07	5.60E-07
Ra-228	5.1841E-12	2,457.879	4,915.758	0.00E+00	1.27E-08	2.55E-08
Ru-106	5.9012E-07	2,457.879	4,915.758	0.00E+00	1.45E-03	2.90E-03
Se-79	1.2379E-05	2,457.879	4,915.758	0.00E+00	3.04E-02	6.09E-02
Sn-126	2.5210E-05	2,457.879	4,915.758	0.00E+00	6.20E-02	1.24E-01
Sr-90	1.1630E+00	2,457.879	4,915.758	0.00E+00	2.86E+03	5.72E+03
Tc-99	3.9357E-04	2,457.879	4,915.758	0.00E+00	9.67E-01	1.93E+00
Th-229	8.5691E-11	2,457.879	4,915.758	0.00E+00	2.11E-07	4.21E-07
Th-230	1.4493E-08	2,457.879	4,915.758	0.00E+00	3.56E-05	7.12E-05
Th-232	5.2923E-12	2,457.879	4,915.758	0.00E+00	1.30E-08	2.60E-08
Tl-208	1.9202E-07	2,457.879	4,915.758	0.00E+00	4.72E-04	9.44E-04
U-232	5.2083E-07	2,457.879	4,915.758	0.00E+00	1.28E-03	2.56E-03
U-233	2.4386E-08	2,457.879	4,915.758	0.00E+00	5.99E-05	1.20E-04
U-234	4.7012E-05	2,457.879	4,915.758	0.00E+00	1.16E-01	2.31E-01
U-235	-1.4492E-06	2,457.879	0.000	2.83E-03	0.00E+00	2.83E-03
U-236	7.5759E-06	2,457.879	4,915.758	0.00E+00	1.86E-02	3.72E-02
U-238	-2.6129E-07	2,457.879	0.000	1.33E-02	1.27E-02	1.33E-02
Y-90	1.1631E+00	2,457.879	4,915.758	0.00E+00	2.86E+03	5.72E+03
Other Radionuclides					4.15E+03	8.30E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.343E+14
0.0250	6.770E+13
0.0375	6.553E+13
0.0575	7.148E+13
0.0850	3.788E+13
0.1250	2.767E+13
0.2250	3.252E+13
0.3750	1.395E+13
0.5750	3.206E+14
0.8500	6.328E+12
1.2500	8.548E+12
1.7500	1.873E+11
2.2500	3.459E+07
2.7500	3.888E+07
3.5000	5.095E+06
5.0000	2.177E+06
7.0000	2.510E+05
11.0000	2.883E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.74E+01	1.35E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:		0 to 5

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		2,457.879
Bounding:		4,915.758

Basis for burnup used in estimate:

Nominal burnup taken from SFD and converted to MWd using BOL=40.965kg
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.71	
Bounding:	3.43	

Estimated EOL HM/Given EOL HM
1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: CONNECTICUT YANKEE (S004)
SNF ID #: 34
Fuel Units & Descr: 1 - 15 X 15 ROD ARRAY
Heavy Metal Mass: BOL=407.84kg ; EOL=393.77kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1975
Estimates as of: 2010
Template: Pathfinder (Light Water, SST, 60 to 100%, U)
[2]Template Burnup(MWd): 6.01
Template BOL Heavy Metal Mass (MT): 0.00012882
Template Decay Time: 35 years

Estimated Canister usage:

PWR
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	2.3344E-08	13,290.342	26,580.683	0.00E+00	3.10E-04	6.21E-04
Am-241	1.1135E-04	13,290.342	26,580.683	0.00E+00	1.48E+00	2.96E+00
Am-242m	8.5075E-09	13,290.342	26,580.683	0.00E+00	1.13E-04	2.26E-04
Am-243	9.8519E-10	13,290.342	26,580.683	0.00E+00	1.31E-05	2.62E-05
C-14	2.3012E-04	13,290.342	26,580.683	0.00E+00	3.06E+00	6.12E+00
Cl-36	1.2261E-06	13,290.342	26,580.683	0.00E+00	1.63E-02	3.26E-02
Cm-243	2.4875E-10	13,290.342	26,580.683	0.00E+00	3.31E-06	6.61E-06
Cm-244	2.3178E-09	13,290.342	26,580.683	0.00E+00	3.08E-05	6.16E-05
Co-60	7.0849E-02	13,290.342	26,580.683	0.00E+00	9.42E+02	1.88E+03
Cs-134	3.0266E-06	13,290.342	26,580.683	0.00E+00	4.02E-02	8.04E-02
Cs-135	3.0316E-05	13,290.342	26,580.683	0.00E+00	4.03E-01	8.06E-01
Cs-137	1.4511E+00	13,290.342	26,580.683	0.00E+00	1.93E+04	3.86E+04
Eu-154	6.6955E-04	13,290.342	26,580.683	0.00E+00	8.90E+00	1.78E+01
Eu-155	6.9850E-04	13,290.342	26,580.683	0.00E+00	9.28E+00	1.86E+01
Fe-55	1.2318E-03	13,290.342	26,580.683	0.00E+00	1.64E+01	3.27E+01
H-3	2.5141E-03	13,290.342	26,580.683	0.00E+00	3.34E+01	6.68E+01
I-129	7.3195E-07	13,290.342	26,580.683	0.00E+00	9.73E-03	1.95E-02
Kr-85	4.1281E-02	13,290.342	26,580.683	0.00E+00	5.49E+02	1.10E+03
Np-237	1.1489E-06	13,290.342	26,580.683	0.00E+00	1.53E-02	3.05E-02
Pa-231	4.5241E-08	13,290.342	26,580.683	0.00E+00	6.01E-04	1.20E-03
Pb-210	6.4476E-13	13,290.342	26,580.683	0.00E+00	8.57E-09	1.71E-08
Pm-147	1.1651E-03	13,290.342	26,580.683	0.00E+00	1.55E+01	3.10E+01
Pu-238	2.9517E-04	13,290.342	26,580.683	0.00E+00	3.92E+00	7.85E+00
Pu-239	6.6772E-04	13,290.342	26,580.683	0.00E+00	8.87E+00	1.77E+01
Pu-240	8.6839E-05	13,290.342	26,580.683	0.00E+00	1.15E+00	2.31E+00
Pu-241	7.1514E-04	13,290.342	26,580.683	0.00E+00	9.50E+00	1.90E+01
Pu-242	1.9717E-09	13,290.342	26,580.683	0.00E+00	2.62E-05	5.24E-05
Ra-226	1.7654E-12	13,290.342	26,580.683	0.00E+00	2.35E-08	4.69E-08
Ra-228	8.2928E-12	13,290.342	26,580.683	0.00E+00	1.10E-07	2.20E-07
Ru-106	1.8419E-10	13,290.342	26,580.683	0.00E+00	2.45E-06	4.90E-06
Se-79	1.3223E-05	13,290.342	26,580.683	0.00E+00	1.76E-01	3.51E-01
Sn-126	1.1493E-05	13,290.342	26,580.683	0.00E+00	1.53E-01	3.05E-01
Sr-90	1.3649E+00	13,290.342	26,580.683	0.00E+00	1.81E+04	3.63E+04
Tc-99	4.6656E-04	13,290.342	26,580.683	0.00E+00	6.20E+00	1.24E+01
Th-229	1.4547E-11	13,290.342	26,580.683	0.00E+00	1.93E-07	3.87E-07
Th-230	1.6617E-10	13,290.342	26,580.683	0.00E+00	2.21E-06	4.42E-06
Th-232	8.3361E-12	13,290.342	26,580.683	0.00E+00	1.11E-07	2.22E-07
Tl-208	2.1664E-08	13,290.342	26,580.683	0.00E+00	2.88E-04	5.76E-04
U-232	5.8669E-08	13,290.342	26,580.683	0.00E+00	7.80E-04	1.56E-03
U-233	3.1847E-09	13,290.342	26,580.683	0.00E+00	4.23E-05	8.47E-05
U-234	3.8769E-07	13,290.342	26,580.683	0.00E+00	5.15E-03	1.03E-02
U-235	-2.7761E-06	13,290.342	0.000	3.53E-02	0.00E+00	3.53E-02
U-236	1.6190E-05	13,290.342	26,580.683	0.00E+00	2.15E-01	4.30E-01
U-238	-2.8547E-09	13,290.342	0.000	1.32E-01	1.32E-01	1.32E-01
Y-90	1.3652E+00	13,290.342	26,580.683	0.00E+00	1.81E+04	3.63E+04
Other Radionuclides					2.19E+04	4.39E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.984E+15
0.0250	4.123E+14
0.0375	3.566E+14
0.0575	3.844E+14
0.0850	2.322E+14
0.1250	1.508E+14
0.2250	1.999E+14
0.3750	8.719E+13
0.5750	1.436E+15
0.8500	1.454E+13
1.2500	1.445E+14
1.7500	3.751E+11
2.2500	7.786E+08
2.7500	2.251E+07
3.5000	2.279E+03
5.0000	9.501E+02
7.0000	1.063E+02
11.0000	1.203E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.32E+02	4.64E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	SST (304L)	SST
BOL HM Constituents:	UO2	U
BOL Enrichment %:	4.000000037	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches Pathfinder Template on all but one parameter (enrichment) making Pathfinder a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	13,139.889	13,290.342
Bounding:		26,580.683

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.70	1.01
Bounding:	1.40	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: COOPER NUCLEAR
SNF ID #: 308
Fuel Units & Descr: 2 - 7 X 7 ROD ARRAY
Heavy Metal Mass: BOL=370.00kg ; EOL=368.20kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1982
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]Template Burnup(MWd): 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 25 years

Estimated Canister usage:
18"x15'
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6376E-10	10,273.050	10,378.500	0.00E+00	6.82E-06	6.89E-06
Am-241	1.3144E-01	10,273.050	10,378.500	0.00E+00	1.35E+03	1.36E+03
Am-242m	3.0039E-04	10,273.050	10,378.500	0.00E+00	3.09E+00	3.12E+00
Am-243	6.2629E-04	10,273.050	10,378.500	0.00E+00	6.43E+00	6.50E+00
C-14	4.7965E-05	10,273.050	10,378.500	0.00E+00	4.93E-01	4.98E-01
Cl-36	8.0297E-07	10,273.050	10,378.500	0.00E+00	8.25E-03	8.33E-03
Cm-243	3.1993E-04	10,273.050	10,378.500	0.00E+00	3.29E+00	3.32E+00
Cm-244	7.1851E-02	10,273.050	10,378.500	0.00E+00	7.38E+02	7.46E+02
Co-60	9.5220E-03	10,273.050	10,378.500	0.00E+00	9.78E+01	9.88E+01
Cs-134	1.1662E-03	10,273.050	10,378.500	0.00E+00	1.20E+01	1.21E+01
Cs-135	1.4433E-05	10,273.050	10,378.500	0.00E+00	1.48E-01	1.50E-01
Cs-137	1.7603E+00	10,273.050	10,378.500	0.00E+00	1.81E+04	1.83E+04
Eu-154	4.5203E-02	10,273.050	10,378.500	0.00E+00	4.64E+02	4.69E+02
Eu-155	7.1479E-03	10,273.050	10,378.500	0.00E+00	7.34E+01	7.42E+01
Fe-55	6.1919E-04	10,273.050	10,378.500	0.00E+00	6.36E+00	6.43E+00
H-3	3.6386E-02	10,273.050	10,378.500	0.00E+00	3.74E+02	3.78E+02
I-129	9.8288E-07	10,273.050	10,378.500	0.00E+00	1.01E-02	1.02E-02
Kr-85	5.3844E-02	10,273.050	10,378.500	0.00E+00	5.53E+02	5.59E+02
Np-237	1.0546E-05	10,273.050	10,378.500	0.00E+00	1.08E-01	1.09E-01
Pa-231	1.1370E-09	10,273.050	10,378.500	0.00E+00	1.17E-05	1.18E-05
Pb-210	3.3624E-11	10,273.050	10,378.500	0.00E+00	3.45E-07	3.49E-07
Pm-147	5.1211E-03	10,273.050	10,378.500	0.00E+00	5.26E+01	5.31E+01
Pu-238	8.0669E-02	10,273.050	10,378.500	0.00E+00	8.29E+02	8.37E+02
Pu-239	1.1626E-02	10,273.050	10,378.500	0.00E+00	1.19E+02	1.21E+02
Pu-240	1.5097E-02	10,273.050	10,378.500	0.00E+00	1.55E+02	1.57E+02
Pu-241	1.4567E+00	10,273.050	10,378.500	0.00E+00	1.50E+04	1.51E+04
Pu-242	6.4260E-05	10,273.050	10,378.500	0.00E+00	6.60E-01	6.67E-01
Ra-226	1.1392E-10	10,273.050	10,378.500	0.00E+00	1.17E-06	1.18E-06
Ra-228	5.1841E-12	10,273.050	10,378.500	0.00E+00	5.33E-08	5.38E-08
Ru-106	5.9012E-07	10,273.050	10,378.500	0.00E+00	6.06E-03	6.12E-03
Se-79	1.2379E-05	10,273.050	10,378.500	0.00E+00	1.27E-01	1.28E-01
Sn-126	2.5210E-05	10,273.050	10,378.500	0.00E+00	2.59E-01	2.62E-01
Sr-90	1.1630E+00	10,273.050	10,378.500	0.00E+00	1.19E+04	1.21E+04
Tc-99	3.9357E-04	10,273.050	10,378.500	0.00E+00	4.04E+00	4.08E+00
Th-229	8.5691E-11	10,273.050	10,378.500	0.00E+00	8.80E-07	8.89E-07
Th-230	1.4493E-08	10,273.050	10,378.500	0.00E+00	1.49E-04	1.50E-04
Th-232	5.2923E-12	10,273.050	10,378.500	0.00E+00	5.44E-08	5.49E-08
Tl-208	1.9202E-07	10,273.050	10,378.500	0.00E+00	1.97E-03	1.99E-03
U-232	5.2083E-07	10,273.050	10,378.500	0.00E+00	5.35E-03	5.41E-03
U-233	2.4386E-08	10,273.050	10,378.500	0.00E+00	2.51E-04	2.53E-04
U-234	4.7012E-05	10,273.050	10,378.500	0.00E+00	4.83E-01	4.88E-01
U-235	-1.4492E-06	10,273.050	0.000	1.28E-02	0.00E+00	1.28E-02
U-236	7.5759E-06	10,273.050	10,378.500	0.00E+00	7.78E-02	7.86E-02
U-238	-2.6129E-07	10,273.050	0.000	1.22E-01	1.20E-01	1.22E-01
Y-90	1.1631E+00	10,273.050	10,378.500	0.00E+00	1.19E+04	1.21E+04
Other Radionuclides					1.74E+04	1.75E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.058E+14
0.0250	1.429E+14
0.0375	1.383E+14
0.0575	1.509E+14
0.0850	7.997E+13
0.1250	5.842E+13
0.2250	6.865E+13
0.3750	2.945E+13
0.5750	6.769E+14
0.8500	1.336E+13
1.2500	1.805E+13
1.7500	3.954E+11
2.2500	7.304E+07
2.7500	8.208E+07
3.5000	1.076E+07
5.0000	4.597E+06
7.0000	5.300E+05
11.0000	6.088E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.82E+02	2.85E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	1.6	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	10,273.050	1,711.715	Nominal burnup taken directly from SFD (converted to MWd).
Bounding:	10,378.500	3,423.430	Bounding burnup taken directly from SFD (converted to MWd).

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.79	0.17
Bounding:	0.80	0.33

Estimated EOL HM/Given EOL HM
0.98

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: CP-5 CONVERTER CYLINDERS
SNF ID #: 36
Fuel Units & Descr: 2 - CONVERTER CYLINDERS
Heavy Metal Mass: BOL=1.23kg ; EOL=1.21kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1979
Estimates as of: 2010
Template: HFBR (Heavy Water, Zirc., 0 to 5%, U)
[2]Template Burnup(MWd): 5
Template BOL Heavy Metal Mass (MT): 0.00034251
Template Decay Time: 25 years

Estimated Canister usage:

HIC
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	3.1940E-09	24.539	49.078	0.00E+00	7.84E-08	1.57E-07
Am-241	2.0920E-02	24.539	49.078	0.00E+00	5.13E-01	1.03E+00
Am-242m	3.7060E-06	24.539	49.078	0.00E+00	9.09E-05	1.82E-04
Am-243	2.0600E-06	24.539	49.078	0.00E+00	5.06E-05	1.01E-04
C-14	1.1278E-03	24.539	49.078	0.00E+00	2.77E-02	5.54E-02
Cl-36	8.3760E-11	24.539	49.078	0.00E+00	2.06E-09	4.11E-09
Cm-243	6.4200E-07	24.539	49.078	0.00E+00	1.58E-05	3.15E-05
Cm-244	1.5322E-05	24.539	49.078	0.00E+00	3.76E-04	7.52E-04
Co-60	2.4000E-01	24.539	49.078	0.00E+00	5.89E+00	1.18E+01
Cs-134	2.2840E-04	24.539	49.078	0.00E+00	5.60E-03	1.12E-02
Cs-135	7.9140E-06	24.539	49.078	0.00E+00	1.94E-04	3.88E-04
Cs-137	1.8038E+00	24.539	49.078	0.00E+00	4.43E+01	8.85E+01
Eu-154	1.5200E-02	24.539	49.078	0.00E+00	3.73E-01	7.46E-01
Eu-155	2.5420E-03	24.539	49.078	0.00E+00	6.24E-02	1.25E-01
Fe-55	8.2660E-04	24.539	49.078	0.00E+00	2.03E-02	4.06E-02
H-3	4.1740E-02	24.539	49.078	0.00E+00	1.02E+00	2.05E+00
I-129	7.5020E-07	24.539	49.078	0.00E+00	1.84E-05	3.68E-05
Kr-85	7.2960E-02	24.539	49.078	0.00E+00	1.79E+00	3.58E+00
Np-237	5.4700E-06	24.539	49.078	0.00E+00	1.34E-04	2.68E-04
Pa-231	6.2740E-09	24.539	49.078	0.00E+00	1.54E-07	3.08E-07
Pb-210	1.7004E-09	24.539	49.078	0.00E+00	4.17E-08	8.35E-08
Pm-147	1.3972E-02	24.539	49.078	0.00E+00	3.43E-01	6.86E-01
Pu-238	6.9520E-03	24.539	49.078	0.00E+00	1.71E-01	3.41E-01
Pu-239	1.8748E-02	24.539	49.078	0.00E+00	4.60E-01	9.20E-01
Pu-240	8.3640E-03	24.539	49.078	0.00E+00	2.05E-01	4.10E-01
Pu-241	2.3640E-01	24.539	49.078	0.00E+00	5.80E+00	1.16E+01
Pu-242	2.0400E-06	24.539	49.078	0.00E+00	5.01E-05	1.00E-04
Ra-226	5.8960E-09	24.539	49.078	0.00E+00	1.45E-07	2.89E-07
Ra-228	1.1638E-09	24.539	49.078	0.00E+00	2.86E-08	5.71E-08
Ru-106	3.1580E-07	24.539	49.078	0.00E+00	7.75E-06	1.55E-05
Se-79	1.2524E-05	24.539	49.078	0.00E+00	3.07E-04	6.15E-04
Sn-126	1.2054E-05	24.539	49.078	0.00E+00	2.96E-04	5.92E-04
Sr-90	1.6036E+00	24.539	49.078	0.00E+00	3.94E+01	7.87E+01
Tc-99	4.4140E-04	24.539	49.078	0.00E+00	1.08E-02	2.17E-02
Th-229	3.0560E-09	24.539	49.078	0.00E+00	7.50E-08	1.50E-07
Th-230	7.5960E-07	24.539	49.078	0.00E+00	1.86E-05	3.73E-05
Th-232	1.1926E-09	24.539	49.078	0.00E+00	2.93E-08	5.85E-08
Tl-208	5.0820E-08	24.539	49.078	0.00E+00	1.25E-06	2.49E-06
U-232	1.3656E-07	24.539	49.078	0.00E+00	3.35E-06	6.70E-06
U-233	9.1580E-07	24.539	49.078	0.00E+00	2.25E-05	4.49E-05
U-234	2.3440E-03	24.539	49.078	0.00E+00	5.75E-02	1.15E-01
U-235	-2.3316E-06	24.539	0.000	2.47E-03	2.42E-03	2.47E-03
U-236	2.6620E-05	24.539	49.078	0.00E+00	6.53E-04	1.31E-03
U-238	-1.3291E-07	24.539	0.000	2.90E-05	2.57E-05	2.90E-05
Y-90	1.6040E+00	24.539	49.078	0.00E+00	3.94E+01	7.87E+01
Other Radionuclides					4.22E+01	8.44E+01

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.362E+12
0.0250	9.060E+11
0.0375	7.966E+11
0.0575	8.552E+11
0.0850	5.077E+11
0.1250	3.395E+11
0.2250	4.370E+11
0.3750	1.910E+11
0.5750	3.296E+12
0.8500	4.429E+10
1.2500	8.963E+11
1.7500	1.226E+09
2.2500	4.708E+06
2.7500	1.023E+05
3.5000	2.724E+02
5.0000	1.076E+02
7.0000	1.212E+01
11.0000	1.376E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.20E-01	**1.24E+00**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	U-Zr	U
BOL Enrichment %:	92.99999968	0 to 5

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		24.539
Bounding:		49.078

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.37	
Bounding:	2.73	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: CVTR FUEL
SNF ID #: 37
Fuel Units & Descr: 34 - ROD
Heavy Metal Mass: BOL=68.66kg ; EOL=67.47kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1967
Estimates as of: 2010
Template: HFBR (Heavy Water, Zirc., 0 to 5%, U)
[2]Template Burnup(MWd): 5
Template BOL Heavy Metal Mass (MT): 0.00034251
Template Decay Time: 35 years

Estimated Canister usage:

18"x15'
0.45

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	4.6920E-09	1,137.419	2,274.839	0.00E+00	5.34E-06	1.07E-05
Am-241	2.2880E-02	1,137.419	2,274.839	0.00E+00	2.60E+01	5.20E+01
Am-242m	3.5400E-06	1,137.419	2,274.839	0.00E+00	4.03E-03	8.05E-03
Am-243	2.0580E-06	1,137.419	2,274.839	0.00E+00	2.34E-03	4.68E-03
C-14	1.1264E-03	1,137.419	2,274.839	0.00E+00	1.28E+00	2.56E+00
Cl-36	8.3760E-11	1,137.419	2,274.839	0.00E+00	9.53E-08	1.91E-07
Cm-243	5.0340E-07	1,137.419	2,274.839	0.00E+00	5.73E-04	1.15E-03
Cm-244	1.0450E-05	1,137.419	2,274.839	0.00E+00	1.19E-02	2.38E-02
Co-60	6.4420E-02	1,137.419	2,274.839	0.00E+00	7.33E+01	1.47E+02
Cs-134	7.9240E-06	1,137.419	2,274.839	0.00E+00	9.01E-03	1.80E-02
Cs-135	7.9140E-06	1,137.419	2,274.839	0.00E+00	9.00E-03	1.80E-02
Cs-137	1.4316E+00	1,137.419	2,274.839	0.00E+00	1.63E+03	3.26E+03
Eu-154	6.7900E-03	1,137.419	2,274.839	0.00E+00	7.72E+00	1.54E+01
Eu-155	6.2800E-04	1,137.419	2,274.839	0.00E+00	7.14E-01	1.43E+00
Fe-55	5.7480E-05	1,137.419	2,274.839	0.00E+00	6.54E-02	1.31E-01
H-3	2.3800E-02	1,137.419	2,274.839	0.00E+00	2.71E+01	5.41E+01
I-129	7.5020E-07	1,137.419	2,274.839	0.00E+00	8.53E-04	1.71E-03
Kr-85	3.8220E-02	1,137.419	2,274.839	0.00E+00	4.35E+01	8.69E+01
Np-237	5.5780E-06	1,137.419	2,274.839	0.00E+00	6.34E-03	1.27E-02
Pa-231	7.8820E-09	1,137.419	2,274.839	0.00E+00	8.97E-06	1.79E-05
Pb-210	4.3840E-09	1,137.419	2,274.839	0.00E+00	4.99E-06	9.97E-06
Pm-147	9.9500E-04	1,137.419	2,274.839	0.00E+00	1.13E+00	2.26E+00
Pu-238	6.4240E-03	1,137.419	2,274.839	0.00E+00	7.31E+00	1.46E+01
Pu-239	1.8744E-02	1,137.419	2,274.839	0.00E+00	2.13E+01	4.26E+01
Pu-240	8.3540E-03	1,137.419	2,274.839	0.00E+00	9.50E+00	1.90E+01
Pu-241	1.4606E-01	1,137.419	2,274.839	0.00E+00	1.66E+02	3.32E+02
Pu-242	2.0400E-06	1,137.419	2,274.839	0.00E+00	2.32E-03	4.64E-03
Ra-226	1.1804E-08	1,137.419	2,274.839	0.00E+00	1.34E-05	2.69E-05
Ra-228	1.1864E-09	1,137.419	2,274.839	0.00E+00	1.35E-06	2.70E-06
Ru-106	3.2580E-10	1,137.419	2,274.839	0.00E+00	3.71E-07	7.41E-07
Se-79	1.2524E-05	1,137.419	2,274.839	0.00E+00	1.42E-02	2.85E-02
Sn-126	1.2052E-05	1,137.419	2,274.839	0.00E+00	1.37E-02	2.74E-02
Sr-90	1.2638E+00	1,137.419	2,274.839	0.00E+00	1.44E+03	2.87E+03
Tc-99	4.4140E-04	1,137.419	2,274.839	0.00E+00	5.02E-01	1.00E+00
Th-229	4.3480E-09	1,137.419	2,274.839	0.00E+00	4.95E-06	9.89E-06
Th-230	1.0760E-06	1,137.419	2,274.839	0.00E+00	1.22E-03	2.45E-03
Th-232	1.1926E-09	1,137.419	2,274.839	0.00E+00	1.36E-06	2.71E-06
Tl-208	4.6200E-08	1,137.419	2,274.839	0.00E+00	5.25E-05	1.05E-04
U-232	1.2406E-07	1,137.419	2,274.839	0.00E+00	1.41E-04	2.82E-04
U-233	9.1620E-07	1,137.419	2,274.839	0.00E+00	1.04E-03	2.08E-03
U-234	2.3440E-03	1,137.419	2,274.839	0.00E+00	2.67E+00	5.33E+00
U-235	-2.3296E-06	1,137.419	0.000	2.67E-03	2.09E-05	2.67E-03
U-236	2.6620E-05	1,137.419	2,274.839	0.00E+00	3.03E-02	6.06E-02
U-238	-1.3291E-07	1,137.419	0.000	2.27E-02	2.25E-02	2.27E-02
Y-90	1.2642E+00	1,137.419	2,274.839	0.00E+00	1.44E+03	2.88E+03
Other Radionuclides					1.55E+03	3.10E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	1.587E+14
0.0250	3.287E+13
0.0375	2.892E+13
0.0575	3.131E+13
0.0850	1.847E+13
0.1250	1.218E+13
0.2250	1.591E+13
0.3750	6.919E+12
0.5750	1.211E+14
0.8500	1.398E+12
1.2500	1.152E+13
1.7500	3.788E+10
2.2500	6.067E+07
2.7500	3.881E+06
3.5000	1.182E+04
5.0000	4.961E+03
7.0000	5.582E+02
11.0000	6.336E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.09E+01	4.18E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ZIRC OR SST	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	1.800011479	0 to 5

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except possibly cladding.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		1,137.419
Bounding:		2,274.839

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.13	
Bounding:	2.27	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: DR-3 (DENMARK)
SNF ID #: 759
Fuel Units & Descr: 375 - 4 CONCENTRIC TUBES
Heavy Metal Mass: BOL=341.66kg ; EOL=309.11kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1997
Estimates as of: 2010
Template: HFBR (Heavy Water, Alum., 10 to 20%, U)
[2]Template Burnup(MWd): 15
Template BOL Heavy Metal Mass (MT): 0.00034251
Template Decay Time: 10 years

Estimated Canister usage:
18"x10'
12.50

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	3.5433E-10	30,937.629	61,875.258	0.00E+00	1.10E-05	2.19E-05
Am-241	1.6993E-02	30,937.629	61,875.258	0.00E+00	5.26E+02	1.05E+03
Am-242m	9.3333E-06	30,937.629	61,875.258	0.00E+00	2.89E-01	5.78E-01
Am-243	6.4067E-06	30,937.629	61,875.258	0.00E+00	1.98E-01	3.96E-01
C-14	2.9653E-08	30,937.629	61,875.258	0.00E+00	9.17E-04	1.83E-03
Cl-36	5.9513E-35	30,937.629	61,875.258	0.00E+00	1.84E-30	3.68E-30
Cm-243	2.8167E-06	30,937.629	61,875.258	0.00E+00	8.71E-02	1.74E-01
Cm-244	1.6140E-04	30,937.629	61,875.258	0.00E+00	4.99E+00	9.99E+00
Co-60	6.0893E-05	30,937.629	61,875.258	0.00E+00	1.88E+00	3.77E+00
Cs-134	6.1567E-02	30,937.629	61,875.258	0.00E+00	1.90E+03	3.81E+03
Cs-135	4.8607E-06	30,937.629	61,875.258	0.00E+00	1.50E-01	3.01E-01
Cs-137	2.5487E+00	30,937.629	61,875.258	0.00E+00	7.88E+04	1.58E+05
Eu-154	4.6760E-02	30,937.629	61,875.258	0.00E+00	1.45E+03	2.89E+03
Eu-155	1.6533E-02	30,937.629	61,875.258	0.00E+00	5.12E+02	1.02E+03
Fe-55	2.0373E-02	30,937.629	61,875.258	0.00E+00	6.30E+02	1.26E+03
H-3	8.1800E-03	30,937.629	61,875.258	0.00E+00	2.53E+02	5.06E+02
I-129	7.1600E-07	30,937.629	61,875.258	0.00E+00	2.22E-02	4.43E-02
Kr-85	1.9547E-01	30,937.629	61,875.258	0.00E+00	6.05E+03	1.21E+04
Np-237	3.6573E-06	30,937.629	61,875.258	0.00E+00	1.13E-01	2.26E-01
Pa-231	1.6420E-09	30,937.629	61,875.258	0.00E+00	5.08E-05	1.02E-04
Pb-210	7.4600E-15	30,937.629	61,875.258	0.00E+00	2.31E-10	4.62E-10
Pm-147	6.5033E-01	30,937.629	61,875.258	0.00E+00	2.01E+04	4.02E+04
Pu-238	5.9807E-03	30,937.629	61,875.258	0.00E+00	1.85E+02	3.70E+02
Pu-239	1.0320E-02	30,937.629	61,875.258	0.00E+00	3.19E+02	6.39E+02
Pu-240	5.4233E-03	30,937.629	61,875.258	0.00E+00	1.68E+02	3.36E+02
Pu-241	6.0807E-01	30,937.629	61,875.258	0.00E+00	1.88E+04	3.76E+04
Pu-242	3.0713E-06	30,937.629	61,875.258	0.00E+00	9.50E-02	1.90E-01
Ra-226	6.1580E-14	30,937.629	61,875.258	0.00E+00	1.91E-09	3.81E-09
Ra-228	4.9953E-15	30,937.629	61,875.258	0.00E+00	1.55E-10	3.09E-10
Ru-106	8.2133E-03	30,937.629	61,875.258	0.00E+00	2.54E+02	5.08E+02
Se-79	1.2540E-05	30,937.629	61,875.258	0.00E+00	3.88E-01	7.76E-01
Sn-126	1.1393E-05	30,937.629	61,875.258	0.00E+00	3.52E-01	7.05E-01
Sr-90	2.3340E+00	30,937.629	61,875.258	0.00E+00	7.22E+04	1.44E+05
Tc-99	4.3540E-04	30,937.629	61,875.258	0.00E+00	1.35E+01	2.69E+01
Th-229	2.4973E-13	30,937.629	61,875.258	0.00E+00	7.73E-09	1.55E-08
Th-230	2.4613E-11	30,937.629	61,875.258	0.00E+00	7.61E-07	1.52E-06
Th-232	9.9467E-15	30,937.629	61,875.258	0.00E+00	3.08E-10	6.15E-10
Tl-208	7.7667E-09	30,937.629	61,875.258	0.00E+00	2.40E-04	4.81E-04
U-232	2.1927E-08	30,937.629	61,875.258	0.00E+00	6.78E-04	1.36E-03
U-233	2.7887E-10	30,937.629	61,875.258	0.00E+00	8.63E-06	1.73E-05
U-234	3.0807E-07	30,937.629	61,875.258	0.00E+00	9.53E-03	1.91E-02
U-235	-2.5341E-06	30,937.629	0.000	1.46E-01	6.75E-02	1.46E-01
U-236	1.3000E-05	30,937.629	61,875.258	0.00E+00	4.02E-01	8.04E-01
U-238	-1.4207E-08	30,937.629	0.000	9.21E-02	9.17E-02	9.21E-02
Y-90	2.3347E+00	30,937.629	61,875.258	0.00E+00	7.22E+04	1.44E+05
Other Radionuclides					7.63E+04	1.53E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	8.068E+15
0.0250	1.697E+15
0.0375	1.487E+15
0.0575	1.574E+15
0.0850	9.482E+14
0.1250	6.576E+14
0.2250	8.142E+14
0.3750	3.650E+14
0.5750	6.082E+15
0.8500	2.321E+14
1.2500	8.419E+13
1.7500	3.252E+12
2.2500	1.966E+11
2.7500	4.211E+09
3.5000	5.289E+08
5.0000	1.484E+05
7.0000	1.687E+04
11.0000	1.924E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.60E+02	1.92E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	19.7578539	10 to 20

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		30,937.629	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		61,875.258	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	2.07	
Bounding:	4.14	

Estimated EOL HM/Given EOL HM
1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: DR-3 (DENMARK)
SNF ID #: 1059
Fuel Units & Descr: 3 - 4 CONCENTRIC TUBES
Heavy Metal Mass: BOL=2.75kg ; EOL=2.52kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1997
Estimates as of: 2010
Template: HFBR (Heavy Water, Alum., 10 to 20%, U)
[2]Template Burnup(MWd): 15
Template BOL Heavy Metal Mass (MT): 0.00034251
Template Decay Time: 10 years

Estimated Canister usage:
18"x10'
0.10

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	3.5433E-10	224.120	448.239	0.00E+00	7.94E-08	1.59E-07
Am-241	1.6993E-02	224.120	448.239	0.00E+00	3.81E+00	7.62E+00
Am-242m	9.3333E-06	224.120	448.239	0.00E+00	2.09E-03	4.18E-03
Am-243	6.4067E-06	224.120	448.239	0.00E+00	1.44E-03	2.87E-03
C-14	2.9653E-08	224.120	448.239	0.00E+00	6.65E-06	1.33E-05
Cl-36	5.9513E-35	224.120	448.239	0.00E+00	1.33E-32	2.67E-32
Cm-243	2.8167E-06	224.120	448.239	0.00E+00	6.31E-04	1.26E-03
Cm-244	1.6140E-04	224.120	448.239	0.00E+00	3.62E-02	7.23E-02
Co-60	6.0893E-05	224.120	448.239	0.00E+00	1.36E-02	2.73E-02
Cs-134	6.1567E-02	224.120	448.239	0.00E+00	1.38E+01	2.76E+01
Cs-135	4.8607E-06	224.120	448.239	0.00E+00	1.09E-03	2.18E-03
Cs-137	2.5487E+00	224.120	448.239	0.00E+00	5.71E+02	1.14E+03
Eu-154	4.6760E-02	224.120	448.239	0.00E+00	1.05E+01	2.10E+01
Eu-155	1.6533E-02	224.120	448.239	0.00E+00	3.71E+00	7.41E+00
Fe-55	2.0373E-02	224.120	448.239	0.00E+00	4.57E+00	9.13E+00
H-3	8.1800E-03	224.120	448.239	0.00E+00	1.83E+00	3.67E+00
I-129	7.1600E-07	224.120	448.239	0.00E+00	1.60E-04	3.21E-04
Kr-85	1.9547E-01	224.120	448.239	0.00E+00	4.38E+01	8.76E+01
Np-237	3.6573E-06	224.120	448.239	0.00E+00	8.20E-04	1.64E-03
Pa-231	1.6420E-09	224.120	448.239	0.00E+00	3.68E-07	7.36E-07
Pb-210	7.4600E-15	224.120	448.239	0.00E+00	1.67E-12	3.34E-12
Pm-147	6.5033E-01	224.120	448.239	0.00E+00	1.46E+02	2.92E+02
Pu-238	5.9807E-03	224.120	448.239	0.00E+00	1.34E+00	2.68E+00
Pu-239	1.0320E-02	224.120	448.239	0.00E+00	2.31E+00	4.63E+00
Pu-240	5.4233E-03	224.120	448.239	0.00E+00	1.22E+00	2.43E+00
Pu-241	6.0807E-01	224.120	448.239	0.00E+00	1.36E+02	2.73E+02
Pu-242	3.0713E-06	224.120	448.239	0.00E+00	6.88E-04	1.38E-03
Ra-226	6.1580E-14	224.120	448.239	0.00E+00	1.38E-11	2.76E-11
Ra-228	4.9953E-15	224.120	448.239	0.00E+00	1.12E-12	2.24E-12
Ru-106	8.2133E-03	224.120	448.239	0.00E+00	1.84E+00	3.68E+00
Se-79	1.2540E-05	224.120	448.239	0.00E+00	2.81E-03	5.62E-03
Sn-126	1.1393E-05	224.120	448.239	0.00E+00	2.55E-03	5.11E-03
Sr-90	2.3340E+00	224.120	448.239	0.00E+00	5.23E+02	1.05E+03
Tc-99	4.3540E-04	224.120	448.239	0.00E+00	9.76E-02	1.95E-01
Th-229	2.4973E-13	224.120	448.239	0.00E+00	5.60E-11	1.12E-10
Th-230	2.4613E-11	224.120	448.239	0.00E+00	5.52E-09	1.10E-08
Th-232	9.9467E-15	224.120	448.239	0.00E+00	2.23E-12	4.46E-12
Tl-208	7.7667E-09	224.120	448.239	0.00E+00	1.74E-06	3.48E-06
U-232	2.1927E-08	224.120	448.239	0.00E+00	4.91E-06	9.83E-06
U-233	2.7887E-10	224.120	448.239	0.00E+00	6.25E-08	1.25E-07
U-234	3.0807E-07	224.120	448.239	0.00E+00	6.90E-05	1.38E-04
U-235	-2.5341E-06	224.120	0.000	1.16E-03	5.97E-04	1.16E-03
U-236	1.3000E-05	224.120	448.239	0.00E+00	2.91E-03	5.83E-03
U-238	-1.4207E-08	224.120	0.000	7.44E-04	7.41E-04	7.44E-04
Y-90	2.3347E+00	224.120	448.239	0.00E+00	5.23E+02	1.05E+03
Other Radionuclides					5.53E+02	1.11E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	5.844E+13
0.0250	1.229E+13
0.0375	1.078E+13
0.0575	1.140E+13
0.0850	6.869E+12
0.1250	4.764E+12
0.2250	5.898E+12
0.3750	2.644E+12
0.5750	4.406E+13
0.8500	1.681E+12
1.2500	6.099E+11
1.7500	2.356E+10
2.2500	1.424E+09
2.7500	3.051E+07
3.5000	3.831E+06
5.0000	1.075E+03
7.0000	1.222E+02
11.0000	1.394E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.96E+00	1.39E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	19.58291238	10 to 20

Basis for Parameter Differences:

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		224.120	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		448.239	Bounding burnup assumed to be twice nominal burnup.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.86	
Bounding:	3.72	

Estimated EOL HM/Given EOL HM
1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	DR-3 (DENMARK)	[1]Fuel decay start date:	1997
SNF ID #:	714	Estimates as of:	2010
Fuel Units & Descr:	88 - 4 CONCENTRIC TUBES	Template:	HFBR (Heavy Water, Alum., 40 to 100%, U)
Heavy Metal Mass:	BOL=14.53kg ; EOL=8.80kg	[2]Template Burnup(MWd):	164.6
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.000377
		Template Decay Time:	10 years

Estimated Canister usage: 18"x10'

2.93

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3262E-10	5,276.815	10,553.630	0.00E+00	7.00E-07	1.40E-06
Am-241	5.9611E-03	5,276.815	10,553.630	0.00E+00	3.15E+01	6.29E+01
Am-242m	1.4332E-06	5,276.815	10,553.630	0.00E+00	7.56E-03	1.51E-02
Am-243	3.7132E-05	5,276.815	10,553.630	0.00E+00	1.96E-01	3.92E-01
C-14	2.6501E-08	5,276.815	10,553.630	0.00E+00	1.40E-04	2.80E-04
Cl-36	4.4441E-31	5,276.815	10,553.630	0.00E+00	2.35E-27	4.69E-27
Cm-243	7.2722E-06	5,276.815	10,553.630	0.00E+00	3.84E-02	7.67E-02
Cm-244	6.8226E-03	5,276.815	10,553.630	0.00E+00	3.60E+01	7.20E+01
Co-60	1.8117E-04	5,276.815	10,553.630	0.00E+00	9.56E-01	1.91E+00
Cs-134	3.0595E-01	5,276.815	10,553.630	0.00E+00	1.61E+03	3.23E+03
Cs-135	4.2564E-06	5,276.815	10,553.630	0.00E+00	2.25E-02	4.49E-02
Cs-137	2.5650E+00	5,276.815	10,553.630	0.00E+00	1.35E+04	2.71E+04
Eu-154	1.1628E-01	5,276.815	10,553.630	0.00E+00	6.14E+02	1.23E+03
Eu-155	5.7776E-02	5,276.815	10,553.630	0.00E+00	3.05E+02	6.10E+02
Fe-55	1.9465E-02	5,276.815	10,553.630	0.00E+00	1.03E+02	2.05E+02
H-3	8.1045E-03	5,276.815	10,553.630	0.00E+00	4.28E+01	8.55E+01
I-129	6.6403E-07	5,276.815	10,553.630	0.00E+00	3.50E-03	7.01E-03
Kr-85	2.0620E-01	5,276.815	10,553.630	0.00E+00	1.09E+03	2.18E+03
Np-237	3.1513E-05	5,276.815	10,553.630	0.00E+00	1.66E-01	3.33E-01
Pa-231	6.0304E-10	5,276.815	10,553.630	0.00E+00	3.18E-06	6.36E-06
Pb-210	2.7017E-12	5,276.815	10,553.630	0.00E+00	1.43E-08	2.85E-08
Pm-147	3.4210E-01	5,276.815	10,553.630	0.00E+00	1.81E+03	3.61E+03
Pu-238	1.6622E-01	5,276.815	10,553.630	0.00E+00	8.77E+02	1.75E+03
Pu-239	6.9563E-04	5,276.815	10,553.630	0.00E+00	3.67E+00	7.34E+00
Pu-240	3.7169E-04	5,276.815	10,553.630	0.00E+00	1.96E+00	3.92E+00
Pu-241	2.1731E-01	5,276.815	10,553.630	0.00E+00	1.15E+03	2.29E+03
Pu-242	3.0911E-06	5,276.815	10,553.630	0.00E+00	1.63E-02	3.26E-02
Ra-226	1.9435E-11	5,276.815	10,553.630	0.00E+00	1.03E-07	2.05E-07
Ra-228	6.1725E-15	5,276.815	10,553.630	0.00E+00	3.26E-11	6.51E-11
Ru-106	7.0778E-03	5,276.815	10,553.630	0.00E+00	3.73E+01	7.47E+01
Se-79	1.2339E-05	5,276.815	10,553.630	0.00E+00	6.51E-02	1.30E-01
Sn-126	1.0194E-05	5,276.815	10,553.630	0.00E+00	5.38E-02	1.08E-01
Sr-90	2.4186E+00	5,276.815	10,553.630	0.00E+00	1.28E+04	2.55E+04
Tc-99	3.8056E-04	5,276.815	10,553.630	0.00E+00	2.01E+00	4.02E+00
Th-229	2.0097E-12	5,276.815	10,553.630	0.00E+00	1.06E-08	2.12E-08
Th-230	6.0577E-09	5,276.815	10,553.630	0.00E+00	3.20E-05	6.39E-05
Th-232	1.2473E-14	5,276.815	10,553.630	0.00E+00	6.58E-11	1.32E-10
Tl-208	4.8791E-08	5,276.815	10,553.630	0.00E+00	2.57E-04	5.15E-04
U-232	1.3821E-07	5,276.815	10,553.630	0.00E+00	7.29E-04	1.46E-03
U-233	2.3906E-09	5,276.815	10,553.630	0.00E+00	1.26E-05	2.52E-05
U-234	4.7697E-05	5,276.815	10,553.630	0.00E+00	2.52E-01	5.03E-01
U-235	-2.8661E-06	5,276.815	0.000	2.79E-02	1.28E-02	2.79E-02
U-236	1.6701E-05	5,276.815	10,553.630	0.00E+00	8.81E-02	1.76E-01
U-238	-9.4194E-09	5,276.815	0.000	5.43E-04	4.94E-04	5.43E-04
Y-90	2.4192E+00	5,276.815	10,553.630	0.00E+00	1.28E+04	2.55E+04
Other Radionuclides					1.32E+04	2.64E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.442E+15
0.0250	3.006E+14
0.0375	2.720E+14
0.0575	2.799E+14
0.0850	1.734E+14
0.1250	1.302E+14
0.2250	1.464E+14
0.3750	6.466E+13
0.5750	1.168E+15
0.8500	1.370E+14
1.2500	3.444E+13
1.7500	9.918E+11
2.2500	4.342E+10
2.7500	6.487E+08
3.5000	7.876E+07
5.0000	4.568E+05
7.0000	5.250E+04
11.0000	6.020E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.08E+02	4.16E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	88.87461392	40 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		5,276.815	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		10,553.630	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.83	
Bounding:	1.66	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	DRCT	[1]Fuel decay start date:	1981
SNF ID #:	756	Estimates as of:	2010
Fuel Units & Descr:	6936 - ROD	Template:	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=15512.36kg ; EOL=15006.04kg	[2]Template Burnup(MWd):	61.92
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.00176911
		Template Decay Time:	25 years

Estimated Canister usage:

18"x15'
8.50

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6376E-10	481,493.979	962,987.957	0.00E+00	3.20E-04	6.39E-04
Am-241	1.3144E-01	481,493.979	962,987.957	0.00E+00	6.33E+04	1.27E+05
Am-242m	3.0039E-04	481,493.979	962,987.957	0.00E+00	1.45E+02	2.89E+02
Am-243	6.2629E-04	481,493.979	962,987.957	0.00E+00	3.02E+02	6.03E+02
C-14	4.7965E-05	481,493.979	962,987.957	0.00E+00	2.31E+01	4.62E+01
Cl-36	8.0297E-07	481,493.979	962,987.957	0.00E+00	3.87E-01	7.73E-01
Cm-243	3.1993E-04	481,493.979	962,987.957	0.00E+00	1.54E+02	3.08E+02
Cm-244	7.1851E-02	481,493.979	962,987.957	0.00E+00	3.46E+04	6.92E+04
Co-60	9.5220E-03	481,493.979	962,987.957	0.00E+00	4.58E+03	9.17E+03
Cs-134	1.1662E-03	481,493.979	962,987.957	0.00E+00	5.62E+02	1.12E+03
Cs-135	1.4433E-05	481,493.979	962,987.957	0.00E+00	6.95E+00	1.39E+01
Cs-137	1.7603E+00	481,493.979	962,987.957	0.00E+00	8.48E+05	1.70E+06
Eu-154	4.5203E-02	481,493.979	962,987.957	0.00E+00	2.18E+04	4.35E+04
Eu-155	7.1479E-03	481,493.979	962,987.957	0.00E+00	3.44E+03	6.88E+03
Fe-55	6.1919E-04	481,493.979	962,987.957	0.00E+00	2.98E+02	5.96E+02
H-3	3.6386E-02	481,493.979	962,987.957	0.00E+00	1.75E+04	3.50E+04
I-129	9.8288E-07	481,493.979	962,987.957	0.00E+00	4.73E-01	9.47E-01
Kr-85	5.3844E-02	481,493.979	962,987.957	0.00E+00	2.59E+04	5.19E+04
Np-237	1.0546E-05	481,493.979	962,987.957	0.00E+00	5.08E+00	1.02E+01
Pa-231	1.1370E-09	481,493.979	962,987.957	0.00E+00	5.47E-04	1.09E-03
Pb-210	3.3624E-11	481,493.979	962,987.957	0.00E+00	1.62E-05	3.24E-05
Pm-147	5.1211E-03	481,493.979	962,987.957	0.00E+00	2.47E+03	4.93E+03
Pu-238	8.0669E-02	481,493.979	962,987.957	0.00E+00	3.88E+04	7.77E+04
Pu-239	1.1626E-02	481,493.979	962,987.957	0.00E+00	5.60E+03	1.12E+04
Pu-240	1.5097E-02	481,493.979	962,987.957	0.00E+00	7.27E+03	1.45E+04
Pu-241	1.4567E+00	481,493.979	962,987.957	0.00E+00	7.01E+05	1.40E+06
Pu-242	6.4260E-05	481,493.979	962,987.957	0.00E+00	3.09E+01	6.19E+01
Ra-226	1.1392E-10	481,493.979	962,987.957	0.00E+00	5.49E-05	1.10E-04
Ra-228	5.1841E-12	481,493.979	962,987.957	0.00E+00	2.50E-06	4.99E-06
Ru-106	5.9012E-07	481,493.979	962,987.957	0.00E+00	2.84E-01	5.68E-01
Se-79	1.2379E-05	481,493.979	962,987.957	0.00E+00	5.96E+00	1.19E+01
Sn-126	2.5210E-05	481,493.979	962,987.957	0.00E+00	1.21E+01	2.43E+01
Sr-90	1.1630E+00	481,493.979	962,987.957	0.00E+00	5.60E+05	1.12E+06
Tc-99	3.9357E-04	481,493.979	962,987.957	0.00E+00	1.90E+02	3.79E+02
Th-229	8.5691E-11	481,493.979	962,987.957	0.00E+00	4.13E-05	8.25E-05
Th-230	1.4493E-08	481,493.979	962,987.957	0.00E+00	6.98E-03	1.40E-02
Th-232	5.2923E-12	481,493.979	962,987.957	0.00E+00	2.55E-06	5.10E-06
Tl-208	1.9202E-07	481,493.979	962,987.957	0.00E+00	9.25E-02	1.85E-01
U-232	5.2083E-07	481,493.979	962,987.957	0.00E+00	2.51E-01	5.02E-01
U-233	2.4386E-08	481,493.979	962,987.957	0.00E+00	1.17E-02	2.35E-02
U-234	4.7012E-05	481,493.979	962,987.957	0.00E+00	2.26E+01	4.53E+01
U-235	-1.4492E-06	481,493.979	0.000	9.81E-01	2.83E-01	9.81E-01
U-236	7.5759E-06	481,493.979	962,987.957	0.00E+00	3.65E+00	7.30E+00
U-238	-2.6129E-07	481,493.979	0.000	5.06E+00	4.94E+00	5.06E+00
Y-90	1.1631E+00	481,493.979	962,987.957	0.00E+00	5.60E+05	1.12E+06
Other Radionuclides					8.13E+05	1.63E+06

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.549E+16
0.0250	1.326E+16
0.0375	1.284E+16
0.0575	1.400E+16
0.0850	7.420E+15
0.1250	5.420E+15
0.2250	6.370E+15
0.3750	2.733E+15
0.5750	6.280E+16
0.8500	1.240E+15
1.2500	1.675E+15
1.7500	3.669E+13
2.2500	6.777E+09
2.7500	7.616E+09
3.5000	9.982E+08
5.0000	4.265E+08
7.0000	4.917E+07
11.0000	5.648E+06

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.32E+04	2.64E+04
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-4	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	2.925317534	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	454,977.636	481,493.979
Bounding:	549,758.180	962,987.957

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.

Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.89	1.06
Bounding:	1.77	1.75

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	DRCT	**[1]Fuel decay start date:**	1981
SNF ID #:	701	**Estimates as of:**	2010
Fuel Units & Descr:	2856 - ROD	**Template:**	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=6338.89kg ; EOL=6144.97kg	**[2]Template Burnup(MWd):**	61.92
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.00176911
		Template Decay Time:	25 years

Estimated Canister usage: **18"x15'** 3.50

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	6.6376E-10	185,919.702	368,822.060	0.00E+00	1.23E-04	2.45E-04
Am-241	1.3144E-01	185,919.702	368,822.060	0.00E+00	2.44E+04	4.85E+04
Am-242m	3.0039E-04	185,919.702	368,822.060	0.00E+00	5.58E+01	1.11E+02
Am-243	6.2629E-04	185,919.702	368,822.060	0.00E+00	1.16E+02	2.31E+02
C-14	4.7965E-05	185,919.702	368,822.060	0.00E+00	8.92E+00	1.77E+01
Cl-36	8.0297E-07	185,919.702	368,822.060	0.00E+00	1.49E-01	2.96E-01
Cm-243	3.1993E-04	185,919.702	368,822.060	0.00E+00	5.95E+01	1.18E+02
Cm-244	7.1851E-02	185,919.702	368,822.060	0.00E+00	1.34E+04	2.65E+04
Co-60	9.5220E-03	185,919.702	368,822.060	0.00E+00	1.77E+03	3.51E+03
Cs-134	1.1662E-03	185,919.702	368,822.060	0.00E+00	2.17E+02	4.30E+02
Cs-135	1.4433E-05	185,919.702	368,822.060	0.00E+00	2.68E+00	5.32E+00
Cs-137	1.7603E+00	185,919.702	368,822.060	0.00E+00	3.27E+05	6.49E+05
Eu-154	4.5203E-02	185,919.702	368,822.060	0.00E+00	8.40E+03	1.67E+04
Eu-155	7.1479E-03	185,919.702	368,822.060	0.00E+00	1.33E+03	2.64E+03
Fe-55	6.1919E-04	185,919.702	368,822.060	0.00E+00	1.15E+02	2.28E+02
H-3	3.6386E-02	185,919.702	368,822.060	0.00E+00	6.76E+03	1.34E+04
I-129	9.8288E-07	185,919.702	368,822.060	0.00E+00	1.83E-01	3.63E-01
Kr-85	5.3844E-02	185,919.702	368,822.060	0.00E+00	1.00E+04	1.99E+04
Np-237	1.0546E-05	185,919.702	368,822.060	0.00E+00	1.96E+00	3.89E+00
Pa-231	1.1370E-09	185,919.702	368,822.060	0.00E+00	2.11E-04	4.19E-04
Pb-210	3.3624E-11	185,919.702	368,822.060	0.00E+00	6.25E-06	1.24E-05
Pm-147	5.1211E-03	185,919.702	368,822.060	0.00E+00	9.52E+02	1.89E+03
Pu-238	8.0669E-02	185,919.702	368,822.060	0.00E+00	1.50E+04	2.98E+04
Pu-239	1.1626E-02	185,919.702	368,822.060	0.00E+00	2.16E+03	4.29E+03
Pu-240	1.5097E-02	185,919.702	368,822.060	0.00E+00	2.81E+03	5.57E+03
Pu-241	1.4567E+00	185,919.702	368,822.060	0.00E+00	2.71E+05	5.37E+05
Pu-242	6.4260E-05	185,919.702	368,822.060	0.00E+00	1.19E+01	2.37E+01
Ra-226	1.1392E-10	185,919.702	368,822.060	0.00E+00	2.12E-05	4.20E-05
Ra-228	5.1841E-12	185,919.702	368,822.060	0.00E+00	9.64E-07	1.91E-06
Ru-106	5.9012E-07	185,919.702	368,822.060	0.00E+00	1.10E-01	2.18E-01
Se-79	1.2379E-05	185,919.702	368,822.060	0.00E+00	2.30E+00	4.57E+00
Sn-126	2.5210E-05	185,919.702	368,822.060	0.00E+00	4.69E+00	9.30E+00
Sr-90	1.1630E+00	185,919.702	368,822.060	0.00E+00	2.16E+05	4.29E+05
Tc-99	3.9357E-04	185,919.702	368,822.060	0.00E+00	7.32E+01	1.45E+02
Th-229	8.5691E-11	185,919.702	368,822.060	0.00E+00	1.59E-05	3.16E-05
Th-230	1.4493E-08	185,919.702	368,822.060	0.00E+00	2.69E-03	5.35E-03
Th-232	5.2923E-12	185,919.702	368,822.060	0.00E+00	9.84E-07	1.95E-06
Tl-208	1.9202E-07	185,919.702	368,822.060	0.00E+00	3.57E-02	7.08E-02
U-232	5.2083E-07	185,919.702	368,822.060	0.00E+00	9.68E-02	1.92E-01
U-233	2.4386E-08	185,919.702	368,822.060	0.00E+00	4.53E-03	8.99E-03
U-234	4.7012E-05	185,919.702	368,822.060	0.00E+00	8.74E+00	1.73E+01
U-235	-1.4492E-06	185,919.702	0.000	3.60E-01	9.10E-02	3.60E-01
U-236	7.5759E-06	185,919.702	368,822.060	0.00E+00	1.41E+00	2.79E+00
U-238	-2.6129E-07	185,919.702	0.000	2.07E+00	2.03E+00	2.07E+00
Y-90	1.1631E+00	185,919.702	368,822.060	0.00E+00	2.16E+05	4.29E+05
Other Radionuclides					3.14E+05	6.23E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.508E+16
0.0250	5.080E+15
0.0375	4.916E+15
0.0575	5.363E+15
0.0850	2.842E+15
0.1250	2.076E+15
0.2250	2.440E+15
0.3750	1.047E+15
0.5750	2.405E+16
0.8500	4.747E+14
1.2500	6.413E+14
1.7500	1.405E+13
2.2500	2.596E+09
2.7500	2.917E+09
3.5000	3.823E+08
5.0000	1.634E+08
7.0000	1.883E+07
11.0000	2.163E+06

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.10E+03	1.01E+04
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-4	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	2.631414612	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	185,919.702	184,411.030	Nominal burnup taken directly from SFD (converted to MWd).
Bounding:	224,650.332	368,822.060	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.84	0.99
Bounding:	1.66	1.64

Estimated EOL HM/Given EOL HM 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: DRESDEN I
SNF ID #: 44
Fuel Units & Descr: 34 - ASSEMBLY
Heavy Metal Mass: BOL= ; EOL=2544.90kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1966
Estimates as of: 2010
Template: LWBR (Light Water, Zirc, 60 to 100%, Th and U)
[2]**Template Burnup(MWd):** 10269.14
Template BOL Heavy Metal Mass (MT): 0.45991251
Template Decay Time: 35 years

Estimated Canister usage:
18"x15'
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	9.7360E-05	30,137.665	60,275.329	0.00E+00	2.93E+00	5.87E+00
Am-241	2.4345E-04	30,137.665	60,275.329	0.00E+00	7.34E+00	1.47E+01
Am-242m	1.4821E-06	30,137.665	60,275.329	0.00E+00	4.47E-02	8.93E-02
Am-243	3.1152E-07	30,137.665	60,275.329	0.00E+00	9.39E-03	1.88E-02
C-14	9.2432E-05	30,137.665	60,275.329	0.00E+00	2.79E+00	5.57E+00
Cl-36	1.8103E-06	30,137.665	60,275.329	0.00E+00	5.46E-02	1.09E-01
Cm-243	3.0597E-07	30,137.665	60,275.329	0.00E+00	9.22E-03	1.84E-02
Cm-244	1.4149E-05	30,137.665	60,275.329	0.00E+00	4.26E-01	8.53E-01
Co-60	8.7369E-04	30,137.665	60,275.329	0.00E+00	2.63E+01	5.27E+01
Cs-134	2.5601E-05	30,137.665	60,275.329	0.00E+00	7.72E-01	1.54E+00
Cs-135	2.8639E-05	30,137.665	60,275.329	0.00E+00	8.63E-01	1.73E+00
Cs-137	1.4772E+00	30,137.665	60,275.329	0.00E+00	4.45E+04	8.90E+04
Eu-154	8.6025E-03	30,137.665	60,275.329	0.00E+00	2.59E+02	5.19E+02
Eu-155	6.6062E-04	30,137.665	60,275.329	0.00E+00	1.99E+01	3.98E+01
Fe-55	2.3011E-06	30,137.665	60,275.329	0.00E+00	6.93E-02	1.39E-01
H-3	2.1277E-03	30,137.665	60,275.329	0.00E+00	6.41E+01	1.28E+02
I-129	1.5853E-06	30,137.665	60,275.329	0.00E+00	4.78E-02	9.56E-02
Kr-85	6.2625E-02	30,137.665	60,275.329	0.00E+00	1.89E+03	3.77E+03
Np-237	1.2620E-07	30,137.665	60,275.329	0.00E+00	3.80E-03	7.61E-03
Pa-231	1.2017E-04	30,137.665	60,275.329	0.00E+00	3.62E+00	7.24E+00
Pb-210	1.4247E-08	30,137.665	60,275.329	0.00E+00	4.29E-04	8.59E-04
Pm-147	2.6224E-04	30,137.665	60,275.329	0.00E+00	7.90E+00	1.58E+01
Pu-238	4.2477E-04	30,137.665	60,275.329	0.00E+00	1.28E+01	2.56E+01
Pu-239	2.7519E-05	30,137.665	60,275.329	0.00E+00	8.29E-01	1.66E+00
Pu-240	1.6184E-05	30,137.665	60,275.329	0.00E+00	4.88E-01	9.76E-01
Pu-241	1.4695E-03	30,137.665	60,275.329	0.00E+00	4.43E+01	8.86E+01
Pu-242	4.0831E-08	30,137.665	60,275.329	0.00E+00	1.23E-03	2.46E-03
Ra-226	2.1423E-08	30,137.665	60,275.329	0.00E+00	6.46E-04	1.29E-03
Ra-228	4.6236E-06	30,137.665	60,275.329	0.00E+00	1.39E-01	2.79E-01
Ru-106	4.0208E-11	30,137.665	60,275.329	0.00E+00	1.21E-06	2.42E-06
Se-79	3.5417E-05	30,137.665	60,275.329	0.00E+00	1.07E+00	2.13E+00
Sn-126	3.9848E-05	30,137.665	60,275.329	0.00E+00	1.20E+00	2.40E+00
Sr-90	1.4928E+00	30,137.665	60,275.329	0.00E+00	4.50E+04	9.00E+04
Tc-99	3.2525E-04	30,137.665	60,275.329	0.00E+00	9.80E+00	1.96E+01
Th-229	6.4582E-05	30,137.665	60,275.329	0.00E+00	1.95E+00	3.89E+00
Th-230	1.1432E-06	30,137.665	60,275.329	0.00E+00	3.45E-02	6.89E-02
Th-232	-9.0328E-08	30,137.665	0.000	2.72E-01	2.69E-01	2.72E-01
Tl-208	1.3964E-02	30,137.665	60,275.329	0.00E+00	4.21E+02	8.42E+02
U-232	3.7822E-02	30,137.665	60,275.329	0.00E+00	1.14E+03	2.28E+03
U-233	-3.3244E-03	30,137.665	0.000	9.15E+02	8.15E+02	9.15E+02
U-234	8.1769E-04	30,137.665	60,275.329	0.00E+00	2.46E+01	4.93E+01
U-235	5.7813E-08	30,137.665	60,275.329	1.87E-04	1.93E-03	3.67E-03
U-236	1.3273E-07	30,137.665	60,275.329	0.00E+00	4.00E-03	8.00E-03
U-238	-3.1121E-10	30,137.665	0.000	1.20E-04	1.10E-04	1.20E-04
Y-90	1.4928E+00	30,137.665	60,275.329	0.00E+00	4.50E+04	9.00E+04
Other Radionuclides					5.03E+04	1.01E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.971E+15
0.0250	1.024E+15
0.0375	8.752E+14
0.0575	9.566E+14
0.0850	6.110E+14
0.1250	3.829E+14
0.2250	5.479E+14
0.3750	2.200E+14
0.5750	3.360E+15
0.8500	6.003E+13
1.2500	2.652E+13
1.7500	4.137E+12
2.2500	1.202E+08
2.7500	2.955E+13
3.5000	1.113E+05
5.0000	3.488E+04
7.0000	2.550E+03
11.0000	1.952E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.27E+02	1.63E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	SST (304)	ZIRC
BOL HM Constituents:	ThO2-UO2	Th and U
BOL Enrichment %:		60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except cladding and enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		30,137.665
Bounding:		60,275.329

Basis for burnup used in estimate:

Nominal burnup taken from SFD and converted to MWd using BOL=2575.869kg
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.52	
Bounding:	1.05	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: DRESDEN I (E00161)
SNF ID #: 928
Fuel Units & Descr: 1 - 6 X 6 ROD ARRAY
Heavy Metal Mass: BOL=111.50kg ; EOL=109.85kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1973
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]Template Burnup(MWd): 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage:
BWR
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	1,566.219	3,132.438	0.00E+00	1.37E-06	2.75E-06
Am-241	1.4352E-01	1,566.219	3,132.438	0.00E+00	2.25E+02	4.50E+02
Am-242m	2.8698E-04	1,566.219	3,132.438	0.00E+00	4.49E-01	8.99E-01
Am-243	6.2565E-04	1,566.219	3,132.438	0.00E+00	9.80E-01	1.96E+00
C-14	4.7901E-05	1,566.219	3,132.438	0.00E+00	7.50E-02	1.50E-01
Cl-36	8.0297E-07	1,566.219	3,132.438	0.00E+00	1.26E-03	2.52E-03
Cm-243	2.5081E-04	1,566.219	3,132.438	0.00E+00	3.93E-01	7.86E-01
Cm-244	4.9015E-02	1,566.219	3,132.438	0.00E+00	7.68E+01	1.54E+02
Co-60	2.5581E-03	1,566.219	3,132.438	0.00E+00	4.01E+00	8.01E+00
Cs-134	4.0536E-05	1,566.219	3,132.438	0.00E+00	6.35E-02	1.27E-01
Cs-135	1.4433E-05	1,566.219	3,132.438	0.00E+00	2.26E-02	4.52E-02
Cs-137	1.3979E+00	1,566.219	3,132.438	0.00E+00	2.19E+03	4.38E+03
Eu-154	2.0203E-02	1,566.219	3,132.438	0.00E+00	3.16E+01	6.33E+01
Eu-155	1.7684E-03	1,566.219	3,132.438	0.00E+00	2.77E+00	5.54E+00
Fe-55	4.3136E-05	1,566.219	3,132.438	0.00E+00	6.76E-02	1.35E-01
H-3	2.0769E-02	1,566.219	3,132.438	0.00E+00	3.25E+01	6.51E+01
I-129	9.8288E-07	1,566.219	3,132.438	0.00E+00	1.54E-03	3.08E-03
Kr-85	2.8214E-02	1,566.219	3,132.438	0.00E+00	4.42E+01	8.84E+01
Np-237	1.1218E-05	1,566.219	3,132.438	0.00E+00	1.76E-02	3.51E-02
Pa-231	1.3036E-09	1,566.219	3,132.438	0.00E+00	2.04E-06	4.08E-06
Pb-210	8.5078E-11	1,566.219	3,132.438	0.00E+00	1.33E-07	2.67E-07
Pm-147	3.6531E-04	1,566.219	3,132.438	0.00E+00	5.72E-01	1.14E+00
Pu-238	7.4564E-02	1,566.219	3,132.438	0.00E+00	1.17E+02	2.34E+02
Pu-239	1.1623E-02	1,566.219	3,132.438	0.00E+00	1.82E+01	3.64E+01
Pu-240	1.5132E-02	1,566.219	3,132.438	0.00E+00	2.37E+01	4.74E+01
Pu-241	9.0036E-01	1,566.219	3,132.438	0.00E+00	1.41E+03	2.82E+03
Pu-242	6.4260E-05	1,566.219	3,132.438	0.00E+00	1.01E-01	2.01E-01
Ra-226	2.2804E-10	1,566.219	3,132.438	0.00E+00	3.57E-07	7.14E-07
Ra-228	5.2713E-12	1,566.219	3,132.438	0.00E+00	8.26E-09	1.65E-08
Ru-106	6.1160E-10	1,566.219	3,132.438	0.00E+00	9.58E-07	1.92E-06
Se-79	1.2377E-05	1,566.219	3,132.438	0.00E+00	1.94E-02	3.88E-02
Sn-126	2.5210E-05	1,566.219	3,132.438	0.00E+00	3.95E-02	7.90E-02
Sr-90	9.1667E-01	1,566.219	3,132.438	0.00E+00	1.44E+03	2.87E+03
Tc-99	3.9357E-04	1,566.219	3,132.438	0.00E+00	6.16E-01	1.23E+00
Th-229	1.2057E-10	1,566.219	3,132.438	0.00E+00	1.89E-07	3.78E-07
Th-230	2.1043E-08	1,566.219	3,132.438	0.00E+00	3.30E-05	6.59E-05
Th-232	5.2972E-12	1,566.219	3,132.438	0.00E+00	8.30E-09	1.66E-08
Tl-208	1.7474E-07	1,566.219	3,132.438	0.00E+00	2.74E-04	5.47E-04
U-232	4.7368E-07	1,566.219	3,132.438	0.00E+00	7.42E-04	1.48E-03
U-233	2.5097E-08	1,566.219	3,132.438	0.00E+00	3.93E-05	7.86E-05
U-234	5.0000E-05	1,566.219	3,132.438	0.00E+00	7.83E-02	1.57E-01
U-235	-1.4489E-06	1,566.219	0.000	3.62E-03	1.35E-03	3.62E-03
U-236	7.5824E-06	1,566.219	3,132.438	0.00E+00	1.19E-02	2.38E-02
U-238	-2.6129E-07	1,566.219	0.000	3.69E-02	3.65E-02	3.69E-02
Y-90	9.1699E-01	1,566.219	3,132.438	0.00E+00	1.44E+03	2.87E+03
Other Radionuclides					2.10E+03	4.20E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.685E+14
0.0250	3.399E+13
0.0375	3.242E+13
0.0575	3.745E+13
0.0850	1.886E+13
0.1250	1.309E+13
0.2250	1.617E+13
0.3750	6.953E+12
0.5750	1.617E+14
0.8500	2.237E+12
1.2500	2.198E+12
1.7500	6.583E+10
2.2500	1.060E+07
2.7500	2.171E+07
3.5000	2.236E+06
5.0000	9.559E+05
7.0000	1.102E+05
11.0000	1.265E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.60E+01	7.21E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	1.50044843	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	1,533.125	1,566.219	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		3,132.438	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.40	1.02
Bounding:	0.80	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: DRESDEN I (UN0064)
SNF ID #: 47
Fuel Units & Descr: 1 - 6 X 6 ROD ARRAY
Heavy Metal Mass: BOL=58.85kg ; EOL=57.28kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1973
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]Template Burnup(MWd): 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage:

BWR
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	1,489.192	2,978.384	0.00E+00	1.31E-06	2.61E-06
Am-241	1.4352E-01	1,489.192	2,978.384	0.00E+00	2.14E+02	4.27E+02
Am-242m	2.8698E-04	1,489.192	2,978.384	0.00E+00	4.27E-01	8.55E-01
Am-243	6.2565E-04	1,489.192	2,978.384	0.00E+00	9.32E-01	1.86E+00
C-14	4.7901E-05	1,489.192	2,978.384	0.00E+00	7.13E-02	1.43E-01
Cl-36	8.0297E-07	1,489.192	2,978.384	0.00E+00	1.20E-03	2.39E-03
Cm-243	2.5081E-04	1,489.192	2,978.384	0.00E+00	3.74E-01	7.47E-01
Cm-244	4.9015E-02	1,489.192	2,978.384	0.00E+00	7.30E+01	1.46E+02
Co-60	2.5581E-03	1,489.192	2,978.384	0.00E+00	3.81E+00	7.62E+00
Cs-134	4.0536E-05	1,489.192	2,978.384	0.00E+00	6.04E-02	1.21E-01
Cs-135	1.4433E-05	1,489.192	2,978.384	0.00E+00	2.15E-02	4.30E-02
Cs-137	1.3979E+00	1,489.192	2,978.384	0.00E+00	2.08E+03	4.16E+03
Eu-154	2.0203E-02	1,489.192	2,978.384	0.00E+00	3.01E+01	6.02E+01
Eu-155	1.7684E-03	1,489.192	2,978.384	0.00E+00	2.63E+00	5.27E+00
Fe-55	4.3136E-05	1,489.192	2,978.384	0.00E+00	6.42E-02	1.28E-01
H-3	2.0769E-02	1,489.192	2,978.384	0.00E+00	3.09E+01	6.19E+01
I-129	9.8288E-07	1,489.192	2,978.384	0.00E+00	1.46E-03	2.93E-03
Kr-85	2.8214E-02	1,489.192	2,978.384	0.00E+00	4.20E+01	8.40E+01
Np-237	1.1218E-05	1,489.192	2,978.384	0.00E+00	1.67E-02	3.34E-02
Pa-231	1.3036E-09	1,489.192	2,978.384	0.00E+00	1.94E-06	3.88E-06
Pb-210	8.5078E-11	1,489.192	2,978.384	0.00E+00	1.27E-07	2.53E-07
Pm-147	3.6531E-04	1,489.192	2,978.384	0.00E+00	5.44E-01	1.09E+00
Pu-238	7.4564E-02	1,489.192	2,978.384	0.00E+00	1.11E+02	2.22E+02
Pu-239	1.1623E-02	1,489.192	2,978.384	0.00E+00	1.73E+01	3.46E+01
Pu-240	1.5132E-02	1,489.192	2,978.384	0.00E+00	2.25E+01	4.51E+01
Pu-241	9.0036E-01	1,489.192	2,978.384	0.00E+00	1.34E+03	2.68E+03
Pu-242	6.4260E-05	1,489.192	2,978.384	0.00E+00	9.57E-02	1.91E-01
Ra-226	2.2804E-10	1,489.192	2,978.384	0.00E+00	3.40E-07	6.79E-07
Ra-228	5.2713E-12	1,489.192	2,978.384	0.00E+00	7.85E-09	1.57E-08
Ru-106	6.1160E-10	1,489.192	2,978.384	0.00E+00	9.11E-07	1.82E-06
Se-79	1.2377E-05	1,489.192	2,978.384	0.00E+00	1.84E-02	3.69E-02
Sn-126	2.5210E-05	1,489.192	2,978.384	0.00E+00	3.75E-02	7.51E-02
Sr-90	9.1667E-01	1,489.192	2,978.384	0.00E+00	1.37E+03	2.73E+03
Tc-99	3.9357E-04	1,489.192	2,978.384	0.00E+00	5.86E-01	1.17E+00
Th-229	1.2057E-10	1,489.192	2,978.384	0.00E+00	1.80E-07	3.59E-07
Th-230	2.1043E-08	1,489.192	2,978.384	0.00E+00	3.13E-05	6.27E-05
Th-232	5.2972E-12	1,489.192	2,978.384	0.00E+00	7.89E-09	1.58E-08
Tl-208	1.7474E-07	1,489.192	2,978.384	0.00E+00	2.60E-04	5.20E-04
U-232	4.7368E-07	1,489.192	2,978.384	0.00E+00	7.05E-04	1.41E-03
U-233	2.5097E-08	1,489.192	2,978.384	0.00E+00	3.74E-05	7.47E-05
U-234	5.0000E-05	1,489.192	2,978.384	0.00E+00	7.45E-02	1.49E-01
U-235	-1.4489E-06	1,489.192	0.000	1.91E-03	0.00E+00	1.91E-03
U-236	7.5824E-06	1,489.192	2,978.384	0.00E+00	1.13E-02	2.26E-02
U-238	-2.6129E-07	1,489.192	0.000	1.95E-02	1.91E-02	1.95E-02
Y-90	9.1699E-01	1,489.192	2,978.384	0.00E+00	1.37E+03	2.73E+03
Other Radionuclides					2.00E+03	4.00E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.603E+14
0.0250	3.232E+13
0.0375	3.082E+13
0.0575	3.561E+13
0.0850	1.793E+13
0.1250	1.244E+13
0.2250	1.538E+13
0.3750	6.611E+12
0.5750	1.538E+14
0.8500	2.127E+12
1.2500	2.090E+12
1.7500	6.259E+10
2.2500	1.008E+07
2.7500	2.064E+07
3.5000	2.126E+06
5.0000	9.089E+05
7.0000	1.048E+05
11.0000	1.203E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.43E+01	6.85E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	1.5005013	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	823.858	1,489.192
Bounding:		2,978.384

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.72	1.81
Bounding:	1.45	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: DRESII, HBR, BR-3, BRP, TMI
SNF ID #: 50
Fuel Units & Descr: 1 - CANISTER OF SCRAP
Heavy Metal Mass: BOL= ; EOL=19.53kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1979
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]**Template Burnup(MWd):** 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 25 years

Estimated Canister usage:
HIC
1.00

II. Estimates	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	6.6376E-10	815.377	815.377	0.00E+00	5.41E-07	5.41E-07
Am-241	1.3144E-01	815.377	815.377	0.00E+00	1.07E+02	1.07E+02
Am-242m	3.0039E-04	815.377	815.377	0.00E+00	2.45E-01	2.45E-01
Am-243	6.2629E-04	815.377	815.377	0.00E+00	5.11E-01	5.11E-01
C-14	4.7965E-05	815.377	815.377	0.00E+00	3.91E-02	3.91E-02
Cl-36	8.0297E-07	815.377	815.377	0.00E+00	6.55E-04	6.55E-04
Cm-243	3.1993E-04	815.377	815.377	0.00E+00	2.61E-01	2.61E-01
Cm-244	7.1851E-02	815.377	815.377	0.00E+00	5.86E+01	5.86E+01
Co-60	9.5220E-03	815.377	815.377	0.00E+00	7.76E+00	7.76E+00
Cs-134	1.1662E-03	815.377	815.377	0.00E+00	9.51E-01	9.51E-01
Cs-135	1.4433E-05	815.377	815.377	0.00E+00	1.18E-02	1.18E-02
Cs-137	1.7603E+00	815.377	815.377	0.00E+00	1.44E+03	1.44E+03
Eu-154	4.5203E-02	815.377	815.377	0.00E+00	3.69E+01	3.69E+01
Eu-155	7.1479E-03	815.377	815.377	0.00E+00	5.83E+00	5.83E+00
Fe-55	6.1919E-04	815.377	815.377	0.00E+00	5.05E-01	5.05E-01
H-3	3.6386E-02	815.377	815.377	0.00E+00	2.97E+01	2.97E+01
I-129	9.8288E-07	815.377	815.377	0.00E+00	8.01E-04	8.01E-04
Kr-85	5.3844E-02	815.377	815.377	0.00E+00	4.39E+01	4.39E+01
Np-237	1.0546E-05	815.377	815.377	0.00E+00	8.60E-03	8.60E-03
Pa-231	1.1370E-09	815.377	815.377	0.00E+00	9.27E-07	9.27E-07
Pb-210	3.3624E-11	815.377	815.377	0.00E+00	2.74E-08	2.74E-08
Pm-147	5.1211E-03	815.377	815.377	0.00E+00	4.18E+00	4.18E+00
Pu-238	8.0669E-02	815.377	815.377	0.00E+00	6.58E+01	6.58E+01
Pu-239	1.1626E-02	815.377	815.377	0.00E+00	9.48E+00	9.48E+00
Pu-240	1.5097E-02	815.377	815.377	0.00E+00	1.23E+01	1.23E+01
Pu-241	1.4567E+00	815.377	815.377	0.00E+00	1.19E+03	1.19E+03
Pu-242	6.4260E-05	815.377	815.377	0.00E+00	5.24E-02	5.24E-02
Ra-226	1.1392E-10	815.377	815.377	0.00E+00	9.29E-08	9.29E-08
Ra-228	5.1841E-12	815.377	815.377	0.00E+00	4.23E-09	4.23E-09
Ru-106	5.9012E-07	815.377	815.377	0.00E+00	4.81E-04	4.81E-04
Se-79	1.2379E-05	815.377	815.377	0.00E+00	1.01E-02	1.01E-02
Sn-126	2.5210E-05	815.377	815.377	0.00E+00	2.06E-02	2.06E-02
Sr-90	1.1630E+00	815.377	815.377	0.00E+00	9.48E+02	9.48E+02
Tc-99	3.9357E-04	815.377	815.377	0.00E+00	3.21E-01	3.21E-01
Th-229	8.5691E-11	815.377	815.377	0.00E+00	6.99E-08	6.99E-08
Th-230	1.4493E-08	815.377	815.377	0.00E+00	1.18E-05	1.18E-05
Th-232	5.2923E-12	815.377	815.377	0.00E+00	4.32E-09	4.32E-09
Tl-208	1.9202E-07	815.377	815.377	0.00E+00	1.57E-04	1.57E-04
U-232	5.2083E-07	815.377	815.377	0.00E+00	4.25E-04	4.25E-04
U-233	2.4386E-08	815.377	815.377	0.00E+00	1.99E-05	1.99E-05
U-234	4.7012E-05	815.377	815.377	0.00E+00	3.83E-02	3.83E-02
U-235	-1.4492E-06	815.377	0.000	1.41E-03	2.28E-04	1.41E-03
U-236	7.5759E-06	815.377	815.377	0.00E+00	6.18E-03	6.18E-03
U-238	-2.6129E-07	815.377	0.000	6.63E-03	6.42E-03	6.63E-03
Y-90	1.1631E+00	815.377	815.377	0.00E+00	9.48E+02	9.48E+02
Other Radionuclides					1.38E+03	1.38E+03

Gamma Sources	
Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	5.545E+13
0.0250	1.123E+13
0.0375	1.087E+13
0.0575	1.186E+13
0.0850	6.283E+12
0.1250	4.589E+12
0.2250	5.393E+12
0.3750	2.314E+12
0.5750	5.318E+13
0.8500	1.050E+12
1.2500	1.418E+12
1.7500	3.107E+10
2.2500	5.738E+06
2.7500	6.448E+06
3.5000	8.452E+05
5.0000	3.612E+05
7.0000	4.164E+04
11.0000	4.783E+03

Thermal Power	
Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.24E+01	2.24E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:		0 to 5

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]	From SFD	Estimated
Nominal:		815.377
Bounding:		815.377

Basis for burnup used in estimate:
Nominal burnup set equal to bounding burnup.
Bounding burnup taken from SFD and converted to MWd using BOL=20.384kg

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.14	
Bounding:	1.14	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	EBR-II & TREAT EXPERIMENTS	**[1]Fuel decay start date:**	1979
SNF ID #:	858	**Estimates as of:**	2010
Fuel Units & Descr:	1 - CANISTER OF SCRAP	**Template:**	FFTF (FAST, SST, 10 to 30%, Pu & U)
Heavy Metal Mass:	BOL= ; EOL=17.84kg	**[2]Template Burnup(MWd):**	5011.2
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.0329181
		Template Decay Time:	25 years

Estimated Canister usage:

HIC
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	3.4503E-12	2,666.340	2,666.340	0.00E+00	9.20E-09	9.20E-09
Am-241	9.5092E-02	2,666.340	2,666.340	3.95E+01	2.93E+02	2.93E+02
Am-242m	2.0115E-03	2,666.340	2,666.340	0.00E+00	5.36E+00	5.36E+00
Am-243	1.0750E-04	2,666.340	2,666.340	0.00E+00	2.87E-01	2.87E-01
C-14	2.6102E-05	2,666.340	2,666.340	0.00E+00	6.96E-02	6.96E-02
Cl-36	3.4243E-10	2,666.340	2,666.340	0.00E+00	9.13E-07	9.13E-07
Cm-243	5.1824E-04	2,666.340	2,666.340	0.00E+00	1.38E+00	1.38E+00
Cm-244	2.1572E-03	2,666.340	2,666.340	0.00E+00	5.75E+00	5.75E+00
Co-60	5.6254E-03	2,666.340	2,666.340	0.00E+00	1.50E+01	1.50E+01
Cs-134	2.5942E-03	2,666.340	2,666.340	0.00E+00	6.92E+00	6.92E+00
Cs-135	4.7693E-05	2,666.340	2,666.340	0.00E+00	1.27E-01	1.27E-01
Cs-137	1.7122E+00	2,666.340	2,666.340	0.00E+00	4.57E+03	4.57E+03
Eu-154	2.5223E-02	2,666.340	2,666.340	0.00E+00	6.73E+01	6.73E+01
Eu-155	2.2689E-02	2,666.340	2,666.340	0.00E+00	6.05E+01	6.05E+01
Fe-55	6.3358E-04	2,666.340	2,666.340	0.00E+00	1.69E+00	1.69E+00
H-3	5.6054E-03	2,666.340	2,666.340	0.00E+00	1.49E+01	1.49E+01
I-129	1.2891E-06	2,666.340	2,666.340	0.00E+00	3.44E-03	3.44E-03
Kr-85	4.1746E-02	2,666.340	2,666.340	0.00E+00	1.11E+02	1.11E+02
Np-237	3.2028E-06	2,666.340	2,666.340	0.00E+00	8.54E-03	8.54E-03
Pa-231	8.5429E-12	2,666.340	2,666.340	0.00E+00	2.28E-08	2.28E-08
Pb-210	7.3535E-13	2,666.340	2,666.340	0.00E+00	1.96E-09	1.96E-09
Pm-147	2.6102E-02	2,666.340	2,666.340	0.00E+00	6.96E+01	6.96E+01
Pu-238	2.3328E-02	2,666.340	2,666.340	0.00E+00	6.22E+01	6.22E+01
Pu-239	-3.5520E-02	2,666.340	0.000	3.25E+02	2.30E+02	3.25E+02
Pu-240	2.0750E-02	2,666.340	2,666.340	1.65E+02	2.20E+02	2.20E+02
Pu-241	-1.1127E+00	2,666.340	0.000	7.41E+03	4.44E+03	7.41E+03
Pu-242	1.1152E-05	2,666.340	2,666.340	4.40E-02	7.37E-02	7.37E-02
Ra-226	2.8297E-12	2,666.340	2,666.340	0.00E+00	7.54E-09	7.54E-09
Ra-228	1.3510E-16	2,666.340	2,666.340	0.00E+00	3.60E-13	3.60E-13
Ru-106	2.5104E-05	2,666.340	2,666.340	0.00E+00	6.69E-02	6.69E-02
Se-79	1.0133E-05	2,666.340	2,666.340	0.00E+00	2.70E-02	2.70E-02
Sn-126	4.3902E-05	2,666.340	2,666.340	0.00E+00	1.17E-01	1.17E-01
Sr-90	6.1522E-01	2,666.340	2,666.340	0.00E+00	1.64E+03	1.64E+03
Tc-99	3.9412E-04	2,666.340	2,666.340	0.00E+00	1.05E+00	1.05E+00
Th-229	2.0554E-12	2,666.340	2,666.340	0.00E+00	5.48E-09	5.48E-09
Th-230	5.3680E-10	2,666.340	2,666.340	0.00E+00	1.43E-06	1.43E-06
Th-232	1.9522E-16	2,666.340	2,666.340	0.00E+00	5.21E-13	5.21E-13
Tl-208	5.1046E-07	2,666.340	2,666.340	0.00E+00	1.36E-03	1.36E-03
U-232	1.3883E-06	2,666.340	2,666.340	0.00E+00	3.70E-03	3.70E-03
U-233	3.7516E-10	2,666.340	2,666.340	0.00E+00	1.00E-06	1.00E-06
U-234	3.1909E-06	2,666.340	2,666.340	0.00E+00	8.51E-03	8.51E-03
U-235	-8.7842E-09	2,666.340	0.000	6.66E-05	4.32E-05	6.66E-05
U-236	1.4813E-07	2,666.340	2,666.340	0.00E+00	3.95E-04	3.95E-04
U-238	-1.7914E-07	2,666.340	0.000	4.85E-03	4.37E-03	4.85E-03
Y-90	6.1522E-01	2,666.340	2,666.340	0.00E+00	1.64E+03	1.64E+03
Other Radionuclides					4.59E+03	4.59E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.066E+14
0.0250	2.131E+13
0.0375	2.497E+13
0.0575	2.329E+13
0.0850	1.204E+13
0.1250	8.658E+12
0.2250	9.621E+12
0.3750	4.198E+12
0.5750	1.674E+14
0.8500	2.068E+12
1.2500	2.667E+12
1.7500	5.589E+10
2.2500	1.204E+07
2.7500	4.857E+07
3.5000	2.811E+05
5.0000	8.992E+04
7.0000	1.027E+04
11.0000	1.176E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.04E+01	**6.34E+01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		2,666.340
Bounding:		2,666.340

Basis for burnup used in estimate:

Nominal burnup set equal to bounding burnup.
Bounding burnup taken from SFD and converted to MWd using BOL=20.510kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.85	
Bounding:	0.85	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBR-II NITRIDE FUEL EXPER
SNF ID #: 363
Fuel Units & Descr: 64 - ROD
Heavy Metal Mass: BOL= ; EOL=9.59kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1994
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage: 18"x10'
0.32

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	833.805	1,563.384	0.00E+00	1.15E-09	2.15E-09
Am-241	7.9527E-02	833.805	1,563.384	2.01E+01	8.64E+01	1.44E+02
Am-242m	2.1053E-03	833.805	1,563.384	0.00E+00	1.76E+00	3.29E+00
Am-243	1.0760E-04	833.805	1,563.384	0.00E+00	8.97E-02	1.68E-01
C-14	2.6141E-05	833.805	1,563.384	0.00E+00	2.18E-02	4.09E-02
Cl-36	3.4243E-10	833.805	1,563.384	0.00E+00	2.86E-07	5.35E-07
Cm-243	6.6092E-04	833.805	1,563.384	0.00E+00	5.51E-01	1.03E+00
Cm-244	2.9933E-03	833.805	1,563.384	0.00E+00	2.50E+00	4.68E+00
Co-60	1.5934E-02	833.805	1,563.384	0.00E+00	1.33E+01	2.49E+01
Cs-134	4.6356E-02	833.805	1,563.384	0.00E+00	3.87E+01	7.25E+01
Cs-135	4.7693E-05	833.805	1,563.384	0.00E+00	3.98E-02	7.46E-02
Cs-137	2.1113E+00	833.805	1,563.384	0.00E+00	1.76E+03	3.30E+03
Eu-154	4.8092E-02	833.805	1,563.384	0.00E+00	4.01E+01	7.52E+01
Eu-155	6.8447E-02	833.805	1,563.384	0.00E+00	5.71E+01	1.07E+02
Fe-55	5.8489E-03	833.805	1,563.384	0.00E+00	4.88E+00	9.14E+00
H-3	8.9300E-03	833.805	1,563.384	0.00E+00	7.45E+00	1.40E+01
I-129	1.2891E-06	833.805	1,563.384	0.00E+00	1.07E-03	2.02E-03
Kr-85	7.0941E-02	833.805	1,563.384	0.00E+00	5.92E+01	1.11E+02
Np-237	2.6541E-06	833.805	1,563.384	0.00E+00	2.21E-03	4.15E-03
Pa-231	4.8970E-12	833.805	1,563.384	0.00E+00	4.08E-09	7.66E-09
Pb-210	2.2170E-13	833.805	1,563.384	0.00E+00	1.85E-10	3.47E-10
Pm-147	2.3627E-01	833.805	1,563.384	0.00E+00	1.97E+02	3.69E+02
Pu-238	2.8636E-02	833.805	1,563.384	0.00E+00	2.39E+01	4.48E+01
Pu-239	-3.5520E-02	833.805	0.000	1.65E+02	1.35E+02	1.65E+02
Pu-240	2.0790E-02	833.805	1,563.384	8.38E+01	1.01E+02	1.16E+02
Pu-241	-4.8316E-01	833.805	0.000	3.76E+03	3.36E+03	3.76E+03
Pu-242	1.1052E-05	833.805	1,563.384	2.24E-02	3.16E-02	3.96E-02
Ra-226	5.7471E-13	833.805	1,563.384	0.00E+00	4.79E-10	8.98E-10
Ra-228	5.4957E-17	833.805	1,563.384	0.00E+00	4.58E-14	8.59E-14
Ru-106	1.4583E-02	833.805	1,563.384	0.00E+00	1.22E+01	2.28E+01
Se-79	1.0137E-05	833.805	1,563.384	0.00E+00	8.45E-03	1.58E-02
Sn-126	4.3922E-05	833.805	1,563.384	0.00E+00	3.66E-02	6.87E-02
Sr-90	7.6329E-01	833.805	1,563.384	0.00E+00	6.36E+02	1.19E+03
Tc-99	3.9412E-04	833.805	1,563.384	0.00E+00	3.29E-01	6.16E-01
Th-229	1.6457E-12	833.805	1,563.384	0.00E+00	1.37E-09	2.57E-09
Th-230	1.8822E-10	833.805	1,563.384	0.00E+00	1.57E-07	2.94E-07
Th-232	9.7601E-17	833.805	1,563.384	0.00E+00	8.14E-14	1.53E-13
Tl-208	5.2722E-07	833.805	1,563.384	0.00E+00	4.40E-04	8.24E-04
U-232	1.4925E-06	833.805	1,563.384	0.00E+00	1.24E-03	2.33E-03
U-233	2.1113E-10	833.805	1,563.384	0.00E+00	1.76E-07	3.30E-07
U-234	1.9528E-06	833.805	1,563.384	0.00E+00	1.63E-03	3.05E-03
U-235	-9.7920E-09	833.805	0.000	3.39E-05	2.57E-05	3.39E-05
U-236	1.1570E-07	833.805	1,563.384	0.00E+00	9.65E-05	1.81E-04
U-238	-1.7914E-07	833.805	0.000	2.47E-03	2.32E-03	2.47E-03
Y-90	7.6329E-01	833.805	1,563.384	0.00E+00	6.36E+02	1.19E+03
Other Radionuclides					1.81E+03	3.39E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.854E+13
0.0250	1.695E+13
0.0375	1.939E+13
0.0575	1.647E+13
0.0850	9.658E+12
0.1250	7.213E+12
0.2250	7.314E+12
0.3750	3.761E+12
0.5750	1.257E+14
0.8500	4.205E+12
1.2500	3.661E+12
1.7500	6.015E+10
2.2500	2.025E+09
2.7500	2.112E+08
3.5000	2.385E+07
5.0000	5.763E+04
7.0000	6.595E+03
11.0000	7.553E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.54E+01	4.19E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	SST
BOL HM Constituents:	Pu/U NITR	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		833.805
Bounding:		1,563.384

Basis for burnup used in estimate:
Nominal burnup taken from SFD and converted to MWd using BOL=10.423kg
Bounding burnup taken from SFD and converted to MWd using BOL=10.423kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.53	
Bounding:	0.99	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBR-II OXIDE FUEL EXPER
SNF ID #: 345
Fuel Units & Descr: 571 - ROD
Heavy Metal Mass: BOL= ; EOL=56.99kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1994
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]**Template Burnup(MWd):** 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage:
18"x10'
2.86

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	4,956.090	12,390.224	0.00E+00	6.81E-09	1.70E-08
Am-241	7.9527E-02	4,956.090	12,390.224	1.19E+02	5.14E+02	1.10E+03
Am-242m	2.1053E-03	4,956.090	12,390.224	0.00E+00	1.04E+01	2.61E+01
Am-243	1.0760E-04	4,956.090	12,390.224	0.00E+00	5.33E-01	1.33E+00
C-14	2.6141E-05	4,956.090	12,390.224	0.00E+00	1.30E-01	3.24E-01
Cl-36	3.4243E-10	4,956.090	12,390.224	0.00E+00	1.70E-06	4.24E-06
Cm-243	6.6092E-04	4,956.090	12,390.224	0.00E+00	3.28E+00	8.19E+00
Cm-244	2.9933E-03	4,956.090	12,390.224	0.00E+00	1.48E+01	3.71E+01
Co-60	1.5934E-02	4,956.090	12,390.224	0.00E+00	7.90E+01	1.97E+02
Cs-134	4.6356E-02	4,956.090	12,390.224	0.00E+00	2.30E+02	5.74E+02
Cs-135	4.7693E-05	4,956.090	12,390.224	0.00E+00	2.36E-01	5.91E-01
Cs-137	2.1113E+00	4,956.090	12,390.224	0.00E+00	1.05E+04	2.62E+04
Eu-154	4.8092E-02	4,956.090	12,390.224	0.00E+00	2.38E+02	5.96E+02
Eu-155	6.8447E-02	4,956.090	12,390.224	0.00E+00	3.39E+02	8.48E+02
Fe-55	5.8489E-03	4,956.090	12,390.224	0.00E+00	2.90E+01	7.25E+01
H-3	8.9300E-03	4,956.090	12,390.224	0.00E+00	4.43E+01	1.11E+02
I-129	1.2891E-06	4,956.090	12,390.224	0.00E+00	6.39E-03	1.60E-02
Kr-85	7.0941E-02	4,956.090	12,390.224	0.00E+00	3.52E+02	8.79E+02
Np-237	2.6541E-06	4,956.090	12,390.224	0.00E+00	1.32E-02	3.29E-02
Pa-231	4.8970E-12	4,956.090	12,390.224	0.00E+00	2.43E-08	6.07E-08
Pb-210	2.2170E-13	4,956.090	12,390.224	0.00E+00	1.10E-09	2.75E-09
Pm-147	2.3627E-01	4,956.090	12,390.224	0.00E+00	1.17E+03	2.93E+03
Pu-238	2.8636E-02	4,956.090	12,390.224	0.00E+00	1.42E+02	3.55E+02
Pu-239	-3.5520E-02	4,956.090	0.000	9.81E+02	8.04E+02	9.81E+02
Pu-240	2.0790E-02	4,956.090	12,390.224	4.98E+02	6.01E+02	7.56E+02
Pu-241	-4.8316E-01	4,956.090	0.000	2.24E+04	2.00E+04	2.24E+04
Pu-242	1.1052E-05	4,956.090	12,390.224	1.33E-01	1.88E-01	2.70E-01
Ra-226	5.7471E-13	4,956.090	12,390.224	0.00E+00	2.85E-09	7.12E-09
Ra-228	5.4957E-17	4,956.090	12,390.224	0.00E+00	2.72E-13	6.81E-13
Ru-106	1.4583E-02	4,956.090	12,390.224	0.00E+00	7.23E+01	1.81E+02
Se-79	1.0137E-05	4,956.090	12,390.224	0.00E+00	5.02E-02	1.26E-01
Sn-126	4.3922E-05	4,956.090	12,390.224	0.00E+00	2.18E-01	5.44E-01
Sr-90	7.6329E-01	4,956.090	12,390.224	0.00E+00	3.78E+03	9.46E+03
Tc-99	3.9412E-04	4,956.090	12,390.224	0.00E+00	1.95E+00	4.88E+00
Th-229	1.6457E-12	4,956.090	12,390.224	0.00E+00	8.16E-09	2.04E-08
Th-230	1.8822E-10	4,956.090	12,390.224	0.00E+00	9.33E-07	2.33E-06
Th-232	9.7601E-17	4,956.090	12,390.224	0.00E+00	4.84E-13	1.21E-12
Tl-208	5.2722E-07	4,956.090	12,390.224	0.00E+00	2.61E-03	6.53E-03
U-232	1.4925E-06	4,956.090	12,390.224	0.00E+00	7.40E-03	1.85E-02
U-233	2.1113E-10	4,956.090	12,390.224	0.00E+00	1.05E-06	2.62E-06
U-234	1.9528E-06	4,956.090	12,390.224	0.00E+00	9.68E-03	2.42E-02
U-235	-9.7920E-09	4,956.090	0.000	2.01E-04	1.53E-04	2.01E-04
U-236	1.1570E-07	4,956.090	12,390.224	0.00E+00	5.73E-04	1.43E-03
U-238	-1.7914E-07	4,956.090	0.000	1.47E-02	1.38E-02	1.47E-02
Y-90	7.6329E-01	4,956.090	12,390.224	0.00E+00	3.78E+03	9.46E+03
Other Radionuclides					1.07E+04	2.69E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.203E+14
0.0250	1.343E+14
0.0375	1.537E+14
0.0575	1.300E+14
0.0850	7.654E+13
0.1250	5.716E+13
0.2250	5.797E+13
0.3750	2.980E+13
0.5750	9.962E+14
0.8500	3.332E+13
1.2500	2.902E+13
1.7500	4.767E+11
2.2500	1.605E+10
2.7500	1.674E+09
3.5000	1.889E+08
5.0000	4.173E+05
7.0000	4.778E+04
11.0000	5.473E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.51E+02	3.15E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]	From SFD	Estimated
Nominal:		4,956.090
Bounding:		12,390.224

Basis for burnup used in estimate:
Nominal burnup taken from SFD and converted to MWd using BOL=61.951kg
Bounding burnup taken from SFD and converted to MWd using BOL=61.951kg

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.53	
Bounding:	1.31	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	EBR-II OXIDE FUEL EXPER	**[1]Fuel decay start date:**	1994	Estimated Canister usage:
SNF ID #:	364	**Estimates as of:**	2010	18"x10'
Fuel Units & Descr:	992 - ROD	**Template:**	FFTF (FAST, SST, 10 to 30%, Pu & U)	4.96
Heavy Metal Mass:	BOL= ; EOL=92.45kg	**[2]Template Burnup(MWd):**	5011.2	
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.0329181	
		Template Decay Time:	15 years	

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	1.3735E-12	8,040.815	20,102.038	0.00E+00	1.10E-08	2.76E-08
Am-241	7.9527E-02	8,040.815	20,102.038	1.94E+02	8.33E+02	1.79E+03
Am-242m	2.1053E-03	8,040.815	20,102.038	0.00E+00	1.69E+01	4.23E+01
Am-243	1.0760E-04	8,040.815	20,102.038	0.00E+00	8.65E-01	2.16E+00
C-14	2.6141E-05	8,040.815	20,102.038	0.00E+00	2.10E-01	5.25E-01
Cl-36	3.4243E-10	8,040.815	20,102.038	0.00E+00	2.75E-06	6.88E-06
Cm-243	6.6092E-04	8,040.815	20,102.038	0.00E+00	5.31E+00	1.33E+01
Cm-244	2.9933E-03	8,040.815	20,102.038	0.00E+00	2.41E+01	6.02E+01
Co-60	1.5934E-02	8,040.815	20,102.038	0.00E+00	1.28E+02	3.20E+02
Cs-134	4.6356E-02	8,040.815	20,102.038	0.00E+00	3.73E+02	9.32E+02
Cs-135	4.7693E-05	8,040.815	20,102.038	0.00E+00	3.83E-01	9.59E-01
Cs-137	2.1113E+00	8,040.815	20,102.038	0.00E+00	1.70E+04	4.24E+04
Eu-154	4.8092E-02	8,040.815	20,102.038	0.00E+00	3.87E+02	9.67E+02
Eu-155	6.8447E-02	8,040.815	20,102.038	0.00E+00	5.50E+02	1.38E+03
Fe-55	5.8489E-03	8,040.815	20,102.038	0.00E+00	4.70E+01	1.18E+02
H-3	8.9300E-03	8,040.815	20,102.038	0.00E+00	7.18E+01	1.80E+02
I-129	1.2891E-06	8,040.815	20,102.038	0.00E+00	1.04E-02	2.59E-02
Kr-85	7.0941E-02	8,040.815	20,102.038	0.00E+00	5.70E+02	1.43E+03
Np-237	2.6541E-06	8,040.815	20,102.038	0.00E+00	2.13E-02	5.34E-02
Pa-231	4.8970E-12	8,040.815	20,102.038	0.00E+00	3.94E-08	9.84E-08
Pb-210	2.2170E-13	8,040.815	20,102.038	0.00E+00	1.78E-09	4.46E-09
Pm-147	2.3627E-01	8,040.815	20,102.038	0.00E+00	1.90E+03	4.75E+03
Pu-238	2.8636E-02	8,040.815	20,102.038	0.00E+00	2.30E+02	5.76E+02
Pu-239	-3.5520E-02	8,040.815	0.000	1.59E+03	1.31E+03	1.59E+03
Pu-240	2.0790E-02	8,040.815	20,102.038	8.09E+02	9.76E+02	1.23E+03
Pu-241	-4.8316E-01	8,040.815	0.000	3.63E+04	3.24E+04	3.63E+04
Pu-242	1.1052E-05	8,040.815	20,102.038	2.16E-01	3.04E-01	4.38E-01
Ra-226	5.7471E-13	8,040.815	20,102.038	0.00E+00	4.62E-09	1.16E-08
Ra-228	5.4957E-17	8,040.815	20,102.038	0.00E+00	4.42E-13	1.10E-12
Ru-106	1.4583E-02	8,040.815	20,102.038	0.00E+00	1.17E+02	2.93E+02
Se-79	1.0137E-05	8,040.815	20,102.038	0.00E+00	8.15E-02	2.04E-01
Sn-126	4.3922E-05	8,040.815	20,102.038	0.00E+00	3.53E-01	8.83E-01
Sr-90	7.6329E-01	8,040.815	20,102.038	0.00E+00	6.14E+03	1.53E+04
Tc-99	3.9412E-04	8,040.815	20,102.038	0.00E+00	3.17E+00	7.92E+00
Th-229	1.6457E-12	8,040.815	20,102.038	0.00E+00	1.32E-08	3.31E-08
Th-230	1.8822E-10	8,040.815	20,102.038	0.00E+00	1.51E-06	3.78E-06
Th-232	9.7601E-17	8,040.815	20,102.038	0.00E+00	7.85E-13	1.96E-12
Tl-208	5.2722E-07	8,040.815	20,102.038	0.00E+00	4.24E-03	1.06E-02
U-232	1.4925E-06	8,040.815	20,102.038	0.00E+00	1.20E-02	3.00E-02
U-233	2.1113E-10	8,040.815	20,102.038	0.00E+00	1.70E-06	4.24E-06
U-234	1.9528E-06	8,040.815	20,102.038	0.00E+00	1.57E-02	3.93E-02
U-235	-9.7920E-09	8,040.815	0.000	3.27E-04	2.48E-04	3.27E-04
U-236	1.1570E-07	8,040.815	20,102.038	0.00E+00	9.30E-04	2.33E-03
U-238	-1.7914E-07	8,040.815	0.000	2.38E-02	2.23E-02	2.38E-02
Y-90	7.6329E-01	8,040.815	20,102.038	0.00E+00	6.14E+03	1.53E+04
Other Radionuclides					1.74E+04	4.36E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.006E+15
0.0250	2.179E+14
0.0375	2.493E+14
0.0575	2.109E+14
0.0850	1.242E+14
0.1250	9.274E+13
0.2250	9.405E+13
0.3750	4.835E+13
0.5750	1.616E+15
0.8500	5.406E+13
1.2500	4.708E+13
1.7500	7.734E+11
2.2500	2.603E+10
2.7500	2.715E+09
3.5000	3.065E+08
5.0000	6.770E+05
7.0000	7.751E+04
11.0000	8.879E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.45E+02	5.12E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		8,040.815	Nominal burnup taken from SFD and converted to MWd using BOL=100.510kg
Bounding:		20,102.038	Bounding burnup taken from SFD and converted to MWd using BOL=100.510kg

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.53	
Bounding:	1.31	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBR-II, FFTF & MTR EXPERIMENTS
SNF ID #: 42
Fuel Units & Descr: 1 - CANISTER OF SCRAP
Heavy Metal Mass: BOL= ; EOL=3.98kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1979
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 25 years

Estimated Canister usage:

HIC
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	3.4503E-12	346.317	346.317	0.00E+00	1.19E-09	1.19E-09
Am-241	9.5092E-02	346.317	346.317	8.35E+00	4.13E+01	4.13E+01
Am-242m	2.0115E-03	346.317	346.317	0.00E+00	6.97E-01	6.97E-01
Am-243	1.0750E-04	346.317	346.317	0.00E+00	3.72E-02	3.72E-02
C-14	2.6102E-05	346.317	346.317	0.00E+00	9.04E-03	9.04E-03
Cl-36	3.4243E-10	346.317	346.317	0.00E+00	1.19E-07	1.19E-07
Cm-243	5.1824E-04	346.317	346.317	0.00E+00	1.79E-01	1.79E-01
Cm-244	2.1572E-03	346.317	346.317	0.00E+00	7.47E-01	7.47E-01
Co-60	5.6254E-03	346.317	346.317	0.00E+00	1.95E+00	1.95E+00
Cs-134	2.5942E-03	346.317	346.317	0.00E+00	8.98E-01	8.98E-01
Cs-135	4.7693E-05	346.317	346.317	0.00E+00	1.65E-02	1.65E-02
Cs-137	1.7122E+00	346.317	346.317	0.00E+00	5.93E+02	5.93E+02
Eu-154	2.5223E-02	346.317	346.317	0.00E+00	8.74E+00	8.74E+00
Eu-155	2.2689E-02	346.317	346.317	0.00E+00	7.86E+00	7.86E+00
Fe-55	6.3358E-04	346.317	346.317	0.00E+00	2.19E-01	2.19E-01
H-3	5.6054E-03	346.317	346.317	0.00E+00	1.94E+00	1.94E+00
I-129	1.2891E-06	346.317	346.317	0.00E+00	4.46E-04	4.46E-04
Kr-85	4.1746E-02	346.317	346.317	0.00E+00	1.45E+01	1.45E+01
Np-237	3.2028E-06	346.317	346.317	0.00E+00	1.11E-03	1.11E-03
Pa-231	8.5429E-12	346.317	346.317	0.00E+00	2.96E-09	2.96E-09
Pb-210	7.3535E-13	346.317	346.317	0.00E+00	2.55E-10	2.55E-10
Pm-147	2.6102E-02	346.317	346.317	0.00E+00	9.04E+00	9.04E+00
Pu-238	2.3328E-02	346.317	346.317	0.00E+00	8.08E+00	8.08E+00
Pu-239	-3.5520E-02	346.317	0.000	6.85E+01	5.62E+01	6.85E+01
Pu-240	2.0750E-02	346.317	346.317	3.48E+01	4.20E+01	4.20E+01
Pu-241	-1.1127E+00	346.317	0.000	1.56E+03	1.18E+03	1.56E+03
Pu-242	1.1152E-05	346.317	346.317	9.29E-03	1.31E-02	1.31E-02
Ra-226	2.8297E-12	346.317	346.317	0.00E+00	9.80E-10	9.80E-10
Ra-228	1.3510E-16	346.317	346.317	0.00E+00	4.68E-14	4.68E-14
Ru-106	2.5104E-05	346.317	346.317	0.00E+00	8.69E-03	8.69E-03
Se-79	1.0133E-05	346.317	346.317	0.00E+00	3.51E-03	3.51E-03
Sn-126	4.3902E-05	346.317	346.317	0.00E+00	1.52E-02	1.52E-02
Sr-90	6.1522E-01	346.317	346.317	0.00E+00	2.13E+02	2.13E+02
Tc-99	3.9412E-04	346.317	346.317	0.00E+00	1.36E-01	1.36E-01
Th-229	2.0554E-12	346.317	346.317	0.00E+00	7.12E-10	7.12E-10
Th-230	5.3680E-10	346.317	346.317	0.00E+00	1.86E-07	1.86E-07
Th-232	1.9522E-16	346.317	346.317	0.00E+00	6.76E-14	6.76E-14
Tl-208	5.1046E-07	346.317	346.317	0.00E+00	1.77E-04	1.77E-04
U-232	1.3883E-06	346.317	346.317	0.00E+00	4.81E-04	4.81E-04
U-233	3.7516E-10	346.317	346.317	0.00E+00	1.30E-07	1.30E-07
U-234	3.1909E-06	346.317	346.317	0.00E+00	1.11E-03	1.11E-03
U-235	-8.7842E-09	346.317	0.000	1.41E-05	1.10E-05	1.41E-05
U-236	1.4813E-07	346.317	346.317	0.00E+00	5.13E-05	5.13E-05
U-238	-1.7914E-07	346.317	0.000	1.02E-03	9.62E-04	1.02E-03
Y-90	6.1522E-01	346.317	346.317	0.00E+00	2.13E+02	2.13E+02
Other Radionuclides					5.96E+02	5.96E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.402E+13
0.0250	2.771E+12
0.0375	3.244E+12
0.0575	3.070E+12
0.0850	1.564E+12
0.1250	1.125E+12
0.2250	1.250E+12
0.3750	5.453E+11
0.5750	2.174E+13
0.8500	2.686E+11
1.2500	3.464E+11
1.7500	7.259E+09
2.2500	1.578E+06
2.7500	6.318E+06
3.5000	4.400E+04
5.0000	1.486E+04
7.0000	1.696E+03
11.0000	1.941E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.20E+00	9.59E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	SST
BOL HM Constituents:	Pu/U CARB	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on moderator and BOL heavy metal, using SST cladding is conservative and enrichment is unknown.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		346.317
Bounding:		346.317

Basis for burnup used in estimate:
Nominal burnup set equal to bounding burnup.
Bounding burnup taken from SFD and converted to MWd using BOL=4.329kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.53	
Bounding:	0.53	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	EBR-II, TREAT, MTR EXPER. & IPNS TARGET	**[1]Fuel decay start date:**	2050
SNF ID #:	1088	**Estimates as of:**	2010
Fuel Units & Descr:	1 - CANISTER OF SCRAP	**Template:**	FERMI (Fast, Zirc, 10 to 40%, U)
Heavy Metal Mass:	BOL= ; EOL=33.25kg	**[2]Template Burnup(MWd):**	58.6725048
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.018774
		Template Decay Time:	5 years

Estimated Canister usage:

HIC
2.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6471E-09	3,750.412	3,750.412	0.00E+00	2.49E-05	2.49E-05
Am-241	2.9452E-07	3,750.412	3,750.412	0.00E+00	1.10E-03	1.10E-03
Am-242m	0.0000E+00	3,750.412	3,750.412	0.00E+00	0.00E+00	0.00E+00
Am-243	8.4009E-15	3,750.412	3,750.412	0.00E+00	3.15E-11	3.15E-11
C-14	2.1799E-05	3,750.412	3,750.412	0.00E+00	8.18E-02	8.18E-02
Cl-36	5.5188E-08	3,750.412	3,750.412	0.00E+00	2.07E-04	2.07E-04
Cm-243	3.2145E-14	3,750.412	3,750.412	0.00E+00	1.21E-10	1.21E-10
Cm-244	1.6510E-15	3,750.412	3,750.412	0.00E+00	6.19E-12	6.19E-12
Co-60	1.0840E-01	3,750.412	3,750.412	0.00E+00	4.07E+02	4.07E+02
Cs-134	1.4973E-02	3,750.412	3,750.412	0.00E+00	5.62E+01	5.62E+01
Cs-135	4.4996E-05	3,750.412	3,750.412	0.00E+00	1.69E-01	1.69E-01
Cs-137	2.7543E+00	3,750.412	3,750.412	0.00E+00	1.03E+04	1.03E+04
Eu-154	2.0793E-03	3,750.412	3,750.412	0.00E+00	7.80E+00	7.80E+00
Eu-155	9.3809E-02	3,750.412	3,750.412	0.00E+00	3.52E+02	3.52E+02
Fe-55	4.2166E-02	3,750.412	3,750.412	0.00E+00	1.58E+02	1.58E+02
H-3	1.9055E-02	3,750.412	3,750.412	0.00E+00	7.15E+01	7.15E+01
I-129	1.1426E-06	3,750.412	3,750.412	0.00E+00	4.29E-03	4.29E-03
Kr-85	2.6861E-01	3,750.412	3,750.412	0.00E+00	1.01E+03	1.01E+03
Np-237	3.3099E-06	3,750.412	3,750.412	0.00E+00	1.24E-02	1.24E-02
Pa-231	4.1655E-08	3,750.412	3,750.412	0.00E+00	1.56E-04	1.56E-04
Pb-210	1.1039E-13	3,750.412	3,750.412	0.00E+00	4.14E-10	4.14E-10
Pm-147	3.2093E+00	3,750.412	3,750.412	0.00E+00	1.20E+04	1.20E+04
Pu-238	2.1731E-04	3,750.412	3,750.412	0.00E+00	8.15E-01	8.15E-01
Pu-239	1.9481E-02	3,750.412	3,750.412	0.00E+00	7.31E+01	7.31E+01
Pu-240	6.8141E-05	3,750.412	3,750.412	0.00E+00	2.56E-01	2.56E-01
Pu-241	1.7708E-05	3,750.412	3,750.412	0.00E+00	6.64E-02	6.64E-02
Pu-242	4.3751E-13	3,750.412	3,750.412	0.00E+00	1.64E-09	1.64E-09
Ra-226	1.0792E-12	3,750.412	3,750.412	0.00E+00	4.05E-09	4.05E-09
Ra-228	1.6234E-11	3,750.412	3,750.412	0.00E+00	6.09E-08	6.09E-08
Ru-106	2.8173E-01	3,750.412	3,750.412	0.00E+00	1.06E+03	1.06E+03
Se-79	1.6493E-05	3,750.412	3,750.412	0.00E+00	6.19E-02	6.19E-02
Sn-126	3.7581E-05	3,750.412	3,750.412	0.00E+00	1.41E-01	1.41E-01
Sr-90	2.4611E+00	3,750.412	3,750.412	0.00E+00	9.23E+03	9.23E+03
Tc-99	4.4842E-04	3,750.412	3,750.412	0.00E+00	1.68E+00	1.68E+00
Th-229	9.4814E-12	3,750.412	3,750.412	0.00E+00	3.56E-08	3.56E-08
Th-230	4.6717E-10	3,750.412	3,750.412	0.00E+00	1.75E-06	1.75E-06
Th-232	2.3674E-11	3,750.412	3,750.412	0.00E+00	8.88E-08	8.88E-08
Tl-208	7.2112E-09	3,750.412	3,750.412	0.00E+00	2.70E-05	2.70E-05
U-232	2.1032E-08	3,750.412	3,750.412	0.00E+00	7.89E-05	7.89E-05
U-233	9.5326E-09	3,750.412	3,750.412	0.00E+00	3.58E-05	3.58E-05
U-234	4.8711E-06	3,750.412	3,750.412	0.00E+00	1.83E-02	1.83E-02
U-235	-2.3191E-06	3,750.412	0.000	2.07E-02	1.21E-02	2.07E-02
U-236	1.2631E-05	3,750.412	3,750.412	0.00E+00	4.74E-02	4.74E-02
U-238	-9.5407E-08	3,750.412	0.000	9.38E-03	9.02E-03	9.38E-03
Y-90	2.4611E+00	3,750.412	3,750.412	0.00E+00	9.23E+03	9.23E+03
Other Radionuclides					1.79E+04	1.79E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.405E+14
0.0250	1.548E+14
0.0375	1.291E+14
0.0575	1.245E+14
0.0850	8.119E+13
0.1250	6.297E+13
0.2250	6.788E+13
0.3750	4.178E+13
0.5750	4.204E+14
0.8500	1.035E+13
1.2500	3.340E+13
1.7500	3.833E+11
2.2500	8.324E+11
2.7500	9.101E+09
3.5000	1.099E+09
5.0000	2.316E+02
7.0000	1.941E+01
11.0000	1.750E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.63E+02	1.63E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	ZIRC
BOL HM Constituents:	U METAL	U
BOL Enrichment %:		10 to 40

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except cladding and enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		3,750.412
Bounding:		3,750.412

Basis for burnup used in estimate:

Nominal burnup set equal to bounding burnup.
Bounding burnup taken from SFD and converted to MWd using BOL=37.504kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	32.00	
Bounding:	32.00	

Estimated EOL HM/Given EOL HM

1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBWR
SNF ID #: 65
Fuel Units & Descr: 61 - 6 FLAT PLATES
Heavy Metal Mass: BOL=1636.02kg ; EOL=1603.52kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1966
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]**Template Burnup(MWd):** 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage:
18"x10'
5.08

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	8.7758E-10	30,906.724	61,813.447	0.00E+00	2.71E-05	5.42E-05
Am-241	1.4352E-01	30,906.724	61,813.447	0.00E+00	4.44E+03	8.87E+03
Am-242m	2.8698E-04	30,906.724	61,813.447	0.00E+00	8.87E+00	1.77E+01
Am-243	6.2565E-04	30,906.724	61,813.447	0.00E+00	1.93E+01	3.87E+01
C-14	4.7901E-05	30,906.724	61,813.447	0.00E+00	1.48E+00	2.96E+00
Cl-36	8.0297E-07	30,906.724	61,813.447	0.00E+00	2.48E-02	4.96E-02
Cm-243	2.5081E-04	30,906.724	61,813.447	0.00E+00	7.75E+00	1.55E+01
Cm-244	4.9015E-02	30,906.724	61,813.447	0.00E+00	1.51E+03	3.03E+03
Co-60	2.5581E-03	30,906.724	61,813.447	0.00E+00	7.91E+01	1.58E+02
Cs-134	4.0536E-05	30,906.724	61,813.447	0.00E+00	1.25E+00	2.51E+00
Cs-135	1.4433E-05	30,906.724	61,813.447	0.00E+00	4.46E-01	8.92E-01
Cs-137	1.3979E+00	30,906.724	61,813.447	0.00E+00	4.32E+04	8.64E+04
Eu-154	2.0203E-02	30,906.724	61,813.447	0.00E+00	6.24E+02	1.25E+03
Eu-155	1.7684E-03	30,906.724	61,813.447	0.00E+00	5.47E+01	1.09E+02
Fe-55	4.3136E-05	30,906.724	61,813.447	0.00E+00	1.33E+00	2.67E+00
H-3	2.0769E-02	30,906.724	61,813.447	0.00E+00	6.42E+02	1.28E+03
I-129	9.8288E-07	30,906.724	61,813.447	0.00E+00	3.04E-02	6.08E-02
Kr-85	2.8214E-02	30,906.724	61,813.447	0.00E+00	8.72E+02	1.74E+03
Np-237	1.1218E-05	30,906.724	61,813.447	0.00E+00	3.47E-01	6.93E-01
Pa-231	1.3036E-09	30,906.724	61,813.447	0.00E+00	4.03E-05	8.06E-05
Pb-210	8.5078E-11	30,906.724	61,813.447	0.00E+00	2.63E-06	5.26E-06
Pm-147	3.6531E-04	30,906.724	61,813.447	0.00E+00	1.13E+01	2.26E+01
Pu-238	7.4564E-02	30,906.724	61,813.447	0.00E+00	2.30E+03	4.61E+03
Pu-239	1.1623E-02	30,906.724	61,813.447	0.00E+00	3.59E+02	7.18E+02
Pu-240	1.5132E-02	30,906.724	61,813.447	0.00E+00	4.68E+02	9.35E+02
Pu-241	9.0036E-01	30,906.724	61,813.447	0.00E+00	2.78E+04	5.57E+04
Pu-242	6.4260E-05	30,906.724	61,813.447	0.00E+00	1.99E+00	3.97E+00
Ra-226	2.2804E-10	30,906.724	61,813.447	0.00E+00	7.05E-06	1.41E-05
Ra-228	5.2713E-12	30,906.724	61,813.447	0.00E+00	1.63E-07	3.26E-07
Ru-106	6.1160E-10	30,906.724	61,813.447	0.00E+00	1.89E-05	3.78E-05
Se-79	1.2377E-05	30,906.724	61,813.447	0.00E+00	3.83E-01	7.65E-01
Sn-126	2.5210E-05	30,906.724	61,813.447	0.00E+00	7.79E-01	1.56E+00
Sr-90	9.1667E-01	30,906.724	61,813.447	0.00E+00	2.83E+04	5.67E+04
Tc-99	3.9357E-04	30,906.724	61,813.447	0.00E+00	1.22E+01	2.43E+01
Th-229	1.2057E-10	30,906.724	61,813.447	0.00E+00	3.73E-06	7.45E-06
Th-230	2.1043E-08	30,906.724	61,813.447	0.00E+00	6.50E-04	1.30E-03
Th-232	5.2972E-12	30,906.724	61,813.447	0.00E+00	1.64E-07	3.27E-07
Tl-208	1.7474E-07	30,906.724	61,813.447	0.00E+00	5.40E-03	1.08E-02
U-232	4.7368E-07	30,906.724	61,813.447	0.00E+00	1.46E-02	2.93E-02
U-233	2.5097E-08	30,906.724	61,813.447	0.00E+00	7.76E-04	1.55E-03
U-234	5.0000E-05	30,906.724	61,813.447	0.00E+00	1.55E+00	3.09E+00
U-235	-1.4489E-06	30,906.724	0.000	2.11E-01	1.66E-01	2.11E-01
U-236	7.5824E-06	30,906.724	61,813.447	0.00E+00	2.34E-01	4.69E-01
U-238	-2.6129E-07	30,906.724	0.000	5.17E-01	5.09E-01	5.17E-01
Y-90	9.1699E-01	30,906.724	61,813.447	0.00E+00	2.83E+04	5.67E+04
Other Radionuclides					4.15E+04	8.30E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.326E+15
0.0250	6.707E+14
0.0375	6.397E+14
0.0575	7.391E+14
0.0850	3.721E+14
0.1250	2.582E+14
0.2250	3.191E+14
0.3750	1.372E+14
0.5750	3.192E+15
0.8500	4.415E+13
1.2500	4.337E+13
1.7500	1.299E+12
2.2500	2.092E+08
2.7500	4.284E+08
3.5000	4.413E+07
5.0000	1.886E+07
7.0000	2.174E+06
11.0000	2.497E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
7.11E+02	**1.42E+03**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	5.973154429	0 to 5

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches PWR Template on all but one parameter (enrichment) making PWR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		30,906.724
Bounding:	2,617.632	61,813.447

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.54	
Bounding:	1.08	23.61

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBWR
SNF ID #: 63
Fuel Units & Descr: 25 - 6 FLAT PLATES
Heavy Metal Mass: BOL=986.00kg ; EOL=932.56kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1966
Estimates as of: 2010
Template: (Worst Case)
[2]**Template Burnup(MWd):** 62.5
Template BOL Heavy Metal Mass (MT): 0.00186865
Template Decay Time: 35 years

Estimated Canister usage:
18"x10'
2.08

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	2.3072E-06	50,784.462	101,568.923	0.00E+00	1.17E-01	2.34E-01
Am-241	8.4448E+00	50,784.462	101,568.923	0.00E+00	4.29E+05	8.58E+05
Am-242m	1.6848E-02	50,784.462	101,568.923	0.00E+00	8.56E+02	1.71E+03
Am-243	1.6320E-02	50,784.462	101,568.923	0.00E+00	8.29E+02	1.66E+03
C-14	1.2090E-01	50,784.462	101,568.923	0.00E+00	6.14E+03	1.23E+04
Cl-36	2.2849E-03	50,784.462	101,568.923	0.00E+00	1.16E+02	2.32E+02
Cm-243	8.6624E-04	50,784.462	101,568.923	0.00E+00	4.40E+01	8.80E+01
Cm-244	1.6848E-01	50,784.462	101,568.923	0.00E+00	8.56E+03	1.71E+04
Co-60	2.8086E+01	50,784.462	101,568.923	0.00E+00	1.43E+06	2.85E+06
Cs-134	3.4148E-04	50,784.462	101,568.923	0.00E+00	1.73E+01	3.47E+01
Cs-135	4.3976E-04	50,784.462	101,568.923	0.00E+00	2.23E+01	4.47E+01
Cs-137	2.1049E+01	50,784.462	101,568.923	0.00E+00	1.07E+06	2.14E+06
Eu-154	1.2500E+00	50,784.462	101,568.923	0.00E+00	6.35E+04	1.27E+05
Eu-155	6.8986E-02	50,784.462	101,568.923	0.00E+00	3.50E+03	7.01E+03
Fe-55	2.9308E-01	50,784.462	101,568.923	0.00E+00	1.49E+04	2.98E+04
H-3	2.4311E-01	50,784.462	101,568.923	0.00E+00	1.23E+04	2.47E+04
I-129	1.0618E-05	50,784.462	101,568.923	0.00E+00	5.39E-01	1.08E+00
Kr-85	5.9882E-01	50,784.462	101,568.923	0.00E+00	3.04E+04	6.08E+04
Np-237	1.5668E-04	50,784.462	101,568.923	0.00E+00	7.96E+00	1.59E+01
Pa-231	2.8656E-06	50,784.462	101,568.923	0.00E+00	1.46E-01	2.91E-01
Pb-210	2.3918E-08	50,784.462	101,568.923	0.00E+00	1.21E-03	2.43E-03
Pm-147	1.6900E-02	50,784.462	101,568.923	0.00E+00	8.58E+02	1.72E+03
Pu-238	-8.6123E-01	50,784.462	0.000	1.27E+05	8.30E+04	1.27E+05
Pu-239	-4.8440E-02	50,784.462	0.000	1.53E+04	1.29E+04	1.53E+04
Pu-240	-3.0095E-01	50,784.462	0.000	1.96E+04	4.29E+03	1.96E+04
Pu-241	-1.0411E+02	50,784.462	0.000	5.04E+06	0.00E+00	5.04E+06
Pu-242	-1.1381E-04	50,784.462	0.000	8.47E+01	7.90E+01	8.47E+01
Ra-226	6.4400E-08	50,784.462	101,568.923	0.00E+00	3.27E-03	6.54E-03
Ra-228	5.9952E-07	50,784.462	101,568.923	0.00E+00	3.04E-02	6.09E-02
Ru-106	8.5526E-07	50,784.462	101,568.923	0.00E+00	4.34E-02	8.69E-02
Se-79	1.9181E-04	50,784.462	101,568.923	0.00E+00	9.74E+00	1.95E+01
Sn-126	1.6671E-04	50,784.462	101,568.923	0.00E+00	8.47E+00	1.69E+01
Sr-90	1.9799E+01	50,784.462	101,568.923	0.00E+00	1.01E+06	2.01E+06
Tc-99	6.7678E-03	50,784.462	101,568.923	0.00E+00	3.44E+02	6.87E+02
Th-229	1.7488E-06	50,784.462	101,568.923	0.00E+00	8.88E-02	1.78E-01
Th-230	5.8704E-06	50,784.462	101,568.923	0.00E+00	2.98E-01	5.96E-01
Th-232	6.0208E-07	50,784.462	101,568.923	0.00E+00	3.06E-02	6.12E-02
Tl-208	8.7573E-05	50,784.462	101,568.923	0.00E+00	4.45E+00	8.89E+00
U-232	2.3706E-04	50,784.462	101,568.923	0.00E+00	1.20E+01	2.41E+01
U-233	3.6128E-04	50,784.462	101,568.923	0.00E+00	1.83E+01	3.67E+01
U-234	1.2788E-02	50,784.462	101,568.923	0.00E+00	6.49E+02	1.30E+03
U-235	5.7486E-04	50,784.462	101,568.923	4.24E-01	2.96E+01	5.88E+01
U-236	2.3485E-04	50,784.462	101,568.923	0.00E+00	1.19E+01	2.39E+01
U-238	1.1581E-04	50,784.462	101,568.923	5.28E-02	5.93E+00	1.18E+01
Y-90	1.9804E+01	50,784.462	101,568.923	0.00E+00	1.01E+06	2.01E+06
Other Radionuclides					3.13E+06	6.26E+06

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.253E+17
0.0250	2.477E+16
0.0375	2.164E+16
0.0575	3.404E+16
0.0850	1.329E+16
0.1250	1.041E+16
0.2250	1.151E+16
0.3750	4.923E+15
0.5750	8.006E+16
0.8500	3.059E+15
1.2500	2.139E+17
1.7500	9.461E+13
2.2500	1.122E+12
2.7500	3.161E+11
3.5000	2.676E+08
5.0000	1.136E+08
7.0000	1.300E+07
11.0000	1.487E+06

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.33E+04	1.06E+05
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	(Worst Case)
Fuel Cladding:	ZIRC	SST/Inconel
BOL HM Constituents:	PuO2-UO2	U, Th, & Pu
BOL Enrichment %:	0.222222216	0 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel didn't closely match any existing templates, therefore the worst case template was used.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		50,784.462
Bounding:		101,568.923

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.54	
Bounding:	3.08	

Estimated EOL HM/Given EOL HM
34.51

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	EBR-II, TREAT, MTR EXPER. & IPNS TARGET	[1]Fuel decay start date:	2050	Estimated Canister usage:
SNF ID #:	1088	Estimates as of:	2010	HIC
Fuel Units & Descr:	1 - CANISTER OF SCRAP	Template:	FERMI (Fast, Zirc, 10 to 40%, U)	2.00
Heavy Metal Mass:	BOL= ; EOL=33.25kg	[2]Template Burnup(MWd):	58.6725048	
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.018774	
		Template Decay Time:	5 years	

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6471E-09	3,750.412	3,750.412	0.00E+00	2.49E-05	2.49E-05
Am-241	2.9452E-07	3,750.412	3,750.412	0.00E+00	1.10E-03	1.10E-03
Am-242m	0.0000E+00	3,750.412	3,750.412	0.00E+00	0.00E+00	0.00E+00
Am-243	8.4009E-15	3,750.412	3,750.412	0.00E+00	3.15E-11	3.15E-11
C-14	2.1799E-05	3,750.412	3,750.412	0.00E+00	8.18E-02	8.18E-02
Cl-36	5.5188E-08	3,750.412	3,750.412	0.00E+00	2.07E-04	2.07E-04
Cm-243	3.2145E-14	3,750.412	3,750.412	0.00E+00	1.21E-10	1.21E-10
Cm-244	1.6510E-15	3,750.412	3,750.412	0.00E+00	6.19E-12	6.19E-12
Co-60	1.0840E-01	3,750.412	3,750.412	0.00E+00	4.07E+02	4.07E+02
Cs-134	1.4973E-02	3,750.412	3,750.412	0.00E+00	5.62E+01	5.62E+01
Cs-135	4.4996E-05	3,750.412	3,750.412	0.00E+00	1.69E-01	1.69E-01
Cs-137	2.7543E+00	3,750.412	3,750.412	0.00E+00	1.03E+04	1.03E+04
Eu-154	2.0793E-03	3,750.412	3,750.412	0.00E+00	7.80E+00	7.80E+00
Eu-155	9.3809E-02	3,750.412	3,750.412	0.00E+00	3.52E+02	3.52E+02
Fe-55	4.2166E-02	3,750.412	3,750.412	0.00E+00	1.58E+02	1.58E+02
H-3	1.9055E-02	3,750.412	3,750.412	0.00E+00	7.15E+01	7.15E+01
I-129	1.1426E-06	3,750.412	3,750.412	0.00E+00	4.29E-03	4.29E-03
Kr-85	2.6861E-01	3,750.412	3,750.412	0.00E+00	1.01E+03	1.01E+03
Np-237	3.3099E-06	3,750.412	3,750.412	0.00E+00	1.24E-02	1.24E-02
Pa-231	4.1655E-08	3,750.412	3,750.412	0.00E+00	1.56E-04	1.56E-04
Pb-210	1.1039E-13	3,750.412	3,750.412	0.00E+00	4.14E-10	4.14E-10
Pm-147	3.2093E+00	3,750.412	3,750.412	0.00E+00	1.20E+04	1.20E+04
Pu-238	2.1731E-04	3,750.412	3,750.412	0.00E+00	8.15E-01	8.15E-01
Pu-239	1.9481E-02	3,750.412	3,750.412	0.00E+00	7.31E+01	7.31E+01
Pu-240	6.8141E-05	3,750.412	3,750.412	0.00E+00	2.56E-01	2.56E-01
Pu-241	1.7708E-05	3,750.412	3,750.412	0.00E+00	6.64E-02	6.64E-02
Pu-242	4.3751E-13	3,750.412	3,750.412	0.00E+00	1.64E-09	1.64E-09
Ra-226	1.0792E-12	3,750.412	3,750.412	0.00E+00	4.05E-09	4.05E-09
Ra-228	1.6234E-11	3,750.412	3,750.412	0.00E+00	6.09E-08	6.09E-08
Ru-106	2.8173E-01	3,750.412	3,750.412	0.00E+00	1.06E+03	1.06E+03
Se-79	1.6493E-05	3,750.412	3,750.412	0.00E+00	6.19E-02	6.19E-02
Sn-126	3.7581E-05	3,750.412	3,750.412	0.00E+00	1.41E-01	1.41E-01
Sr-90	2.4611E+00	3,750.412	3,750.412	0.00E+00	9.23E+03	9.23E+03
Tc-99	4.4842E-04	3,750.412	3,750.412	0.00E+00	1.68E+00	1.68E+00
Th-229	9.4814E-12	3,750.412	3,750.412	0.00E+00	3.56E-08	3.56E-08
Th-230	4.6717E-10	3,750.412	3,750.412	0.00E+00	1.75E-06	1.75E-06
Th-232	2.3674E-11	3,750.412	3,750.412	0.00E+00	8.88E-08	8.88E-08
Tl-208	7.2112E-09	3,750.412	3,750.412	0.00E+00	2.70E-05	2.70E-05
U-232	2.1032E-08	3,750.412	3,750.412	0.00E+00	7.89E-05	7.89E-05
U-233	9.5326E-09	3,750.412	3,750.412	0.00E+00	3.58E-05	3.58E-05
U-234	4.8711E-06	3,750.412	3,750.412	0.00E+00	1.83E-02	1.83E-02
U-235	-2.3191E-06	3,750.412	0.000	2.07E-02	1.21E-02	2.07E-02
U-236	1.2631E-05	3,750.412	3,750.412	0.00E+00	4.74E-02	4.74E-02
U-238	-9.5407E-08	3,750.412	0.000	9.38E-03	9.02E-03	9.38E-03
Y-90	2.4611E+00	3,750.412	3,750.412	0.00E+00	9.23E+03	9.23E+03
Other Radionuclides					1.79E+04	1.79E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.405E+14
0.0250	1.548E+14
0.0375	1.291E+14
0.0575	1.245E+14
0.0850	8.119E+13
0.1250	6.297E+13
0.2250	6.788E+13
0.3750	4.178E+13
0.5750	4.204E+14
0.8500	1.035E+13
1.2500	3.340E+13
1.7500	3.833E+11
2.2500	8.324E+11
2.7500	9.101E+09
3.5000	1.099E+09
5.0000	2.316E+02
7.0000	1.941E+01
11.0000	1.750E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.63E+02	1.63E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	ZIRC
BOL HM Constituents:	U METAL	U
BOL Enrichment %:		10 to 40

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except cladding and enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		3,750.412
Bounding:		3,750.412

Basis for burnup used in estimate:

Nominal burnup set equal to bounding burnup.
Bounding burnup taken from SFD and converted to MWd using BOL=37.504kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	32.00	
Bounding:	32.00	

Estimated EOL HM/Given EOL HM: 1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	EBWR	[1]Fuel decay start date:	1966
SNF ID #:	60	Estimates as of:	2010
Fuel Units & Descr:	51 - 6 FLAT PLATES	Template:	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=1358.64kg ; EOL=1357.82kg	[2]Template Burnup(MWd):	61.92
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.00176911
		Template Decay Time:	35 years

Estimated Canister usage: **18"x10'** 4.25

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	775.977	1,551.955	0.00E+00	6.81E-07	1.36E-06
Am-241	1.4352E-01	775.977	1,551.955	0.00E+00	1.11E+02	2.23E+02
Am-242m	2.8698E-04	775.977	1,551.955	0.00E+00	2.23E-01	4.45E-01
Am-243	6.2565E-04	775.977	1,551.955	0.00E+00	4.85E-01	9.71E-01
C-14	4.7901E-05	775.977	1,551.955	0.00E+00	3.72E-02	7.43E-02
Cl-36	8.0297E-07	775.977	1,551.955	0.00E+00	6.23E-04	1.25E-03
Cm-243	2.5081E-04	775.977	1,551.955	0.00E+00	1.95E-01	3.89E-01
Cm-244	4.9015E-02	775.977	1,551.955	0.00E+00	3.80E+01	7.61E+01
Co-60	2.5581E-03	775.977	1,551.955	0.00E+00	1.99E+00	3.97E+00
Cs-134	4.0536E-05	775.977	1,551.955	0.00E+00	3.15E-02	6.29E-02
Cs-135	1.4433E-05	775.977	1,551.955	0.00E+00	1.12E-02	2.24E-02
Cs-137	1.3979E+00	775.977	1,551.955	0.00E+00	1.08E+03	2.17E+03
Eu-154	2.0203E-02	775.977	1,551.955	0.00E+00	1.57E+01	3.14E+01
Eu-155	1.7684E-03	775.977	1,551.955	0.00E+00	1.37E+00	2.74E+00
Fe-55	4.3136E-05	775.977	1,551.955	0.00E+00	3.35E-02	6.69E-02
H-3	2.0769E-02	775.977	1,551.955	0.00E+00	1.61E+01	3.22E+01
I-129	9.8288E-07	775.977	1,551.955	0.00E+00	7.63E-04	1.53E-03
Kr-85	2.8214E-02	775.977	1,551.955	0.00E+00	2.19E+01	4.38E+01
Np-237	1.1218E-05	775.977	1,551.955	0.00E+00	8.70E-03	1.74E-02
Pa-231	1.3036E-09	775.977	1,551.955	0.00E+00	1.01E-06	2.02E-06
Pb-210	8.5078E-11	775.977	1,551.955	0.00E+00	6.60E-08	1.32E-07
Pm-147	3.6531E-04	775.977	1,551.955	0.00E+00	2.83E-01	5.67E-01
Pu-238	7.4564E-02	775.977	1,551.955	0.00E+00	5.79E+01	1.16E+02
Pu-239	1.1623E-02	775.977	1,551.955	0.00E+00	9.02E+00	1.80E+01
Pu-240	1.5132E-02	775.977	1,551.955	0.00E+00	1.17E+01	2.35E+01
Pu-241	9.0036E-01	775.977	1,551.955	0.00E+00	6.99E+02	1.40E+03
Pu-242	6.4260E-05	775.977	1,551.955	0.00E+00	4.99E-02	9.97E-02
Ra-226	2.2804E-10	775.977	1,551.955	0.00E+00	1.77E-07	3.54E-07
Ra-228	5.2713E-12	775.977	1,551.955	0.00E+00	4.09E-09	8.18E-09
Ru-106	6.1160E-10	775.977	1,551.955	0.00E+00	4.75E-07	9.49E-07
Se-79	1.2377E-05	775.977	1,551.955	0.00E+00	9.60E-03	1.92E-02
Sn-126	2.5210E-05	775.977	1,551.955	0.00E+00	1.96E-02	3.91E-02
Sr-90	9.1667E-01	775.977	1,551.955	0.00E+00	7.11E+02	1.42E+03
Tc-99	3.9357E-04	775.977	1,551.955	0.00E+00	3.05E-01	6.11E-01
Th-229	1.2057E-10	775.977	1,551.955	0.00E+00	9.36E-08	1.87E-07
Th-230	2.1043E-08	775.977	1,551.955	0.00E+00	1.63E-05	3.27E-05
Th-232	5.2972E-12	775.977	1,551.955	0.00E+00	4.11E-09	8.22E-09
Tl-208	1.7474E-07	775.977	1,551.955	0.00E+00	1.36E-04	2.71E-04
U-232	4.7368E-07	775.977	1,551.955	0.00E+00	3.68E-04	7.35E-04
U-233	2.5097E-08	775.977	1,551.955	0.00E+00	1.95E-05	3.89E-05
U-234	5.0000E-05	775.977	1,551.955	0.00E+00	3.88E-02	7.76E-02
U-235	-1.4489E-06	775.977	0.000	2.09E-02	1.98E-02	2.09E-02
U-236	7.5824E-06	775.977	1,551.955	0.00E+00	5.88E-03	1.18E-02
U-238	-2.6129E-07	775.977	0.000	4.53E-01	4.53E-01	4.53E-01
Y-90	9.1699E-01	775.977	1,551.955	0.00E+00	7.12E+02	1.42E+03
Other Radionuclides					1.04E+03	2.08E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	8.351E+13
0.0250	1.684E+13
0.0375	1.606E+13
0.0575	1.856E+13
0.0850	9.344E+12
0.1250	6.484E+12
0.2250	8.012E+12
0.3750	3.445E+12
0.5750	8.013E+13
0.8500	1.109E+12
1.2500	1.089E+12
1.7500	3.261E+10
2.2500	5.256E+06
2.7500	1.076E+07
3.5000	1.110E+06
5.0000	4.746E+05
7.0000	5.470E+04
11.0000	6.283E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.79E+01	3.57E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:	0.711000391	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		775.977	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,551.955	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.02	
Bounding:	0.03	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBWR (FUEL FOLLOWER)
SNF ID #: 740
Fuel Units & Descr: 4 - CANISTER OF SCRAP
Heavy Metal Mass: BOL=1.76kg ; EOL=1.73kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1966
Estimates as of: 2010
Template: Pathfinder (Light Water, SST, 60 to 100%, U)
[2]Template Burnup(MWd): 6.01
Template BOL Heavy Metal Mass (MT): 0.00012882
Template Decay Time: 35 years

Estimated Canister usage:
HIC
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	2.3344E-08	29.851	59.702	0.00E+00	6.97E-07	1.39E-06
Am-241	1.1135E-04	29.851	59.702	0.00E+00	3.32E-03	6.65E-03
Am-242m	8.5075E-09	29.851	59.702	0.00E+00	2.54E-07	5.08E-07
Am-243	9.8519E-10	29.851	59.702	0.00E+00	2.94E-08	5.88E-08
C-14	2.3012E-04	29.851	59.702	0.00E+00	6.87E-03	1.37E-02
Cl-36	1.2261E-06	29.851	59.702	0.00E+00	3.66E-05	7.32E-05
Cm-243	2.4875E-10	29.851	59.702	0.00E+00	7.43E-09	1.49E-08
Cm-244	2.3178E-09	29.851	59.702	0.00E+00	6.92E-08	1.38E-07
Co-60	7.0849E-02	29.851	59.702	0.00E+00	2.11E+00	4.23E+00
Cs-134	3.0266E-06	29.851	59.702	0.00E+00	9.03E-05	1.81E-04
Cs-135	3.0316E-05	29.851	59.702	0.00E+00	9.05E-04	1.81E-03
Cs-137	1.4511E+00	29.851	59.702	0.00E+00	4.33E+01	8.66E+01
Eu-154	6.6955E-04	29.851	59.702	0.00E+00	2.00E-02	4.00E-02
Eu-155	6.9850E-04	29.851	59.702	0.00E+00	2.09E-02	4.17E-02
Fe-55	1.2318E-03	29.851	59.702	0.00E+00	3.68E-02	7.35E-02
H-3	2.5141E-03	29.851	59.702	0.00E+00	7.50E-02	1.50E-01
I-129	7.3195E-07	29.851	59.702	0.00E+00	2.18E-05	4.37E-05
Kr-85	4.1281E-02	29.851	59.702	0.00E+00	1.23E+00	2.46E+00
Np-237	1.1489E-06	29.851	59.702	0.00E+00	3.43E-05	6.86E-05
Pa-231	4.5241E-08	29.851	59.702	0.00E+00	1.35E-06	2.70E-06
Pb-210	6.4476E-13	29.851	59.702	0.00E+00	1.92E-11	3.85E-11
Pm-147	1.1651E-03	29.851	59.702	0.00E+00	3.48E-02	6.96E-02
Pu-238	2.9517E-04	29.851	59.702	0.00E+00	8.81E-03	1.76E-02
Pu-239	6.6772E-04	29.851	59.702	0.00E+00	1.99E-02	3.99E-02
Pu-240	8.6839E-05	29.851	59.702	0.00E+00	2.59E-03	5.18E-03
Pu-241	7.1514E-04	29.851	59.702	0.00E+00	2.13E-02	4.27E-02
Pu-242	1.9717E-09	29.851	59.702	0.00E+00	5.89E-08	1.18E-07
Ra-226	1.7654E-12	29.851	59.702	0.00E+00	5.27E-11	1.05E-10
Ra-228	8.2928E-12	29.851	59.702	0.00E+00	2.48E-10	4.95E-10
Ru-106	1.8419E-10	29.851	59.702	0.00E+00	5.50E-09	1.10E-08
Se-79	1.3223E-05	29.851	59.702	0.00E+00	3.95E-04	7.89E-04
Sn-126	1.1493E-05	29.851	59.702	0.00E+00	3.43E-04	6.86E-04
Sr-90	1.3649E+00	29.851	59.702	0.00E+00	4.07E+01	8.15E+01
Tc-99	4.6656E-04	29.851	59.702	0.00E+00	1.39E-02	2.79E-02
Th-229	1.4547E-11	29.851	59.702	0.00E+00	4.34E-10	8.69E-10
Th-230	1.6617E-10	29.851	59.702	0.00E+00	4.96E-09	9.92E-09
Th-232	8.3361E-12	29.851	59.702	0.00E+00	2.49E-10	4.98E-10
Tl-208	2.1664E-08	29.851	59.702	0.00E+00	6.47E-07	1.29E-06
U-232	5.8669E-08	29.851	59.702	0.00E+00	1.75E-06	3.50E-06
U-233	3.1847E-09	29.851	59.702	0.00E+00	9.51E-08	1.90E-07
U-234	3.8769E-07	29.851	59.702	0.00E+00	1.16E-05	2.31E-05
U-235	-2.7761E-06	29.851	0.000	3.56E-03	3.48E-03	3.56E-03
U-236	1.6190E-05	29.851	59.702	0.00E+00	4.83E-04	9.67E-04
U-238	-2.8547E-09	29.851	0.000	3.76E-05	3.76E-05	3.76E-05
Y-90	1.3652E+00	29.851	59.702	0.00E+00	4.08E+01	8.15E+01
Other Radionuclides					4.93E+01	9.86E+01

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.456E+12
0.0250	9.260E+11
0.0375	8.009E+11
0.0575	8.633E+11
0.0850	5.216E+11
0.1250	3.387E+11
0.2250	4.491E+11
0.3750	1.958E+11
0.5750	3.226E+12
0.8500	3.266E+10
1.2500	3.246E+11
1.7500	8.425E+08
2.2500	1.749E+06
2.7500	5.055E+04
3.5000	3.862E+00
5.0000	1.591E+00
7.0000	1.759E-01
11.0000	1.976E-02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.21E-01	1.04E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC	SST
BOL HM Constituents:	UO2	U
BOL Enrichment %:	93.63636364	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches Pathfinder Template on all but one parameter (cladding, but substituting Stainless Steel is a good conservative assumption).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		29.851
Bounding:		59.702

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.36	
Bounding:	0.73	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBWR (SPIKES)
SNF ID #: 891
Fuel Units & Descr: 31 - 7 X 7 ROD ARRAY
Heavy Metal Mass: BOL=29.21kg ; EOL=26.99kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1966
Estimates as of: 2010
Template: Pathfinder (Light Water, SST, 60 to 100%, U)
[2]Template Burnup(MWd): 6.01
Template BOL Heavy Metal Mass (MT): 0.00012882
Template Decay Time: 35 years

Estimated Canister usage: 18"x10'
2.58

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	2.3344E-08	2,093.811	4,187.623	0.00E+00	4.89E-05	9.78E-05
Am-241	1.1135E-04	2,093.811	4,187.623	0.00E+00	2.33E-01	4.66E-01
Am-242m	8.5075E-09	2,093.811	4,187.623	0.00E+00	1.78E-05	3.56E-05
Am-243	9.8519E-10	2,093.811	4,187.623	0.00E+00	2.06E-06	4.13E-06
C-14	2.3012E-04	2,093.811	4,187.623	0.00E+00	4.82E-01	9.64E-01
Cl-36	1.2261E-06	2,093.811	4,187.623	0.00E+00	2.57E-03	5.13E-03
Cm-243	2.4875E-10	2,093.811	4,187.623	0.00E+00	5.21E-07	1.04E-06
Cm-244	2.3178E-09	2,093.811	4,187.623	0.00E+00	4.85E-06	9.71E-06
Co-60	7.0849E-02	2,093.811	4,187.623	0.00E+00	1.48E+02	2.97E+02
Cs-134	3.0266E-06	2,093.811	4,187.623	0.00E+00	6.34E-03	1.27E-02
Cs-135	3.0316E-05	2,093.811	4,187.623	0.00E+00	6.35E-02	1.27E-01
Cs-137	1.4511E+00	2,093.811	4,187.623	0.00E+00	3.04E+03	6.08E+03
Eu-154	6.6955E-04	2,093.811	4,187.623	0.00E+00	1.40E+00	2.80E+00
Eu-155	6.9850E-04	2,093.811	4,187.623	0.00E+00	1.46E+00	2.93E+00
Fe-55	1.2318E-03	2,093.811	4,187.623	0.00E+00	2.58E+00	5.16E+00
H-3	2.5141E-03	2,093.811	4,187.623	0.00E+00	5.26E+00	1.05E+01
I-129	7.3195E-07	2,093.811	4,187.623	0.00E+00	1.53E-03	3.07E-03
Kr-85	4.1281E-02	2,093.811	4,187.623	0.00E+00	8.64E+01	1.73E+02
Np-237	1.1489E-06	2,093.811	4,187.623	0.00E+00	2.41E-03	4.81E-03
Pa-231	4.5241E-08	2,093.811	4,187.623	0.00E+00	9.47E-05	1.89E-04
Pb-210	6.4476E-13	2,093.811	4,187.623	0.00E+00	1.35E-09	2.70E-09
Pm-147	1.1651E-03	2,093.811	4,187.623	0.00E+00	2.44E+00	4.88E+00
Pu-238	2.9517E-04	2,093.811	4,187.623	0.00E+00	6.18E-01	1.24E+00
Pu-239	6.6772E-04	2,093.811	4,187.623	0.00E+00	1.40E+00	2.80E+00
Pu-240	8.6839E-05	2,093.811	4,187.623	0.00E+00	1.82E-01	3.64E-01
Pu-241	7.1514E-04	2,093.811	4,187.623	0.00E+00	1.50E+00	2.99E+00
Pu-242	1.9717E-09	2,093.811	4,187.623	0.00E+00	4.13E-06	8.26E-06
Ra-226	1.7654E-12	2,093.811	4,187.623	0.00E+00	3.70E-09	7.39E-09
Ra-228	8.2928E-12	2,093.811	4,187.623	0.00E+00	1.74E-08	3.47E-08
Ru-106	1.8419E-10	2,093.811	4,187.623	0.00E+00	3.86E-07	7.71E-07
Se-79	1.3223E-05	2,093.811	4,187.623	0.00E+00	2.77E-02	5.54E-02
Sn-126	1.1493E-05	2,093.811	4,187.623	0.00E+00	2.41E-02	4.81E-02
Sr-90	1.3649E+00	2,093.811	4,187.623	0.00E+00	2.86E+03	5.72E+03
Tc-99	4.6656E-04	2,093.811	4,187.623	0.00E+00	9.77E-01	1.95E+00
Th-229	1.4547E-11	2,093.811	4,187.623	0.00E+00	3.05E-08	6.09E-08
Th-230	1.6617E-10	2,093.811	4,187.623	0.00E+00	3.48E-07	6.96E-07
Th-232	8.3361E-12	2,093.811	4,187.623	0.00E+00	1.75E-08	3.49E-08
Tl-208	2.1664E-08	2,093.811	4,187.623	0.00E+00	4.54E-05	9.07E-05
U-232	5.8669E-08	2,093.811	4,187.623	0.00E+00	1.23E-04	2.46E-04
U-233	3.1847E-09	2,093.811	4,187.623	0.00E+00	6.67E-06	1.33E-05
U-234	3.8769E-07	2,093.811	4,187.623	0.00E+00	8.12E-04	1.62E-03
U-235	-2.7761E-06	2,093.811	0.000	5.88E-02	5.30E-02	5.88E-02
U-236	1.6190E-05	2,093.811	4,187.623	0.00E+00	3.39E-02	6.78E-02
U-238	-2.8547E-09	2,093.811	0.000	6.68E-04	6.62E-04	6.68E-04
Y-90	1.3652E+00	2,093.811	4,187.623	0.00E+00	2.86E+03	5.72E+03
Other Radionuclides					3.46E+03	6.91E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.126E+14
0.0250	6.495E+13
0.0375	5.618E+13
0.0575	6.056E+13
0.0850	3.659E+13
0.1250	2.376E+13
0.2250	3.149E+13
0.3750	1.374E+13
0.5750	2.263E+14
0.8500	2.291E+12
1.2500	2.277E+13
1.7500	5.910E+10
2.2500	1.227E+08
2.7500	3.546E+06
3.5000	2.539E+02
5.0000	1.045E+02
7.0000	1.154E+01
11.0000	1.295E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.66E+01	7.31E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC-2	SST
BOL HM Constituents:	UO2	U
BOL Enrichment %:	93.18999022	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches Pathfinder Template on all but one parameter (cladding, but substituting Stainless Steel is a good conservative assumption).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	1,233.244	2,093.811
Bounding:	1,767.055	4,187.623

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.54	1.70
Bounding:	3.07	2.37

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBWR ENRICHED HEAVY
SNF ID #: 64
Fuel Units & Descr: 53 - 6 FLAT PLATES
Heavy Metal Mass: BOL=2989.20kg ; EOL=2982.96kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1966
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]**Template Burnup(MWd):** 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage: **18"x10'** 4.42

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	5,932.138	11,864.276	0.00E+00	5.21E-06	1.04E-05
Am-241	1.4352E-01	5,932.138	11,864.276	0.00E+00	8.51E+02	1.70E+03
Am-242m	2.8698E-04	5,932.138	11,864.276	0.00E+00	1.70E+00	3.40E+00
Am-243	6.2565E-04	5,932.138	11,864.276	0.00E+00	3.71E+00	7.42E+00
C-14	4.7901E-05	5,932.138	11,864.276	0.00E+00	2.84E-01	5.68E-01
Cl-36	8.0297E-07	5,932.138	11,864.276	0.00E+00	4.76E-03	9.53E-03
Cm-243	2.5081E-04	5,932.138	11,864.276	0.00E+00	1.49E+00	2.98E+00
Cm-244	4.9015E-02	5,932.138	11,864.276	0.00E+00	2.91E+02	5.82E+02
Co-60	2.5581E-03	5,932.138	11,864.276	0.00E+00	1.52E+01	3.04E+01
Cs-134	4.0536E-05	5,932.138	11,864.276	0.00E+00	2.40E-01	4.81E-01
Cs-135	1.4433E-05	5,932.138	11,864.276	0.00E+00	8.56E-02	1.71E-01
Cs-137	1.3979E+00	5,932.138	11,864.276	0.00E+00	8.29E+03	1.66E+04
Eu-154	2.0203E-02	5,932.138	11,864.276	0.00E+00	1.20E+02	2.40E+02
Eu-155	1.7684E-03	5,932.138	11,864.276	0.00E+00	1.05E+01	2.10E+01
Fe-55	4.3136E-05	5,932.138	11,864.276	0.00E+00	2.56E-01	5.12E-01
H-3	2.0769E-02	5,932.138	11,864.276	0.00E+00	1.23E+02	2.46E+02
I-129	9.8288E-07	5,932.138	11,864.276	0.00E+00	5.83E-03	1.17E-02
Kr-85	2.8214E-02	5,932.138	11,864.276	0.00E+00	1.67E+02	3.35E+02
Np-237	1.1218E-05	5,932.138	11,864.276	0.00E+00	6.65E-02	1.33E-01
Pa-231	1.3036E-09	5,932.138	11,864.276	0.00E+00	7.73E-06	1.55E-05
Pb-210	8.5078E-11	5,932.138	11,864.276	0.00E+00	5.05E-07	1.01E-06
Pm-147	3.6531E-04	5,932.138	11,864.276	0.00E+00	2.17E+00	4.33E+00
Pu-238	7.4564E-02	5,932.138	11,864.276	0.00E+00	4.42E+02	8.85E+02
Pu-239	1.1623E-02	5,932.138	11,864.276	0.00E+00	6.89E+01	1.38E+02
Pu-240	1.5132E-02	5,932.138	11,864.276	0.00E+00	8.98E+01	1.80E+02
Pu-241	9.0036E-01	5,932.138	11,864.276	0.00E+00	5.34E+03	1.07E+04
Pu-242	6.4260E-05	5,932.138	11,864.276	0.00E+00	3.81E-01	7.62E-01
Ra-226	2.2804E-10	5,932.138	11,864.276	0.00E+00	1.35E-06	2.71E-06
Ra-228	5.2713E-12	5,932.138	11,864.276	0.00E+00	3.13E-08	6.25E-08
Ru-106	6.1160E-10	5,932.138	11,864.276	0.00E+00	3.63E-06	7.26E-06
Se-79	1.2377E-05	5,932.138	11,864.276	0.00E+00	7.34E-02	1.47E-01
Sn-126	2.5210E-05	5,932.138	11,864.276	0.00E+00	1.50E-01	2.99E-01
Sr-90	9.1667E-01	5,932.138	11,864.276	0.00E+00	5.44E+03	1.09E+04
Tc-99	3.9357E-04	5,932.138	11,864.276	0.00E+00	2.33E+00	4.67E+00
Th-229	1.2057E-10	5,932.138	11,864.276	0.00E+00	7.15E-07	1.43E-06
Th-230	2.1043E-08	5,932.138	11,864.276	0.00E+00	1.25E-04	2.50E-04
Th-232	5.2972E-12	5,932.138	11,864.276	0.00E+00	3.14E-08	6.28E-08
Tl-208	1.7474E-07	5,932.138	11,864.276	0.00E+00	1.04E-03	2.07E-03
U-232	4.7368E-07	5,932.138	11,864.276	0.00E+00	2.81E-03	5.62E-03
U-233	2.5097E-08	5,932.138	11,864.276	0.00E+00	1.49E-04	2.98E-04
U-234	5.0000E-05	5,932.138	11,864.276	0.00E+00	2.97E-01	5.93E-01
U-235	-1.4489E-06	5,932.138	0.000	9.28E-02	8.42E-02	9.28E-02
U-236	7.5824E-06	5,932.138	11,864.276	0.00E+00	4.50E-02	9.00E-02
U-238	-2.6129E-07	5,932.138	0.000	9.90E-01	9.89E-01	9.90E-01
Y-90	9.1699E-01	5,932.138	11,864.276	0.00E+00	5.44E+03	1.09E+04
Other Radionuclides					7.96E+03	1.59E+04

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	6.384E+14
0.0250	1.287E+14
0.0375	1.228E+14
0.0575	1.419E+14
0.0850	7.143E+13
0.1250	4.957E+13
0.2250	6.125E+13
0.3750	2.634E+13
0.5750	6.126E+14
0.8500	8.474E+12
1.2500	8.325E+12
1.7500	2.493E+11
2.2500	4.015E+07
2.7500	8.224E+07
3.5000	8.475E+06
5.0000	3.623E+06
7.0000	4.175E+05
11.0000	4.796E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.36E+02	2.73E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U METAL	U
BOL Enrichment %:	1.436170175	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		5,932.138
Bounding:	4,782.720	11,864.276

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.06	
Bounding:	0.11	2.48

Estimated EOL HM/Given EOL HM 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBWR ENRICHED THIN
SNF ID #: 887
Fuel Units & Descr: 54 - 6 FLAT PLATES
Heavy Metal Mass: BOL= ; EOL=2194.10kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1966
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]Template Burnup(MWd): 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage: 18"x10'
4.50

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	3,516.478	3,516.478	0.00E+00	3.09E-06	3.09E-06
Am-241	1.4352E-01	3,516.478	3,516.478	0.00E+00	5.05E+02	5.05E+02
Am-242m	2.8698E-04	3,516.478	3,516.478	0.00E+00	1.01E+00	1.01E+00
Am-243	6.2565E-04	3,516.478	3,516.478	0.00E+00	2.20E+00	2.20E+00
C-14	4.7901E-05	3,516.478	3,516.478	0.00E+00	1.68E-01	1.68E-01
Cl-36	8.0297E-07	3,516.478	3,516.478	0.00E+00	2.82E-03	2.82E-03
Cm-243	2.5081E-04	3,516.478	3,516.478	0.00E+00	8.82E-01	8.82E-01
Cm-244	4.9015E-02	3,516.478	3,516.478	0.00E+00	1.72E+02	1.72E+02
Co-60	2.5581E-03	3,516.478	3,516.478	0.00E+00	9.00E+00	9.00E+00
Cs-134	4.0536E-05	3,516.478	3,516.478	0.00E+00	1.43E-01	1.43E-01
Cs-135	1.4433E-05	3,516.478	3,516.478	0.00E+00	5.08E-02	5.08E-02
Cs-137	1.3979E+00	3,516.478	3,516.478	0.00E+00	4.92E+03	4.92E+03
Eu-154	2.0203E-02	3,516.478	3,516.478	0.00E+00	7.10E+01	7.10E+01
Eu-155	1.7684E-03	3,516.478	3,516.478	0.00E+00	6.22E+00	6.22E+00
Fe-55	4.3136E-05	3,516.478	3,516.478	0.00E+00	1.52E-01	1.52E-01
H-3	2.0769E-02	3,516.478	3,516.478	0.00E+00	7.30E+01	7.30E+01
I-129	9.8288E-07	3,516.478	3,516.478	0.00E+00	3.46E-03	3.46E-03
Kr-85	2.8214E-02	3,516.478	3,516.478	0.00E+00	9.92E+01	9.92E+01
Np-237	1.1218E-05	3,516.478	3,516.478	0.00E+00	3.94E-02	3.94E-02
Pa-231	1.3036E-09	3,516.478	3,516.478	0.00E+00	4.58E-06	4.58E-06
Pb-210	8.5078E-11	3,516.478	3,516.478	0.00E+00	2.99E-07	2.99E-07
Pm-147	3.6531E-04	3,516.478	3,516.478	0.00E+00	1.28E+00	1.28E+00
Pu-238	7.4564E-02	3,516.478	3,516.478	0.00E+00	2.62E+02	2.62E+02
Pu-239	1.1623E-02	3,516.478	3,516.478	0.00E+00	4.09E+01	4.09E+01
Pu-240	1.5132E-02	3,516.478	3,516.478	0.00E+00	5.32E+01	5.32E+01
Pu-241	9.0036E-01	3,516.478	3,516.478	0.00E+00	3.17E+03	3.17E+03
Pu-242	6.4260E-05	3,516.478	3,516.478	0.00E+00	2.26E-01	2.26E-01
Ra-226	2.2804E-10	3,516.478	3,516.478	0.00E+00	8.02E-07	8.02E-07
Ra-228	5.2713E-12	3,516.478	3,516.478	0.00E+00	1.85E-08	1.85E-08
Ru-106	6.1160E-10	3,516.478	3,516.478	0.00E+00	2.15E-06	2.15E-06
Se-79	1.2377E-05	3,516.478	3,516.478	0.00E+00	4.35E-02	4.35E-02
Sn-126	2.5210E-05	3,516.478	3,516.478	0.00E+00	8.87E-02	8.87E-02
Sr-90	9.1667E-01	3,516.478	3,516.478	0.00E+00	3.22E+03	3.22E+03
Tc-99	3.9357E-04	3,516.478	3,516.478	0.00E+00	1.38E+00	1.38E+00
Th-229	1.2057E-10	3,516.478	3,516.478	0.00E+00	4.24E-07	4.24E-07
Th-230	2.1043E-08	3,516.478	3,516.478	0.00E+00	7.40E-05	7.40E-05
Th-232	5.2972E-12	3,516.478	3,516.478	0.00E+00	1.86E-08	1.86E-08
Tl-208	1.7474E-07	3,516.478	3,516.478	0.00E+00	6.14E-04	6.14E-04
U-232	4.7368E-07	3,516.478	3,516.478	0.00E+00	1.67E-03	1.67E-03
U-233	2.5097E-08	3,516.478	3,516.478	0.00E+00	8.83E-05	8.83E-05
U-234	5.0000E-05	3,516.478	3,516.478	0.00E+00	1.76E-01	1.76E-01
U-235	-1.4489E-06	3,516.478	0.000	1.52E-01	1.47E-01	1.52E-01
U-236	7.5824E-06	3,516.478	3,516.478	0.00E+00	2.67E-02	2.67E-02
U-238	-2.6129E-07	3,516.478	0.000	7.15E-01	7.14E-01	7.15E-01
Y-90	9.1699E-01	3,516.478	3,516.478	0.00E+00	3.22E+03	3.22E+03
Other Radionuclides					4.72E+03	4.72E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.892E+14
0.0250	3.815E+13
0.0375	3.639E+13
0.0575	4.204E+13
0.0850	2.117E+13
0.1250	1.469E+13
0.2250	1.816E+13
0.3750	7.806E+12
0.5750	1.816E+14
0.8500	2.512E+12
1.2500	2.467E+12
1.7500	7.390E+10
2.2500	1.191E+07
2.7500	2.438E+07
3.5000	2.514E+06
5.0000	1.075E+06
7.0000	1.239E+05
11.0000	1.423E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.09E+01	8.09E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U METAL	U
BOL Enrichment %:		0 to 5

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		3,516.478
Bounding:		3,516.478

Basis for burnup used in estimate:
Nominal burnup set equal to bounding burnup.
Bounding burnup taken from SFD and converted to MWd using BOL=2197.799kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.05	
Bounding:	0.05	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	EBWR ET-11	Fuel decay start date:[1]	1966	Estimated Canister usage:
SNF ID #:	888	Estimates as of:	2010	18"x10'
Fuel Units & Descr:	1 - 6 FLAT PLATES	Template:	PWR (Light Water, Zirc, 0 to 5%, U)	0.08
Heavy Metal Mass:	BOL=40.20kg ; EOL=38.37kg	Template Burnup(MWd):[2]	61.92	
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.00176911	
		Template Decay Time:	35 years	

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	1,744.998	3,489.996	0.00E+00	1.53E-06	3.06E-06
Am-241	1.4352E-01	1,744.998	3,489.996	0.00E+00	2.50E+02	5.01E+02
Am-242m	2.8698E-04	1,744.998	3,489.996	0.00E+00	5.01E-01	1.00E+00
Am-243	6.2565E-04	1,744.998	3,489.996	0.00E+00	1.09E+00	2.18E+00
C-14	4.7901E-05	1,744.998	3,489.996	0.00E+00	8.36E-02	1.67E-01
Cl-36	8.0297E-07	1,744.998	3,489.996	0.00E+00	1.40E-03	2.80E-03
Cm-243	2.5081E-04	1,744.998	3,489.996	0.00E+00	4.38E-01	8.75E-01
Cm-244	4.9015E-02	1,744.998	3,489.996	0.00E+00	8.55E+01	1.71E+02
Co-60	2.5581E-03	1,744.998	3,489.996	0.00E+00	4.46E+00	8.93E+00
Cs-134	4.0536E-05	1,744.998	3,489.996	0.00E+00	7.07E-02	1.41E-01
Cs-135	1.4433E-05	1,744.998	3,489.996	0.00E+00	2.52E-02	5.04E-02
Cs-137	1.3979E+00	1,744.998	3,489.996	0.00E+00	2.44E+03	4.88E+03
Eu-154	2.0203E-02	1,744.998	3,489.996	0.00E+00	3.53E+01	7.05E+01
Eu-155	1.7684E-03	1,744.998	3,489.996	0.00E+00	3.09E+00	6.17E+00
Fe-55	4.3136E-05	1,744.998	3,489.996	0.00E+00	7.53E-02	1.51E-01
H-3	2.0769E-02	1,744.998	3,489.996	0.00E+00	3.62E+01	7.25E+01
I-129	9.8288E-07	1,744.998	3,489.996	0.00E+00	1.72E-03	3.43E-03
Kr-85	2.8214E-02	1,744.998	3,489.996	0.00E+00	4.92E+01	9.85E+01
Np-237	1.1218E-05	1,744.998	3,489.996	0.00E+00	1.96E-02	3.91E-02
Pa-231	1.3036E-09	1,744.998	3,489.996	0.00E+00	2.27E-06	4.55E-06
Pb-210	8.5078E-11	1,744.998	3,489.996	0.00E+00	1.48E-07	2.97E-07
Pm-147	3.6531E-04	1,744.998	3,489.996	0.00E+00	6.37E-01	1.27E+00
Pu-238	7.4564E-02	1,744.998	3,489.996	0.00E+00	1.30E+02	2.60E+02
Pu-239	1.1623E-02	1,744.998	3,489.996	0.00E+00	2.03E+01	4.06E+01
Pu-240	1.5132E-02	1,744.998	3,489.996	0.00E+00	2.64E+01	5.28E+01
Pu-241	9.0036E-01	1,744.998	3,489.996	0.00E+00	1.57E+03	3.14E+03
Pu-242	6.4260E-05	1,744.998	3,489.996	0.00E+00	1.12E-01	2.24E-01
Ra-226	2.2804E-10	1,744.998	3,489.996	0.00E+00	3.98E-07	7.96E-07
Ra-228	5.2713E-12	1,744.998	3,489.996	0.00E+00	9.20E-09	1.84E-08
Ru-106	6.1160E-10	1,744.998	3,489.996	0.00E+00	1.07E-06	2.13E-06
Se-79	1.2377E-05	1,744.998	3,489.996	0.00E+00	2.16E-02	4.32E-02
Sn-126	2.5210E-05	1,744.998	3,489.996	0.00E+00	4.40E-02	8.80E-02
Sr-90	9.1667E-01	1,744.998	3,489.996	0.00E+00	1.60E+03	3.20E+03
Tc-99	3.9357E-04	1,744.998	3,489.996	0.00E+00	6.87E-01	1.37E+00
Th-229	1.2057E-10	1,744.998	3,489.996	0.00E+00	2.10E-07	4.21E-07
Th-230	2.1043E-08	1,744.998	3,489.996	0.00E+00	3.67E-05	7.34E-05
Th-232	5.2972E-12	1,744.998	3,489.996	0.00E+00	9.24E-09	1.85E-08
Tl-208	1.7474E-07	1,744.998	3,489.996	0.00E+00	3.05E-04	6.10E-04
U-232	4.7368E-07	1,744.998	3,489.996	0.00E+00	8.27E-04	1.65E-03
U-233	2.5097E-08	1,744.998	3,489.996	0.00E+00	4.38E-05	8.76E-05
U-234	5.0000E-05	1,744.998	3,489.996	0.00E+00	8.72E-02	1.74E-01
U-235	-1.4489E-06	1,744.998	0.000	1.26E-03	0.00E+00	1.26E-03
U-236	7.5824E-06	1,744.998	3,489.996	0.00E+00	1.32E-02	2.65E-02
U-238	-2.6129E-07	1,744.998	0.000	1.33E-02	1.29E-02	1.33E-02
Y-90	9.1699E-01	1,744.998	3,489.996	0.00E+00	1.60E+03	3.20E+03
Other Radionuclides					2.34E+03	4.68E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.878E+14
0.0250	3.787E+13
0.0375	3.612E+13
0.0575	4.173E+13
0.0850	2.101E+13
0.1250	1.458E+13
0.2250	1.802E+13
0.3750	7.747E+12
0.5750	1.802E+14
0.8500	2.493E+12
1.2500	2.449E+12
1.7500	7.334E+10
2.2500	1.181E+07
2.7500	2.419E+07
3.5000	2.491E+06
5.0000	1.065E+06
7.0000	1.227E+05
11.0000	1.410E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
4.01E+01	8.03E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U METAL	U
BOL Enrichment %:	1.447761165	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,744.998	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	64.320	3,489.996	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.24	
Bounding:	2.48	54.26

Estimated EOL HM/Given EOL HM: 1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EBWR NORMAL HEAVY
SNF ID #: 889
Fuel Units & Descr: 11 - 6 FLAT PLATES
Heavy Metal Mass: BOL=620.40kg ; EOL=566.14kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1966
Estimates as of: 2010
Template: PWR (Light Water, Zirc, 0 to 5%, U)
[2]**Template Burnup(MWd):** 61.92
Template BOL Heavy Metal Mass (MT): 0.00176911
Template Decay Time: 35 years

Estimated Canister usage:
18"x10'
0.92

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	51,594.224	103,188.448	0.00E+00	4.53E-05	9.06E-05
Am-241	1.4352E-01	51,594.224	103,188.448	0.00E+00	7.41E+03	1.48E+04
Am-242m	2.8698E-04	51,594.224	103,188.448	0.00E+00	1.48E+01	2.96E+01
Am-243	6.2565E-04	51,594.224	103,188.448	0.00E+00	3.23E+01	6.46E+01
C-14	4.7901E-05	51,594.224	103,188.448	0.00E+00	2.47E+00	4.94E+00
Cl-36	8.0297E-07	51,594.224	103,188.448	0.00E+00	4.14E-02	8.29E-02
Cm-243	2.5081E-04	51,594.224	103,188.448	0.00E+00	1.29E+01	2.59E+01
Cm-244	4.9015E-02	51,594.224	103,188.448	0.00E+00	2.53E+03	5.06E+03
Co-60	2.5581E-03	51,594.224	103,188.448	0.00E+00	1.32E+02	2.64E+02
Cs-134	4.0536E-05	51,594.224	103,188.448	0.00E+00	2.09E+00	4.18E+00
Cs-135	1.4433E-05	51,594.224	103,188.448	0.00E+00	7.45E-01	1.49E+00
Cs-137	1.3979E+00	51,594.224	103,188.448	0.00E+00	7.21E+04	1.44E+05
Eu-154	2.0203E-02	51,594.224	103,188.448	0.00E+00	1.04E+03	2.08E+03
Eu-155	1.7684E-03	51,594.224	103,188.448	0.00E+00	9.12E+01	1.82E+02
Fe-55	4.3136E-05	51,594.224	103,188.448	0.00E+00	2.23E+00	4.45E+00
H-3	2.0769E-02	51,594.224	103,188.448	0.00E+00	1.07E+03	2.14E+03
I-129	9.8288E-07	51,594.224	103,188.448	0.00E+00	5.07E-02	1.01E-01
Kr-85	2.8214E-02	51,594.224	103,188.448	0.00E+00	1.46E+03	2.91E+03
Np-237	1.1218E-05	51,594.224	103,188.448	0.00E+00	5.79E-01	1.16E+00
Pa-231	1.3036E-09	51,594.224	103,188.448	0.00E+00	6.73E-05	1.35E-04
Pb-210	8.5078E-11	51,594.224	103,188.448	0.00E+00	4.39E-06	8.78E-06
Pm-147	3.6531E-04	51,594.224	103,188.448	0.00E+00	1.88E+01	3.77E+01
Pu-238	7.4564E-02	51,594.224	103,188.448	0.00E+00	3.85E+03	7.69E+03
Pu-239	1.1623E-02	51,594.224	103,188.448	0.00E+00	6.00E+02	1.20E+03
Pu-240	1.5132E-02	51,594.224	103,188.448	0.00E+00	7.81E+02	1.56E+03
Pu-241	9.0036E-01	51,594.224	103,188.448	0.00E+00	4.65E+04	9.29E+04
Pu-242	6.4260E-05	51,594.224	103,188.448	0.00E+00	3.32E+00	6.63E+00
Ra-226	2.2804E-10	51,594.224	103,188.448	0.00E+00	1.18E-05	2.35E-05
Ra-228	5.2713E-12	51,594.224	103,188.448	0.00E+00	2.72E-07	5.44E-07
Ru-106	6.1160E-10	51,594.224	103,188.448	0.00E+00	3.16E-05	6.31E-05
Se-79	1.2377E-05	51,594.224	103,188.448	0.00E+00	6.39E-01	1.28E+00
Sn-126	2.5210E-05	51,594.224	103,188.448	0.00E+00	1.30E+00	2.60E+00
Sr-90	9.1667E-01	51,594.224	103,188.448	0.00E+00	4.73E+04	9.46E+04
Tc-99	3.9357E-04	51,594.224	103,188.448	0.00E+00	2.03E+01	4.06E+01
Th-229	1.2057E-10	51,594.224	103,188.448	0.00E+00	6.22E-06	1.24E-05
Th-230	2.1043E-08	51,594.224	103,188.448	0.00E+00	1.09E-03	2.17E-03
Th-232	5.2972E-12	51,594.224	103,188.448	0.00E+00	2.73E-07	5.47E-07
Tl-208	1.7474E-07	51,594.224	103,188.448	0.00E+00	9.02E-03	1.80E-02
U-232	4.7368E-07	51,594.224	103,188.448	0.00E+00	2.44E-02	4.89E-02
U-233	2.5097E-08	51,594.224	103,188.448	0.00E+00	1.29E-03	2.59E-03
U-234	5.0000E-05	51,594.224	103,188.448	0.00E+00	2.58E+00	5.16E+00
U-235	-1.4489E-06	51,594.224	0.000	9.56E-03	0.00E+00	9.56E-03
U-236	7.5824E-06	51,594.224	103,188.448	0.00E+00	3.91E-01	7.82E-01
U-238	-2.6129E-07	51,594.224	0.000	2.07E-01	1.94E-01	2.07E-01
Y-90	9.1699E-01	51,594.224	103,188.448	0.00E+00	4.73E+04	9.46E+04
Other Radionuclides					6.93E+04	1.39E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	5.552E+15
0.0250	1.120E+15
0.0375	1.068E+15
0.0575	1.234E+15
0.0850	6.212E+14
0.1250	4.311E+14
0.2250	5.327E+14
0.3750	2.291E+14
0.5750	5.328E+15
0.8500	7.370E+13
1.2500	7.240E+13
1.7500	2.168E+12
2.2500	3.492E+08
2.7500	7.152E+08
3.5000	7.366E+07
5.0000	3.149E+07
7.0000	3.629E+06
11.0000	4.168E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.19E+03	2.37E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U METAL	U
BOL Enrichment %:	0.712765938	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		51,594.224	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	992.640	103,188.448	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	2.38	
Bounding:	4.75	103.95

Estimated EOL HM/Given EOL HM
1.05

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	EBWR NORMAL THIN	[1]Fuel decay start date:	1966
SNF ID #:	890	Estimates as of:	2010
Fuel Units & Descr:	7 - 6 FLAT PLATES	Template:	PWR (Light Water, Zirc, 0 to 5%, U)
Heavy Metal Mass:	BOL=281.40kg : EOL=279.08kg	[2]Template Burnup(MWd):	61.92
ROD Storage Site:	INEEL	Template BOL Heavy Metal Mass (MT):	0.00176911
		Template Decay Time:	35 years

Estimated Canister usage:

18"x10'
0.58

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.7758E-10	2,210.006	4,420.012	0.00E+00	1.94E-06	3.88E-06
Am-241	1.4352E-01	2,210.006	4,420.012	0.00E+00	3.17E+02	6.34E+02
Am-242m	2.8698E-04	2,210.006	4,420.012	0.00E+00	6.34E-01	1.27E+00
Am-243	6.2565E-04	2,210.006	4,420.012	0.00E+00	1.38E+00	2.77E+00
C-14	4.7901E-05	2,210.006	4,420.012	0.00E+00	1.06E-01	2.12E-01
Cl-36	8.0297E-07	2,210.006	4,420.012	0.00E+00	1.77E-03	3.55E-03
Cm-243	2.5081E-04	2,210.006	4,420.012	0.00E+00	5.54E-01	1.11E+00
Cm-244	4.9015E-02	2,210.006	4,420.012	0.00E+00	1.08E+02	2.17E+02
Co-60	2.5581E-03	2,210.006	4,420.012	0.00E+00	5.65E+00	1.13E+01
Cs-134	4.0536E-05	2,210.006	4,420.012	0.00E+00	8.96E-02	1.79E-01
Cs-135	1.4433E-05	2,210.006	4,420.012	0.00E+00	3.19E-02	6.38E-02
Cs-137	1.3979E+00	2,210.006	4,420.012	0.00E+00	3.09E+03	6.18E+03
Eu-154	2.0203E-02	2,210.006	4,420.012	0.00E+00	4.46E+01	8.93E+01
Eu-155	1.7684E-03	2,210.006	4,420.012	0.00E+00	3.91E+00	7.82E+00
Fe-55	4.3136E-05	2,210.006	4,420.012	0.00E+00	9.53E-02	1.91E-01
H-3	2.0769E-02	2,210.006	4,420.012	0.00E+00	4.59E+01	9.18E+01
I-129	9.8288E-07	2,210.006	4,420.012	0.00E+00	2.17E-03	4.34E-03
Kr-85	2.8214E-02	2,210.006	4,420.012	0.00E+00	6.24E+01	1.25E+02
Np-237	1.1218E-05	2,210.006	4,420.012	0.00E+00	2.48E-02	4.96E-02
Pa-231	1.3036E-09	2,210.006	4,420.012	0.00E+00	2.88E-06	5.76E-06
Pb-210	8.5078E-11	2,210.006	4,420.012	0.00E+00	1.88E-07	3.76E-07
Pm-147	3.6531E-04	2,210.006	4,420.012	0.00E+00	8.07E-01	1.61E+00
Pu-238	7.4564E-02	2,210.006	4,420.012	0.00E+00	1.65E+02	3.30E+02
Pu-239	1.1623E-02	2,210.006	4,420.012	0.00E+00	2.57E+01	5.14E+01
Pu-240	1.5132E-02	2,210.006	4,420.012	0.00E+00	3.34E+01	6.69E+01
Pu-241	9.0036E-01	2,210.006	4,420.012	0.00E+00	1.99E+03	3.98E+03
Pu-242	6.4260E-05	2,210.006	4,420.012	0.00E+00	1.42E-01	2.84E-01
Ra-226	2.2804E-10	2,210.006	4,420.012	0.00E+00	5.04E-07	1.01E-06
Ra-228	5.2713E-12	2,210.006	4,420.012	0.00E+00	1.16E-08	2.33E-08
Ru-106	6.1160E-10	2,210.006	4,420.012	0.00E+00	1.35E-06	2.70E-06
Se-79	1.2377E-05	2,210.006	4,420.012	0.00E+00	2.74E-02	5.47E-02
Sn-126	2.5210E-05	2,210.006	4,420.012	0.00E+00	5.57E-02	1.11E-01
Sr-90	9.1667E-01	2,210.006	4,420.012	0.00E+00	2.03E+03	4.05E+03
Tc-99	3.9357E-04	2,210.006	4,420.012	0.00E+00	8.70E-01	1.74E+00
Th-229	1.2057E-10	2,210.006	4,420.012	0.00E+00	2.66E-07	5.33E-07
Th-230	2.1043E-08	2,210.006	4,420.012	0.00E+00	4.65E-05	9.30E-05
Th-232	5.2972E-12	2,210.006	4,420.012	0.00E+00	1.17E-08	2.34E-08
Tl-208	1.7474E-07	2,210.006	4,420.012	0.00E+00	3.86E-04	7.72E-04
U-232	4.7368E-07	2,210.006	4,420.012	0.00E+00	1.05E-03	2.09E-03
U-233	2.5097E-08	2,210.006	4,420.012	0.00E+00	5.55E-05	1.11E-04
U-234	5.0000E-05	2,210.006	4,420.012	0.00E+00	1.11E-01	2.21E-01
U-235	-1.4489E-06	2,210.006	0.000	4.36E-03	1.15E-03	4.36E-03
U-236	7.5824E-06	2,210.006	4,420.012	0.00E+00	1.68E-02	3.35E-02
U-238	-2.6129E-07	2,210.006	0.000	9.39E-02	9.33E-02	9.39E-02
Y-90	9.1699E-01	2,210.006	4,420.012	0.00E+00	2.03E+03	4.05E+03
Other Radionuclides					2.97E+03	5.93E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.378E+14
0.0250	4.796E+13
0.0375	4.574E+13
0.0575	5.285E+13
0.0850	2.661E+13
0.1250	1.847E+13
0.2250	2.282E+13
0.3750	9.812E+12
0.5750	2.282E+14
0.8500	3.157E+12
1.2500	3.101E+12
1.7500	9.288E+10
2.2500	1.496E+07
2.7500	3.064E+07
3.5000	3.156E+06
5.0000	1.349E+06
7.0000	1.555E+05
11.0000	1.786E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.08E+01	1.02E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U METAL	U
BOL Enrichment %:	0.716417866	0 to 5

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		2,210.006	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	450.240	4,420.012	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.22	
Bounding:	0.45	9.82

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ENEA SALUGGIA (ITALY)
SNF ID #: 574
Fuel Units & Descr: 116 - MTR TYPE
Heavy Metal Mass: BOL=18.56kg ; EOL=17.23kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1996
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 10 years

Estimated Canister usage: 18"x10'
3.22

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.8404E-10	1,263.324	2,526.648	0.00E+00	3.59E-07	7.18E-07
Am-241	1.4935E-03	1,263.324	2,526.648	0.00E+00	1.89E+00	3.77E+00
Am-242m	4.4390E-07	1,263.324	2,526.648	0.00E+00	5.61E-04	1.12E-03
Am-243	1.4913E-06	1,263.324	2,526.648	0.00E+00	1.88E-03	3.77E-03
C-14	5.7217E-09	1,263.324	2,526.648	0.00E+00	7.23E-06	1.45E-05
Cl-36	1.3124E-32	1,263.324	2,526.648	0.00E+00	1.66E-29	3.32E-29
Cm-243	2.0967E-07	1,263.324	2,526.648	0.00E+00	2.65E-04	5.30E-04
Cm-244	4.3001E-05	1,263.324	2,526.648	0.00E+00	5.43E-02	1.09E-01
Co-60	1.9798E-05	1,263.324	2,526.648	0.00E+00	2.50E-02	5.00E-02
Cs-134	9.0795E-02	1,263.324	2,526.648	0.00E+00	1.15E+02	2.29E+02
Cs-135	3.4477E-06	1,263.324	2,526.648	0.00E+00	4.36E-03	8.71E-03
Cs-137	2.5588E+00	1,263.324	2,526.648	0.00E+00	3.23E+03	6.47E+03
Eu-154	5.4847E-02	1,263.324	2,526.648	0.00E+00	6.93E+01	1.39E+02
Eu-155	1.9469E-02	1,263.324	2,526.648	0.00E+00	2.46E+01	4.92E+01
Fe-55	1.7797E-03	1,263.324	2,526.648	0.00E+00	2.25E+00	4.50E+00
H-3	8.0065E-03	1,263.324	2,526.648	0.00E+00	1.01E+01	2.02E+01
I-129	7.5300E-07	1,263.324	2,526.648	0.00E+00	9.51E-04	1.90E-03
Kr-85	2.0705E-01	1,263.324	2,526.648	0.00E+00	2.62E+02	5.23E+02
Np-237	9.5507E-06	1,263.324	2,526.648	0.00E+00	1.21E-02	2.41E-02
Pa-231	1.2740E-09	1,263.324	2,526.648	0.00E+00	1.61E-06	3.22E-06
Pb-210	1.1838E-11	1,263.324	2,526.648	0.00E+00	1.50E-08	2.99E-08
Pm-147	6.7974E-01	1,263.324	2,526.648	0.00E+00	8.59E+02	1.72E+03
Pu-238	1.9755E-02	1,263.324	2,526.648	0.00E+00	2.50E+01	4.99E+01
Pu-239	4.2838E-04	1,263.324	2,526.648	0.00E+00	5.41E-01	1.08E+00
Pu-240	2.4390E-04	1,263.324	2,526.648	0.00E+00	3.08E-01	6.16E-01
Pu-241	5.4058E-02	1,263.324	2,526.648	0.00E+00	6.83E+01	1.37E+02
Pu-242	3.6329E-07	1,263.324	2,526.648	0.00E+00	4.59E-04	9.18E-04
Ra-226	8.3742E-11	1,263.324	2,526.648	0.00E+00	1.06E-07	2.12E-07
Ra-228	5.7734E-15	1,263.324	2,526.648	0.00E+00	7.29E-12	1.46E-11
Ru-106	6.1356E-03	1,263.324	2,526.648	0.00E+00	7.75E+00	1.55E+01
Se-79	1.2936E-05	1,263.324	2,526.648	0.00E+00	1.63E-02	3.27E-02
Sn-126	1.1574E-05	1,263.324	2,526.648	0.00E+00	1.46E-02	2.92E-02
Sr-90	2.4417E+00	1,263.324	2,526.648	0.00E+00	3.08E+03	6.17E+03
Tc-99	4.2239E-04	1,263.324	2,526.648	0.00E+00	5.34E-01	1.07E+00
Th-229	2.8568E-12	1,263.324	2,526.648	0.00E+00	3.61E-09	7.22E-09
Th-230	2.5310E-08	1,263.324	2,526.648	0.00E+00	3.20E-05	6.40E-05
Th-232	1.1631E-14	1,263.324	2,526.648	0.00E+00	1.47E-11	2.94E-11
Tl-208	4.6705E-08	1,263.324	2,526.648	0.00E+00	5.90E-05	1.18E-04
U-232	1.3151E-07	1,263.324	2,526.648	0.00E+00	1.66E-04	3.32E-04
U-233	2.1650E-09	1,263.324	2,526.648	0.00E+00	2.74E-06	5.47E-06
U-234	1.8399E-04	1,263.324	2,526.648	0.00E+00	2.32E-01	4.65E-01
U-235	-2.7235E-06	1,263.324	0.000	3.74E-02	3.39E-02	3.74E-02
U-236	1.5493E-05	1,263.324	2,526.648	0.00E+00	1.96E-02	3.91E-02
U-238	-4.2851E-09	1,263.324	0.000	4.29E-04	4.23E-04	4.29E-04
Y-90	2.4423E+00	1,263.324	2,526.648	0.00E+00	3.09E+03	6.17E+03
Other Radionuclides					3.14E+03	6.28E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.436E+14
0.0250	7.232E+13
0.0375	6.305E+13
0.0575	6.661E+13
0.0850	4.052E+13
0.1250	2.835E+13
0.2250	3.480E+13
0.3750	1.560E+13
0.5750	2.532E+14
0.8500	1.235E+13
1.2500	4.020E+12
1.7500	1.468E+11
2.2500	9.705E+09
2.7500	1.354E+08
3.5000	1.613E+07
5.0000	1.340E+03
7.0000	1.490E+02
11.0000	1.676E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
4.00E+01	8.00E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.125	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,263.324	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		2,526.648	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.22	
Bounding:	0.43	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ENEA SALUGGIA (ITALY)
SNF ID #: 760
Fuel Units & Descr: 32 - MTR TYPE
Heavy Metal Mass: BOL=22.40kg ; EOL=21.57kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 1996
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 10 years

Estimated Canister usage:

18"x10'
0.89

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	2.8404E-10	787.920	1,575.840	0.00E+00	2.24E-07	4.48E-07
Am-241	1.4935E-03	787.920	1,575.840	0.00E+00	1.18E+00	2.35E+00
Am-242m	4.4390E-07	787.920	1,575.840	0.00E+00	3.50E-04	7.00E-04
Am-243	1.4913E-06	787.920	1,575.840	0.00E+00	1.18E-03	2.35E-03
C-14	5.7217E-09	787.920	1,575.840	0.00E+00	4.51E-06	9.02E-06
Cl-36	1.3124E-32	787.920	1,575.840	0.00E+00	1.03E-29	2.07E-29
Cm-243	2.0967E-07	787.920	1,575.840	0.00E+00	1.65E-04	3.30E-04
Cm-244	4.3001E-05	787.920	1,575.840	0.00E+00	3.39E-02	6.78E-02
Co-60	1.9798E-05	787.920	1,575.840	0.00E+00	1.56E-02	3.12E-02
Cs-134	9.0795E-02	787.920	1,575.840	0.00E+00	7.15E+01	1.43E+02
Cs-135	3.4477E-06	787.920	1,575.840	0.00E+00	2.72E-03	5.43E-03
Cs-137	2.5588E+00	787.920	1,575.840	0.00E+00	2.02E+03	4.03E+03
Eu-154	5.4847E-02	787.920	1,575.840	0.00E+00	4.32E+01	8.64E+01
Eu-155	1.9469E-02	787.920	1,575.840	0.00E+00	1.53E+01	3.07E+01
Fe-55	1.7797E-03	787.920	1,575.840	0.00E+00	1.40E+00	2.80E+00
H-3	8.0065E-03	787.920	1,575.840	0.00E+00	6.31E+00	1.26E+01
I-129	7.5300E-07	787.920	1,575.840	0.00E+00	5.93E-04	1.19E-03
Kr-85	2.0705E-01	787.920	1,575.840	0.00E+00	1.63E+02	3.26E+02
Np-237	9.5507E-06	787.920	1,575.840	0.00E+00	7.53E-03	1.51E-02
Pa-231	1.2740E-09	787.920	1,575.840	0.00E+00	1.00E-06	2.01E-06
Pb-210	1.1838E-11	787.920	1,575.840	0.00E+00	9.33E-09	1.87E-08
Pm-147	6.7974E-01	787.920	1,575.840	0.00E+00	5.36E+02	1.07E+03
Pu-238	1.9755E-02	787.920	1,575.840	0.00E+00	1.56E+01	3.11E+01
Pu-239	4.2838E-04	787.920	1,575.840	0.00E+00	3.38E-01	6.75E-01
Pu-240	2.4390E-04	787.920	1,575.840	0.00E+00	1.92E-01	3.84E-01
Pu-241	5.4058E-02	787.920	1,575.840	0.00E+00	4.26E+01	8.52E+01
Pu-242	3.6329E-07	787.920	1,575.840	0.00E+00	2.86E-04	5.72E-04
Ra-226	8.3742E-11	787.920	1,575.840	0.00E+00	6.60E-08	1.32E-07
Ra-228	5.7734E-15	787.920	1,575.840	0.00E+00	4.55E-12	9.10E-12
Ru-106	6.1356E-03	787.920	1,575.840	0.00E+00	4.83E+00	9.67E+00
Se-79	1.2936E-05	787.920	1,575.840	0.00E+00	1.02E-02	2.04E-02
Sn-126	1.1574E-05	787.920	1,575.840	0.00E+00	9.12E-03	1.82E-02
Sr-90	2.4417E+00	787.920	1,575.840	0.00E+00	1.92E+03	3.85E+03
Tc-99	4.2239E-04	787.920	1,575.840	0.00E+00	3.33E-01	6.66E-01
Th-229	2.8568E-12	787.920	1,575.840	0.00E+00	2.25E-09	4.50E-09
Th-230	2.5310E-08	787.920	1,575.840	0.00E+00	1.99E-05	3.99E-05
Th-232	1.1631E-14	787.920	1,575.840	0.00E+00	9.16E-12	1.83E-11
Tl-208	4.6705E-08	787.920	1,575.840	0.00E+00	3.68E-05	7.36E-05
U-232	1.3151E-07	787.920	1,575.840	0.00E+00	1.04E-04	2.07E-04
U-233	2.1650E-09	787.920	1,575.840	0.00E+00	1.71E-06	3.41E-06
U-234	1.8399E-04	787.920	1,575.840	0.00E+00	1.45E-01	2.90E-01
U-235	-2.7235E-06	787.920	0.000	9.68E-03	7.54E-03	9.68E-03
U-236	1.5493E-05	787.920	1,575.840	0.00E+00	1.22E-02	2.44E-02
U-238	-4.2851E-09	787.920	0.000	6.02E-03	6.02E-03	6.02E-03
Y-90	2.4423E+00	787.920	1,575.840	0.00E+00	1.92E+03	3.85E+03
Other Radionuclides					1.96E+03	3.92E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.143E+14
0.0250	4.510E+13
0.0375	3.933E+13
0.0575	4.154E+13
0.0850	2.527E+13
0.1250	1.768E+13
0.2250	2.170E+13
0.3750	9.727E+12
0.5750	1.579E+14
0.8500	7.703E+12
1.2500	2.507E+12
1.7500	9.156E+10
2.2500	6.053E+09
2.7500	8.445E+07
3.5000	1.006E+07
5.0000	8.490E+02
7.0000	9.440E+01
11.0000	1.062E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.49E+01	4.99E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		787.920
Bounding:		1,575.840

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.11	
Bounding:	0.22	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: EPRI
SNF ID #: 67
Fuel Units & Descr: 1 - CANISTER OF SCRAP
Heavy Metal Mass: BOL= ; EOL=.02kg
ROD Storage Site: INEEL

[1]**Fuel decay start date:** 1966
Estimates as of: 2010
Template: (Worst Case)
[2]**Template Burnup(MWd):** 62.5
Template BOL Heavy Metal Mass (MT): 0.00186865
Template Decay Time: 35 years

Estimated Canister usage:
18"x10'
0.03

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	2.3072E-06	19.007	19.007	0.00E+00	4.39E-05	4.39E-05
Am-241	8.4448E+00	19.007	19.007	0.00E+00	1.61E+02	1.61E+02
Am-242m	1.6848E-02	19.007	19.007	0.00E+00	3.20E-01	3.20E-01
Am-243	1.6320E-02	19.007	19.007	0.00E+00	3.10E-01	3.10E-01
C-14	1.2090E-01	19.007	19.007	0.00E+00	2.30E+00	2.30E+00
Cl-36	2.2849E-03	19.007	19.007	0.00E+00	4.34E-02	4.34E-02
Cm-243	8.6624E-04	19.007	19.007	0.00E+00	1.65E-02	1.65E-02
Cm-244	1.6848E-01	19.007	19.007	0.00E+00	3.20E+00	3.20E+00
Co-60	2.8086E+01	19.007	19.007	0.00E+00	5.34E+02	5.34E+02
Cs-134	3.4148E-04	19.007	19.007	0.00E+00	6.49E-03	6.49E-03
Cs-135	4.3976E-04	19.007	19.007	0.00E+00	8.36E-03	8.36E-03
Cs-137	2.1049E+01	19.007	19.007	0.00E+00	4.00E+02	4.00E+02
Eu-154	1.2500E+00	19.007	19.007	0.00E+00	2.38E+01	2.38E+01
Eu-155	6.8986E-02	19.007	19.007	0.00E+00	1.31E+00	1.31E+00
Fe-55	2.9308E-01	19.007	19.007	0.00E+00	5.57E+00	5.57E+00
H-3	2.4311E-01	19.007	19.007	0.00E+00	4.62E+00	4.62E+00
I-129	1.0618E-05	19.007	19.007	0.00E+00	2.02E-04	2.02E-04
Kr-85	5.9882E-01	19.007	19.007	0.00E+00	1.14E+01	1.14E+01
Np-237	1.5668E-04	19.007	19.007	0.00E+00	2.98E-03	2.98E-03
Pa-231	2.8656E-06	19.007	19.007	0.00E+00	5.45E-05	5.45E-05
Pb-210	2.3918E-08	19.007	19.007	0.00E+00	4.55E-07	4.55E-07
Pm-147	1.6900E-02	19.007	19.007	0.00E+00	3.21E-01	3.21E-01
Pu-238	-8.6123E-01	19.007	0.000	5.14E+00	0.00E+00	5.14E+00
Pu-239	-4.8440E-02	19.007	0.000	6.22E-01	0.00E+00	6.22E-01
Pu-240	-3.0095E-01	19.007	0.000	7.94E-01	0.00E+00	7.94E-01
Pu-241	-1.0411E+02	19.007	0.000	2.04E+02	0.00E+00	2.04E+02
Pu-242	-1.1381E-04	19.007	0.000	3.44E-03	1.27E-03	3.44E-03
Ra-226	6.4400E-08	19.007	19.007	0.00E+00	1.22E-06	1.22E-06
Ra-228	5.9952E-07	19.007	19.007	0.00E+00	1.14E-05	1.14E-05
Ru-106	8.5526E-07	19.007	19.007	0.00E+00	1.63E-05	1.63E-05
Se-79	1.9181E-04	19.007	19.007	0.00E+00	3.65E-03	3.65E-03
Sn-126	1.6671E-04	19.007	19.007	0.00E+00	3.17E-03	3.17E-03
Sr-90	1.9799E+01	19.007	19.007	0.00E+00	3.76E+02	3.76E+02
Tc-99	6.7678E-03	19.007	19.007	0.00E+00	1.29E-01	1.29E-01
Th-229	1.7488E-06	19.007	19.007	0.00E+00	3.32E-05	3.32E-05
Th-230	5.8704E-06	19.007	19.007	0.00E+00	1.12E-04	1.12E-04
Th-232	6.0208E-07	19.007	19.007	0.00E+00	1.14E-05	1.14E-05
Tl-208	8.7573E-05	19.007	19.007	0.00E+00	1.66E-03	1.66E-03
U-232	2.3706E-04	19.007	19.007	0.00E+00	4.51E-03	4.51E-03
U-233	3.6128E-04	19.007	19.007	0.00E+00	6.87E-03	6.87E-03
U-234	1.2788E-02	19.007	19.007	0.00E+00	2.43E-01	2.43E-01
U-235	5.8772E-04	19.007	19.007	0.00E+00	1.12E-02	1.12E-02
U-236	2.3485E-04	19.007	19.007	0.00E+00	4.46E-03	4.46E-03
U-238	1.1741E-04	19.007	19.007	0.00E+00	2.23E-03	2.23E-03
Y-90	1.9804E+01	19.007	19.007	0.00E+00	3.76E+02	3.76E+02
Other Radionuclides					1.17E+03	1.17E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.329E+13
0.0250	4.635E+12
0.0375	4.049E+12
0.0575	6.370E+12
0.0850	2.486E+12
0.1250	1.949E+12
0.2250	2.154E+12
0.3750	9.213E+11
0.5750	1.498E+13
0.8500	5.725E+11
1.2500	4.002E+13
1.7500	1.770E+10
2.2500	2.099E+08
2.7500	5.914E+07
3.5000	4.734E+04
5.0000	2.010E+04
7.0000	2.302E+03
11.0000	2.634E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.87E+01	1.90E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used	Basis for Parameter Differences:
Reactor Moderator:	LIGHT WATER	(Worst Case)	This Template was used for the following reasons:
Fuel Cladding:	SST	SST/Inconel	This fuel didn't closely match any existing templates, therefore the worst case template was used.
BOL HM Constituents:	PuO2	U, Th, & Pu	
BOL Enrichment %:		0 to 100	

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		19.007	Nominal burnup set equal to bounding burnup.
Bounding:		19.007	Bounding burnup estimated by assuming BOL heavy metal mass was twice EOL.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup	Estimated EOL HM/Given EOL HM
Nominal:	14.21		601.11
Bounding:	14.21		

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	ERR	**[1]Fuel decay start date:**	1966	
SNF ID #:	68	**Estimates as of:**	2010	
Fuel Units & Descr:	190 - 5 X 5 ROD ARRAY	**Template:**	LWBR (Light Water, Zirc, 60 to 100%, Th and U)	
Heavy Metal Mass:	BOL=5079.65kg ; EOL=5032.83kg	**[2]Template Burnup(MWd):**	10269.14	
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.45991251	
		Template Decay Time:	35 years	

Estimated Canister usage:

18"x10'
10.56

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	9.7360E-05	45,559.594	91,119.189	0.00E+00	4.44E+00	8.87E+00
Am-241	2.4345E-04	45,559.594	91,119.189	0.00E+00	1.11E+01	2.22E+01
Am-242m	1.4821E-06	45,559.594	91,119.189	0.00E+00	6.75E-02	1.35E-01
Am-243	3.1152E-07	45,559.594	91,119.189	0.00E+00	1.42E-02	2.84E-02
C-14	9.2432E-05	45,559.594	91,119.189	0.00E+00	4.21E+00	8.42E+00
Cl-36	1.8103E-06	45,559.594	91,119.189	0.00E+00	8.25E-02	1.65E-01
Cm-243	3.0597E-07	45,559.594	91,119.189	0.00E+00	1.39E-02	2.79E-02
Cm-244	1.4149E-05	45,559.594	91,119.189	0.00E+00	6.45E-01	1.29E+00
Co-60	8.7369E-04	45,559.594	91,119.189	0.00E+00	3.98E+01	7.96E+01
Cs-134	2.5601E-05	45,559.594	91,119.189	0.00E+00	1.17E+00	2.33E+00
Cs-135	2.8639E-05	45,559.594	91,119.189	0.00E+00	1.30E+00	2.61E+00
Cs-137	1.4772E+00	45,559.594	91,119.189	0.00E+00	6.73E+04	1.35E+05
Eu-154	8.6025E-03	45,559.594	91,119.189	0.00E+00	3.92E+02	7.84E+02
Eu-155	6.6062E-04	45,559.594	91,119.189	0.00E+00	3.01E+01	6.02E+01
Fe-55	2.3011E-06	45,559.594	91,119.189	0.00E+00	1.05E-01	2.10E-01
H-3	2.1277E-03	45,559.594	91,119.189	0.00E+00	9.69E+01	1.94E+02
I-129	1.5853E-06	45,559.594	91,119.189	0.00E+00	7.22E-02	1.44E-01
Kr-85	6.2625E-02	45,559.594	91,119.189	0.00E+00	2.85E+03	5.71E+03
Np-237	1.2620E-07	45,559.594	91,119.189	0.00E+00	5.75E-03	1.15E-02
Pa-231	1.2017E-04	45,559.594	91,119.189	0.00E+00	5.47E+00	1.09E+01
Pb-210	1.4247E-08	45,559.594	91,119.189	0.00E+00	6.49E-04	1.30E-03
Pm-147	2.6224E-04	45,559.594	91,119.189	0.00E+00	1.19E+01	2.39E+01
Pu-238	4.2477E-04	45,559.594	91,119.189	0.00E+00	1.94E+01	3.87E+01
Pu-239	2.7519E-05	45,559.594	91,119.189	0.00E+00	1.25E+00	2.51E+00
Pu-240	1.6184E-05	45,559.594	91,119.189	0.00E+00	7.37E-01	1.47E+00
Pu-241	1.4695E-03	45,559.594	91,119.189	0.00E+00	6.69E+01	1.34E+02
Pu-242	4.0831E-08	45,559.594	91,119.189	0.00E+00	1.86E-03	3.72E-03
Ra-226	2.1423E-08	45,559.594	91,119.189	0.00E+00	9.76E-04	1.95E-03
Ra-228	4.6236E-06	45,559.594	91,119.189	0.00E+00	2.11E-01	4.21E-01
Ru-106	4.0208E-11	45,559.594	91,119.189	0.00E+00	1.83E-06	3.66E-06
Se-79	3.5417E-05	45,559.594	91,119.189	0.00E+00	1.61E+00	3.23E+00
Sn-126	3.9848E-05	45,559.594	91,119.189	0.00E+00	1.82E+00	3.63E+00
Sr-90	1.4928E+00	45,559.594	91,119.189	0.00E+00	6.80E+04	1.36E+05
Tc-99	3.2525E-04	45,559.594	91,119.189	0.00E+00	1.48E+01	2.96E+01
Th-229	6.4582E-05	45,559.594	91,119.189	0.00E+00	2.94E+00	5.88E+00
Th-230	1.1432E-06	45,559.594	91,119.189	0.00E+00	5.21E-02	1.04E-01
Th-232	-9.0328E-08	45,559.594	0.000	5.36E-01	5.32E-01	5.36E-01
Tl-208	1.3964E-02	45,559.594	91,119.189	0.00E+00	6.36E+02	1.27E+03
U-232	3.7822E-02	45,559.594	91,119.189	0.00E+00	1.72E+03	3.45E+03
U-233	-3.3244E-03	45,559.594	0.000	1.80E+03	1.65E+03	1.80E+03
U-234	8.1769E-04	45,559.594	91,119.189	0.00E+00	3.73E+01	7.45E+01
U-235	5.7813E-08	45,559.594	91,119.189	3.69E-04	3.00E-03	5.64E-03
U-236	1.3273E-07	45,559.594	91,119.189	0.00E+00	6.05E-03	1.21E-02
U-238	-3.1121E-10	45,559.594	0.000	2.36E-04	2.22E-04	2.36E-04
Y-90	1.4928E+00	45,559.594	91,119.189	0.00E+00	6.80E+04	1.36E+05
Other Radionuclides					7.60E+04	1.52E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.516E+15
0.0250	1.548E+15
0.0375	1.323E+15
0.0575	1.446E+15
0.0850	9.237E+14
0.1250	5.788E+14
0.2250	8.283E+14
0.3750	3.326E+14
0.5750	5.079E+15
0.8500	9.075E+13
1.2500	4.009E+13
1.7500	6.254E+12
2.2500	1.817E+08
2.7500	4.467E+13
3.5000	1.709E+05
5.0000	5.354E+04
7.0000	3.908E+03
11.0000	2.985E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.26E+03	**2.48E+03**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	SST (304)	ZIRC
BOL HM Constituents:	ThO2-UO2	Th and U
BOL Enrichment %:	92.94902719	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches LWBR Template on all but one parameter (cladding) making LWBR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	27,491.066	45,559.594
Bounding:	66,035.450	91,119.189

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.40	1.66
Bounding:	0.80	1.38

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ERR
SNF ID #: 1057
Fuel Units & Descr: 4 - ROD
Heavy Metal Mass: BOL=4.29kg ; EOL=4.23kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1966
Estimates as of: 2010
Template: LWBR (Light Water, Zirc, 60 to 100%, Th and U)
[2]Template Burnup(MWd): 10269.14
Template BOL Heavy Metal Mass (MT): 0.45991251
Template Decay Time: 35 years

Estimated Canister usage:
18"x10'
0.17

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	9.7360E-05	56.833	113.665	0.00E+00	5.53E-03	1.11E-02
Am-241	2.4345E-04	56.833	113.665	0.00E+00	1.38E-02	2.77E-02
Am-242m	1.4821E-06	56.833	113.665	0.00E+00	8.42E-05	1.68E-04
Am-243	3.1152E-07	56.833	113.665	0.00E+00	1.77E-05	3.54E-05
C-14	9.2432E-05	56.833	113.665	0.00E+00	5.25E-03	1.05E-02
Cl-36	1.8103E-06	56.833	113.665	0.00E+00	1.03E-04	2.06E-04
Cm-243	3.0597E-07	56.833	113.665	0.00E+00	1.74E-05	3.48E-05
Cm-244	1.4149E-05	56.833	113.665	0.00E+00	8.04E-04	1.61E-03
Co-60	8.7369E-04	56.833	113.665	0.00E+00	4.97E-02	9.93E-02
Cs-134	2.5601E-05	56.833	113.665	0.00E+00	1.45E-03	2.91E-03
Cs-135	2.8639E-05	56.833	113.665	0.00E+00	1.63E-03	3.26E-03
Cs-137	1.4772E+00	56.833	113.665	0.00E+00	8.40E+01	1.68E+02
Eu-154	8.6025E-03	56.833	113.665	0.00E+00	4.89E-01	9.78E-01
Eu-155	6.6062E-04	56.833	113.665	0.00E+00	3.75E-02	7.51E-02
Fe-55	2.3011E-06	56.833	113.665	0.00E+00	1.31E-04	2.62E-04
H-3	2.1277E-03	56.833	113.665	0.00E+00	1.21E-01	2.42E-01
I-129	1.5853E-06	56.833	113.665	0.00E+00	9.01E-05	1.80E-04
Kr-85	6.2625E-02	56.833	113.665	0.00E+00	3.56E+00	7.12E+00
Np-237	1.2620E-07	56.833	113.665	0.00E+00	7.17E-06	1.43E-05
Pa-231	1.2017E-04	56.833	113.665	0.00E+00	6.83E-03	1.37E-02
Pb-210	1.4247E-08	56.833	113.665	0.00E+00	8.10E-07	1.62E-06
Pm-147	2.6224E-04	56.833	113.665	0.00E+00	1.49E-02	2.98E-02
Pu-238	4.2477E-04	56.833	113.665	0.00E+00	2.41E-02	4.83E-02
Pu-239	2.7519E-05	56.833	113.665	0.00E+00	1.56E-03	3.13E-03
Pu-240	1.6184E-05	56.833	113.665	0.00E+00	9.20E-04	1.84E-03
Pu-241	1.4695E-03	56.833	113.665	0.00E+00	8.35E-02	1.67E-01
Pu-242	4.0831E-08	56.833	113.665	0.00E+00	2.32E-06	4.64E-06
Ra-226	2.1423E-08	56.833	113.665	0.00E+00	1.22E-06	2.44E-06
Ra-228	4.6236E-06	56.833	113.665	0.00E+00	2.63E-04	5.26E-04
Ru-106	4.0208E-11	56.833	113.665	0.00E+00	2.29E-09	4.57E-09
Se-79	3.5417E-05	56.833	113.665	0.00E+00	2.01E-03	4.03E-03
Sn-126	3.9848E-05	56.833	113.665	0.00E+00	2.26E-03	4.53E-03
Sr-90	1.4928E+00	56.833	113.665	0.00E+00	8.48E+01	1.70E+02
Tc-99	3.2525E-04	56.833	113.665	0.00E+00	1.85E-02	3.70E-02
Th-229	6.4582E-05	56.833	113.665	0.00E+00	3.67E-03	7.34E-03
Th-230	1.1432E-06	56.833	113.665	0.00E+00	6.50E-05	1.30E-04
Th-232	-9.0328E-08	56.833	0.000	4.53E-04	4.48E-04	4.53E-04
Tl-208	1.3964E-02	56.833	113.665	0.00E+00	7.94E-01	1.59E+00
U-232	3.7822E-02	56.833	113.665	0.00E+00	2.15E+00	4.30E+00
U-233	-3.3244E-03	56.833	0.000	1.52E+00	1.34E+00	1.52E+00
U-234	8.1769E-04	56.833	113.665	0.00E+00	4.65E-02	9.29E-02
U-235	5.7813E-08	56.833	113.665	3.12E-07	3.60E-06	6.88E-06
U-236	1.3273E-07	56.833	113.665	0.00E+00	7.54E-06	1.51E-05
U-238	-3.1121E-10	56.833	0.000	1.99E-07	1.82E-07	1.99E-07
Y-90	1.4928E+00	56.833	113.665	0.00E+00	8.48E+01	1.70E+02
Other Radionuclides					9.48E+01	1.90E+02

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	9.374E+12
0.0250	1.931E+12
0.0375	1.650E+12
0.0575	1.804E+12
0.0850	1.152E+12
0.1250	7.220E+11
0.2250	1.033E+12
0.3750	4.149E+11
0.5750	6.335E+12
0.8500	1.132E+11
1.2500	5.001E+10
1.7500	7.801E+09
2.2500	2.267E+05
2.7500	5.573E+10
3.5000	2.085E+02
5.0000	6.538E+01
7.0000	4.783E+00
11.0000	3.665E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.55E+00	3.07E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	SST (304)	ZIRC
BOL HM Constituents:	ThO2-UO2	Th and U
BOL Enrichment %:	93.0868939	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches LWBR Template on all but one parameter (cladding) making LWBR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	28.264	56.833
Bounding:	45.487	113.665

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.59	2.01
Bounding:	1.19	2.50

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: ESSOR (ITALY)
SNF ID #: 762
Fuel Units & Descr: 12 - 18 CURVED PLATES
Heavy Metal Mass: BOL=7.80kg ; EOL=5.73kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 2006
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'
1.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	1,960.330	3,920.660	0.00E+00	2.85E-07	5.70E-07
Am-241	1.1190E-03	1,960.330	3,920.660	0.00E+00	2.19E+00	4.39E+00
Am-242m	4.5425E-07	1,960.330	3,920.660	0.00E+00	8.90E-04	1.78E-03
Am-243	1.4921E-06	1,960.330	3,920.660	0.00E+00	2.93E-03	5.85E-03
C-14	5.7244E-09	1,960.330	3,920.660	0.00E+00	1.12E-05	2.24E-05
Cl-36	1.3124E-32	1,960.330	3,920.660	0.00E+00	2.57E-29	5.15E-29
Cm-243	2.3676E-07	1,960.330	3,920.660	0.00E+00	4.64E-04	9.28E-04
Cm-244	5.2042E-05	1,960.330	3,920.660	0.00E+00	1.02E-01	2.04E-01
Co-60	3.8208E-05	1,960.330	3,920.660	0.00E+00	7.49E-02	1.50E-01
Cs-134	4.8693E-01	1,960.330	3,920.660	0.00E+00	9.55E+02	1.91E+03
Cs-135	3.4477E-06	1,960.330	3,920.660	0.00E+00	6.76E-03	1.35E-02
Cs-137	2.8731E+00	1,960.330	3,920.660	0.00E+00	5.63E+03	1.13E+04
Eu-154	8.2053E-02	1,960.330	3,920.660	0.00E+00	1.61E+02	3.22E+02
Eu-155	3.9134E-02	1,960.330	3,920.660	0.00E+00	7.67E+01	1.53E+02
Fe-55	6.7429E-03	1,960.330	3,920.660	0.00E+00	1.32E+01	2.64E+01
H-3	1.0599E-02	1,960.330	3,920.660	0.00E+00	2.08E+01	4.16E+01
I-129	7.5300E-07	1,960.330	3,920.660	0.00E+00	1.48E-03	2.95E-03
Kr-85	2.8595E-01	1,960.330	3,920.660	0.00E+00	5.61E+02	1.12E+03
Np-237	9.5479E-06	1,960.330	3,920.660	0.00E+00	1.87E-02	3.74E-02
Pa-231	8.9297E-10	1,960.330	3,920.660	0.00E+00	1.75E-06	3.50E-06
Pb-210	3.7609E-12	1,960.330	3,920.660	0.00E+00	7.37E-09	1.47E-08
Pm-147	2.5452E+00	1,960.330	3,920.660	0.00E+00	4.99E+03	9.98E+03
Pu-238	2.0550E-02	1,960.330	3,920.660	0.00E+00	4.03E+01	8.06E+01
Pu-239	4.2838E-04	1,960.330	3,920.660	0.00E+00	8.40E-01	1.68E+00
Pu-240	2.4401E-04	1,960.330	3,920.660	0.00E+00	4.78E-01	9.57E-01
Pu-241	6.8764E-02	1,960.330	3,920.660	0.00E+00	1.35E+02	2.70E+02
Pu-242	3.6329E-07	1,960.330	3,920.660	0.00E+00	7.12E-04	1.42E-03
Ra-226	3.8045E-11	1,960.330	3,920.660	0.00E+00	7.46E-08	1.49E-07
Ra-228	2.9902E-15	1,960.330	3,920.660	0.00E+00	5.86E-12	1.17E-11
Ru-106	1.9055E-01	1,960.330	3,920.660	0.00E+00	3.74E+02	7.47E+02
Se-79	1.2936E-05	1,960.330	3,920.660	0.00E+00	2.54E-02	5.07E-02
Sn-126	1.1574E-05	1,960.330	3,920.660	0.00E+00	2.27E-02	4.54E-02
Sr-90	2.7505E+00	1,960.330	3,920.660	0.00E+00	5.39E+03	1.08E+04
Tc-99	4.2239E-04	1,960.330	3,920.660	0.00E+00	8.28E-01	1.66E+00
Th-229	1.8848E-12	1,960.330	3,920.660	0.00E+00	3.69E-09	7.39E-09
Th-230	1.7042E-08	1,960.330	3,920.660	0.00E+00	3.34E-05	6.68E-05
Th-232	7.8132E-15	1,960.330	3,920.660	0.00E+00	1.53E-11	3.06E-11
Tl-208	4.4063E-08	1,960.330	3,920.660	0.00E+00	8.64E-05	1.73E-04
U-232	1.3151E-07	1,960.330	3,920.660	0.00E+00	2.58E-04	5.16E-04
U-233	1.9564E-09	1,960.330	3,920.660	0.00E+00	3.84E-06	7.67E-06
U-234	1.8371E-04	1,960.330	3,920.660	0.00E+00	3.60E-01	7.20E-01
U-235	-2.7235E-06	1,960.330	0.000	1.56E-02	1.03E-02	1.56E-02
U-236	1.5493E-05	1,960.330	3,920.660	0.00E+00	3.04E-02	6.07E-02
U-238	-4.2851E-09	1,960.330	0.000	1.96E-04	1.87E-04	1.96E-04
Y-90	2.7505E+00	1,960.330	3,920.660	0.00E+00	5.39E+03	1.08E+04
Other Radionuclides					1.01E+04	2.02E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.564E+14
0.0250	1.630E+14
0.0375	1.504E+14
0.0575	1.479E+14
0.0850	9.426E+13
0.1250	8.163E+13
0.2250	7.989E+13
0.3750	3.867E+13
0.5750	5.312E+14
0.8500	7.438E+13
1.2500	1.384E+13
1.7500	5.804E+11
2.2500	1.217E+12
2.7500	7.003E+09
3.5000	7.770E+08
5.0000	2.322E+03
7.0000	2.589E+02
11.0000	2.918E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.94E+01	1.99E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.52828863	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,960.330	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		3,920.660	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.80	
Bounding:	1.60	

Estimated EOL HM/Given EOL HM
1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FAST REACTOR FUEL	**[1]Fuel decay start date:**	1985
SNF ID #:	1029	**Estimates as of:**	2010
Fuel Units & Descr:	11 - CANISTER OF SCRAP	**Template:**	FFTF (FAST, SST, 10 to 30%, Pu & U)
Heavy Metal Mass:	BOL=13.33kg ; EOL=11.09kg	**[2]Template Burnup(MWd):**	5011.2
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.0329181
		Template Decay Time:	25 years

Estimated Canister usage: 18"x10' — 0.85

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	3.4503E-12	3,998.940	7,997.880	0.00E+00	1.38E-08	2.76E-08
Am-241	9.5092E-02	3,998.940	7,997.880	2.57E+01	4.06E+02	7.86E+02
Am-242m	2.0115E-03	3,998.940	7,997.880	0.00E+00	8.04E+00	1.61E+01
Am-243	1.0750E-04	3,998.940	7,997.880	0.00E+00	4.30E-01	8.60E-01
C-14	2.6102E-05	3,998.940	7,997.880	0.00E+00	1.04E-01	2.09E-01
Cl-36	3.4243E-10	3,998.940	7,997.880	0.00E+00	1.37E-06	2.74E-06
Cm-243	5.1824E-04	3,998.940	7,997.880	0.00E+00	2.07E+00	4.14E+00
Cm-244	2.1572E-03	3,998.940	7,997.880	0.00E+00	8.63E+00	1.73E+01
Co-60	5.6254E-03	3,998.940	7,997.880	0.00E+00	2.25E+01	4.50E+01
Cs-134	2.5942E-03	3,998.940	7,997.880	0.00E+00	1.04E+01	2.07E+01
Cs-135	4.7693E-05	3,998.940	7,997.880	0.00E+00	1.91E-01	3.81E-01
Cs-137	1.7122E+00	3,998.940	7,997.880	0.00E+00	6.85E+03	1.37E+04
Eu-154	2.5223E-02	3,998.940	7,997.880	0.00E+00	1.01E+02	2.02E+02
Eu-155	2.2689E-02	3,998.940	7,997.880	0.00E+00	9.07E+01	1.81E+02
Fe-55	6.3358E-04	3,998.940	7,997.880	0.00E+00	2.53E+00	5.07E+00
H-3	5.6054E-03	3,998.940	7,997.880	0.00E+00	2.24E+01	4.48E+01
I-129	1.2891E-06	3,998.940	7,997.880	0.00E+00	5.16E-03	1.03E-02
Kr-85	4.1746E-02	3,998.940	7,997.880	0.00E+00	1.67E+02	3.34E+02
Np-237	3.2028E-06	3,998.940	7,997.880	0.00E+00	1.28E-02	2.56E-02
Pa-231	8.5429E-12	3,998.940	7,997.880	0.00E+00	3.42E-08	6.83E-08
Pb-210	7.3535E-13	3,998.940	7,997.880	0.00E+00	2.94E-09	5.88E-09
Pm-147	2.6102E-02	3,998.940	7,997.880	0.00E+00	1.04E+02	2.09E+02
Pu-238	2.3328E-02	3,998.940	7,997.880	0.00E+00	9.33E+01	1.87E+02
Pu-239	-3.5520E-02	3,998.940	0.000	2.11E+02	6.89E+01	2.11E+02
Pu-240	2.0750E-02	3,998.940	7,997.880	1.07E+02	1.90E+02	2.73E+02
Pu-241	-1.1127E+00	3,998.940	0.000	4.81E+03	3.63E+02	4.81E+03
Pu-242	1.1152E-05	3,998.940	7,997.880	2.86E-02	7.32E-02	1.18E-01
Ra-226	2.8297E-12	3,998.940	7,997.880	0.00E+00	1.13E-08	2.26E-08
Ra-228	1.3510E-16	3,998.940	7,997.880	0.00E+00	5.40E-13	1.08E-12
Ru-106	2.5104E-05	3,998.940	7,997.880	0.00E+00	1.00E-01	2.01E-01
Se-79	1.0133E-05	3,998.940	7,997.880	0.00E+00	4.05E-02	8.10E-02
Sn-126	4.3902E-05	3,998.940	7,997.880	0.00E+00	1.76E-01	3.51E-01
Sr-90	6.1522E-01	3,998.940	7,997.880	0.00E+00	2.46E+03	4.92E+03
Tc-99	3.9412E-04	3,998.940	7,997.880	0.00E+00	1.58E+00	3.15E+00
Th-229	2.0554E-12	3,998.940	7,997.880	0.00E+00	8.22E-09	1.64E-08
Th-230	5.3680E-10	3,998.940	7,997.880	0.00E+00	2.15E-06	4.29E-06
Th-232	1.9522E-16	3,998.940	7,997.880	0.00E+00	7.81E-13	1.56E-12
Tl-208	5.1046E-07	3,998.940	7,997.880	0.00E+00	2.04E-03	4.08E-03
U-232	1.3883E-06	3,998.940	7,997.880	0.00E+00	5.55E-03	1.11E-02
U-233	3.7516E-10	3,998.940	7,997.880	0.00E+00	1.50E-06	3.00E-06
U-234	3.1909E-06	3,998.940	7,997.880	0.00E+00	1.28E-02	2.55E-02
U-235	-8.7842E-09	3,998.940	0.000	4.33E-05	8.19E-06	4.33E-05
U-236	1.4813E-07	3,998.940	7,997.880	0.00E+00	5.92E-04	1.18E-03
U-238	-1.7914E-07	3,998.940	0.000	3.15E-03	2.44E-03	3.15E-03
Y-90	6.1522E-01	3,998.940	7,997.880	0.00E+00	2.46E+03	4.92E+03
Other Radionuclides					6.88E+03	1.38E+04

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	3.148E+14
0.0250	6.384E+13
0.0375	7.490E+13
0.0575	6.858E+13
0.0850	3.612E+13
0.1250	2.597E+13
0.2250	2.886E+13
0.3750	1.259E+13
0.5750	5.020E+14
0.8500	6.202E+12
1.2500	8.000E+12
1.7500	1.676E+11
2.2500	3.569E+07
2.7500	1.455E+08
3.5000	6.265E+05
5.0000	1.777E+05
7.0000	2.033E+04
11.0000	2.328E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
7.64E+01	1.51E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	SST
BOL HM Constituents:	Pu/U CARB	Pu and U
BOL Enrichment %:	31.10053362	10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (very close to 30%)

Burnup Summary (MWd)[2]	From SFD	Estimated
Nominal:	3,998.940	2,231.045
Bounding:		7,997.880

Basis for burnup used in estimate:

Nominal burnup taken directly from SFD (converted to MWd).
Bounding burnup assumed to be twice nominal burnup.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.97	0.56
Bounding:	3.94	

Estimated EOL HM/Given EOL HM: 0.83

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FAST REACTOR FUEL
SNF ID #: 906
Fuel Units & Descr: 1 - CANISTER OF SCRAP
Heavy Metal Mass: BOL=9.04kg ; EOL=9.04kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1985
Estimates as of: 2010
Template: (Worst Case)
[2]Template Burnup(MWd): 62.5
Template BOL Heavy Metal Mass (MT): 0.00186865
Template Decay Time: 25 years

Estimated Canister usage:

18"x10'
0.08

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.9648E-06	904.400	1,808.800	0.00E+00	1.78E-03	3.55E-03
Am-241	7.8064E+00	904.400	1,808.800	0.00E+00	7.06E+03	1.41E+04
Am-242m	1.7632E-02	904.400	1,808.800	0.00E+00	1.59E+01	3.19E+01
Am-243	1.6336E-02	904.400	1,808.800	0.00E+00	1.48E+01	2.95E+01
C-14	1.2101E-01	904.400	1,808.800	0.00E+00	1.09E+02	2.19E+02
Cl-36	2.2849E-03	904.400	1,808.800	0.00E+00	2.07E+00	4.13E+00
Cm-243	1.1046E-03	904.400	1,808.800	0.00E+00	9.99E-01	2.00E+00
Cm-244	2.4704E-01	904.400	1,808.800	0.00E+00	2.23E+02	4.47E+02
Co-60	1.0466E+02	904.400	1,808.800	0.00E+00	9.47E+04	1.89E+05
Cs-134	9.8289E-03	904.400	1,808.800	0.00E+00	8.89E+00	1.78E+01
Cs-135	4.3976E-04	904.400	1,808.800	0.00E+00	3.98E-01	7.95E-01
Cs-137	2.6526E+01	904.400	1,808.800	0.00E+00	2.40E+04	4.80E+04
Eu-154	2.7975E+00	904.400	1,808.800	0.00E+00	2.53E+03	5.06E+03
Eu-155	2.7881E-01	904.400	1,808.800	0.00E+00	2.52E+02	5.04E+02
Fe-55	4.2151E+00	904.400	1,808.800	0.00E+00	3.81E+03	7.62E+03
H-3	4.2599E-01	904.400	1,808.800	0.00E+00	3.85E+02	7.71E+02
I-129	1.0618E-05	904.400	1,808.800	0.00E+00	9.60E-03	1.92E-02
Kr-85	1.1426E+00	904.400	1,808.800	0.00E+00	1.03E+03	2.07E+03
Np-237	1.5647E-04	904.400	1,808.800	0.00E+00	1.42E-01	2.83E-01
Pa-231	2.8624E-06	904.400	1,808.800	0.00E+00	2.59E-03	5.18E-03
Pb-210	9.2770E-09	904.400	1,808.800	0.00E+00	8.39E-06	1.68E-05
Pm-147	2.3690E-01	904.400	1,808.800	0.00E+00	2.14E+02	4.29E+02
Pu-238	3.2240E+00	904.400	1,808.800	0.00E+00	2.92E+03	5.83E+03
Pu-239	4.1664E-01	904.400	1,808.800	0.00E+00	3.77E+02	7.54E+02
Pu-240	2.9264E-01	904.400	1,808.800	0.00E+00	2.65E+02	5.29E+02
Pu-241	7.8816E+01	904.400	1,808.800	0.00E+00	7.13E+04	1.43E+05
Pu-242	2.4560E-03	904.400	1,808.800	0.00E+00	2.22E+00	4.44E+00
Ra-226	3.2167E-08	904.400	1,808.800	0.00E+00	2.91E-05	5.82E-05
Ra-228	5.9024E-07	904.400	1,808.800	0.00E+00	5.34E-04	1.07E-03
Ru-106	3.9140E-06	904.400	1,808.800	0.00E+00	3.54E-03	7.08E-03
Se-79	1.9184E-04	904.400	1,808.800	0.00E+00	1.73E-01	3.47E-01
Sn-126	1.6671E-04	904.400	1,808.800	0.00E+00	1.51E-01	3.02E-01
Sr-90	2.5126E+01	904.400	1,808.800	0.00E+00	2.27E+04	4.54E+04
Tc-99	6.7678E-03	904.400	1,808.800	0.00E+00	6.12E+00	1.22E+01
Th-229	1.2398E-06	904.400	1,808.800	0.00E+00	1.12E-03	2.24E-03
Th-230	4.1442E-06	904.400	1,808.800	0.00E+00	3.75E-03	7.50E-03
Th-232	-4.2431E-09	904.400	0.000	1.83E-04	1.80E-04	1.83E-04
Tl-208	9.6478E-05	904.400	1,808.800	0.00E+00	8.73E-02	1.75E-01
U-232	2.6103E-04	904.400	1,808.800	0.00E+00	2.36E-01	4.72E-01
U-233	3.6128E-04	904.400	1,808.800	0.00E+00	3.27E-01	6.53E-01
U-234	1.2788E-02	904.400	1,808.800	0.00E+00	1.16E+01	2.31E+01
U-235	5.7486E-04	904.400	1,808.800	3.89E-03	5.24E-01	1.04E+00
U-236	2.3485E-04	904.400	1,808.800	0.00E+00	2.12E-01	4.25E-01
U-238	1.1581E-04	904.400	1,808.800	4.84E-04	1.05E-01	2.10E-01
Y-90	2.5126E+01	904.400	1,808.800	0.00E+00	2.27E+04	4.54E+04
Other Radionuclides					6.34E+04	1.27E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.067E+15
0.0250	6.002E+14
0.0375	5.356E+14
0.0575	7.308E+14
0.0850	3.161E+14
0.1250	2.749E+14
0.2250	2.685E+14
0.3750	1.132E+14
0.5750	1.805E+15
0.8500	1.088E+14
1.2500	1.411E+16
1.7500	3.420E+12
2.2500	7.431E+10
2.7500	6.365E+09
3.5000	7.129E+06
5.0000	3.029E+06
7.0000	3.472E+05
11.0000	3.976E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.14E+03	4.27E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	(Worst Case)
Fuel Cladding:	SST	SST/Inconel
BOL HM Constituents:	ThO2-UO2	U, Th, & Pu
BOL Enrichment %:	7.591623037	0 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel didn't closely match any existing templates, therefore the worst case template was used.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	904.400	
Bounding:		1,808.800

Basis for burnup used in estimate:

Nominal burnup taken directly from SFD (converted to MWd).
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	2.99	0.00
Bounding:	5.98	

Estimated EOL HM/Given EOL HM

63.13

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FERMI CORE I & 2 (CORE FOIL)
SNF ID #: 457
Fuel Units & Descr: 136 - ROD
Heavy Metal Mass: BOL=18.21kg ; EOL=17.73kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1972
Estimates as of: 2010
Template: FERMI (Fast, Zirc, 10 to 40%, U)
[2]Template Burnup(MWd): 58.6725048
Template BOL Heavy Metal Mass (MT): 0.018774
Template Decay Time: 35 years

Estimated Canister usage:
18"x10'
0.04

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	9.6110E-08	419.738	839.476	0.00E+00	4.03E-05	8.07E-05
Am-241	6.5601E-07	419.738	839.476	0.00E+00	2.75E-04	5.51E-04
Am-242m	0.0000E+00	419.738	839.476	0.00E+00	0.00E+00	0.00E+00
Am-243	8.3770E-15	419.738	839.476	0.00E+00	3.52E-12	7.03E-12
C-14	2.1714E-05	419.738	839.476	0.00E+00	9.11E-03	1.82E-02
Cl-36	5.5188E-08	419.738	839.476	0.00E+00	2.32E-05	4.63E-05
Cm-243	1.5496E-14	419.738	839.476	0.00E+00	6.50E-12	1.30E-11
Cm-244	5.2375E-16	419.738	839.476	0.00E+00	2.20E-13	4.40E-13
Co-60	2.0947E-03	419.738	839.476	0.00E+00	8.79E-01	1.76E+00
Cs-134	6.2448E-07	419.738	839.476	0.00E+00	2.62E-04	5.24E-04
Cs-135	4.4996E-05	419.738	839.476	0.00E+00	1.89E-02	3.78E-02
Cs-137	1.3775E+00	419.738	839.476	0.00E+00	5.78E+02	1.16E+03
Eu-154	1.8510E-04	419.738	839.476	0.00E+00	7.77E-02	1.55E-01
Eu-155	1.4163E-03	419.738	839.476	0.00E+00	5.94E-01	1.19E+00
Fe-55	1.4179E-05	419.738	839.476	0.00E+00	5.95E-03	1.19E-02
H-3	3.5383E-03	419.738	839.476	0.00E+00	1.49E+00	2.97E+00
I-129	1.1426E-06	419.738	839.476	0.00E+00	4.80E-04	9.59E-04
Kr-85	3.8604E-02	419.738	839.476	0.00E+00	1.62E+01	3.24E+01
Np-237	3.3099E-06	419.738	839.476	0.00E+00	1.39E-03	2.78E-03
Pa-231	1.8953E-07	419.738	839.476	0.00E+00	7.96E-05	1.59E-04
Pb-210	8.9531E-12	419.738	839.476	0.00E+00	3.76E-09	7.52E-09
Pm-147	1.1588E-03	419.738	839.476	0.00E+00	4.86E-01	9.73E-01
Pu-238	1.7146E-04	419.738	839.476	0.00E+00	7.20E-02	1.44E-01
Pu-239	1.9464E-02	419.738	839.476	0.00E+00	8.17E+00	1.63E+01
Pu-240	6.7919E-05	419.738	839.476	0.00E+00	2.85E-02	5.70E-02
Pu-241	4.1774E-06	419.738	839.476	0.00E+00	1.75E-03	3.51E-03
Pu-242	4.3751E-13	419.738	839.476	0.00E+00	1.84E-10	3.67E-10
Ra-226	2.4219E-11	419.738	839.476	0.00E+00	1.02E-08	2.03E-08
Ra-228	2.3572E-11	419.738	839.476	0.00E+00	9.89E-09	1.98E-08
Ru-106	3.0951E-10	419.738	839.476	0.00E+00	1.30E-07	2.60E-07
Se-79	1.6488E-05	419.738	839.476	0.00E+00	6.92E-03	1.38E-02
Sn-126	3.7564E-05	419.738	839.476	0.00E+00	1.58E-02	3.15E-02
Sr-90	1.2052E+00	419.738	839.476	0.00E+00	5.06E+02	1.01E+03
Tc-99	4.4825E-04	419.738	839.476	0.00E+00	1.88E-01	3.76E-01
Th-229	4.6478E-11	419.738	839.476	0.00E+00	1.95E-08	3.90E-08
Th-230	2.2259E-09	419.738	839.476	0.00E+00	9.34E-07	1.87E-06
Th-232	2.3691E-11	419.738	839.476	0.00E+00	9.94E-09	1.99E-08
Tl-208	5.8256E-09	419.738	839.476	0.00E+00	2.45E-06	4.89E-06
U-232	1.5759E-08	419.738	839.476	0.00E+00	6.61E-06	1.32E-05
U-233	1.0110E-08	419.738	839.476	0.00E+00	4.24E-06	8.49E-06
U-234	4.9001E-06	419.738	839.476	0.00E+00	2.06E-03	4.11E-03
U-235	-2.3191E-06	419.738	0.000	1.01E-02	9.14E-03	1.01E-02
U-236	1.2633E-05	419.738	839.476	0.00E+00	5.30E-03	1.06E-02
U-238	-9.5407E-08	419.738	0.000	4.55E-03	4.51E-03	4.55E-03
Y-90	1.2053E+00	419.738	839.476	0.00E+00	5.06E+02	1.01E+03
Other Radionuclides					5.75E+02	1.15E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	5.555E+13
0.0250	1.154E+13
0.0375	1.015E+13
0.0575	1.075E+13
0.0850	6.503E+12
0.1250	4.212E+12
0.2250	5.582E+12
0.3750	2.432E+12
0.5750	4.297E+13
0.8500	3.968E+11
1.2500	2.632E+11
1.7500	1.024E+10
2.2500	1.806E+06
2.7500	1.741E+05
3.5000	1.660E+02
5.0000	5.707E+01
7.0000	4.951E+00
11.0000	4.617E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.48E+00	1.30E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U-Mo	U
BOL Enrichment %:	25.69081404	10 to 40

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	29.137	419.738	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	50.352	839.476	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	7.38	14.41
Bounding:	14.75	16.67

Estimated EOL HM/Given EOL HM
1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FERMI CORE I & 2 (CORE SHIM)
SNF ID #: 69
Fuel Units & Descr: 280 - ROD
Heavy Metal Mass: BOL=37.49kg ; EOL=36.82kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1972
Estimates as of: 2010
Template: FERMI (Fast, Zirc, 10 to 40%, U)
[2]Template Burnup(MWd): 58.6725048
Template BOL Heavy Metal Mass (MT): 0.018774
Template Decay Time: 35 years

Estimated Canister usage:
18"x10'
0.07

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	9.6110E-08	592.571	1,185.142	0.00E+00	5.70E-05	1.14E-04
Am-241	6.5601E-07	592.571	1,185.142	0.00E+00	3.89E-04	7.77E-04
Am-242m	0.0000E+00	592.571	1,185.142	0.00E+00	0.00E+00	0.00E+00
Am-243	8.3770E-15	592.571	1,185.142	0.00E+00	4.96E-12	9.93E-12
C-14	2.1714E-05	592.571	1,185.142	0.00E+00	1.29E-02	2.57E-02
Cl-36	5.5188E-08	592.571	1,185.142	0.00E+00	3.27E-05	6.54E-05
Cm-243	1.5496E-14	592.571	1,185.142	0.00E+00	9.18E-12	1.84E-11
Cm-244	5.2375E-16	592.571	1,185.142	0.00E+00	3.10E-13	6.21E-13
Co-60	2.0947E-03	592.571	1,185.142	0.00E+00	1.24E+00	2.48E+00
Cs-134	6.2448E-07	592.571	1,185.142	0.00E+00	3.70E-04	7.40E-04
Cs-135	4.4996E-05	592.571	1,185.142	0.00E+00	2.67E-02	5.33E-02
Cs-137	1.3775E+00	592.571	1,185.142	0.00E+00	8.16E+02	1.63E+03
Eu-154	1.8510E-04	592.571	1,185.142	0.00E+00	1.10E-01	2.19E-01
Eu-155	1.4163E-03	592.571	1,185.142	0.00E+00	8.39E-01	1.68E+00
Fe-55	1.4179E-05	592.571	1,185.142	0.00E+00	8.40E-03	1.68E-02
H-3	3.5383E-03	592.571	1,185.142	0.00E+00	2.10E+00	4.19E+00
I-129	1.1426E-06	592.571	1,185.142	0.00E+00	6.77E-04	1.35E-03
Kr-85	3.8604E-02	592.571	1,185.142	0.00E+00	2.29E+01	4.58E+01
Np-237	3.3099E-06	592.571	1,185.142	0.00E+00	1.96E-03	3.92E-03
Pa-231	1.8953E-07	592.571	1,185.142	0.00E+00	1.12E-04	2.25E-04
Pb-210	8.9531E-12	592.571	1,185.142	0.00E+00	5.31E-09	1.06E-08
Pm-147	1.1588E-03	592.571	1,185.142	0.00E+00	6.87E-01	1.37E+00
Pu-238	1.7146E-04	592.571	1,185.142	0.00E+00	1.02E-01	2.03E-01
Pu-239	1.9464E-02	592.571	1,185.142	0.00E+00	1.15E+01	2.31E+01
Pu-240	6.7919E-05	592.571	1,185.142	0.00E+00	4.02E-02	8.05E-02
Pu-241	4.1774E-06	592.571	1,185.142	0.00E+00	2.48E-03	4.95E-03
Pu-242	4.3751E-13	592.571	1,185.142	0.00E+00	2.59E-10	5.19E-10
Ra-226	2.4219E-11	592.571	1,185.142	0.00E+00	1.44E-08	2.87E-08
Ra-228	2.3572E-11	592.571	1,185.142	0.00E+00	1.40E-08	2.79E-08
Ru-106	3.0951E-10	592.571	1,185.142	0.00E+00	1.83E-07	3.67E-07
Se-79	1.6488E-05	592.571	1,185.142	0.00E+00	9.77E-03	1.95E-02
Sn-126	3.7564E-05	592.571	1,185.142	0.00E+00	2.23E-02	4.45E-02
Sr-90	1.2052E+00	592.571	1,185.142	0.00E+00	7.14E+02	1.43E+03
Tc-99	4.4825E-04	592.571	1,185.142	0.00E+00	2.66E-01	5.31E-01
Th-229	4.6478E-11	592.571	1,185.142	0.00E+00	2.75E-08	5.51E-08
Th-230	2.2259E-09	592.571	1,185.142	0.00E+00	1.32E-06	2.64E-06
Th-232	2.3691E-11	592.571	1,185.142	0.00E+00	1.40E-08	2.81E-08
Tl-208	5.8256E-09	592.571	1,185.142	0.00E+00	3.45E-06	6.90E-06
U-232	1.5759E-08	592.571	1,185.142	0.00E+00	9.34E-06	1.87E-05
U-233	1.0110E-08	592.571	1,185.142	0.00E+00	5.99E-06	1.20E-05
U-234	4.9001E-06	592.571	1,185.142	0.00E+00	2.90E-03	5.81E-03
U-235	-2.3191E-06	592.571	0.000	1.10E-02	9.61E-03	1.10E-02
U-236	1.2633E-05	592.571	1,185.142	0.00E+00	7.49E-03	1.50E-02
U-238	-9.5407E-08	592.571	0.000	1.09E-02	1.08E-02	1.09E-02
Y-90	1.2053E+00	592.571	1,185.142	0.00E+00	7.14E+02	1.43E+03
Other Radionuclides					8.11E+02	1.62E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.842E+13
0.0250	1.629E+13
0.0375	1.433E+13
0.0575	1.518E+13
0.0850	9.181E+12
0.1250	5.946E+12
0.2250	7.880E+12
0.3750	3.433E+12
0.5750	6.066E+13
0.8500	5.602E+11
1.2500	3.716E+11
1.7500	1.446E+10
2.2500	2.550E+06
2.7500	2.457E+05
3.5000	2.580E+02
5.0000	9.076E+01
7.0000	8.164E+00
11.0000	7.869E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.14E+00	1.83E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U-Mo	U
BOL Enrichment %:	13.55265123	10 to 40

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:	59.987	592.571	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	103.665	1,185.142	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	5.06	9.88
Bounding:	10.11	11.43

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FERMI CORE I & 2 (DECLAD)	[1]**Fuel decay start date:**	1972
SNF ID #:	453	**Estimates as of:**	2010
Fuel Units & Descr:	976 - ROD	**Template:**	FERMI (Fast, Zirc, 10 to 40%, U)
Heavy Metal Mass:	BOL=130.69kg ; EOL=110.97kg	[2]**Template Burnup(MWd):**	58.6725048
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.018774
		Template Decay Time:	35 years

Estimated Canister usage: 18"x10' — 1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	9.6110E-08	17,384.907	34,769.813	0.00E+00	1.67E-03	3.34E-03
Am-241	6.5601E-07	17,384.907	34,769.813	0.00E+00	1.14E-02	2.28E-02
Am-242m	0.0000E+00	17,384.907	34,769.813	0.00E+00	0.00E+00	0.00E+00
Am-243	8.3770E-15	17,384.907	34,769.813	0.00E+00	1.46E-10	2.91E-10
C-14	2.1714E-05	17,384.907	34,769.813	0.00E+00	3.77E-01	7.55E-01
Cl-36	5.5188E-08	17,384.907	34,769.813	0.00E+00	9.59E-04	1.92E-03
Cm-243	1.5496E-14	17,384.907	34,769.813	0.00E+00	2.69E-10	5.39E-10
Cm-244	5.2375E-16	17,384.907	34,769.813	0.00E+00	9.11E-12	1.82E-11
Co-60	2.0947E-03	17,384.907	34,769.813	0.00E+00	3.64E+01	7.28E+01
Cs-134	6.2448E-07	17,384.907	34,769.813	0.00E+00	1.09E-02	2.17E-02
Cs-135	4.4996E-05	17,384.907	34,769.813	0.00E+00	7.82E-01	1.56E+00
Cs-137	1.3775E+00	17,384.907	34,769.813	0.00E+00	2.39E+04	4.79E+04
Eu-154	1.8510E-04	17,384.907	34,769.813	0.00E+00	3.22E+00	6.44E+00
Eu-155	1.4163E-03	17,384.907	34,769.813	0.00E+00	2.46E+01	4.92E+01
Fe-55	1.4179E-05	17,384.907	34,769.813	0.00E+00	2.46E-01	4.93E-01
H-3	3.5383E-03	17,384.907	34,769.813	0.00E+00	6.15E+01	1.23E+02
I-129	1.1426E-06	17,384.907	34,769.813	0.00E+00	1.99E-02	3.97E-02
Kr-85	3.8604E-02	17,384.907	34,769.813	0.00E+00	6.71E+02	1.34E+03
Np-237	3.3099E-06	17,384.907	34,769.813	0.00E+00	5.75E-02	1.15E-01
Pa-231	1.8953E-07	17,384.907	34,769.813	0.00E+00	3.29E-03	6.59E-03
Pb-210	8.9531E-12	17,384.907	34,769.813	0.00E+00	1.56E-07	3.11E-07
Pm-147	1.1588E-03	17,384.907	34,769.813	0.00E+00	2.01E+01	4.03E+01
Pu-238	1.7146E-04	17,384.907	34,769.813	0.00E+00	2.98E+00	5.96E+00
Pu-239	1.9464E-02	17,384.907	34,769.813	0.00E+00	3.38E+02	6.77E+02
Pu-240	6.7919E-05	17,384.907	34,769.813	0.00E+00	1.18E+00	2.36E+00
Pu-241	4.1774E-06	17,384.907	34,769.813	0.00E+00	7.26E-02	1.45E-01
Pu-242	4.3751E-13	17,384.907	34,769.813	0.00E+00	7.61E-09	1.52E-08
Ra-226	2.4219E-11	17,384.907	34,769.813	0.00E+00	4.21E-07	8.42E-07
Ra-228	2.3572E-11	17,384.907	34,769.813	0.00E+00	4.10E-07	8.20E-07
Ru-106	3.0951E-10	17,384.907	34,769.813	0.00E+00	5.38E-06	1.08E-05
Se-79	1.6488E-05	17,384.907	34,769.813	0.00E+00	2.87E-01	5.73E-01
Sn-126	3.7564E-05	17,384.907	34,769.813	0.00E+00	6.53E-01	1.31E+00
Sr-90	1.2052E+00	17,384.907	34,769.813	0.00E+00	2.10E+04	4.19E+04
Tc-99	4.4825E-04	17,384.907	34,769.813	0.00E+00	7.79E+00	1.56E+01
Th-229	4.6478E-11	17,384.907	34,769.813	0.00E+00	8.08E-07	1.62E-06
Th-230	2.2259E-09	17,384.907	34,769.813	0.00E+00	3.87E-05	7.74E-05
Th-232	2.3691E-11	17,384.907	34,769.813	0.00E+00	4.12E-07	8.24E-07
Tl-208	5.8256E-09	17,384.907	34,769.813	0.00E+00	1.01E-04	2.03E-04
U-232	1.5759E-08	17,384.907	34,769.813	0.00E+00	2.74E-04	5.48E-04
U-233	1.0110E-08	17,384.907	34,769.813	0.00E+00	1.76E-04	3.52E-04
U-234	4.9001E-06	17,384.907	34,769.813	0.00E+00	8.52E-02	1.70E-01
U-235	-2.3191E-06	17,384.907	0.000	7.26E-02	3.22E-02	7.26E-02
U-236	1.2633E-05	17,384.907	34,769.813	0.00E+00	2.20E-01	4.39E-01
U-238	-9.5407E-08	17,384.907	0.000	3.26E-02	3.10E-02	3.26E-02
Y-90	1.2053E+00	17,384.907	34,769.813	0.00E+00	2.10E+04	4.19E+04
Other Radionuclides					2.38E+04	4.76E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.301E+15
0.0250	4.779E+14
0.0375	4.204E+14
0.0575	4.453E+14
0.0850	2.693E+14
0.1250	1.745E+14
0.2250	2.312E+14
0.3750	1.007E+14
0.5750	1.780E+15
0.8500	1.644E+13
1.2500	1.090E+13
1.7500	4.242E+11
2.2500	7.481E+07
2.7500	7.208E+06
3.5000	6.033E+03
5.0000	2.002E+03
7.0000	1.635E+02
11.0000	1.434E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.68E+02	5.37E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	NONE	ZIRC
BOL HM Constituents:	U-Mo	U
BOL Enrichment %:	25.69081404	10 to 40

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except cladding.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	209.098	17,384.907
Bounding:	361.348	34,769.813

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	42.57	83.14
Bounding:	85.13	96.22

Estimated EOL HM/Given EOL HM: 1.04

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FERMI CORE I & 2 (SECTIONED)
SNF ID #: 454
Fuel Units & Descr: 980 - ROD
Heavy Metal Mass: BOL=131.22kg ; EOL=125.05kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1972
Estimates as of: 2010
Template: FERMI (Fast, Zirc, 10 to 40%, U)
[2]Template Burnup(MWd): 58.6725048
Template BOL Heavy Metal Mass (MT): 0.018774
Template Decay Time: 35 years

Estimated Canister usage:

18"x10'
0.26

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	9.6110E-08	5,444.247	10,888.494	0.00E+00	5.23E-04	1.05E-03
Am-241	6.5601E-07	5,444.247	10,888.494	0.00E+00	3.57E-03	7.14E-03
Am-242m	0.0000E+00	5,444.247	10,888.494	0.00E+00	0.00E+00	0.00E+00
Am-243	8.3770E-15	5,444.247	10,888.494	0.00E+00	4.56E-11	9.12E-11
C-14	2.1714E-05	5,444.247	10,888.494	0.00E+00	1.18E-01	2.36E-01
Cl-36	5.5188E-08	5,444.247	10,888.494	0.00E+00	3.00E-04	6.01E-04
Cm-243	1.5496E-14	5,444.247	10,888.494	0.00E+00	8.44E-11	1.69E-10
Cm-244	5.2375E-16	5,444.247	10,888.494	0.00E+00	2.85E-12	5.70E-12
Co-60	2.0947E-03	5,444.247	10,888.494	0.00E+00	1.14E+01	2.28E+01
Cs-134	6.2448E-07	5,444.247	10,888.494	0.00E+00	3.40E-03	6.80E-03
Cs-135	4.4996E-05	5,444.247	10,888.494	0.00E+00	2.45E-01	4.90E-01
Cs-137	1.3775E+00	5,444.247	10,888.494	0.00E+00	7.50E+03	1.50E+04
Eu-154	1.8510E-04	5,444.247	10,888.494	0.00E+00	1.01E+00	2.02E+00
Eu-155	1.4163E-03	5,444.247	10,888.494	0.00E+00	7.71E+00	1.54E+01
Fe-55	1.4179E-05	5,444.247	10,888.494	0.00E+00	7.72E-02	1.54E-01
H-3	3.5383E-03	5,444.247	10,888.494	0.00E+00	1.93E+01	3.85E+01
I-129	1.1426E-06	5,444.247	10,888.494	0.00E+00	6.22E-03	1.24E-02
Kr-85	3.8604E-02	5,444.247	10,888.494	0.00E+00	2.10E+02	4.20E+02
Np-237	3.3099E-06	5,444.247	10,888.494	0.00E+00	1.80E-02	3.60E-02
Pa-231	1.8953E-07	5,444.247	10,888.494	0.00E+00	1.03E-03	2.06E-03
Pb-210	8.9531E-12	5,444.247	10,888.494	0.00E+00	4.87E-08	9.75E-08
Pm-147	1.1588E-03	5,444.247	10,888.494	0.00E+00	6.31E+00	1.26E+01
Pu-238	1.7146E-04	5,444.247	10,888.494	0.00E+00	9.33E-01	1.87E+00
Pu-239	1.9464E-02	5,444.247	10,888.494	0.00E+00	1.06E+02	2.12E+02
Pu-240	6.7919E-05	5,444.247	10,888.494	0.00E+00	3.70E-01	7.40E-01
Pu-241	4.1774E-06	5,444.247	10,888.494	0.00E+00	2.27E-02	4.55E-02
Pu-242	4.3751E-13	5,444.247	10,888.494	0.00E+00	2.38E-09	4.76E-09
Ra-226	2.4219E-11	5,444.247	10,888.494	0.00E+00	1.32E-07	2.64E-07
Ra-228	2.3572E-11	5,444.247	10,888.494	0.00E+00	1.28E-07	2.57E-07
Ru-106	3.0951E-10	5,444.247	10,888.494	0.00E+00	1.69E-06	3.37E-06
Se-79	1.6488E-05	5,444.247	10,888.494	0.00E+00	8.98E-02	1.80E-01
Sn-126	3.7564E-05	5,444.247	10,888.494	0.00E+00	2.05E-01	4.09E-01
Sr-90	1.2052E+00	5,444.247	10,888.494	0.00E+00	6.56E+03	1.31E+04
Tc-99	4.4825E-04	5,444.247	10,888.494	0.00E+00	2.44E+00	4.88E+00
Th-229	4.6478E-11	5,444.247	10,888.494	0.00E+00	2.53E-07	5.06E-07
Th-230	2.2259E-09	5,444.247	10,888.494	0.00E+00	1.21E-05	2.42E-05
Th-232	2.3691E-11	5,444.247	10,888.494	0.00E+00	1.29E-07	2.58E-07
Tl-208	5.8256E-09	5,444.247	10,888.494	0.00E+00	3.17E-05	6.34E-05
U-232	1.5759E-08	5,444.247	10,888.494	0.00E+00	8.58E-05	1.72E-04
U-233	1.0110E-08	5,444.247	10,888.494	0.00E+00	5.50E-05	1.10E-04
U-234	4.9001E-06	5,444.247	10,888.494	0.00E+00	2.67E-02	5.34E-02
U-235	-2.3191E-06	5,444.247	0.000	7.31E-02	6.04E-02	7.31E-02
U-236	1.2633E-05	5,444.247	10,888.494	0.00E+00	6.88E-02	1.38E-01
U-238	-9.5407E-08	5,444.247	0.000	3.27E-02	3.22E-02	3.27E-02
Y-90	1.2053E+00	5,444.247	10,888.494	0.00E+00	6.56E+03	1.31E+04
Other Radionuclides					7.45E+03	1.49E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.205E+14
0.0250	1.497E+14
0.0375	1.317E+14
0.0575	1.395E+14
0.0850	8.435E+13
0.1250	5.463E+13
0.2250	7.240E+13
0.3750	3.155E+13
0.5750	5.573E+14
0.8500	5.147E+12
1.2500	3.414E+12
1.7500	1.329E+11
2.2500	2.343E+07
2.7500	2.257E+06
3.5000	2.011E+03
5.0000	6.793E+02
7.0000	5.720E+01
11.0000	5.182E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.40E+01	1.68E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U-Mo	U
BOL Enrichment %:	25.76549664	10 to 40

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	209.955	5,444.247
Bounding:	362.829	10,888.494

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	13.28	25.93
Bounding:	26.55	30.01

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FERMI CORE I & 2 (SODIUM WORTH)
SNF ID #: 455
Fuel Units & Descr: 420 - ROD
Heavy Metal Mass: BOL=56.24kg ; EOL=55.40kg
ROD Storage Site: INEEL

[1]Fuel decay start date: 1972
Estimates as of: 2010
Template: FERMI (Fast, Zirc, 10 to 40%, U)
[2]Template Burnup(MWd): 58.6725048
Template BOL Heavy Metal Mass (MT): 0.018774
Template Decay Time: 35 years

Estimated Canister usage:
18"x10'
0.11

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	9.6110E-08	740.714	1,481.428	0.00E+00	7.12E-05	1.42E-04
Am-241	6.5601E-07	740.714	1,481.428	0.00E+00	4.86E-04	9.72E-04
Am-242m	0.0000E+00	740.714	1,481.428	0.00E+00	0.00E+00	0.00E+00
Am-243	8.3770E-15	740.714	1,481.428	0.00E+00	6.20E-12	1.24E-11
C-14	2.1714E-05	740.714	1,481.428	0.00E+00	1.61E-02	3.22E-02
Cl-36	5.5188E-08	740.714	1,481.428	0.00E+00	4.09E-05	8.18E-05
Cm-243	1.5496E-14	740.714	1,481.428	0.00E+00	1.15E-11	2.30E-11
Cm-244	5.2375E-16	740.714	1,481.428	0.00E+00	3.88E-13	7.76E-13
Co-60	2.0947E-03	740.714	1,481.428	0.00E+00	1.55E+00	3.10E+00
Cs-134	6.2448E-07	740.714	1,481.428	0.00E+00	4.63E-04	9.25E-04
Cs-135	4.4996E-05	740.714	1,481.428	0.00E+00	3.33E-02	6.67E-02
Cs-137	1.3775E+00	740.714	1,481.428	0.00E+00	1.02E+03	2.04E+03
Eu-154	1.8510E-04	740.714	1,481.428	0.00E+00	1.37E-01	2.74E-01
Eu-155	1.4163E-03	740.714	1,481.428	0.00E+00	1.05E+00	2.10E+00
Fe-55	1.4179E-05	740.714	1,481.428	0.00E+00	1.05E-02	2.10E-02
H-3	3.5383E-03	740.714	1,481.428	0.00E+00	2.62E+00	5.24E+00
I-129	1.1426E-06	740.714	1,481.428	0.00E+00	8.46E-04	1.69E-03
Kr-85	3.8604E-02	740.714	1,481.428	0.00E+00	2.86E+01	5.72E+01
Np-237	3.3099E-06	740.714	1,481.428	0.00E+00	2.45E-03	4.90E-03
Pa-231	1.8953E-07	740.714	1,481.428	0.00E+00	1.40E-04	2.81E-04
Pb-210	8.9531E-12	740.714	1,481.428	0.00E+00	6.63E-09	1.33E-08
Pm-147	1.1588E-03	740.714	1,481.428	0.00E+00	8.58E-01	1.72E+00
Pu-238	1.7146E-04	740.714	1,481.428	0.00E+00	1.27E-01	2.54E-01
Pu-239	1.9464E-02	740.714	1,481.428	0.00E+00	1.44E+01	2.88E+01
Pu-240	6.7919E-05	740.714	1,481.428	0.00E+00	5.03E-02	1.01E-01
Pu-241	4.1774E-06	740.714	1,481.428	0.00E+00	3.09E-03	6.19E-03
Pu-242	4.3751E-13	740.714	1,481.428	0.00E+00	3.24E-10	6.48E-10
Ra-226	2.4219E-11	740.714	1,481.428	0.00E+00	1.79E-08	3.59E-08
Ra-228	2.3572E-11	740.714	1,481.428	0.00E+00	1.75E-08	3.49E-08
Ru-106	3.0951E-10	740.714	1,481.428	0.00E+00	2.29E-07	4.59E-07
Se-79	1.6488E-05	740.714	1,481.428	0.00E+00	1.22E-02	2.44E-02
Sn-126	3.7564E-05	740.714	1,481.428	0.00E+00	2.78E-02	5.56E-02
Sr-90	1.2052E+00	740.714	1,481.428	0.00E+00	8.93E+02	1.79E+03
Tc-99	4.4825E-04	740.714	1,481.428	0.00E+00	3.32E-01	6.64E-01
Th-229	4.6478E-11	740.714	1,481.428	0.00E+00	3.44E-08	6.89E-08
Th-230	2.2259E-09	740.714	1,481.428	0.00E+00	1.65E-06	3.30E-06
Th-232	2.3691E-11	740.714	1,481.428	0.00E+00	1.75E-08	3.51E-08
Tl-208	5.8256E-09	740.714	1,481.428	0.00E+00	4.32E-06	8.63E-06
U-232	1.5759E-08	740.714	1,481.428	0.00E+00	1.17E-05	2.33E-05
U-233	1.0110E-08	740.714	1,481.428	0.00E+00	7.49E-06	1.50E-05
U-234	4.9001E-06	740.714	1,481.428	0.00E+00	3.63E-03	7.26E-03
U-235	-2.3191E-06	740.714	0.000	3.12E-02	2.95E-02	3.12E-02
U-236	1.2633E-05	740.714	1,481.428	0.00E+00	9.36E-03	1.87E-02
U-238	-9.5407E-08	740.714	0.000	1.40E-02	1.40E-02	1.40E-02
Y-90	1.2053E+00	740.714	1,481.428	0.00E+00	8.93E+02	1.79E+03
Other Radionuclides					1.01E+03	2.03E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	9.802E+13
0.0250	2.036E+13
0.0375	1.791E+13
0.0575	1.897E+13
0.0850	1.148E+13
0.1250	7.433E+12
0.2250	9.851E+12
0.3750	4.292E+12
0.5750	7.582E+13
0.8500	7.002E+11
1.2500	4.645E+11
1.7500	1.808E+10
2.2500	3.187E+06
2.7500	3.072E+05
3.5000	3.254E+02
5.0000	1.147E+02
7.0000	1.034E+01
11.0000	9.995E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.14E+01	2.29E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U-Mo	U
BOL Enrichment %:	25.69081404	10 to 40

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	89.981	740.714
Bounding:	155.498	1,481.428

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	4.21	8.23
Bounding:	8.43	9.53

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FERMI CORE I & 2 (STD FUEL SUBASSEMBLY)	**[1]Fuel decay start date:**	1972
SNF ID #:	456	**Estimates as of:**	2010
Fuel Units & Descr:	27160 - ROD	**Template:**	FERMI (Fast, Zirc, 10 to 40%, U)
Heavy Metal Mass:	BOL=3636.72kg ; EOL=3566.11kg	**[2]Template Burnup(MWd):**	58.6725048
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.018774
		Template Decay Time:	35 years

Estimated Canister usage: 18"x10'

7.07

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	9.6110E-08	62,269.344	124,538.688	0.00E+00	5.98E-03	1.20E-02
Am-241	6.5601E-07	62,269.344	124,538.688	0.00E+00	4.08E-02	8.17E-02
Am-242m	0.0000E+00	62,269.344	124,538.688	0.00E+00	0.00E+00	0.00E+00
Am-243	8.3770E-15	62,269.344	124,538.688	0.00E+00	5.22E-10	1.04E-09
C-14	2.1714E-05	62,269.344	124,538.688	0.00E+00	1.35E+00	2.70E+00
Cl-36	5.5188E-08	62,269.344	124,538.688	0.00E+00	3.44E-03	6.87E-03
Cm-243	1.5496E-14	62,269.344	124,538.688	0.00E+00	9.65E-10	1.93E-09
Cm-244	5.2375E-16	62,269.344	124,538.688	0.00E+00	3.26E-11	6.52E-11
Co-60	2.0947E-03	62,269.344	124,538.688	0.00E+00	1.30E+02	2.61E+02
Cs-134	6.2448E-07	62,269.344	124,538.688	0.00E+00	3.89E-02	7.78E-02
Cs-135	4.4996E-05	62,269.344	124,538.688	0.00E+00	2.80E+00	5.60E+00
Cs-137	1.3775E+00	62,269.344	124,538.688	0.00E+00	8.58E+04	1.72E+05
Eu-154	1.8510E-04	62,269.344	124,538.688	0.00E+00	1.15E+01	2.31E+01
Eu-155	1.4163E-03	62,269.344	124,538.688	0.00E+00	8.82E+01	1.76E+02
Fe-55	1.4179E-05	62,269.344	124,538.688	0.00E+00	8.83E-01	1.77E+00
H-3	3.5383E-03	62,269.344	124,538.688	0.00E+00	2.20E+02	4.41E+02
I-129	1.1426E-06	62,269.344	124,538.688	0.00E+00	7.11E-02	1.42E-01
Kr-85	3.8604E-02	62,269.344	124,538.688	0.00E+00	2.40E+03	4.81E+03
Np-237	3.3099E-06	62,269.344	124,538.688	0.00E+00	2.06E-01	4.12E-01
Pa-231	1.8953E-07	62,269.344	124,538.688	0.00E+00	1.18E-02	2.36E-02
Pb-210	8.9531E-12	62,269.344	124,538.688	0.00E+00	5.58E-07	1.12E-06
Pm-147	1.1588E-03	62,269.344	124,538.688	0.00E+00	7.22E+01	1.44E+02
Pu-238	1.7146E-04	62,269.344	124,538.688	0.00E+00	1.07E+01	2.14E+01
Pu-239	1.9464E-02	62,269.344	124,538.688	0.00E+00	1.21E+03	2.42E+03
Pu-240	6.7919E-05	62,269.344	124,538.688	0.00E+00	4.23E+00	8.46E+00
Pu-241	4.1774E-06	62,269.344	124,538.688	0.00E+00	2.60E-01	5.20E-01
Pu-242	4.3751E-13	62,269.344	124,538.688	0.00E+00	2.72E-08	5.45E-08
Ra-226	2.4219E-11	62,269.344	124,538.688	0.00E+00	1.51E-06	3.02E-06
Ra-228	2.3572E-11	62,269.344	124,538.688	0.00E+00	1.47E-06	2.94E-06
Ru-106	3.0951E-10	62,269.344	124,538.688	0.00E+00	1.93E-05	3.85E-05
Se-79	1.6488E-05	62,269.344	124,538.688	0.00E+00	1.03E+00	2.05E+00
Sn-126	3.7564E-05	62,269.344	124,538.688	0.00E+00	2.34E+00	4.68E+00
Sr-90	1.2052E+00	62,269.344	124,538.688	0.00E+00	7.50E+04	1.50E+05
Tc-99	4.4825E-04	62,269.344	124,538.688	0.00E+00	2.79E+01	5.58E+01
Th-229	4.6478E-11	62,269.344	124,538.688	0.00E+00	2.89E-06	5.79E-06
Th-230	2.2259E-09	62,269.344	124,538.688	0.00E+00	1.39E-04	2.77E-04
Th-232	2.3691E-11	62,269.344	124,538.688	0.00E+00	1.48E-06	2.95E-06
Tl-208	5.8256E-09	62,269.344	124,538.688	0.00E+00	3.63E-04	7.26E-04
U-232	1.5759E-08	62,269.344	124,538.688	0.00E+00	9.81E-04	1.96E-03
U-233	1.0110E-08	62,269.344	124,538.688	0.00E+00	6.30E-04	1.26E-03
U-234	4.9001E-06	62,269.344	124,538.688	0.00E+00	3.05E-01	6.10E-01
U-235	-2.3191E-06	62,269.344	0.000	2.02E+00	1.87E+00	2.02E+00
U-236	1.2633E-05	62,269.344	124,538.688	0.00E+00	7.87E-01	1.57E+00
U-238	-9.5407E-08	62,269.344	0.000	9.08E-01	9.02E-01	9.08E-01
Y-90	1.2053E+00	62,269.344	124,538.688	0.00E+00	7.51E+04	1.50E+05
Other Radionuclides					8.53E+04	1.71E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	8.241E+15
0.0250	1.712E+15
0.0375	1.506E+15
0.0575	1.595E+15
0.0850	9.647E+14
0.1250	6.249E+14
0.2250	8.281E+14
0.3750	3.608E+14
0.5750	6.374E+15
0.8500	5.887E+13
1.2500	3.905E+13
1.7500	1.520E+12
2.2500	2.680E+08
2.7500	2.582E+07
3.5000	2.589E+04
5.0000	9.008E+03
7.0000	7.968E+02
11.0000	7.566E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.61E+02	**1.92E+03**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	ZIRC	ZIRC
BOL HM Constituents:	U-Mo	U
BOL Enrichment %:	25.69081404	10 to 40

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		62,269.344	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:	5,818.758	124,538.688	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	5.48	
Bounding:	10.96	21.40

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FFTF CARBIDE FUEL EXPER.	**[1]Fuel decay start date:**	1993		Estimated Canister usage:
SNF ID #:	347	**Estimates as of:**	2010		18"x10'
Fuel Units & Descr:	15 - ELEMENT	**Template:**	FFTF (FAST, SST, 10 to 30%, Pu & U)		0.31
Heavy Metal Mass:	BOL= ; EOL=7.36kg	**[2]Template Burnup(MWd):**	5011.2		
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.0329181		
		Template Decay Time:	15 years		

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	525.780	652.692	0.00E+00	7.22E-10	8.96E-10
Am-241	7.9527E-02	525.780	652.692	1.52E+01	5.70E+01	6.71E+01
Am-242m	2.1053E-03	525.780	652.692	0.00E+00	1.11E+00	1.37E+00
Am-243	1.0760E-04	525.780	652.692	0.00E+00	5.66E-02	7.02E-02
C-14	2.6141E-05	525.780	652.692	0.00E+00	1.37E-02	1.71E-02
Cl-36	3.4243E-10	525.780	652.692	0.00E+00	1.80E-07	2.24E-07
Cm-243	6.6092E-04	525.780	652.692	0.00E+00	3.47E-01	4.31E-01
Cm-244	2.9933E-03	525.780	652.692	0.00E+00	1.57E+00	1.95E+00
Co-60	1.5934E-02	525.780	652.692	0.00E+00	8.38E+00	1.04E+01
Cs-134	4.6356E-02	525.780	652.692	0.00E+00	2.44E+01	3.03E+01
Cs-135	4.7693E-05	525.780	652.692	0.00E+00	2.51E-02	3.11E-02
Cs-137	2.1113E+00	525.780	652.692	0.00E+00	1.11E+03	1.38E+03
Eu-154	4.8092E-02	525.780	652.692	0.00E+00	2.53E+01	3.14E+01
Eu-155	6.8447E-02	525.780	652.692	0.00E+00	3.60E+01	4.47E+01
Fe-55	5.8489E-03	525.780	652.692	0.00E+00	3.08E+00	3.82E+00
H-3	8.9300E-03	525.780	652.692	0.00E+00	4.70E+00	5.83E+00
I-129	1.2891E-06	525.780	652.692	0.00E+00	6.78E-04	8.41E-04
Kr-85	7.0941E-02	525.780	652.692	0.00E+00	3.73E+01	4.63E+01
Np-237	2.6541E-06	525.780	652.692	0.00E+00	1.40E-03	1.73E-03
Pa-231	4.8970E-12	525.780	652.692	0.00E+00	2.57E-09	3.20E-09
Pb-210	2.2170E-13	525.780	652.692	0.00E+00	1.17E-10	1.45E-10
Pm-147	2.3627E-01	525.780	652.692	0.00E+00	1.24E+02	1.54E+02
Pu-238	2.8636E-02	525.780	652.692	0.00E+00	1.51E+01	1.87E+01
Pu-239	-3.5520E-02	525.780	0.000	1.25E+02	1.06E+02	1.25E+02
Pu-240	2.0790E-02	525.780	652.692	6.34E+01	7.43E+01	7.70E+01
Pu-241	-4.8316E-01	525.780	0.000	2.85E+03	2.59E+03	2.85E+03
Pu-242	1.1052E-05	525.780	652.692	1.69E-02	2.27E-02	2.41E-02
Ra-226	5.7471E-13	525.780	652.692	0.00E+00	3.02E-10	3.75E-10
Ra-228	5.4957E-17	525.780	652.692	0.00E+00	2.89E-14	3.59E-14
Ru-106	1.4583E-02	525.780	652.692	0.00E+00	7.67E+00	9.52E+00
Se-79	1.0137E-05	525.780	652.692	0.00E+00	5.33E-03	6.62E-03
Sn-126	4.3922E-05	525.780	652.692	0.00E+00	2.31E-02	2.87E-02
Sr-90	7.6329E-01	525.780	652.692	0.00E+00	4.01E+02	4.98E+02
Tc-99	3.9412E-04	525.780	652.692	0.00E+00	2.07E-01	2.57E-01
Th-229	1.6457E-12	525.780	652.692	0.00E+00	8.65E-10	1.07E-09
Th-230	1.8822E-10	525.780	652.692	0.00E+00	9.90E-08	1.23E-07
Th-232	9.7601E-17	525.780	652.692	0.00E+00	5.13E-14	6.37E-14
Tl-208	5.2722E-07	525.780	652.692	0.00E+00	2.77E-04	3.44E-04
U-232	1.4925E-06	525.780	652.692	0.00E+00	7.85E-04	9.74E-04
U-233	2.1113E-10	525.780	652.692	0.00E+00	1.11E-07	1.38E-07
U-234	1.9528E-06	525.780	652.692	0.00E+00	1.03E-03	1.27E-03
U-235	-9.7920E-09	525.780	0.000	2.56E-05	2.05E-05	2.56E-05
U-236	1.1570E-07	525.780	652.692	0.00E+00	6.08E-05	7.55E-05
U-238	-1.7914E-07	525.780	0.000	1.86E-03	1.77E-03	1.86E-03
Y-90	7.6329E-01	525.780	652.692	0.00E+00	4.01E+02	4.98E+02
Other Radionuclides					1.14E+03	1.42E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.315E+13
0.0250	7.084E+12
0.0375	8.096E+12
0.0575	6.972E+12
0.0850	4.032E+12
0.1250	3.012E+12
0.2250	3.054E+12
0.3750	1.570E+12
0.5750	5.248E+13
0.8500	1.755E+12
1.2500	1.529E+12
1.7500	2.511E+10
2.2500	8.453E+08
2.7500	8.818E+07
3.5000	9.972E+06
5.0000	3.081E+04
7.0000	3.521E+03
11.0000	4.031E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.71E+01	**2.04E+01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (D9)	SST
BOL HM Constituents:	Pu/U CARB	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		525.780
Bounding:		652.692

Basis for burnup used in estimate:

Nominal burnup taken from SFD and converted to MWd using BOL=7.883kg
Bounding burnup taken from SFD and converted to MWd using BOL=7.883kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.44	
Bounding:	0.54	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FFTF OXIDE EXPERIMENTS	**[1]Fuel decay start date:**	1993
SNF ID #:	349	**Estimates as of:**	2010
Fuel Units & Descr:	1 - HEX ARRAY 91 ROD	**Template:**	FFTF (FAST, SST, 10 to 30%, Pu & U)
Heavy Metal Mass:	BOL= ; EOL=.25kg	**[2]Template Burnup(MWd):**	5011.2
ROD Storage Site:	INEEL	**Template BOL Heavy Metal Mass (MT):**	0.0329181
		Template Decay Time:	15 years

Estimated Canister usage: 18"x10' 0.02

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	33.977	62.291	0.00E+00	4.67E-11	8.56E-11
Am-241	7.9527E-02	33.977	62.291	5.46E-01	3.25E+00	5.50E+00
Am-242m	2.1053E-03	33.977	62.291	0.00E+00	7.15E-02	1.31E-01
Am-243	1.0760E-04	33.977	62.291	0.00E+00	3.66E-03	6.70E-03
C-14	2.6141E-05	33.977	62.291	0.00E+00	8.88E-04	1.63E-03
Cl-36	3.4243E-10	33.977	62.291	0.00E+00	1.16E-08	2.13E-08
Cm-243	6.6092E-04	33.977	62.291	0.00E+00	2.25E-02	4.12E-02
Cm-244	2.9933E-03	33.977	62.291	0.00E+00	1.02E-01	1.86E-01
Co-60	1.5934E-02	33.977	62.291	0.00E+00	5.41E-01	9.93E-01
Cs-134	4.6356E-02	33.977	62.291	0.00E+00	1.58E+00	2.89E+00
Cs-135	4.7693E-05	33.977	62.291	0.00E+00	1.62E-03	2.97E-03
Cs-137	2.1113E+00	33.977	62.291	0.00E+00	7.17E+01	1.32E+02
Eu-154	4.8092E-02	33.977	62.291	0.00E+00	1.63E+00	3.00E+00
Eu-155	6.8447E-02	33.977	62.291	0.00E+00	2.33E+00	4.26E+00
Fe-55	5.8489E-03	33.977	62.291	0.00E+00	1.99E-01	3.64E-01
H-3	8.9300E-03	33.977	62.291	0.00E+00	3.03E-01	5.56E-01
I-129	1.2891E-06	33.977	62.291	0.00E+00	4.38E-05	8.03E-05
Kr-85	7.0941E-02	33.977	62.291	0.00E+00	2.41E+00	4.42E+00
Np-237	2.6541E-06	33.977	62.291	0.00E+00	9.02E-05	1.65E-04
Pa-231	4.8970E-12	33.977	62.291	0.00E+00	1.66E-10	3.05E-10
Pb-210	2.2170E-13	33.977	62.291	0.00E+00	7.53E-12	1.38E-11
Pm-147	2.3627E-01	33.977	62.291	0.00E+00	8.03E+00	1.47E+01
Pu-238	2.8636E-02	33.977	62.291	0.00E+00	9.73E-01	1.78E+00
Pu-239	-3.5520E-02	33.977	0.000	4.48E+00	3.27E+00	4.48E+00
Pu-240	2.0790E-02	33.977	62.291	2.28E+00	2.98E+00	3.57E+00
Pu-241	-4.8316E-01	33.977	0.000	1.02E+02	8.58E+01	1.02E+02
Pu-242	1.1052E-05	33.977	62.291	6.07E-04	9.83E-04	1.30E-03
Ra-226	5.7471E-13	33.977	62.291	0.00E+00	1.95E-11	3.58E-11
Ra-228	5.4957E-17	33.977	62.291	0.00E+00	1.87E-15	3.42E-15
Ru-106	1.4583E-02	33.977	62.291	0.00E+00	4.95E-01	9.08E-01
Se-79	1.0137E-05	33.977	62.291	0.00E+00	3.44E-04	6.31E-04
Sn-126	4.3922E-05	33.977	62.291	0.00E+00	1.49E-03	2.74E-03
Sr-90	7.6329E-01	33.977	62.291	0.00E+00	2.59E+01	4.75E+01
Tc-99	3.9412E-04	33.977	62.291	0.00E+00	1.34E-02	2.45E-02
Th-229	1.6457E-12	33.977	62.291	0.00E+00	5.59E-11	1.03E-10
Th-230	1.8822E-10	33.977	62.291	0.00E+00	6.40E-09	1.17E-08
Th-232	9.7601E-17	33.977	62.291	0.00E+00	3.32E-15	6.08E-15
Tl-208	5.2722E-07	33.977	62.291	0.00E+00	1.79E-05	3.28E-05
U-232	1.4925E-06	33.977	62.291	0.00E+00	5.07E-05	9.30E-05
U-233	2.1113E-10	33.977	62.291	0.00E+00	7.17E-09	1.32E-08
U-234	1.9528E-06	33.977	62.291	0.00E+00	6.64E-05	1.22E-04
U-235	-9.7920E-09	33.977	0.000	9.20E-07	5.87E-07	9.20E-07
U-236	1.1570E-07	33.977	62.291	0.00E+00	3.93E-06	7.21E-06
U-238	-1.7914E-07	33.977	0.000	6.70E-05	6.09E-05	6.70E-05
Y-90	7.6329E-01	33.977	62.291	0.00E+00	2.59E+01	4.75E+01
Other Radionuclides					7.37E+01	1.35E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.115E+12
0.0250	6.752E+11
0.0375	7.726E+11
0.0575	6.529E+11
0.0850	3.848E+11
0.1250	2.874E+11
0.2250	2.914E+11
0.3750	1.498E+11
0.5750	5.008E+12
0.8500	1.675E+11
1.2500	1.459E+11
1.7500	2.397E+09
2.2500	8.067E+07
2.7500	8.414E+06
3.5000	9.495E+05
5.0000	2.044E+03
7.0000	2.340E+02
11.0000	2.681E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.19E-01	1.56E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		33.977	Nominal burnup taken from SFD and converted to MWd using BOL=0.283kg
Bounding:		62.291	Bounding burnup taken from SFD and converted to MWd using BOL=0.283kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.79	
Bounding:	1.45	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FFTF-DFA/TDFA	[1]Fuel decay start date:	1992
SNF ID #:	71	Estimates as of:	2010
Fuel Units & Descr:	261 - HEX ARRAY 217 ROD	Template:	FFTF (FAST, SST, 10 to 30%, Pu & U)
Heavy Metal Mass:	BOL=9083.09kg ; EOL=8443.74kg	[2]Template Burnup(MWd):	5011.2
ROD Storage Site:	HANFORD	Template BOL Heavy Metal Mass (MT):	0.0329181
		Template Decay Time:	15 years

Estimated Canister usage: 18"x15' — 52.20

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	638,157.184	1,362,463.065	0.00E+00	8.77E-07	1.87E-06
Am-241	7.9527E-02	638,157.184	1,362,463.065	1.75E+04	6.83E+04	1.26E+05
Am-242m	2.1053E-03	638,157.184	1,362,463.065	0.00E+00	1.34E+03	2.87E+03
Am-243	1.0760E-04	638,157.184	1,362,463.065	0.00E+00	6.87E+01	1.47E+02
C-14	2.6141E-05	638,157.184	1,362,463.065	0.00E+00	1.67E+01	3.56E+01
Cl-36	3.4243E-10	638,157.184	1,362,463.065	0.00E+00	2.19E-04	4.67E-04
Cm-243	6.6092E-04	638,157.184	1,362,463.065	0.00E+00	4.22E+02	9.00E+02
Cm-244	2.9933E-03	638,157.184	1,362,463.065	0.00E+00	1.91E+03	4.08E+03
Co-60	1.5934E-02	638,157.184	1,362,463.065	0.00E+00	1.02E+04	2.17E+04
Cs-134	4.6356E-02	638,157.184	1,362,463.065	0.00E+00	2.96E+04	6.32E+04
Cs-135	4.7693E-05	638,157.184	1,362,463.065	0.00E+00	3.04E+01	6.50E+01
Cs-137	2.1113E+00	638,157.184	1,362,463.065	0.00E+00	1.35E+06	2.88E+06
Eu-154	4.8092E-02	638,157.184	1,362,463.065	0.00E+00	3.07E+04	6.55E+04
Eu-155	6.8447E-02	638,157.184	1,362,463.065	0.00E+00	4.37E+04	9.33E+04
Fe-55	5.8489E-03	638,157.184	1,362,463.065	0.00E+00	3.73E+03	7.97E+03
H-3	8.9300E-03	638,157.184	1,362,463.065	0.00E+00	5.70E+03	1.22E+04
I-129	1.2891E-06	638,157.184	1,362,463.065	0.00E+00	8.23E-01	1.76E+00
Kr-85	7.0941E-02	638,157.184	1,362,463.065	0.00E+00	4.53E+04	9.67E+04
Np-237	2.6541E-06	638,157.184	1,362,463.065	0.00E+00	1.69E+00	3.62E+00
Pa-231	4.8970E-12	638,157.184	1,362,463.065	0.00E+00	3.13E-06	6.67E-06
Pb-210	2.2170E-13	638,157.184	1,362,463.065	0.00E+00	1.41E-07	3.02E-07
Pm-147	2.3627E-01	638,157.184	1,362,463.065	0.00E+00	1.51E+05	3.22E+05
Pu-238	2.8636E-02	638,157.184	1,362,463.065	0.00E+00	1.83E+04	3.90E+04
Pu-239	-3.5520E-02	638,157.184	0.000	1.44E+05	1.21E+05	1.44E+05
Pu-240	2.0790E-02	638,157.184	1,362,463.065	7.31E+04	8.63E+04	1.01E+05
Pu-241	-4.8316E-01	638,157.184	0.000	3.28E+06	2.97E+06	3.28E+06
Pu-242	1.1052E-05	638,157.184	1,362,463.065	1.95E+01	2.65E+01	3.45E+01
Ra-226	5.7471E-13	638,157.184	1,362,463.065	0.00E+00	3.67E-07	7.83E-07
Ra-228	5.4957E-17	638,157.184	1,362,463.065	0.00E+00	3.51E-11	7.49E-11
Ru-106	1.4583E-02	638,157.184	1,362,463.065	0.00E+00	9.31E+03	1.99E+04
Se-79	1.0137E-05	638,157.184	1,362,463.065	0.00E+00	6.47E+00	1.38E+01
Sn-126	4.3922E-05	638,157.184	1,362,463.065	0.00E+00	2.80E+01	5.98E+01
Sr-90	7.6329E-01	638,157.184	1,362,463.065	0.00E+00	4.87E+05	1.04E+06
Tc-99	3.9412E-04	638,157.184	1,362,463.065	0.00E+00	2.52E+02	5.37E+02
Th-229	1.6457E-12	638,157.184	1,362,463.065	0.00E+00	1.05E-06	2.24E-06
Th-230	1.8822E-10	638,157.184	1,362,463.065	0.00E+00	1.20E-04	2.56E-04
Th-232	9.7601E-17	638,157.184	1,362,463.065	0.00E+00	6.23E-11	1.33E-10
Tl-208	5.2722E-07	638,157.184	1,362,463.065	0.00E+00	3.36E-01	7.18E-01
U-232	1.4925E-06	638,157.184	1,362,463.065	0.00E+00	9.52E-01	2.03E+00
U-233	2.1113E-10	638,157.184	1,362,463.065	0.00E+00	1.35E-04	2.88E-04
U-234	1.9528E-06	638,157.184	1,362,463.065	0.00E+00	1.25E+00	2.66E+00
U-235	-9.7920E-09	638,157.184	0.000	2.95E-02	2.33E-02	2.95E-02
U-236	1.1570E-07	638,157.184	1,362,463.065	0.00E+00	7.38E-02	1.58E-01
U-238	-1.7914E-07	638,157.184	0.000	2.15E+00	2.03E+00	2.15E+00
Y-90	7.6329E-01	638,157.184	1,362,463.065	0.00E+00	4.87E+05	1.04E+06
Other Radionuclides					1.38E+06	2.95E+06

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.844E+16
0.0250	1.477E+16
0.0375	1.690E+16
0.0575	1.436E+16
0.0850	8.417E+15
0.1250	6.286E+15
0.2250	6.374E+15
0.3750	3.277E+15
0.5750	1.095E+17
0.8500	3.664E+15
1.2500	3.191E+15
1.7500	5.242E+13
2.2500	1.764E+12
2.7500	1.840E+11
3.5000	2.078E+10
5.0000	5.022E+07
7.0000	5.747E+06
11.0000	6.582E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.03E+04	3.65E+04
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (316)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:	0.709999934	10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]	From SFD	Estimated
Nominal:	635,816.097	638,157.184
Bounding:	1,362,463.065	1,276,314.369

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup taken directly from SFD (converted to MWd).

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.46	1.00
Bounding:	0.99	0.94

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-DFA/TDFA PINS
SNF ID #: 323
Fuel Units & Descr: 2768 - ROD
Heavy Metal Mass: BOL= ; EOL=443.99kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage:
18"x15'
41.94

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	31,146.436	69,045.345	0.00E+00	4.28E-08	9.48E-08
Am-241	7.9527E-02	31,146.436	69,045.345	9.16E+02	3.39E+03	6.41E+03
Am-242m	2.1053E-03	31,146.436	69,045.345	0.00E+00	6.56E+01	1.45E+02
Am-243	1.0760E-04	31,146.436	69,045.345	0.00E+00	3.35E+00	7.43E+00
C-14	2.6141E-05	31,146.436	69,045.345	0.00E+00	8.14E-01	1.80E+00
Cl-36	3.4243E-10	31,146.436	69,045.345	0.00E+00	1.07E-05	2.36E-05
Cm-243	6.6092E-04	31,146.436	69,045.345	0.00E+00	2.06E+01	4.56E+01
Cm-244	2.9933E-03	31,146.436	69,045.345	0.00E+00	9.32E+01	2.07E+02
Co-60	1.5934E-02	31,146.436	69,045.345	0.00E+00	4.96E+02	1.10E+03
Cs-134	4.6356E-02	31,146.436	69,045.345	0.00E+00	1.44E+03	3.20E+03
Cs-135	4.7693E-05	31,146.436	69,045.345	0.00E+00	1.49E+00	3.29E+00
Cs-137	2.1113E+00	31,146.436	69,045.345	0.00E+00	6.58E+04	1.46E+05
Eu-154	4.8092E-02	31,146.436	69,045.345	0.00E+00	1.50E+03	3.32E+03
Eu-155	6.8447E-02	31,146.436	69,045.345	0.00E+00	2.13E+03	4.73E+03
Fe-55	5.8489E-03	31,146.436	69,045.345	0.00E+00	1.82E+02	4.04E+02
H-3	8.9300E-03	31,146.436	69,045.345	0.00E+00	2.78E+02	6.17E+02
I-129	1.2891E-06	31,146.436	69,045.345	0.00E+00	4.02E-02	8.90E-02
Kr-85	7.0941E-02	31,146.436	69,045.345	0.00E+00	2.21E+03	4.90E+03
Np-237	2.6541E-06	31,146.436	69,045.345	0.00E+00	8.27E-02	1.83E-01
Pa-231	4.8970E-12	31,146.436	69,045.345	0.00E+00	1.53E-07	3.38E-07
Pb-210	2.2170E-13	31,146.436	69,045.345	0.00E+00	6.91E-09	1.53E-08
Pm-147	2.3627E-01	31,146.436	69,045.345	0.00E+00	7.36E+03	1.63E+04
Pu-238	2.8636E-02	31,146.436	69,045.345	0.00E+00	8.92E+02	1.98E+03
Pu-239	-3.5520E-02	31,146.436	0.000	7.52E+03	6.41E+03	7.52E+03
Pu-240	2.0790E-02	31,146.436	69,045.345	3.82E+03	4.47E+03	5.26E+03
Pu-241	-4.8316E-01	31,146.436	0.000	1.72E+05	1.57E+05	1.72E+05
Pu-242	1.1052E-05	31,146.436	69,045.345	1.02E+00	1.36E+00	1.78E+00
Ra-226	5.7471E-13	31,146.436	69,045.345	0.00E+00	1.79E-08	3.97E-08
Ra-228	5.4957E-17	31,146.436	69,045.345	0.00E+00	1.71E-12	3.79E-12
Ru-106	1.4583E-02	31,146.436	69,045.345	0.00E+00	4.54E+02	1.01E+03
Se-79	1.0137E-05	31,146.436	69,045.345	0.00E+00	3.16E-01	7.00E-01
Sn-126	4.3922E-05	31,146.436	69,045.345	0.00E+00	1.37E+00	3.03E+00
Sr-90	7.6329E-01	31,146.436	69,045.345	0.00E+00	2.38E+04	5.27E+04
Tc-99	3.9412E-04	31,146.436	69,045.345	0.00E+00	1.23E+01	2.72E+01
Th-229	1.6457E-12	31,146.436	69,045.345	0.00E+00	5.13E-08	1.14E-07
Th-230	1.8822E-10	31,146.436	69,045.345	0.00E+00	5.86E-06	1.30E-05
Th-232	9.7601E-17	31,146.436	69,045.345	0.00E+00	3.04E-12	6.74E-12
Tl-208	5.2722E-07	31,146.436	69,045.345	0.00E+00	1.64E-02	3.64E-02
U-232	1.4925E-06	31,146.436	69,045.345	0.00E+00	4.65E-02	1.03E-01
U-233	2.1113E-10	31,146.436	69,045.345	0.00E+00	6.58E-06	1.46E-05
U-234	1.9528E-06	31,146.436	69,045.345	0.00E+00	6.08E-02	1.35E-01
U-235	-9.7920E-09	31,146.436	0.000	1.54E-03	1.24E-03	1.54E-03
U-236	1.1570E-07	31,146.436	69,045.345	0.00E+00	3.60E-03	7.99E-03
U-238	-1.7914E-07	31,146.436	0.000	1.12E-01	1.07E-01	1.12E-01
Y-90	7.6329E-01	31,146.436	69,045.345	0.00E+00	2.38E+04	5.27E+04
Other Radionuclides					6.75E+04	1.50E+05

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	3.470E+15
0.0250	7.487E+14
0.0375	8.564E+14
0.0575	7.280E+14
0.0850	4.265E+14
0.1250	3.186E+14
0.2250	3.230E+14
0.3750	1.661E+14
0.5750	5.551E+15
0.8500	1.857E+14
1.2500	1.617E+14
1.7500	2.656E+12
2.2500	8.941E+10
2.7500	9.327E+09
3.5000	1.053E+09
5.0000	2.574E+06
7.0000	2.945E+05
11.0000	3.373E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.02E+03	1.86E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (316)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		31,146.436	Nominal burnup taken from SFD and converted to MWd using BOL=475.192kg
Bounding:		69,045.345	Bounding burnup taken from SFD and converted to MWd using BOL=475.192kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.43	
Bounding:	0.95	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA PINS
SNF ID #: 320
Fuel Units & Descr: 1645 - ROD
Heavy Metal Mass: BOL= ; EOL=389.70kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage:
18"x15'
24.92

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	27,338.134	60,603.111	0.00E+00	3.75E-08	8.32E-08
Am-241	7.9527E-02	27,338.134	60,603.111	8.04E+02	2.98E+03	5.62E+03
Am-242m	2.1053E-03	27,338.134	60,603.111	0.00E+00	5.76E+01	1.28E+02
Am-243	1.0760E-04	27,338.134	60,603.111	0.00E+00	2.94E+00	6.52E+00
C-14	2.6141E-05	27,338.134	60,603.111	0.00E+00	7.15E-01	1.58E+00
Cl-36	3.4243E-10	27,338.134	60,603.111	0.00E+00	9.36E-06	2.08E-05
Cm-243	6.6092E-04	27,338.134	60,603.111	0.00E+00	1.81E+01	4.01E+01
Cm-244	2.9933E-03	27,338.134	60,603.111	0.00E+00	8.18E+01	1.81E+02
Co-60	1.5934E-02	27,338.134	60,603.111	0.00E+00	4.36E+02	9.66E+02
Cs-134	4.6356E-02	27,338.134	60,603.111	0.00E+00	1.27E+03	2.81E+03
Cs-135	4.7693E-05	27,338.134	60,603.111	0.00E+00	1.30E+00	2.89E+00
Cs-137	2.1113E+00	27,338.134	60,603.111	0.00E+00	5.77E+04	1.28E+05
Eu-154	4.8092E-02	27,338.134	60,603.111	0.00E+00	1.31E+03	2.91E+03
Eu-155	6.8447E-02	27,338.134	60,603.111	0.00E+00	1.87E+03	4.15E+03
Fe-55	5.8489E-03	27,338.134	60,603.111	0.00E+00	1.60E+02	3.54E+02
H-3	8.9300E-03	27,338.134	60,603.111	0.00E+00	2.44E+02	5.41E+02
I-129	1.2891E-06	27,338.134	60,603.111	0.00E+00	3.52E-02	7.81E-02
Kr-85	7.0941E-02	27,338.134	60,603.111	0.00E+00	1.94E+03	4.30E+03
Np-237	2.6541E-06	27,338.134	60,603.111	0.00E+00	7.26E-02	1.61E-01
Pa-231	4.8970E-12	27,338.134	60,603.111	0.00E+00	1.34E-07	2.97E-07
Pb-210	2.2170E-13	27,338.134	60,603.111	0.00E+00	6.06E-09	1.34E-08
Pm-147	2.3627E-01	27,338.134	60,603.111	0.00E+00	6.46E+03	1.43E+04
Pu-238	2.8636E-02	27,338.134	60,603.111	0.00E+00	7.83E+02	1.74E+03
Pu-239	-3.5520E-02	27,338.134	0.000	6.60E+03	5.63E+03	6.60E+03
Pu-240	2.0790E-02	27,338.134	60,603.111	3.36E+03	3.92E+03	4.62E+03
Pu-241	-4.8316E-01	27,338.134	0.000	1.51E+05	1.37E+05	1.51E+05
Pu-242	1.1052E-05	27,338.134	60,603.111	8.95E-01	1.20E+00	1.56E+00
Ra-226	5.7471E-13	27,338.134	60,603.111	0.00E+00	1.57E-08	3.48E-08
Ra-228	5.4957E-17	27,338.134	60,603.111	0.00E+00	1.50E-12	3.33E-12
Ru-106	1.4583E-02	27,338.134	60,603.111	0.00E+00	3.99E+02	8.84E+02
Se-79	1.0137E-05	27,338.134	60,603.111	0.00E+00	2.77E-01	6.14E-01
Sn-126	4.3922E-05	27,338.134	60,603.111	0.00E+00	1.20E+00	2.66E+00
Sr-90	7.6329E-01	27,338.134	60,603.111	0.00E+00	2.09E+04	4.63E+04
Tc-99	3.9412E-04	27,338.134	60,603.111	0.00E+00	1.08E+01	2.39E+01
Th-229	1.6457E-12	27,338.134	60,603.111	0.00E+00	4.50E-08	9.97E-08
Th-230	1.8822E-10	27,338.134	60,603.111	0.00E+00	5.15E-06	1.14E-05
Th-232	9.7601E-17	27,338.134	60,603.111	0.00E+00	2.67E-12	5.91E-12
Tl-208	5.2722E-07	27,338.134	60,603.111	0.00E+00	1.44E-02	3.20E-02
U-232	1.4925E-06	27,338.134	60,603.111	0.00E+00	4.08E-02	9.04E-02
U-233	2.1113E-10	27,338.134	60,603.111	0.00E+00	5.77E-06	1.28E-05
U-234	1.9528E-06	27,338.134	60,603.111	0.00E+00	5.34E-02	1.18E-01
U-235	-9.7920E-09	27,338.134	0.000	1.36E-03	1.09E-03	1.36E-03
U-236	1.1570E-07	27,338.134	60,603.111	0.00E+00	3.16E-03	7.01E-03
U-238	-1.7914E-07	27,338.134	0.000	9.87E-02	9.38E-02	9.87E-02
Y-90	7.6329E-01	27,338.134	60,603.111	0.00E+00	2.09E+04	4.63E+04
Other Radionuclides					5.93E+04	1.31E+05

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	3.046E+15
0.0250	6.572E+14
0.0375	7.517E+14
0.0575	6.390E+14
0.0850	3.744E+14
0.1250	2.796E+14
0.2250	2.835E+14
0.3750	1.458E+14
0.5750	4.872E+15
0.8500	1.630E+14
1.2500	1.419E+14
1.7500	2.332E+12
2.2500	7.848E+10
2.7500	8.186E+09
3.5000	9.245E+08
5.0000	2.259E+06
7.0000	2.585E+05
11.0000	2.960E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.93E+02	1.64E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (HT9)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		27,338.134
Bounding:		60,603.111

Basis for burnup used in estimate:
Nominal burnup taken from SFD and converted to MWd using BOL=417.090kg
Bounding burnup taken from SFD and converted to MWd using BOL=417.090kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.43	
Bounding:	0.95	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FFTF-TFA PINS (AC-3)	**Fuel decay start date:**[1]	1992
SNF ID #:	1046	**Estimates as of:**	2010
Fuel Units & Descr:	72 - ROD	**Template:**	FFTF (FAST, SST, 10 to 30%, Pu & U)
Heavy Metal Mass:	BOL= ; EOL=8.88kg	**Template Burnup(MWd):**[2]	5011.2
ROD Storage Site:	HANFORD	**Template BOL Heavy Metal Mass (MT):**	0.0329181
		Template Decay Time:	15 years

Estimated Canister usage:

18"x15'
1.09

II. Estimates

Radionuclide	m: Ci/MWd From Template	x_n: Nominal Fuel Burnup (MWd)[2]	x_b: Bounding Fuel Burnup (MWd)[2]	b: Initial Activity (Ci)	y_n: Nominal Fuel Inventories(Ci)	y_b: Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	634.538	787.703	0.00E+00	8.72E-10	1.08E-09
Am-241	7.9527E-02	634.538	787.703	1.83E+01	6.88E+01	8.10E+01
Am-242m	2.1053E-03	634.538	787.703	0.00E+00	1.34E+00	1.66E+00
Am-243	1.0760E-04	634.538	787.703	0.00E+00	6.83E-02	8.48E-02
C-14	2.6141E-05	634.538	787.703	0.00E+00	1.66E-02	2.06E-02
Cl-36	3.4243E-10	634.538	787.703	0.00E+00	2.17E-07	2.70E-07
Cm-243	6.6092E-04	634.538	787.703	0.00E+00	4.19E-01	5.21E-01
Cm-244	2.9933E-03	634.538	787.703	0.00E+00	1.90E+00	2.36E+00
Co-60	1.5934E-02	634.538	787.703	0.00E+00	1.01E+01	1.26E+01
Cs-134	4.6356E-02	634.538	787.703	0.00E+00	2.94E+01	3.65E+01
Cs-135	4.7693E-05	634.538	787.703	0.00E+00	3.03E-02	3.76E-02
Cs-137	2.1113E+00	634.538	787.703	0.00E+00	1.34E+03	1.66E+03
Eu-154	4.8092E-02	634.538	787.703	0.00E+00	3.05E+01	3.79E+01
Eu-155	6.8447E-02	634.538	787.703	0.00E+00	4.34E+01	5.39E+01
Fe-55	5.8489E-03	634.538	787.703	0.00E+00	3.71E+00	4.61E+00
H-3	8.9300E-03	634.538	787.703	0.00E+00	5.67E+00	7.03E+00
I-129	1.2891E-06	634.538	787.703	0.00E+00	8.18E-04	1.02E-03
Kr-85	7.0941E-02	634.538	787.703	0.00E+00	4.50E+01	5.59E+01
Np-237	2.6541E-06	634.538	787.703	0.00E+00	1.68E-03	2.09E-03
Pa-231	4.8970E-12	634.538	787.703	0.00E+00	3.11E-09	3.86E-09
Pb-210	2.2170E-13	634.538	787.703	0.00E+00	1.41E-10	1.75E-10
Pm-147	2.3627E-01	634.538	787.703	0.00E+00	1.50E+02	1.86E+02
Pu-238	2.8636E-02	634.538	787.703	0.00E+00	1.82E+01	2.26E+01
Pu-239	-3.5520E-02	634.538	0.000	1.51E+02	1.28E+02	1.51E+02
Pu-240	2.0790E-02	634.538	787.703	7.65E+01	8.97E+01	9.29E+01
Pu-241	-4.8316E-01	634.538	0.000	3.44E+03	3.13E+03	3.44E+03
Pu-242	1.1052E-05	634.538	787.703	2.04E-02	2.74E-02	2.91E-02
Ra-226	5.7471E-13	634.538	787.703	0.00E+00	3.65E-10	4.53E-10
Ra-228	5.4957E-17	634.538	787.703	0.00E+00	3.49E-14	4.33E-14
Ru-106	1.4583E-02	634.538	787.703	0.00E+00	9.25E+00	1.15E+01
Se-79	1.0137E-05	634.538	787.703	0.00E+00	6.43E-03	7.99E-03
Sn-126	4.3922E-05	634.538	787.703	0.00E+00	2.79E-02	3.46E-02
Sr-90	7.6329E-01	634.538	787.703	0.00E+00	4.84E+02	6.01E+02
Tc-99	3.9412E-04	634.538	787.703	0.00E+00	2.50E-01	3.10E-01
Th-229	1.6457E-12	634.538	787.703	0.00E+00	1.04E-09	1.30E-09
Th-230	1.8822E-10	634.538	787.703	0.00E+00	1.19E-07	1.48E-07
Th-232	9.7601E-17	634.538	787.703	0.00E+00	6.19E-14	7.69E-14
Tl-208	5.2722E-07	634.538	787.703	0.00E+00	3.35E-04	4.15E-04
U-232	1.4925E-06	634.538	787.703	0.00E+00	9.47E-04	1.18E-03
U-233	2.1113E-10	634.538	787.703	0.00E+00	1.34E-07	1.66E-07
U-234	1.9528E-06	634.538	787.703	0.00E+00	1.24E-03	1.54E-03
U-235	-9.7920E-09	634.538	0.000	3.09E-05	2.47E-05	3.09E-05
U-236	1.1570E-07	634.538	787.703	0.00E+00	7.34E-05	9.11E-05
U-238	-1.7914E-07	634.538	0.000	2.25E-03	2.14E-03	2.25E-03
Y-90	7.6329E-01	634.538	787.703	0.00E+00	4.84E+02	6.01E+02
Other Radionuclides					1.38E+03	1.71E+03

Gamma Sources

Photon Energy Group (Avg. MeV)	Total Photons/sec (bounding)
0.0150	4.001E+13
0.0250	8.549E+12
0.0375	9.771E+12
0.0575	8.415E+12
0.0850	4.866E+12
0.1250	3.635E+12
0.2250	3.685E+12
0.3750	1.895E+12
0.5750	6.333E+13
0.8500	2.118E+12
1.2500	1.845E+12
1.7500	3.031E+10
2.2500	1.020E+09
2.7500	1.064E+08
3.5000	1.203E+07
5.0000	3.718E+04
7.0000	4.249E+03
11.0000	4.864E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.06E+01	2.46E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (HT9)	SST
BOL HM Constituents:	Pu/U CARB	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		634.538
Bounding:		787.703

Basis for burnup used in estimate:

Nominal burnup taken from SFD and converted to MWd using BOL=9.513kg
Bounding burnup taken from SFD and converted to MWd using BOL=9.513kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.44	
Bounding:	0.54	

Estimated EOL HM/Given EOL HM

1.00

[1] Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2] Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-AB-1	**[1]Fuel decay start date:**	1992		Estimated
SNF ID #: 317	**Estimates as of:**	2010		Canister usage:
Fuel Units & Descr: 1 - HEX ARRAY 217 ROD	**Template:**	FFTF (FAST, SST, 10 to 30%, Pu & U)		18"x15'
Heavy Metal Mass: BOL= ; EOL=34.65kg	**[2]Template Burnup(MWd):**	5011.2		0.20
ROD Storage Site: HANFORD	**Template BOL Heavy Metal Mass (MT):**	0.0329181		
	Template Decay Time:	15 years		

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	251.327	502.655	0.00E+00	3.45E-10	6.90E-10
Am-241	7.9527E-02	251.327	502.655	6.73E+01	8.73E+01	1.07E+02
Am-242m	2.1053E-03	251.327	502.655	0.00E+00	5.29E-01	1.06E+00
Am-243	1.0760E-04	251.327	502.655	0.00E+00	2.70E-02	5.41E-02
C-14	2.6141E-05	251.327	502.655	0.00E+00	6.57E-03	1.31E-02
Cl-36	3.4243E-10	251.327	502.655	0.00E+00	8.61E-08	1.72E-07
Cm-243	6.6092E-04	251.327	502.655	0.00E+00	1.66E-01	3.32E-01
Cm-244	2.9933E-03	251.327	502.655	0.00E+00	7.52E-01	1.50E+00
Co-60	1.5934E-02	251.327	502.655	0.00E+00	4.00E+00	8.01E+00
Cs-134	4.6356E-02	251.327	502.655	0.00E+00	1.17E+01	2.33E+01
Cs-135	4.7693E-05	251.327	502.655	0.00E+00	1.20E-02	2.40E-02
Cs-137	2.1113E+00	251.327	502.655	0.00E+00	5.31E+02	1.06E+03
Eu-154	4.8092E-02	251.327	502.655	0.00E+00	1.21E+01	2.42E+01
Eu-155	6.8447E-02	251.327	502.655	0.00E+00	1.72E+01	3.44E+01
Fe-55	5.8489E-03	251.327	502.655	0.00E+00	1.47E+00	2.94E+00
H-3	8.9300E-03	251.327	502.655	0.00E+00	2.24E+00	4.49E+00
I-129	1.2891E-06	251.327	502.655	0.00E+00	3.24E-04	6.48E-04
Kr-85	7.0941E-02	251.327	502.655	0.00E+00	1.78E+01	3.57E+01
Np-237	2.6541E-06	251.327	502.655	0.00E+00	6.67E-04	1.33E-03
Pa-231	4.8970E-12	251.327	502.655	0.00E+00	1.23E-09	2.46E-09
Pb-210	2.2170E-13	251.327	502.655	0.00E+00	5.57E-11	1.11E-10
Pm-147	2.3627E-01	251.327	502.655	0.00E+00	5.94E+01	1.19E+02
Pu-238	2.8636E-02	251.327	502.655	0.00E+00	7.20E+00	1.44E+01
Pu-239	-3.5520E-02	251.327	0.000	5.52E+02	5.44E+02	5.52E+02
Pu-240	2.0790E-02	251.327	502.655	2.81E+02	2.86E+02	2.91E+02
Pu-241	-4.8316E-01	251.327	0.000	1.26E+04	1.25E+04	1.26E+04
Pu-242	1.1052E-05	251.327	502.655	7.49E-02	7.77E-02	8.04E-02
Ra-226	5.7471E-13	251.327	502.655	0.00E+00	1.44E-10	2.89E-10
Ra-228	5.4957E-17	251.327	502.655	0.00E+00	1.38E-14	2.76E-14
Ru-106	1.4583E-02	251.327	502.655	0.00E+00	3.67E+00	7.33E+00
Se-79	1.0137E-05	251.327	502.655	0.00E+00	2.55E-03	5.10E-03
Sn-126	4.3922E-05	251.327	502.655	0.00E+00	1.10E-02	2.21E-02
Sr-90	7.6329E-01	251.327	502.655	0.00E+00	1.92E+02	3.84E+02
Tc-99	3.9412E-04	251.327	502.655	0.00E+00	9.91E-02	1.98E-01
Th-229	1.6457E-12	251.327	502.655	0.00E+00	4.14E-10	8.27E-10
Th-230	1.8822E-10	251.327	502.655	0.00E+00	4.73E-08	9.46E-08
Th-232	9.7601E-17	251.327	502.655	0.00E+00	2.45E-14	4.91E-14
Tl-208	5.2722E-07	251.327	502.655	0.00E+00	1.33E-04	2.65E-04
U-232	1.4925E-06	251.327	502.655	0.00E+00	3.75E-04	7.50E-04
U-233	2.1113E-10	251.327	502.655	0.00E+00	5.31E-08	1.06E-07
U-234	1.9528E-06	251.327	502.655	0.00E+00	4.91E-04	9.82E-04
U-235	-9.7920E-09	251.327	0.000	1.13E-04	1.11E-04	1.13E-04
U-236	1.1570E-07	251.327	502.655	0.00E+00	2.91E-05	5.82E-05
U-238	-1.7914E-07	251.327	0.000	8.26E-03	8.21E-03	8.26E-03
Y-90	7.6329E-01	251.327	502.655	0.00E+00	1.92E+02	3.84E+02
Other Radionuclides					5.45E+02	1.09E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.853E+13
0.0250	5.507E+12
0.0375	6.240E+12
0.0575	6.141E+12
0.0850	3.106E+12
0.1250	2.322E+12
0.2250	2.352E+12
0.3750	1.210E+12
0.5750	4.041E+13
0.8500	1.352E+12
1.2500	1.177E+12
1.7500	1.934E+10
2.2500	6.512E+08
2.7500	6.806E+07
3.5000	7.809E+06
5.0000	7.880E+04
7.0000	8.981E+03
11.0000	1.027E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.35E+01	3.91E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (316)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		251.327	Nominal burnup taken from SFD and converted to MWd using BOL=34.907kg
Bounding:		502.655	Bounding burnup assumed to be twice nominal burnup.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.05	
Bounding:	0.09	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-ABA-1 THRU 6
SNF ID #: 318
Fuel Units & Descr: 6 - HEX ARRAY 91 ROD
Heavy Metal Mass: BOL= ; EOL=257.43kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1992
Estimates as of: 2010
Template: FERMI (Fast, Zirc, 10 to 40%, U)
[2]Template Burnup(MWd): 58.6725048
Template BOL Heavy Metal Mass (MT): 0.018774
Template Decay Time: 15 years

Estimated Canister usage:

18"x15'
1.20

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.1509E-08	5,934.579	8,479.480	0.00E+00	1.28E-04	1.82E-04
Am-241	4.6529E-07	5,934.579	8,479.480	0.00E+00	2.76E-03	3.95E-03
Am-242m	0.0000E+00	5,934.579	8,479.480	0.00E+00	0.00E+00	0.00E+00
Am-243	8.3923E-15	5,934.579	8,479.480	0.00E+00	4.98E-11	7.12E-11
C-14	2.1765E-05	5,934.579	8,479.480	0.00E+00	1.29E-01	1.85E-01
Cl-36	5.5188E-08	5,934.579	8,479.480	0.00E+00	3.28E-04	4.68E-04
Cm-243	2.5208E-14	5,934.579	8,479.480	0.00E+00	1.50E-10	2.14E-10
Cm-244	1.1259E-15	5,934.579	8,479.480	0.00E+00	6.68E-12	9.55E-12
Co-60	2.9094E-02	5,934.579	8,479.480	0.00E+00	1.73E+02	2.47E+02
Cs-134	5.1932E-04	5,934.579	8,479.480	0.00E+00	3.08E+00	4.40E+00
Cs-135	4.4996E-05	5,934.579	8,479.480	0.00E+00	2.67E-01	3.82E-01
Cs-137	2.1867E+00	5,934.579	8,479.480	0.00E+00	1.30E+04	1.85E+04
Eu-154	9.2837E-04	5,934.579	8,479.480	0.00E+00	5.51E+00	7.87E+00
Eu-155	2.3180E-02	5,934.579	8,479.480	0.00E+00	1.38E+02	1.97E+02
Fe-55	2.9332E-03	5,934.579	8,479.480	0.00E+00	1.74E+01	2.49E+01
H-3	1.0871E-02	5,934.579	8,479.480	0.00E+00	6.45E+01	9.22E+01
I-129	1.1426E-06	5,934.579	8,479.480	0.00E+00	6.78E-03	9.69E-03
Kr-85	1.4068E-01	5,934.579	8,479.480	0.00E+00	8.35E+02	1.19E+03
Np-237	3.3099E-06	5,934.579	8,479.480	0.00E+00	1.96E-02	2.81E-02
Pa-231	7.8640E-08	5,934.579	8,479.480	0.00E+00	4.67E-04	6.67E-04
Pb-210	7.4277E-13	5,934.579	8,479.480	0.00E+00	4.41E-09	6.30E-09
Pm-147	2.2856E-01	5,934.579	8,479.480	0.00E+00	1.36E+03	1.94E+03
Pu-238	2.0095E-04	5,934.579	8,479.480	0.00E+00	1.19E+00	1.70E+00
Pu-239	1.9481E-02	5,934.579	8,479.480	0.00E+00	1.16E+02	1.65E+02
Pu-240	6.8056E-05	5,934.579	8,479.480	0.00E+00	4.04E-01	5.77E-01
Pu-241	1.0939E-05	5,934.579	8,479.480	0.00E+00	6.49E-02	9.28E-02
Pu-242	4.3751E-13	5,934.579	8,479.480	0.00E+00	2.60E-09	3.71E-09
Ra-226	4.0428E-12	5,934.579	8,479.480	0.00E+00	2.40E-08	3.43E-08
Ra-228	2.1032E-11	5,934.579	8,479.480	0.00E+00	1.25E-07	1.78E-07
Ru-106	2.9077E-04	5,934.579	8,479.480	0.00E+00	1.73E+00	2.47E+00
Se-79	1.6492E-05	5,934.579	8,479.480	0.00E+00	9.79E-02	1.40E-01
Sn-126	3.7564E-05	5,934.579	8,479.480	0.00E+00	2.23E-01	3.19E-01
Sr-90	1.9396E+00	5,934.579	8,479.480	0.00E+00	1.15E+04	1.64E+04
Tc-99	4.4842E-04	5,934.579	8,479.480	0.00E+00	2.66E+00	3.80E+00
Th-229	1.8544E-11	5,934.579	8,479.480	0.00E+00	1.10E-07	1.57E-07
Th-230	9.0605E-10	5,934.579	8,479.480	0.00E+00	5.38E-06	7.68E-06
Th-232	2.3674E-11	5,934.579	8,479.480	0.00E+00	1.40E-07	2.01E-07
Tl-208	7.0323E-09	5,934.579	8,479.480	0.00E+00	4.17E-05	5.96E-05
U-232	1.9106E-08	5,934.579	8,479.480	0.00E+00	1.13E-04	1.62E-04
U-233	9.6774E-09	5,934.579	8,479.480	0.00E+00	5.74E-05	8.21E-05
U-234	4.8796E-06	5,934.579	8,479.480	0.00E+00	2.90E-02	4.14E-02
U-235	-2.3191E-06	5,934.579	0.000	1.46E-01	1.32E-01	1.46E-01
U-236	1.2633E-05	5,934.579	8,479.480	0.00E+00	7.50E-02	1.07E-01
U-238	-9.5407E-08	5,934.579	0.000	6.61E-02	6.55E-02	6.61E-02
Y-90	1.9396E+00	5,934.579	8,479.480	0.00E+00	1.15E+04	1.64E+04
Other Radionuclides					1.29E+04	1.84E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	9.091E+14
0.0250	1.927E+14
0.0375	1.675E+14
0.0575	1.759E+14
0.0850	1.081E+14
0.1250	6.989E+13
0.2250	9.128E+13
0.3750	4.178E+13
0.5750	6.926E+14
0.8500	6.689E+12
1.2500	2.054E+13
1.7500	1.701E+11
2.2500	4.864E+08
2.7500	2.222E+07
3.5000	2.566E+06
5.0000	6.262E+02
7.0000	5.570E+01
11.0000	5.315E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.48E+02	2.12E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (HT9)	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:		10 to 40

Basis for Parameter Differences:
This Template was used for the following reasons:
This template is a good approximation since it is a FAST, Uranium fuel

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		5,934.579
Bounding:		8,479.480

Basis for burnup used in estimate:
Nominal burnup taken from SFD and converted to MWd using BOL=264.158kg
Bounding burnup taken from SFD and converted to MWd using BOL=264.158kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	7.19	
Bounding:	10.27	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-ACN-1 PINS
SNF ID #: 321
Fuel Units & Descr: 90 - ROD
Heavy Metal Mass: BOL= ; EOL=14.35kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage: 18"x15'
0.02

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	1,038.590	2,077.181	0.00E+00	1.43E-09	2.85E-09
Am-241	7.9527E-02	1,038.590	2,077.181	2.97E+01	1.12E+02	1.95E+02
Am-242m	2.1053E-03	1,038.590	2,077.181	0.00E+00	2.19E+00	4.37E+00
Am-243	1.0760E-04	1,038.590	2,077.181	0.00E+00	1.12E-01	2.24E-01
C-14	2.6141E-05	1,038.590	2,077.181	0.00E+00	2.72E-02	5.43E-02
Cl-36	3.4243E-10	1,038.590	2,077.181	0.00E+00	3.56E-07	7.11E-07
Cm-243	6.6092E-04	1,038.590	2,077.181	0.00E+00	6.86E-01	1.37E+00
Cm-244	2.9933E-03	1,038.590	2,077.181	0.00E+00	3.11E+00	6.22E+00
Co-60	1.5934E-02	1,038.590	2,077.181	0.00E+00	1.65E+01	3.31E+01
Cs-134	4.6356E-02	1,038.590	2,077.181	0.00E+00	4.81E+01	9.63E+01
Cs-135	4.7693E-05	1,038.590	2,077.181	0.00E+00	4.95E-02	9.91E-02
Cs-137	2.1113E+00	1,038.590	2,077.181	0.00E+00	2.19E+03	4.39E+03
Eu-154	4.8092E-02	1,038.590	2,077.181	0.00E+00	4.99E+01	9.99E+01
Eu-155	6.8447E-02	1,038.590	2,077.181	0.00E+00	7.11E+01	1.42E+02
Fe-55	5.8489E-03	1,038.590	2,077.181	0.00E+00	6.07E+00	1.21E+01
H-3	8.9300E-03	1,038.590	2,077.181	0.00E+00	9.27E+00	1.85E+01
I-129	1.2891E-06	1,038.590	2,077.181	0.00E+00	1.34E-03	2.68E-03
Kr-85	7.0941E-02	1,038.590	2,077.181	0.00E+00	7.37E+01	1.47E+02
Np-237	2.6541E-06	1,038.590	2,077.181	0.00E+00	2.76E-03	5.51E-03
Pa-231	4.8970E-12	1,038.590	2,077.181	0.00E+00	5.09E-09	1.02E-08
Pb-210	2.2170E-13	1,038.590	2,077.181	0.00E+00	2.30E-10	4.61E-10
Pm-147	2.3627E-01	1,038.590	2,077.181	0.00E+00	2.45E+02	4.91E+02
Pu-238	2.8636E-02	1,038.590	2,077.181	0.00E+00	2.97E+01	5.95E+01
Pu-239	-3.5520E-02	1,038.590	0.000	2.44E+02	2.07E+02	2.44E+02
Pu-240	2.0790E-02	1,038.590	2,077.181	1.24E+02	1.45E+02	1.67E+02
Pu-241	-4.8316E-01	1,038.590	0.000	5.56E+03	5.05E+03	5.56E+03
Pu-242	1.1052E-05	1,038.590	2,077.181	3.30E-02	4.45E-02	5.60E-02
Ra-226	5.7471E-13	1,038.590	2,077.181	0.00E+00	5.97E-10	1.19E-09
Ra-228	5.4957E-17	1,038.590	2,077.181	0.00E+00	5.71E-14	1.14E-13
Ru-106	1.4583E-02	1,038.590	2,077.181	0.00E+00	1.51E+01	3.03E+01
Se-79	1.0137E-05	1,038.590	2,077.181	0.00E+00	1.05E-02	2.11E-02
Sn-126	4.3922E-05	1,038.590	2,077.181	0.00E+00	4.56E-02	9.12E-02
Sr-90	7.6329E-01	1,038.590	2,077.181	0.00E+00	7.93E+02	1.59E+03
Tc-99	3.9412E-04	1,038.590	2,077.181	0.00E+00	4.09E-01	8.19E-01
Th-229	1.6457E-12	1,038.590	2,077.181	0.00E+00	1.71E-09	3.42E-09
Th-230	1.8822E-10	1,038.590	2,077.181	0.00E+00	1.95E-07	3.91E-07
Th-232	9.7601E-17	1,038.590	2,077.181	0.00E+00	1.01E-13	2.03E-13
Tl-208	5.2722E-07	1,038.590	2,077.181	0.00E+00	5.48E-04	1.10E-03
U-232	1.4925E-06	1,038.590	2,077.181	0.00E+00	1.55E-03	3.10E-03
U-233	2.1113E-10	1,038.590	2,077.181	0.00E+00	2.19E-07	4.39E-07
U-234	1.9528E-06	1,038.590	2,077.181	0.00E+00	2.03E-03	4.06E-03
U-235	-9.7920E-09	1,038.590	0.000	5.00E-05	3.98E-05	5.00E-05
U-236	1.1570E-07	1,038.590	2,077.181	0.00E+00	1.20E-04	2.40E-04
U-238	-1.7914E-07	1,038.590	0.000	3.64E-03	3.45E-03	3.64E-03
Y-90	7.6329E-01	1,038.590	2,077.181	0.00E+00	7.93E+02	1.59E+03
Other Radionuclides					2.25E+03	4.50E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.045E+14
0.0250	2.253E+13
0.0375	2.576E+13
0.0575	2.193E+13
0.0850	1.283E+13
0.1250	9.584E+12
0.2250	9.718E+12
0.3750	4.997E+12
0.5750	1.670E+14
0.8500	5.586E+12
1.2500	4.864E+12
1.7500	7.992E+10
2.2500	2.690E+09
2.7500	2.806E+08
3.5000	3.169E+07
5.0000	7.951E+04
7.0000	9.097E+03
11.0000	1.042E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.36E+01	5.69E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (D9)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,038.590	Nominal burnup taken from SFD and converted to MWd using BOL=15.387kg
Bounding:		2,077.181	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.44	
Bounding:	0.89	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FFTF-TFA-ACN-1 RODS	[1]**Fuel decay start date:**	1992
SNF ID #:	865	**Estimates as of:**	2010
Fuel Units & Descr:	16 - ROD	**Template:**	FFTF (FAST, SST, 10 to 30%, Pu & U)
Heavy Metal Mass:	BOL= ; EOL=2.56kg	[2]**Template Burnup(MWd):**	5011.2
ROD Storage Site:	HANFORD	**Template BOL Heavy Metal Mass (MT):**	0.0329181
		Template Decay Time:	15 years

Estimated Canister usage:

18"x15'
1.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	185.217	370.435	0.00E+00	2.54E-10	5.09E-10
Am-241	7.9527E-02	185.217	370.435	5.29E+00	2.00E+01	3.48E+01
Am-242m	2.1053E-03	185.217	370.435	0.00E+00	3.90E-01	7.80E-01
Am-243	1.0760E-04	185.217	370.435	0.00E+00	1.99E-02	3.99E-02
C-14	2.6141E-05	185.217	370.435	0.00E+00	4.84E-03	9.68E-03
Cl-36	3.4243E-10	185.217	370.435	0.00E+00	6.34E-08	1.27E-07
Cm-243	6.6092E-04	185.217	370.435	0.00E+00	1.22E-01	2.45E-01
Cm-244	2.9933E-03	185.217	370.435	0.00E+00	5.54E-01	1.11E+00
Co-60	1.5934E-02	185.217	370.435	0.00E+00	2.95E+00	5.90E+00
Cs-134	4.6356E-02	185.217	370.435	0.00E+00	8.59E+00	1.72E+01
Cs-135	4.7693E-05	185.217	370.435	0.00E+00	8.83E-03	1.77E-02
Cs-137	2.1113E+00	185.217	370.435	0.00E+00	3.91E+02	7.82E+02
Eu-154	4.8092E-02	185.217	370.435	0.00E+00	8.91E+00	1.78E+01
Eu-155	6.8447E-02	185.217	370.435	0.00E+00	1.27E+01	2.54E+01
Fe-55	5.8489E-03	185.217	370.435	0.00E+00	1.08E+00	2.17E+00
H-3	8.9300E-03	185.217	370.435	0.00E+00	1.65E+00	3.31E+00
I-129	1.2891E-06	185.217	370.435	0.00E+00	2.39E-04	4.78E-04
Kr-85	7.0941E-02	185.217	370.435	0.00E+00	1.31E+01	2.63E+01
Np-237	2.6541E-06	185.217	370.435	0.00E+00	4.92E-04	9.83E-04
Pa-231	4.8970E-12	185.217	370.435	0.00E+00	9.07E-10	1.81E-09
Pb-210	2.2170E-13	185.217	370.435	0.00E+00	4.11E-11	8.21E-11
Pm-147	2.3627E-01	185.217	370.435	0.00E+00	4.38E+01	8.75E+01
Pu-238	2.8636E-02	185.217	370.435	0.00E+00	5.30E+00	1.06E+01
Pu-239	-3.5520E-02	185.217	0.000	4.34E+01	3.68E+01	4.34E+01
Pu-240	2.0790E-02	185.217	370.435	2.21E+01	2.59E+01	2.98E+01
Pu-241	-4.8316E-01	185.217	0.000	9.91E+02	9.01E+02	9.91E+02
Pu-242	1.1052E-05	185.217	370.435	5.89E-03	7.93E-03	9.98E-03
Ra-226	5.7471E-13	185.217	370.435	0.00E+00	1.06E-10	2.13E-10
Ra-228	5.4957E-17	185.217	370.435	0.00E+00	1.02E-14	2.04E-14
Ru-106	1.4583E-02	185.217	370.435	0.00E+00	2.70E+00	5.40E+00
Se-79	1.0137E-05	185.217	370.435	0.00E+00	1.88E-03	3.76E-03
Sn-126	4.3922E-05	185.217	370.435	0.00E+00	8.14E-03	1.63E-02
Sr-90	7.6329E-01	185.217	370.435	0.00E+00	1.41E+02	2.83E+02
Tc-99	3.9412E-04	185.217	370.435	0.00E+00	7.30E-02	1.46E-01
Th-229	1.6457E-12	185.217	370.435	0.00E+00	3.05E-10	6.10E-10
Th-230	1.8822E-10	185.217	370.435	0.00E+00	3.49E-08	6.97E-08
Th-232	9.7601E-17	185.217	370.435	0.00E+00	1.81E-14	3.62E-14
Tl-208	5.2722E-07	185.217	370.435	0.00E+00	9.77E-05	1.95E-04
U-232	1.4925E-06	185.217	370.435	0.00E+00	2.76E-04	5.53E-04
U-233	2.1113E-10	185.217	370.435	0.00E+00	3.91E-08	7.82E-08
U-234	1.9528E-06	185.217	370.435	0.00E+00	3.62E-04	7.23E-04
U-235	-9.7920E-09	185.217	0.000	8.92E-06	7.10E-06	8.92E-06
U-236	1.1570E-07	185.217	370.435	0.00E+00	2.14E-05	4.29E-05
U-238	-1.7914E-07	185.217	0.000	6.49E-04	6.16E-04	6.49E-04
Y-90	7.6329E-01	185.217	370.435	0.00E+00	1.41E+02	2.83E+02
Other Radionuclides					4.02E+02	8.03E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.864E+13
0.0250	4.017E+12
0.0375	4.595E+12
0.0575	3.911E+12
0.0850	2.288E+12
0.1250	1.709E+12
0.2250	1.733E+12
0.3750	8.911E+11
0.5750	2.978E+13
0.8500	9.962E+11
1.2500	8.675E+11
1.7500	1.425E+10
2.2500	4.797E+08
2.7500	5.004E+07
3.5000	5.652E+06
5.0000	1.418E+04
7.0000	1.622E+03
11.0000	1.858E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.99E+00	1.02E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	SST
BOL HM Constituents:	Pu/U CARB	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		185.217
Bounding:		370.435

Basis for burnup used in estimate:

Nominal burnup taken from SFD and converted to MWd using BOL=2.744kg
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.44	
Bounding:	0.89	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-ACO-2, 4 THRU 16
SNF ID #: 329
Fuel Units & Descr: 14 - HEX ARRAY 169 ROD
Heavy Metal Mass: BOL= ; EOL=605.98kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage: **18"x15'**
2.80

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	96,319.972	140,074.700	0.00E+00	1.32E-07	1.92E-07
Am-241	7.9527E-02	96,319.972	140,074.700	1.35E+03	9.01E+03	1.25E+04
Am-242m	2.1053E-03	96,319.972	140,074.700	0.00E+00	2.03E+02	2.95E+02
Am-243	1.0760E-04	96,319.972	140,074.700	0.00E+00	1.04E+01	1.51E+01
C-14	2.6141E-05	96,319.972	140,074.700	0.00E+00	2.52E+00	3.66E+00
Cl-36	3.4243E-10	96,319.972	140,074.700	0.00E+00	3.30E-05	4.80E-05
Cm-243	6.6092E-04	96,319.972	140,074.700	0.00E+00	6.37E+01	9.26E+01
Cm-244	2.9933E-03	96,319.972	140,074.700	0.00E+00	2.88E+02	4.19E+02
Co-60	1.5934E-02	96,319.972	140,074.700	0.00E+00	1.53E+03	2.23E+03
Cs-134	4.6356E-02	96,319.972	140,074.700	0.00E+00	4.47E+03	6.49E+03
Cs-135	4.7693E-05	96,319.972	140,074.700	0.00E+00	4.59E+00	6.68E+00
Cs-137	2.1113E+00	96,319.972	140,074.700	0.00E+00	2.03E+05	2.96E+05
Eu-154	4.8092E-02	96,319.972	140,074.700	0.00E+00	4.63E+03	6.74E+03
Eu-155	6.8447E-02	96,319.972	140,074.700	0.00E+00	6.59E+03	9.59E+03
Fe-55	5.8489E-03	96,319.972	140,074.700	0.00E+00	5.63E+02	8.19E+02
H-3	8.9300E-03	96,319.972	140,074.700	0.00E+00	8.60E+02	1.25E+03
I-129	1.2891E-06	96,319.972	140,074.700	0.00E+00	1.24E-01	1.81E-01
Kr-85	7.0941E-02	96,319.972	140,074.700	0.00E+00	6.83E+03	9.94E+03
Np-237	2.6541E-06	96,319.972	140,074.700	0.00E+00	2.56E-01	3.72E-01
Pa-231	4.8970E-12	96,319.972	140,074.700	0.00E+00	4.72E-07	6.86E-07
Pb-210	2.2170E-13	96,319.972	140,074.700	0.00E+00	2.14E-08	3.11E-08
Pm-147	2.3627E-01	96,319.972	140,074.700	0.00E+00	2.28E+04	3.31E+04
Pu-238	2.8636E-02	96,319.972	140,074.700	0.00E+00	2.76E+03	4.01E+03
Pu-239	-3.5520E-02	96,319.972	0.000	1.11E+04	7.70E+03	1.11E+04
Pu-240	2.0790E-02	96,319.972	140,074.700	5.65E+03	7.65E+03	8.56E+03
Pu-241	-4.8316E-01	96,319.972	0.000	2.54E+05	2.07E+05	2.54E+05
Pu-242	1.1052E-05	96,319.972	140,074.700	1.51E+00	2.57E+00	3.06E+00
Ra-226	5.7471E-13	96,319.972	140,074.700	0.00E+00	5.54E-08	8.05E-08
Ra-228	5.4957E-17	96,319.972	140,074.700	0.00E+00	5.29E-12	7.70E-12
Ru-106	1.4583E-02	96,319.972	140,074.700	0.00E+00	1.40E+03	2.04E+03
Se-79	1.0137E-05	96,319.972	140,074.700	0.00E+00	9.76E-01	1.42E+00
Sn-126	4.3922E-05	96,319.972	140,074.700	0.00E+00	4.23E+00	6.15E+00
Sr-90	7.6329E-01	96,319.972	140,074.700	0.00E+00	7.35E+04	1.07E+05
Tc-99	3.9412E-04	96,319.972	140,074.700	0.00E+00	3.80E+01	5.52E+01
Th-229	1.6457E-12	96,319.972	140,074.700	0.00E+00	1.59E-07	2.31E-07
Th-230	1.8822E-10	96,319.972	140,074.700	0.00E+00	1.81E-05	2.64E-05
Th-232	9.7601E-17	96,319.972	140,074.700	0.00E+00	9.40E-12	1.37E-11
Tl-208	5.2722E-07	96,319.972	140,074.700	0.00E+00	5.08E-02	7.39E-02
U-232	1.4925E-06	96,319.972	140,074.700	0.00E+00	1.44E-01	2.09E-01
U-233	2.1113E-10	96,319.972	140,074.700	0.00E+00	2.03E-05	2.96E-05
U-234	1.9528E-06	96,319.972	140,074.700	0.00E+00	1.88E-01	2.74E-01
U-235	-9.7920E-09	96,319.972	0.000	2.28E-03	1.34E-03	2.28E-03
U-236	1.1570E-07	96,319.972	140,074.700	0.00E+00	1.11E-02	1.62E-02
U-238	-1.7914E-07	96,319.972	0.000	1.66E-01	1.49E-01	1.66E-01
Y-90	7.6329E-01	96,319.972	140,074.700	0.00E+00	7.35E+04	1.07E+05
Other Radionuclides					2.09E+05	3.04E+05

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	7.013E+15
0.0250	1.518E+15
0.0375	1.737E+15
0.0575	1.470E+15
0.0850	8.653E+14
0.1250	6.463E+14
0.2250	6.553E+14
0.3750	3.369E+14
0.5750	1.126E+16
0.8500	3.767E+14
1.2500	3.280E+14
1.7500	5.389E+12
2.2500	1.814E+11
2.7500	1.892E+10
3.5000	2.136E+09
5.0000	4.722E+06
7.0000	5.406E+05
11.0000	6.192E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.52E+03	3.57E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (316)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		96,319.972
Bounding:		140,074.700

Basis for burnup used in estimate:
Nominal burnup taken from SFD and converted to MWd using BOL=702.481kg
Bounding burnup taken from SFD and converted to MWd using BOL=702.481kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.90	
Bounding:	1.31	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-CRBR-3 & CRBR-5
SNF ID #: 322
Fuel Units & Descr: 2 - HEX ARRAY 217 ROD
Heavy Metal Mass: BOL= ; EOL=69.40kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage: 18"x15'
0.40

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	5,116.338	5,738.646	0.00E+00	7.03E-09	7.88E-09
Am-241	7.9527E-02	5,116.338	5,738.646	1.44E+02	5.51E+02	6.00E+02
Am-242m	2.1053E-03	5,116.338	5,738.646	0.00E+00	1.08E+01	1.21E+01
Am-243	1.0760E-04	5,116.338	5,738.646	0.00E+00	5.51E-01	6.17E-01
C-14	2.6141E-05	5,116.338	5,738.646	0.00E+00	1.34E-01	1.50E-01
Cl-36	3.4243E-10	5,116.338	5,738.646	0.00E+00	1.75E-06	1.97E-06
Cm-243	6.6092E-04	5,116.338	5,738.646	0.00E+00	3.38E+00	3.79E+00
Cm-244	2.9933E-03	5,116.338	5,738.646	0.00E+00	1.53E+01	1.72E+01
Co-60	1.5934E-02	5,116.338	5,738.646	0.00E+00	8.15E+01	9.14E+01
Cs-134	4.6356E-02	5,116.338	5,738.646	0.00E+00	2.37E+02	2.66E+02
Cs-135	4.7693E-05	5,116.338	5,738.646	0.00E+00	2.44E-01	2.74E-01
Cs-137	2.1113E+00	5,116.338	5,738.646	0.00E+00	1.08E+04	1.21E+04
Eu-154	4.8092E-02	5,116.338	5,738.646	0.00E+00	2.46E+02	2.76E+02
Eu-155	6.8447E-02	5,116.338	5,738.646	0.00E+00	3.50E+02	3.93E+02
Fe-55	5.8489E-03	5,116.338	5,738.646	0.00E+00	2.99E+01	3.36E+01
H-3	8.9300E-03	5,116.338	5,738.646	0.00E+00	4.57E+01	5.12E+01
I-129	1.2891E-06	5,116.338	5,738.646	0.00E+00	6.60E-03	7.40E-03
Kr-85	7.0941E-02	5,116.338	5,738.646	0.00E+00	3.63E+02	4.07E+02
Np-237	2.6541E-06	5,116.338	5,738.646	0.00E+00	1.36E-02	1.52E-02
Pa-231	4.8970E-12	5,116.338	5,738.646	0.00E+00	2.51E-08	2.81E-08
Pb-210	2.2170E-13	5,116.338	5,738.646	0.00E+00	1.13E-09	1.27E-09
Pm-147	2.3627E-01	5,116.338	5,738.646	0.00E+00	1.21E+03	1.36E+03
Pu-238	2.8636E-02	5,116.338	5,738.646	0.00E+00	1.47E+02	1.64E+02
Pu-239	-3.5520E-02	5,116.338	0.000	1.18E+03	9.98E+02	1.18E+03
Pu-240	2.0790E-02	5,116.338	5,738.646	6.00E+02	7.06E+02	7.19E+02
Pu-241	-4.8316E-01	5,116.338	0.000	2.69E+04	2.44E+04	2.69E+04
Pu-242	1.1052E-05	5,116.338	5,738.646	1.60E-01	2.16E-01	2.23E-01
Ra-226	5.7471E-13	5,116.338	5,738.646	0.00E+00	2.94E-09	3.30E-09
Ra-228	5.4957E-17	5,116.338	5,738.646	0.00E+00	2.81E-13	3.15E-13
Ru-106	1.4583E-02	5,116.338	5,738.646	0.00E+00	7.46E+01	8.37E+01
Se-79	1.0137E-05	5,116.338	5,738.646	0.00E+00	5.19E-02	5.82E-02
Sn-126	4.3922E-05	5,116.338	5,738.646	0.00E+00	2.25E-01	2.52E-01
Sr-90	7.6329E-01	5,116.338	5,738.646	0.00E+00	3.91E+03	4.38E+03
Tc-99	3.9412E-04	5,116.338	5,738.646	0.00E+00	2.02E+00	2.26E+00
Th-229	1.6457E-12	5,116.338	5,738.646	0.00E+00	8.42E-09	9.44E-09
Th-230	1.8822E-10	5,116.338	5,738.646	0.00E+00	9.63E-07	1.08E-06
Th-232	9.7601E-17	5,116.338	5,738.646	0.00E+00	4.99E-13	5.60E-13
Tl-208	5.2722E-07	5,116.338	5,738.646	0.00E+00	2.70E-03	3.03E-03
U-232	1.4925E-06	5,116.338	5,738.646	0.00E+00	7.64E-03	8.56E-03
U-233	2.1113E-10	5,116.338	5,738.646	0.00E+00	1.08E-06	1.21E-06
U-234	1.9528E-06	5,116.338	5,738.646	0.00E+00	9.99E-03	1.12E-02
U-235	-9.7920E-09	5,116.338	0.000	2.42E-04	1.92E-04	2.42E-04
U-236	1.1570E-07	5,116.338	5,738.646	0.00E+00	5.92E-04	6.64E-04
U-238	-1.7914E-07	5,116.338	0.000	1.76E-02	1.67E-02	1.76E-02
Y-90	7.6329E-01	5,116.338	5,738.646	0.00E+00	3.91E+03	4.38E+03
Other Radionuclides					1.11E+04	1.24E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.921E+14
0.0250	6.229E+13
0.0375	7.118E+13
0.0575	6.144E+13
0.0850	3.545E+13
0.1250	2.648E+13
0.2250	2.685E+13
0.3750	1.381E+13
0.5750	4.614E+14
0.8500	1.543E+13
1.2500	1.344E+13
1.7500	2.208E+11
2.2500	7.432E+09
2.7500	7.754E+08
3.5000	8.770E+07
5.0000	2.808E+05
7.0000	3.209E+04
11.0000	3.674E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.64E+02	1.83E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		5,116.338	Nominal burnup taken from SFD and converted to MWd using BOL=74.528kg
Bounding:		5,738.646	Bounding burnup taken from SFD and converted to MWd using BOL=74.528kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.45	
Bounding:	0.51	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-DEA-2
SNF ID #: 324
Fuel Units & Descr: 1 - HEX ARRAY 217 ROD
Heavy Metal Mass: BOL= ; EOL=34.61kg
ROD Storage Site: HANFORD

[1]**Fuel decay start date:** 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]**Template Burnup(MWd):** 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage:
18"x15'
0.20

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	3.461	6.922	0.00E+00	4.75E-12	9.51E-12
Am-241	7.9527E-02	3.461	6.922	6.67E+01	6.70E+01	6.73E+01
Am-242m	2.1053E-03	3.461	6.922	0.00E+00	7.29E-03	1.46E-02
Am-243	1.0760E-04	3.461	6.922	0.00E+00	3.72E-04	7.45E-04
C-14	2.6141E-05	3.461	6.922	0.00E+00	9.05E-05	1.81E-04
Cl-36	3.4243E-10	3.461	6.922	0.00E+00	1.19E-09	2.37E-09
Cm-243	6.6092E-04	3.461	6.922	0.00E+00	2.29E-03	4.57E-03
Cm-244	2.9933E-03	3.461	6.922	0.00E+00	1.04E-02	2.07E-02
Co-60	1.5934E-02	3.461	6.922	0.00E+00	5.51E-02	1.10E-01
Cs-134	4.6356E-02	3.461	6.922	0.00E+00	1.60E-01	3.21E-01
Cs-135	4.7693E-05	3.461	6.922	0.00E+00	1.65E-04	3.30E-04
Cs-137	2.1113E+00	3.461	6.922	0.00E+00	7.31E+00	1.46E+01
Eu-154	4.8092E-02	3.461	6.922	0.00E+00	1.66E-01	3.33E-01
Eu-155	6.8447E-02	3.461	6.922	0.00E+00	2.37E-01	4.74E-01
Fe-55	5.8489E-03	3.461	6.922	0.00E+00	2.02E-02	4.05E-02
H-3	8.9300E-03	3.461	6.922	0.00E+00	3.09E-02	6.18E-02
I-129	1.2891E-06	3.461	6.922	0.00E+00	4.46E-06	8.92E-06
Kr-85	7.0941E-02	3.461	6.922	0.00E+00	2.46E-01	4.91E-01
Np-237	2.6541E-06	3.461	6.922	0.00E+00	9.19E-06	1.84E-05
Pa-231	4.8970E-12	3.461	6.922	0.00E+00	1.69E-11	3.39E-11
Pb-210	2.2170E-13	3.461	6.922	0.00E+00	7.67E-13	1.53E-12
Pm-147	2.3627E-01	3.461	6.922	0.00E+00	8.18E-01	1.64E+00
Pu-238	2.8636E-02	3.461	6.922	0.00E+00	9.91E-02	1.98E-01
Pu-239	-3.5520E-02	3.461	0.000	5.48E+02	5.48E+02	5.48E+02
Pu-240	2.0790E-02	3.461	6.922	2.78E+02	2.78E+02	2.79E+02
Pu-241	-4.8316E-01	3.461	0.000	1.25E+04	1.25E+04	1.25E+04
Pu-242	1.1052E-05	3.461	6.922	7.42E-02	7.43E-02	7.43E-02
Ra-226	5.7471E-13	3.461	6.922	0.00E+00	1.99E-12	3.98E-12
Ra-228	5.4957E-17	3.461	6.922	0.00E+00	1.90E-16	3.80E-16
Ru-106	1.4583E-02	3.461	6.922	0.00E+00	5.05E-02	1.01E-01
Se-79	1.0137E-05	3.461	6.922	0.00E+00	3.51E-05	7.02E-05
Sn-126	4.3922E-05	3.461	6.922	0.00E+00	1.52E-04	3.04E-04
Sr-90	7.6329E-01	3.461	6.922	0.00E+00	2.64E+00	5.28E+00
Tc-99	3.9412E-04	3.461	6.922	0.00E+00	1.36E-03	2.73E-03
Th-229	1.6457E-12	3.461	6.922	0.00E+00	5.70E-12	1.14E-11
Th-230	1.8822E-10	3.461	6.922	0.00E+00	6.51E-10	1.30E-09
Th-232	9.7601E-17	3.461	6.922	0.00E+00	3.38E-16	6.76E-16
Tl-208	5.2722E-07	3.461	6.922	0.00E+00	1.82E-06	3.65E-06
U-232	1.4925E-06	3.461	6.922	0.00E+00	5.17E-06	1.03E-05
U-233	2.1113E-10	3.461	6.922	0.00E+00	7.31E-10	1.46E-09
U-234	1.9528E-06	3.461	6.922	0.00E+00	6.76E-06	1.35E-05
U-235	-9.7920E-09	3.461	0.000	1.12E-04	1.12E-04	1.12E-04
U-236	1.1570E-07	3.461	6.922	0.00E+00	4.00E-07	8.01E-07
U-238	-1.7914E-07	3.461	0.000	8.19E-03	8.19E-03	8.19E-03
Y-90	7.6329E-01	3.461	6.922	0.00E+00	2.64E+00	5.28E+00
Other Radionuclides					7.51E+00	1.50E+01

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.943E+12
0.0250	1.374E+11
0.0375	9.222E+10
0.0575	9.979E+11
0.0850	4.379E+10
0.1250	3.482E+10
0.2250	3.270E+10
0.3750	1.797E+10
0.5750	5.566E+11
0.8500	1.863E+10
1.2500	1.621E+10
1.7500	2.668E+08
2.2500	9.267E+06
2.7500	1.110E+06
3.5000	2.611E+05
5.0000	6.627E+04
7.0000	7.544E+03
11.0000	8.623E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.82E+01	2.83E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (316)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		3.461
Bounding:		6.922

Basis for burnup used in estimate:
Nominal burnup taken from SFD and converted to MWd using BOL=34.610kg
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	
Bounding:	0.00	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FFTF-TFA-FC-1	**[1]Fuel decay start date:**	1992
SNF ID #:	325	**Estimates as of:**	2010
Fuel Units & Descr:	1 - HEX ARRAY 91 ROD	**Template:**	FFTF (FAST, SST, 10 to 30%, Pu & U)
Heavy Metal Mass:	BOL= ; EOL=42.58kg	**[2]Template Burnup(MWd):**	5011.2
ROD Storage Site:	HANFORD	**Template BOL Heavy Metal Mass (MT):**	0.0329181
		Template Decay Time:	15 years

Estimated Canister usage: 18"x15'

0.20

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	2,694.342	5,388.684	0.00E+00	3.70E-09	7.40E-09
Am-241	7.9527E-02	2,694.342	5,388.684	8.73E+01	3.02E+02	5.16E+02
Am-242m	2.1053E-03	2,694.342	5,388.684	0.00E+00	5.67E+00	1.13E+01
Am-243	1.0760E-04	2,694.342	5,388.684	0.00E+00	2.90E-01	5.80E-01
C-14	2.6141E-05	2,694.342	5,388.684	0.00E+00	7.04E-02	1.41E-01
Cl-36	3.4243E-10	2,694.342	5,388.684	0.00E+00	9.23E-07	1.85E-06
Cm-243	6.6092E-04	2,694.342	5,388.684	0.00E+00	1.78E+00	3.56E+00
Cm-244	2.9933E-03	2,694.342	5,388.684	0.00E+00	8.06E+00	1.61E+01
Co-60	1.5934E-02	2,694.342	5,388.684	0.00E+00	4.29E+01	8.59E+01
Cs-134	4.6356E-02	2,694.342	5,388.684	0.00E+00	1.25E+02	2.50E+02
Cs-135	4.7693E-05	2,694.342	5,388.684	0.00E+00	1.29E-01	2.57E-01
Cs-137	2.1113E+00	2,694.342	5,388.684	0.00E+00	5.69E+03	1.14E+04
Eu-154	4.8092E-02	2,694.342	5,388.684	0.00E+00	1.30E+02	2.59E+02
Eu-155	6.8447E-02	2,694.342	5,388.684	0.00E+00	1.84E+02	3.69E+02
Fe-55	5.8489E-03	2,694.342	5,388.684	0.00E+00	1.58E+01	3.15E+01
H-3	8.9300E-03	2,694.342	5,388.684	0.00E+00	2.41E+01	4.81E+01
I-129	1.2891E-06	2,694.342	5,388.684	0.00E+00	3.47E-03	6.95E-03
Kr-85	7.0941E-02	2,694.342	5,388.684	0.00E+00	1.91E+02	3.82E+02
Np-237	2.6541E-06	2,694.342	5,388.684	0.00E+00	7.15E-03	1.43E-02
Pa-231	4.8970E-12	2,694.342	5,388.684	0.00E+00	1.32E-08	2.64E-08
Pb-210	2.2170E-13	2,694.342	5,388.684	0.00E+00	5.97E-10	1.19E-09
Pm-147	2.3627E-01	2,694.342	5,388.684	0.00E+00	6.37E+02	1.27E+03
Pu-238	2.8636E-02	2,694.342	5,388.684	0.00E+00	7.72E+01	1.54E+02
Pu-239	-3.5520E-02	2,694.342	0.000	7.17E+02	6.21E+02	7.17E+02
Pu-240	2.0790E-02	2,694.342	5,388.684	3.64E+02	4.20E+02	4.76E+02
Pu-241	-4.8316E-01	2,694.342	0.000	1.64E+04	1.50E+04	1.64E+04
Pu-242	1.1052E-05	2,694.342	5,388.684	9.71E-02	1.27E-01	1.57E-01
Ra-226	5.7471E-13	2,694.342	5,388.684	0.00E+00	1.55E-09	3.10E-09
Ra-228	5.4957E-17	2,694.342	5,388.684	0.00E+00	1.48E-13	2.96E-13
Ru-106	1.4583E-02	2,694.342	5,388.684	0.00E+00	3.93E+01	7.86E+01
Se-79	1.0137E-05	2,694.342	5,388.684	0.00E+00	2.73E-02	5.46E-02
Sn-126	4.3922E-05	2,694.342	5,388.684	0.00E+00	1.18E-01	2.37E-01
Sr-90	7.6329E-01	2,694.342	5,388.684	0.00E+00	2.06E+03	4.11E+03
Tc-99	3.9412E-04	2,694.342	5,388.684	0.00E+00	1.06E+00	2.12E+00
Th-229	1.6457E-12	2,694.342	5,388.684	0.00E+00	4.43E-09	8.87E-09
Th-230	1.8822E-10	2,694.342	5,388.684	0.00E+00	5.07E-07	1.01E-06
Th-232	9.7601E-17	2,694.342	5,388.684	0.00E+00	2.63E-13	5.26E-13
Tl-208	5.2722E-07	2,694.342	5,388.684	0.00E+00	1.42E-03	2.84E-03
U-232	1.4925E-06	2,694.342	5,388.684	0.00E+00	4.02E-03	8.04E-03
U-233	2.1113E-10	2,694.342	5,388.684	0.00E+00	5.69E-07	1.14E-06
U-234	1.9528E-06	2,694.342	5,388.684	0.00E+00	5.26E-03	1.05E-02
U-235	-9.7920E-09	2,694.342	0.000	1.47E-04	1.21E-04	1.47E-04
U-236	1.1570E-07	2,694.342	5,388.684	0.00E+00	3.12E-04	6.23E-04
U-238	-1.7914E-07	2,694.342	0.000	1.07E-02	1.02E-02	1.07E-02
Y-90	7.6329E-01	2,694.342	5,388.684	0.00E+00	2.06E+03	4.11E+03
Other Radionuclides					5.84E+03	1.17E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.717E+14
0.0250	5.845E+13
0.0375	6.684E+13
0.0575	5.703E+13
0.0850	3.329E+13
0.1250	2.486E+13
0.2250	2.521E+13
0.3750	1.296E+13
0.5750	4.332E+14
0.8500	1.449E+13
1.2500	1.262E+13
1.7500	2.073E+11
2.2500	6.978E+09
2.7500	7.280E+08
3.5000	8.224E+07
5.0000	2.165E+05
7.0000	2.477E+04
11.0000	2.836E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.15E+01	1.52E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (D9)	SST
BOL HM Constituents:	Pu/U CARB	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		2,694.342
Bounding:		5,388.684

Basis for burnup used in estimate:

Nominal burnup taken from SFD and converted to MWd using BOL=45.283kg
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.39	
Bounding:	0.78	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-MFF-1 & 1A (CDE)
SNF ID #: 330
Fuel Units & Descr: 2 - HEX ARRAY 169 ROD
Heavy Metal Mass: BOL= ; EOL=88.11kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage:
18"x15'
0.40

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	10,382.823	20,765.646	0.00E+00	1.43E-08	2.85E-08
Am-241	7.9527E-02	10,382.823	20,765.646	1.90E+02	1.02E+03	1.84E+03
Am-242m	2.1053E-03	10,382.823	20,765.646	0.00E+00	2.19E+01	4.37E+01
Am-243	1.0760E-04	10,382.823	20,765.646	0.00E+00	1.12E+00	2.23E+00
C-14	2.6141E-05	10,382.823	20,765.646	0.00E+00	2.71E-01	5.43E-01
Cl-36	3.4243E-10	10,382.823	20,765.646	0.00E+00	3.56E-06	7.11E-06
Cm-243	6.6092E-04	10,382.823	20,765.646	0.00E+00	6.86E+00	1.37E+01
Cm-244	2.9933E-03	10,382.823	20,765.646	0.00E+00	3.11E+01	6.22E+01
Co-60	1.5934E-02	10,382.823	20,765.646	0.00E+00	1.65E+02	3.31E+02
Cs-134	4.6356E-02	10,382.823	20,765.646	0.00E+00	4.81E+02	9.63E+02
Cs-135	4.7693E-05	10,382.823	20,765.646	0.00E+00	4.95E-01	9.90E-01
Cs-137	2.1113E+00	10,382.823	20,765.646	0.00E+00	2.19E+04	4.38E+04
Eu-154	4.8092E-02	10,382.823	20,765.646	0.00E+00	4.99E+02	9.99E+02
Eu-155	6.8447E-02	10,382.823	20,765.646	0.00E+00	7.11E+02	1.42E+03
Fe-55	5.8489E-03	10,382.823	20,765.646	0.00E+00	6.07E+01	1.21E+02
H-3	8.9300E-03	10,382.823	20,765.646	0.00E+00	9.27E+01	1.85E+02
I-129	1.2891E-06	10,382.823	20,765.646	0.00E+00	1.34E-02	2.68E-02
Kr-85	7.0941E-02	10,382.823	20,765.646	0.00E+00	7.37E+02	1.47E+03
Np-237	2.6541E-06	10,382.823	20,765.646	0.00E+00	2.76E-02	5.51E-02
Pa-231	4.8970E-12	10,382.823	20,765.646	0.00E+00	5.08E-08	1.02E-07
Pb-210	2.2170E-13	10,382.823	20,765.646	0.00E+00	2.30E-09	4.60E-09
Pm-147	2.3627E-01	10,382.823	20,765.646	0.00E+00	2.45E+03	4.91E+03
Pu-238	2.8636E-02	10,382.823	20,765.646	0.00E+00	2.97E+02	5.95E+02
Pu-239	-3.5520E-02	10,382.823	0.000	1.56E+03	1.19E+03	1.56E+03
Pu-240	2.0790E-02	10,382.823	20,765.646	7.92E+02	1.01E+03	1.22E+03
Pu-241	-4.8316E-01	10,382.823	0.000	3.56E+04	3.06E+04	3.56E+04
Pu-242	1.1052E-05	10,382.823	20,765.646	2.11E-01	3.26E-01	4.41E-01
Ra-226	5.7471E-13	10,382.823	20,765.646	0.00E+00	5.97E-09	1.19E-08
Ra-228	5.4957E-17	10,382.823	20,765.646	0.00E+00	5.71E-13	1.14E-12
Ru-106	1.4583E-02	10,382.823	20,765.646	0.00E+00	1.51E+02	3.03E+02
Se-79	1.0137E-05	10,382.823	20,765.646	0.00E+00	1.05E-01	2.11E-01
Sn-126	4.3922E-05	10,382.823	20,765.646	0.00E+00	4.56E-01	9.12E-01
Sr-90	7.6329E-01	10,382.823	20,765.646	0.00E+00	7.93E+03	1.59E+04
Tc-99	3.9412E-04	10,382.823	20,765.646	0.00E+00	4.09E+00	8.18E+00
Th-229	1.6457E-12	10,382.823	20,765.646	0.00E+00	1.71E-08	3.42E-08
Th-230	1.8822E-10	10,382.823	20,765.646	0.00E+00	1.95E-06	3.91E-06
Th-232	9.7601E-17	10,382.823	20,765.646	0.00E+00	1.01E-12	2.03E-12
Tl-208	5.2722E-07	10,382.823	20,765.646	0.00E+00	5.47E-03	1.09E-02
U-232	1.4925E-06	10,382.823	20,765.646	0.00E+00	1.55E-02	3.10E-02
U-233	2.1113E-10	10,382.823	20,765.646	0.00E+00	2.19E-06	4.38E-06
U-234	1.9528E-06	10,382.823	20,765.646	0.00E+00	2.03E-02	4.06E-02
U-235	-9.7920E-09	10,382.823	0.000	3.20E-04	2.18E-04	3.20E-04
U-236	1.1570E-07	10,382.823	20,765.646	0.00E+00	1.20E-03	2.40E-03
U-238	-1.7914E-07	10,382.823	0.000	2.33E-02	2.14E-02	2.33E-02
Y-90	7.6329E-01	10,382.823	20,765.646	0.00E+00	7.93E+03	1.59E+04
Other Radionuclides					2.25E+04	4.50E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.039E+15
0.0250	2.251E+14
0.0375	2.575E+14
0.0575	2.178E+14
0.0850	1.283E+14
0.1250	9.581E+13
0.2250	9.715E+13
0.3750	4.995E+13
0.5750	1.670E+15
0.8500	5.585E+13
1.2500	4.863E+13
1.7500	7.989E+11
2.2500	2.689E+10
2.7500	2.805E+09
3.5000	3.166E+08
5.0000	6.892E+05
7.0000	7.892E+04
11.0000	9.040E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.91E+02	5.24E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (HT9)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		10,382.823	Nominal burnup taken from SFD and converted to MWd using BOL=98.509kg
Bounding:		20,765.646	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.69	
Bounding:	1.38	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-P0-2,4 & 5
SNF ID #: 333
Fuel Units & Descr: 3 - HEX ARRAY 169 ROD
Heavy Metal Mass: BOL= ; EOL=131.25kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage:
18"x15'
0.60

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	10,725.307	11,359.598	0.00E+00	1.47E-08	1.56E-08
Am-241	7.9527E-02	10,725.307	11,359.598	2.74E+02	1.13E+03	1.18E+03
Am-242m	2.1053E-03	10,725.307	11,359.598	0.00E+00	2.26E+01	2.39E+01
Am-243	1.0760E-04	10,725.307	11,359.598	0.00E+00	1.15E+00	1.22E+00
C-14	2.6141E-05	10,725.307	11,359.598	0.00E+00	2.80E-01	2.97E-01
Cl-36	3.4243E-10	10,725.307	11,359.598	0.00E+00	3.67E-06	3.89E-06
Cm-243	6.6092E-04	10,725.307	11,359.598	0.00E+00	7.09E+00	7.51E+00
Cm-244	2.9933E-03	10,725.307	11,359.598	0.00E+00	3.21E+01	3.40E+01
Co-60	1.5934E-02	10,725.307	11,359.598	0.00E+00	1.71E+02	1.81E+02
Cs-134	4.6356E-02	10,725.307	11,359.598	0.00E+00	4.97E+02	5.27E+02
Cs-135	4.7693E-05	10,725.307	11,359.598	0.00E+00	5.12E-01	5.42E-01
Cs-137	2.1113E+00	10,725.307	11,359.598	0.00E+00	2.26E+04	2.40E+04
Eu-154	4.8092E-02	10,725.307	11,359.598	0.00E+00	5.16E+02	5.46E+02
Eu-155	6.8447E-02	10,725.307	11,359.598	0.00E+00	7.34E+02	7.78E+02
Fe-55	5.8489E-03	10,725.307	11,359.598	0.00E+00	6.27E+01	6.64E+01
H-3	8.9300E-03	10,725.307	11,359.598	0.00E+00	9.58E+01	1.01E+02
I-129	1.2891E-06	10,725.307	11,359.598	0.00E+00	1.38E-02	1.46E-02
Kr-85	7.0941E-02	10,725.307	11,359.598	0.00E+00	7.61E+02	8.06E+02
Np-237	2.6541E-06	10,725.307	11,359.598	0.00E+00	2.85E-02	3.01E-02
Pa-231	4.8970E-12	10,725.307	11,359.598	0.00E+00	5.25E-08	5.56E-08
Pb-210	2.2170E-13	10,725.307	11,359.598	0.00E+00	2.38E-09	2.52E-09
Pm-147	2.3627E-01	10,725.307	11,359.598	0.00E+00	2.53E+03	2.68E+03
Pu-238	2.8636E-02	10,725.307	11,359.598	0.00E+00	3.07E+02	3.25E+02
Pu-239	-3.5520E-02	10,725.307	0.000	2.25E+03	1.87E+03	2.25E+03
Pu-240	2.0790E-02	10,725.307	11,359.598	1.14E+03	1.37E+03	1.38E+03
Pu-241	-4.8316E-01	10,725.307	0.000	5.13E+04	4.61E+04	5.13E+04
Pu-242	1.1052E-05	10,725.307	11,359.598	3.05E-01	4.23E-01	4.30E-01
Ra-226	5.7471E-13	10,725.307	11,359.598	0.00E+00	6.16E-09	6.53E-09
Ra-228	5.4957E-17	10,725.307	11,359.598	0.00E+00	5.89E-13	6.24E-13
Ru-106	1.4583E-02	10,725.307	11,359.598	0.00E+00	1.56E+02	1.66E+02
Se-79	1.0137E-05	10,725.307	11,359.598	0.00E+00	1.09E-01	1.15E-01
Sn-126	4.3922E-05	10,725.307	11,359.598	0.00E+00	4.71E-01	4.99E-01
Sr-90	7.6329E-01	10,725.307	11,359.598	0.00E+00	8.19E+03	8.67E+03
Tc-99	3.9412E-04	10,725.307	11,359.598	0.00E+00	4.23E+00	4.48E+00
Th-229	1.6457E-12	10,725.307	11,359.598	0.00E+00	1.77E-08	1.87E-08
Th-230	1.8822E-10	10,725.307	11,359.598	0.00E+00	2.02E-06	2.14E-06
Th-232	9.7601E-17	10,725.307	11,359.598	0.00E+00	1.05E-12	1.11E-12
Tl-208	5.2722E-07	10,725.307	11,359.598	0.00E+00	5.65E-03	5.99E-03
U-232	1.4925E-06	10,725.307	11,359.598	0.00E+00	1.60E-02	1.70E-02
U-233	2.1113E-10	10,725.307	11,359.598	0.00E+00	2.26E-06	2.40E-06
U-234	1.9528E-06	10,725.307	11,359.598	0.00E+00	2.09E-02	2.22E-02
U-235	-9.7920E-09	10,725.307	0.000	4.61E-04	3.56E-04	4.61E-04
U-236	1.1570E-07	10,725.307	11,359.598	0.00E+00	1.24E-03	1.31E-03
U-238	-1.7914E-07	10,725.307	0.000	3.36E-02	3.17E-02	3.36E-02
Y-90	7.6329E-01	10,725.307	11,359.598	0.00E+00	8.19E+03	8.67E+03
Other Radionuclides					2.33E+04	2.46E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	5.775E+14
0.0250	1.233E+14
0.0375	1.409E+14
0.0575	1.215E+14
0.0850	7.018E+13
0.1250	5.242E+13
0.2250	5.315E+13
0.3750	2.733E+13
0.5750	9.133E+14
0.8500	3.055E+13
1.2500	2.660E+13
1.7500	4.370E+11
2.2500	1.471E+10
2.7500	1.535E+09
3.5000	1.736E+08
5.0000	5.453E+05
7.0000	6.233E+04
11.0000	7.134E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.33E+02	3.58E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (D9)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		10,725.307
Bounding:		11,359.598

Basis for burnup used in estimate:
Nominal burnup taken from SFD and converted to MWd using BOL=141.995kg
Bounding burnup taken from SFD and converted to MWd using BOL=141.995kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.50	
Bounding:	0.53	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-SRF-3&4
SNF ID #: 334
Fuel Units & Descr: 2 - HEX ARRAY 91 ROD
Heavy Metal Mass: BOL= ; EOL=85.81kg
ROD Storage Site: HANFORD

[1]**Fuel decay start date:** 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]**Template Burnup(MWd):** 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage:
18"x15'
0.40

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	3,631.587	3,953.599	0.00E+00	4.99E-09	5.43E-09
Am-241	7.9527E-02	3,631.587	3,953.599	1.72E+02	4.61E+02	4.87E+02
Am-242m	2.1053E-03	3,631.587	3,953.599	0.00E+00	7.65E+00	8.32E+00
Am-243	1.0760E-04	3,631.587	3,953.599	0.00E+00	3.91E-01	4.25E-01
C-14	2.6141E-05	3,631.587	3,953.599	0.00E+00	9.49E-02	1.03E-01
Cl-36	3.4243E-10	3,631.587	3,953.599	0.00E+00	1.24E-06	1.35E-06
Cm-243	6.6092E-04	3,631.587	3,953.599	0.00E+00	2.40E+00	2.61E+00
Cm-244	2.9933E-03	3,631.587	3,953.599	0.00E+00	1.09E+01	1.18E+01
Co-60	1.5934E-02	3,631.587	3,953.599	0.00E+00	5.79E+01	6.30E+01
Cs-134	4.6356E-02	3,631.587	3,953.599	0.00E+00	1.68E+02	1.83E+02
Cs-135	4.7693E-05	3,631.587	3,953.599	0.00E+00	1.73E-01	1.89E-01
Cs-137	2.1113E+00	3,631.587	3,953.599	0.00E+00	7.67E+03	8.35E+03
Eu-154	4.8092E-02	3,631.587	3,953.599	0.00E+00	1.75E+02	1.90E+02
Eu-155	6.8447E-02	3,631.587	3,953.599	0.00E+00	2.49E+02	2.71E+02
Fe-55	5.8489E-03	3,631.587	3,953.599	0.00E+00	2.12E+01	2.31E+01
H-3	8.9300E-03	3,631.587	3,953.599	0.00E+00	3.24E+01	3.53E+01
I-129	1.2891E-06	3,631.587	3,953.599	0.00E+00	4.68E-03	5.10E-03
Kr-85	7.0941E-02	3,631.587	3,953.599	0.00E+00	2.58E+02	2.80E+02
Np-237	2.6541E-06	3,631.587	3,953.599	0.00E+00	9.64E-03	1.05E-02
Pa-231	4.8970E-12	3,631.587	3,953.599	0.00E+00	1.78E-08	1.94E-08
Pb-210	2.2170E-13	3,631.587	3,953.599	0.00E+00	8.05E-10	8.77E-10
Pm-147	2.3627E-01	3,631.587	3,953.599	0.00E+00	8.58E+02	9.34E+02
Pu-238	2.8636E-02	3,631.587	3,953.599	0.00E+00	1.04E+02	1.13E+02
Pu-239	-3.5520E-02	3,631.587	0.000	1.42E+03	1.29E+03	1.42E+03
Pu-240	2.0790E-02	3,631.587	3,953.599	7.20E+02	7.95E+02	8.02E+02
Pu-241	-4.8316E-01	3,631.587	0.000	3.23E+04	3.05E+04	3.23E+04
Pu-242	1.1052E-05	3,631.587	3,953.599	1.92E-01	2.32E-01	2.36E-01
Ra-226	5.7471E-13	3,631.587	3,953.599	0.00E+00	2.09E-09	2.27E-09
Ra-228	5.4957E-17	3,631.587	3,953.599	0.00E+00	2.00E-13	2.17E-13
Ru-106	1.4583E-02	3,631.587	3,953.599	0.00E+00	5.30E+01	5.77E+01
Se-79	1.0137E-05	3,631.587	3,953.599	0.00E+00	3.68E-02	4.01E-02
Sn-126	4.3922E-05	3,631.587	3,953.599	0.00E+00	1.60E-01	1.74E-01
Sr-90	7.6329E-01	3,631.587	3,953.599	0.00E+00	2.77E+03	3.02E+03
Tc-99	3.9412E-04	3,631.587	3,953.599	0.00E+00	1.43E+00	1.56E+00
Th-229	1.6457E-12	3,631.587	3,953.599	0.00E+00	5.98E-09	6.51E-09
Th-230	1.8822E-10	3,631.587	3,953.599	0.00E+00	6.84E-07	7.44E-07
Th-232	9.7601E-17	3,631.587	3,953.599	0.00E+00	3.54E-13	3.86E-13
Tl-208	5.2722E-07	3,631.587	3,953.599	0.00E+00	1.91E-03	2.08E-03
U-232	1.4925E-06	3,631.587	3,953.599	0.00E+00	5.42E-03	5.90E-03
U-233	2.1113E-10	3,631.587	3,953.599	0.00E+00	7.67E-07	8.35E-07
U-234	1.9528E-06	3,631.587	3,953.599	0.00E+00	7.09E-03	7.72E-03
U-235	-9.7920E-09	3,631.587	0.000	2.91E-04	2.55E-04	2.91E-04
U-236	1.1570E-07	3,631.587	3,953.599	0.00E+00	4.20E-04	4.57E-04
U-238	-1.7914E-07	3,631.587	0.000	2.12E-02	2.05E-02	2.12E-02
Y-90	7.6329E-01	3,631.587	3,953.599	0.00E+00	2.77E+03	3.02E+03
Other Radionuclides					7.88E+03	8.57E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	2.052E+14
0.0250	4.298E+13
0.0375	4.905E+13
0.0575	4.335E+13
0.0850	2.443E+13
0.1250	1.825E+13
0.2250	1.850E+13
0.3750	9.513E+12
0.5750	3.179E+14
0.8500	1.063E+13
1.2500	9.259E+12
1.7500	1.521E+11
2.2500	5.121E+09
2.7500	5.344E+08
3.5000	6.059E+07
5.0000	2.662E+05
7.0000	3.039E+04
11.0000	3.478E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.46E+02	1.57E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (316)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		3,631.587
Bounding:		3,953.599

Basis for burnup used in estimate:
Nominal burnup taken from SFD and converted to MWd using BOL=89.448kg
Bounding burnup taken from SFD and converted to MWd using BOL=89.448kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.27	
Bounding:	0.29	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FFTF-TFA-UO-1
SNF ID #: 335
Fuel Units & Descr: 1 - HEX ARRAY 217 ROD
Heavy Metal Mass: BOL= ; EOL=35.01kg
ROD Storage Site: HANFORD

[1]Fuel decay start date: 1992
Estimates as of: 2010
Template: FFTF (FAST, SST, 10 to 30%, Pu & U)
[2]Template Burnup(MWd): 5011.2
Template BOL Heavy Metal Mass (MT): 0.0329181
Template Decay Time: 15 years

Estimated Canister usage: 18"x15'
0.20

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.3735E-12	835.266	1,229.597	0.00E+00	1.15E-09	1.69E-09
Am-241	7.9527E-02	835.266	1,229.597	6.91E+01	1.36E+02	1.67E+02
Am-242m	2.1053E-03	835.266	1,229.597	0.00E+00	1.76E+00	2.59E+00
Am-243	1.0760E-04	835.266	1,229.597	0.00E+00	8.99E-02	1.32E-01
C-14	2.6141E-05	835.266	1,229.597	0.00E+00	2.18E-02	3.21E-02
Cl-36	3.4243E-10	835.266	1,229.597	0.00E+00	2.86E-07	4.21E-07
Cm-243	6.6092E-04	835.266	1,229.597	0.00E+00	5.52E-01	8.13E-01
Cm-244	2.9933E-03	835.266	1,229.597	0.00E+00	2.50E+00	3.68E+00
Co-60	1.5934E-02	835.266	1,229.597	0.00E+00	1.33E+01	1.96E+01
Cs-134	4.6356E-02	835.266	1,229.597	0.00E+00	3.87E+01	5.70E+01
Cs-135	4.7693E-05	835.266	1,229.597	0.00E+00	3.98E-02	5.86E-02
Cs-137	2.1113E+00	835.266	1,229.597	0.00E+00	1.76E+03	2.60E+03
Eu-154	4.8092E-02	835.266	1,229.597	0.00E+00	4.02E+01	5.91E+01
Eu-155	6.8447E-02	835.266	1,229.597	0.00E+00	5.72E+01	8.42E+01
Fe-55	5.8489E-03	835.266	1,229.597	0.00E+00	4.89E+00	7.19E+00
H-3	8.9300E-03	835.266	1,229.597	0.00E+00	7.46E+00	1.10E+01
I-129	1.2891E-06	835.266	1,229.597	0.00E+00	1.08E-03	1.59E-03
Kr-85	7.0941E-02	835.266	1,229.597	0.00E+00	5.93E+01	8.72E+01
Np-237	2.6541E-06	835.266	1,229.597	0.00E+00	2.22E-03	3.26E-03
Pa-231	4.8970E-12	835.266	1,229.597	0.00E+00	4.09E-09	6.02E-09
Pb-210	2.2170E-13	835.266	1,229.597	0.00E+00	1.85E-10	2.73E-10
Pm-147	2.3627E-01	835.266	1,229.597	0.00E+00	1.97E+02	2.91E+02
Pu-238	2.8636E-02	835.266	1,229.597	0.00E+00	2.39E+01	3.52E+01
Pu-239	-3.5520E-02	835.266	0.000	5.67E+02	5.38E+02	5.67E+02
Pu-240	2.0790E-02	835.266	1,229.597	2.88E+02	3.06E+02	3.14E+02
Pu-241	-4.8316E-01	835.266	0.000	1.29E+04	1.25E+04	1.29E+04
Pu-242	1.1052E-05	835.266	1,229.597	7.69E-02	8.61E-02	9.05E-02
Ra-226	5.7471E-13	835.266	1,229.597	0.00E+00	4.80E-10	7.07E-10
Ra-228	5.4957E-17	835.266	1,229.597	0.00E+00	4.59E-14	6.76E-14
Ru-106	1.4583E-02	835.266	1,229.597	0.00E+00	1.22E+01	1.79E+01
Se-79	1.0137E-05	835.266	1,229.597	0.00E+00	8.47E-03	1.25E-02
Sn-126	4.3922E-05	835.266	1,229.597	0.00E+00	3.67E-02	5.40E-02
Sr-90	7.6329E-01	835.266	1,229.597	0.00E+00	6.38E+02	9.39E+02
Tc-99	3.9412E-04	835.266	1,229.597	0.00E+00	3.29E-01	4.85E-01
Th-229	1.6457E-12	835.266	1,229.597	0.00E+00	1.37E-09	2.02E-09
Th-230	1.8822E-10	835.266	1,229.597	0.00E+00	1.57E-07	2.31E-07
Th-232	9.7601E-17	835.266	1,229.597	0.00E+00	8.15E-14	1.20E-13
Tl-208	5.2722E-07	835.266	1,229.597	0.00E+00	4.40E-04	6.48E-04
U-232	1.4925E-06	835.266	1,229.597	0.00E+00	1.25E-03	1.84E-03
U-233	2.1113E-10	835.266	1,229.597	0.00E+00	1.76E-07	2.60E-07
U-234	1.9528E-06	835.266	1,229.597	0.00E+00	1.63E-03	2.40E-03
U-235	-9.7920E-09	835.266	0.000	1.16E-04	1.08E-04	1.16E-04
U-236	1.1570E-07	835.266	1,229.597	0.00E+00	9.66E-05	1.42E-04
U-238	-1.7914E-07	835.266	0.000	8.48E-03	8.33E-03	8.48E-03
Y-90	7.6329E-01	835.266	1,229.597	0.00E+00	6.38E+02	9.39E+02
Other Radionuclides					1.81E+03	2.67E+03

Gamma Sources

Photon Energy Group (Avg. MeV)	Total Photons/sec (bounding)
0.0150	6.464E+13
0.0250	1.338E+13
0.0375	1.526E+13
0.0575	1.370E+13
0.0850	7.597E+12
0.1250	5.675E+12
0.2250	5.753E+12
0.3750	2.959E+12
0.5750	9.886E+13
0.8500	3.307E+12
1.2500	2.880E+12
1.7500	4.731E+10
2.2500	1.593E+09
2.7500	1.662E+08
3.5000	1.888E+07
5.0000	9.814E+04
7.0000	1.120E+04
11.0000	1.281E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
4.61E+01	5.55E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (D9)	SST
BOL HM Constituents:	PuO2-UO2	Pu and U
BOL Enrichment %:		10 to 30

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		835.266
Bounding:		1,229.597

Basis for burnup used in estimate:
Nominal burnup taken from SFD and converted to MWd using BOL=35.848kg
Bounding burnup taken from SFD and converted to MWd using BOL=35.848kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.15	
Bounding:	0.23	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FFTF-TFA-WBO18 & WBO42	[1]Fuel decay start date:	1992
SNF ID #:	336	Estimates as of:	2010
Fuel Units & Descr:	2 - HEX ARRAY 61 ROD	Template:	FERMI (Fast, Zirc, 10 to 40%, U)
Heavy Metal Mass:	BOL= ; EOL=94.98kg	[2]Template Burnup(MWd):	58.6725048
ROD Storage Site:	HANFORD	Template BOL Heavy Metal Mass (MT):	0.018774
		Template Decay Time:	15 years

Estimated Canister usage: 18"x15'

0.40

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.1509E-08	1,204.373	1,348.897	0.00E+00	2.59E-05	2.90E-05
Am-241	4.6529E-07	1,204.373	1,348.897	0.00E+00	5.60E-04	6.28E-04
Am-242m	0.0000E+00	1,204.373	1,348.897	0.00E+00	0.00E+00	0.00E+00
Am-243	8.3923E-15	1,204.373	1,348.897	0.00E+00	1.01E-11	1.13E-11
C-14	2.1765E-05	1,204.373	1,348.897	0.00E+00	2.62E-02	2.94E-02
Cl-36	5.5188E-08	1,204.373	1,348.897	0.00E+00	6.65E-05	7.44E-05
Cm-243	2.5208E-14	1,204.373	1,348.897	0.00E+00	3.04E-11	3.40E-11
Cm-244	1.1259E-15	1,204.373	1,348.897	0.00E+00	1.36E-12	1.52E-12
Co-60	2.9094E-02	1,204.373	1,348.897	0.00E+00	3.50E+01	3.92E+01
Cs-134	5.1932E-04	1,204.373	1,348.897	0.00E+00	6.25E-01	7.01E-01
Cs-135	4.4996E-05	1,204.373	1,348.897	0.00E+00	5.42E-02	6.07E-02
Cs-137	2.1867E+00	1,204.373	1,348.897	0.00E+00	2.63E+03	2.95E+03
Eu-154	9.2837E-04	1,204.373	1,348.897	0.00E+00	1.12E+00	1.25E+00
Eu-155	2.3180E-02	1,204.373	1,348.897	0.00E+00	2.79E+01	3.13E+01
Fe-55	2.9332E-03	1,204.373	1,348.897	0.00E+00	3.53E+00	3.96E+00
H-3	1.0871E-02	1,204.373	1,348.897	0.00E+00	1.31E+01	1.47E+01
I-129	1.1426E-06	1,204.373	1,348.897	0.00E+00	1.38E-03	1.54E-03
Kr-85	1.4068E-01	1,204.373	1,348.897	0.00E+00	1.69E+02	1.90E+02
Np-237	3.3099E-06	1,204.373	1,348.897	0.00E+00	3.99E-03	4.46E-03
Pa-231	7.8640E-08	1,204.373	1,348.897	0.00E+00	9.47E-05	1.06E-04
Pb-210	7.4277E-13	1,204.373	1,348.897	0.00E+00	8.95E-10	1.00E-09
Pm-147	2.2856E-01	1,204.373	1,348.897	0.00E+00	2.75E+02	3.08E+02
Pu-238	2.0095E-04	1,204.373	1,348.897	0.00E+00	2.42E-01	2.71E-01
Pu-239	1.9481E-02	1,204.373	1,348.897	0.00E+00	2.35E+01	2.63E+01
Pu-240	6.8056E-05	1,204.373	1,348.897	0.00E+00	8.20E-02	9.18E-02
Pu-241	1.0939E-05	1,204.373	1,348.897	0.00E+00	1.32E-02	1.48E-02
Pu-242	4.3751E-13	1,204.373	1,348.897	0.00E+00	5.27E-10	5.90E-10
Ra-226	4.0428E-12	1,204.373	1,348.897	0.00E+00	4.87E-09	5.45E-09
Ra-228	2.1032E-11	1,204.373	1,348.897	0.00E+00	2.53E-08	2.84E-08
Ru-106	2.9077E-04	1,204.373	1,348.897	0.00E+00	3.50E-01	3.92E-01
Se-79	1.6492E-05	1,204.373	1,348.897	0.00E+00	1.99E-02	2.22E-02
Sn-126	3.7564E-05	1,204.373	1,348.897	0.00E+00	4.52E-02	5.07E-02
Sr-90	1.9396E+00	1,204.373	1,348.897	0.00E+00	2.34E+03	2.62E+03
Tc-99	4.4842E-04	1,204.373	1,348.897	0.00E+00	5.40E-01	6.05E-01
Th-229	1.8544E-11	1,204.373	1,348.897	0.00E+00	2.23E-08	2.50E-08
Th-230	9.0605E-10	1,204.373	1,348.897	0.00E+00	1.09E-06	1.22E-06
Th-232	2.3674E-11	1,204.373	1,348.897	0.00E+00	2.85E-08	3.19E-08
Tl-208	7.0323E-09	1,204.373	1,348.897	0.00E+00	8.47E-06	9.49E-06
U-232	1.9106E-08	1,204.373	1,348.897	0.00E+00	2.30E-05	2.58E-05
U-233	9.6774E-09	1,204.373	1,348.897	0.00E+00	1.17E-05	1.31E-05
U-234	4.8796E-06	1,204.373	1,348.897	0.00E+00	5.88E-03	6.58E-03
U-235	-2.3191E-06	1,204.373	0.000	5.33E-02	5.05E-02	5.33E-02
U-236	1.2633E-05	1,204.373	1,348.897	0.00E+00	1.52E-02	1.70E-02
U-238	-9.5407E-08	1,204.373	0.000	2.41E-02	2.40E-02	2.41E-02
Y-90	1.9396E+00	1,204.373	1,348.897	0.00E+00	2.34E+03	2.62E+03
Other Radionuclides					2.62E+03	2.93E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	1.446E+14
0.0250	3.066E+13
0.0375	2.665E+13
0.0575	2.799E+13
0.0850	1.720E+13
0.1250	1.112E+13
0.2250	1.452E+13
0.3750	6.646E+12
0.5750	1.102E+14
0.8500	1.064E+12
1.2500	3.267E+12
1.7500	2.705E+10
2.2500	7.737E+07
2.7500	3.535E+06
3.5000	4.083E+05
5.0000	1.311E+02
7.0000	1.249E+01
11.0000	1.262E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.01E+01	3.37E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	FAST	FAST
Fuel Cladding:	SST (316)	ZIRC
BOL HM Constituents:	UO2	U
BOL Enrichment %:		10 to 40

Basis for Parameter Differences:

This Template was used for the following reasons:
This template is a good approximation since it is a FAST, Uranium fuel

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		1,204.373
Bounding:		1,348.897

Basis for burnup used in estimate:

Nominal burnup taken from SFD and converted to MWd using BOL=96.350kg
Bounding burnup taken from SFD and converted to MWd using BOL=96.350kg

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	4.00	
Bounding:	4.48	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FMRB (GERMANY)	[1]Fuel decay start date:	1994	Estimated Canister usage:
SNF ID #:	577	Estimates as of:	2010	18"x10'
Fuel Units & Descr:	92 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)	3.83
Heavy Metal Mass:	BOL=13.14kg ; EOL=11.67kg	[2]Template Burnup(MWd):	367.2	
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689	
		Template Decay Time:	15 years	

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	4.5861E-10	1,394.013	2,788.025	0.00E+00	6.39E-07	1.28E-06
Am-241	1.7832E-03	1,394.013	2,788.025	0.00E+00	2.49E+00	4.97E+00
Am-242m	4.3410E-07	1,394.013	2,788.025	0.00E+00	6.05E-04	1.21E-03
Am-243	1.4907E-06	1,394.013	2,788.025	0.00E+00	2.08E-03	4.16E-03
C-14	5.7162E-09	1,394.013	2,788.025	0.00E+00	7.97E-06	1.59E-05
Cl-36	1.3124E-32	1,394.013	2,788.025	0.00E+00	1.83E-29	3.66E-29
Cm-243	1.8568E-07	1,394.013	2,788.025	0.00E+00	2.59E-04	5.18E-04
Cm-244	3.5512E-05	1,394.013	2,788.025	0.00E+00	4.95E-02	9.90E-02
Co-60	1.0261E-05	1,394.013	2,788.025	0.00E+00	1.43E-02	2.86E-02
Cs-134	1.6931E-02	1,394.013	2,788.025	0.00E+00	2.36E+01	4.72E+01
Cs-135	3.4477E-06	1,394.013	2,788.025	0.00E+00	4.81E-03	9.61E-03
Cs-137	2.2800E+00	1,394.013	2,788.025	0.00E+00	3.18E+03	6.36E+03
Eu-154	3.6656E-02	1,394.013	2,788.025	0.00E+00	5.11E+01	1.02E+02
Eu-155	9.6841E-03	1,394.013	2,788.025	0.00E+00	1.35E+01	2.70E+01
Fe-55	4.6977E-04	1,394.013	2,788.025	0.00E+00	6.55E-01	1.31E+00
H-3	6.0485E-03	1,394.013	2,788.025	0.00E+00	8.43E+00	1.69E+01
I-129	7.5300E-07	1,394.013	2,788.025	0.00E+00	1.05E-03	2.10E-03
Kr-85	1.4989E-01	1,394.013	2,788.025	0.00E+00	2.09E+02	4.18E+02
Np-237	9.5534E-06	1,394.013	2,788.025	0.00E+00	1.33E-02	2.66E-02
Pa-231	1.6550E-09	1,394.013	2,788.025	0.00E+00	2.31E-06	4.61E-06
Pb-210	2.6631E-11	1,394.013	2,788.025	0.00E+00	3.71E-08	7.42E-08
Pm-147	1.8156E-01	1,394.013	2,788.025	0.00E+00	2.53E+02	5.06E+02
Pu-238	1.8990E-02	1,394.013	2,788.025	0.00E+00	2.65E+01	5.29E+01
Pu-239	4.2838E-04	1,394.013	2,788.025	0.00E+00	5.97E-01	1.19E+00
Pu-240	2.4379E-04	1,394.013	2,788.025	0.00E+00	3.40E-01	6.80E-01
Pu-241	4.2511E-02	1,394.013	2,788.025	0.00E+00	5.93E+01	1.19E+02
Pu-242	3.6329E-07	1,394.013	2,788.025	0.00E+00	5.06E-04	1.01E-03
Ra-226	1.4725E-10	1,394.013	2,788.025	0.00E+00	2.05E-07	4.11E-07
Ra-228	8.9760E-15	1,394.013	2,788.025	0.00E+00	1.25E-11	2.50E-11
Ru-106	1.9752E-04	1,394.013	2,788.025	0.00E+00	2.75E-01	5.51E-01
Se-79	1.2933E-05	1,394.013	2,788.025	0.00E+00	1.80E-02	3.61E-02
Sn-126	1.1574E-05	1,394.013	2,788.025	0.00E+00	1.61E-02	3.23E-02
Sr-90	2.1680E+00	1,394.013	2,788.025	0.00E+00	3.02E+03	6.04E+03
Tc-99	4.2239E-04	1,394.013	2,788.025	0.00E+00	5.89E-01	1.18E+00
Th-229	3.9270E-12	1,394.013	2,788.025	0.00E+00	5.47E-09	1.09E-08
Th-230	3.3578E-08	1,394.013	2,788.025	0.00E+00	4.68E-05	9.36E-05
Th-232	1.5452E-14	1,394.013	2,788.025	0.00E+00	2.15E-11	4.31E-11
Tl-208	4.6705E-08	1,394.013	2,788.025	0.00E+00	6.51E-05	1.30E-04
U-232	1.3045E-07	1,394.013	2,788.025	0.00E+00	1.82E-04	3.64E-04
U-233	2.3739E-09	1,394.013	2,788.025	0.00E+00	3.31E-06	6.62E-06
U-234	1.8423E-04	1,394.013	2,788.025	0.00E+00	2.57E-01	5.14E-01
U-235	-2.7235E-06	1,394.013	0.000	2.59E-02	2.21E-02	2.59E-02
U-236	1.5493E-05	1,394.013	2,788.025	0.00E+00	2.16E-02	4.32E-02
U-238	-4.2851E-09	1,394.013	0.000	3.86E-04	3.80E-04	3.86E-04
Y-90	2.1686E+00	1,394.013	2,788.025	0.00E+00	3.02E+03	6.05E+03
Other Radionuclides					3.03E+03	6.06E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	3.326E+14
0.0250	6.936E+13
0.0375	6.057E+13
0.0575	6.458E+13
0.0850	3.912E+13
0.1250	2.682E+13
0.2250	3.370E+13
0.3750	1.476E+13
0.5750	2.396E+14
0.8500	5.692E+12
1.2500	2.876E+12
1.7500	1.205E+11
2.2500	1.507E+08
2.7500	9.059E+06
3.5000	5.760E+05
5.0000	1.332E+03
7.0000	1.476E+02
11.0000	1.657E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.77E+01	7.55E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	91.25787542	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,394.013	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		2,788.025	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.34	
Bounding:	0.67	

Estimated EOL HM/Given EOL HM: 1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRG-1 (GERMANY)
SNF ID #: 581
Fuel Units & Descr: 7 - MTR TYPE
Heavy Metal Mass: BOL=9.57kg ; EOL=8.64kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1994
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 15 years

Estimated Canister usage: 18"x10'
0.29

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	4.5861E-10	881.012	1,762.024	0.00E+00	4.04E-07	8.08E-07
Am-241	1.7832E-03	881.012	1,762.024	0.00E+00	1.57E+00	3.14E+00
Am-242m	4.3410E-07	881.012	1,762.024	0.00E+00	3.82E-04	7.65E-04
Am-243	1.4907E-06	881.012	1,762.024	0.00E+00	1.31E-03	2.63E-03
C-14	5.7162E-09	881.012	1,762.024	0.00E+00	5.04E-06	1.01E-05
Cl-36	1.3124E-32	881.012	1,762.024	0.00E+00	1.16E-29	2.31E-29
Cm-243	1.8568E-07	881.012	1,762.024	0.00E+00	1.64E-04	3.27E-04
Cm-244	3.5512E-05	881.012	1,762.024	0.00E+00	3.13E-02	6.26E-02
Co-60	1.0261E-05	881.012	1,762.024	0.00E+00	9.04E-03	1.81E-02
Cs-134	1.6931E-02	881.012	1,762.024	0.00E+00	1.49E+01	2.98E+01
Cs-135	3.4477E-06	881.012	1,762.024	0.00E+00	3.04E-03	6.07E-03
Cs-137	2.2800E+00	881.012	1,762.024	0.00E+00	2.01E+03	4.02E+03
Eu-154	3.6656E-02	881.012	1,762.024	0.00E+00	3.23E+01	6.46E+01
Eu-155	9.6841E-03	881.012	1,762.024	0.00E+00	8.53E+00	1.71E+01
Fe-55	4.6977E-04	881.012	1,762.024	0.00E+00	4.14E-01	8.28E-01
H-3	6.0485E-03	881.012	1,762.024	0.00E+00	5.33E+00	1.07E+01
I-129	7.5300E-07	881.012	1,762.024	0.00E+00	6.63E-04	1.33E-03
Kr-85	1.4989E-01	881.012	1,762.024	0.00E+00	1.32E+02	2.64E+02
Np-237	9.5534E-06	881.012	1,762.024	0.00E+00	8.42E-03	1.68E-02
Pa-231	1.6550E-09	881.012	1,762.024	0.00E+00	1.46E-06	2.92E-06
Pb-210	2.6631E-11	881.012	1,762.024	0.00E+00	2.35E-08	4.69E-08
Pm-147	1.8156E-01	881.012	1,762.024	0.00E+00	1.60E+02	3.20E+02
Pu-238	1.8990E-02	881.012	1,762.024	0.00E+00	1.67E+01	3.35E+01
Pu-239	4.2838E-04	881.012	1,762.024	0.00E+00	3.77E-01	7.55E-01
Pu-240	2.4379E-04	881.012	1,762.024	0.00E+00	2.15E-01	4.30E-01
Pu-241	4.2511E-02	881.012	1,762.024	0.00E+00	3.75E+01	7.49E+01
Pu-242	3.6329E-07	881.012	1,762.024	0.00E+00	3.20E-04	6.40E-04
Ra-226	1.4725E-10	881.012	1,762.024	0.00E+00	1.30E-07	2.59E-07
Ra-228	8.9760E-15	881.012	1,762.024	0.00E+00	7.91E-12	1.58E-11
Ru-106	1.9752E-04	881.012	1,762.024	0.00E+00	1.74E-01	3.48E-01
Se-79	1.2933E-05	881.012	1,762.024	0.00E+00	1.14E-02	2.28E-02
Sn-126	1.1574E-05	881.012	1,762.024	0.00E+00	1.02E-02	2.04E-02
Sr-90	2.1680E+00	881.012	1,762.024	0.00E+00	1.91E+03	3.82E+03
Tc-99	4.2239E-04	881.012	1,762.024	0.00E+00	3.72E-01	7.44E-01
Th-229	3.9270E-12	881.012	1,762.024	0.00E+00	3.46E-09	6.92E-09
Th-230	3.3578E-08	881.012	1,762.024	0.00E+00	2.96E-05	5.92E-05
Th-232	1.5452E-14	881.012	1,762.024	0.00E+00	1.36E-11	2.72E-11
Tl-208	4.6705E-08	881.012	1,762.024	0.00E+00	4.11E-05	8.23E-05
U-232	1.3045E-07	881.012	1,762.024	0.00E+00	1.15E-04	2.30E-04
U-233	2.3739E-09	881.012	1,762.024	0.00E+00	2.09E-06	4.18E-06
U-234	1.8423E-04	881.012	1,762.024	0.00E+00	1.62E-01	3.25E-01
U-235	-2.7235E-06	881.012	0.000	4.08E-03	1.68E-03	4.08E-03
U-236	1.5493E-05	881.012	1,762.024	0.00E+00	1.36E-02	2.73E-02
U-238	-4.2851E-09	881.012	0.000	2.58E-03	2.58E-03	2.58E-03
Y-90	2.1686E+00	881.012	1,762.024	0.00E+00	1.91E+03	3.82E+03
Other Radionuclides					1.92E+03	3.83E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.102E+14
0.0250	4.384E+13
0.0375	3.828E+13
0.0575	4.082E+13
0.0850	2.472E+13
0.1250	1.695E+13
0.2250	2.130E+13
0.3750	9.330E+12
0.5750	1.515E+14
0.8500	3.597E+12
1.2500	1.817E+12
1.7500	7.616E+10
2.2500	9.527E+07
2.7500	5.725E+06
3.5000	3.640E+05
5.0000	8.473E+02
7.0000	9.388E+01
11.0000	1.054E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.38E+01	4.77E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3O8	U
BOL Enrichment %:	19.73077542	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		881.012
Bounding:		1,762.024

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.29	
Bounding:	0.59	

Estimated EOL HM/Given EOL HM: 1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRG-1 (GERMANY)	**Fuel decay start date:**[1]	1995
SNF ID #:	742	**Estimates as of:**	2010
Fuel Units & Descr:	141 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=23.42kg ; EOL=16.54kg	**Template Burnup(MWd):**[2]	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	15 years

Estimated Canister usage:

18"x10'
5.88

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	4.5861E-10	6,516.251	13,032.502	0.00E+00	2.99E-06	5.98E-06
Am-241	1.7832E-03	6,516.251	13,032.502	0.00E+00	1.16E+01	2.32E+01
Am-242m	4.3410E-07	6,516.251	13,032.502	0.00E+00	2.83E-03	5.66E-03
Am-243	1.4907E-06	6,516.251	13,032.502	0.00E+00	9.71E-03	1.94E-02
C-14	5.7162E-09	6,516.251	13,032.502	0.00E+00	3.72E-05	7.45E-05
Cl-36	1.3124E-32	6,516.251	13,032.502	0.00E+00	8.55E-29	1.71E-28
Cm-243	1.8568E-07	6,516.251	13,032.502	0.00E+00	1.21E-03	2.42E-03
Cm-244	3.5512E-05	6,516.251	13,032.502	0.00E+00	2.31E-01	4.63E-01
Co-60	1.0261E-05	6,516.251	13,032.502	0.00E+00	6.69E-02	1.34E-01
Cs-134	1.6931E-02	6,516.251	13,032.502	0.00E+00	1.10E+02	2.21E+02
Cs-135	3.4477E-06	6,516.251	13,032.502	0.00E+00	2.25E-02	4.49E-02
Cs-137	2.2800E+00	6,516.251	13,032.502	0.00E+00	1.49E+04	2.97E+04
Eu-154	3.6656E-02	6,516.251	13,032.502	0.00E+00	2.39E+02	4.78E+02
Eu-155	9.6841E-03	6,516.251	13,032.502	0.00E+00	6.31E+01	1.26E+02
Fe-55	4.6977E-04	6,516.251	13,032.502	0.00E+00	3.06E+00	6.12E+00
H-3	6.0485E-03	6,516.251	13,032.502	0.00E+00	3.94E+01	7.88E+01
I-129	7.5300E-07	6,516.251	13,032.502	0.00E+00	4.91E-03	9.81E-03
Kr-85	1.4989E-01	6,516.251	13,032.502	0.00E+00	9.77E+02	1.95E+03
Np-237	9.5534E-06	6,516.251	13,032.502	0.00E+00	6.23E-02	1.25E-01
Pa-231	1.6550E-09	6,516.251	13,032.502	0.00E+00	1.08E-05	2.16E-05
Pb-210	2.6631E-11	6,516.251	13,032.502	0.00E+00	1.74E-07	3.47E-07
Pm-147	1.8156E-01	6,516.251	13,032.502	0.00E+00	1.18E+03	2.37E+03
Pu-238	1.8990E-02	6,516.251	13,032.502	0.00E+00	1.24E+02	2.47E+02
Pu-239	4.2838E-04	6,516.251	13,032.502	0.00E+00	2.79E+00	5.58E+00
Pu-240	2.4379E-04	6,516.251	13,032.502	0.00E+00	1.59E+00	3.18E+00
Pu-241	4.2511E-02	6,516.251	13,032.502	0.00E+00	2.77E+02	5.54E+02
Pu-242	3.6329E-07	6,516.251	13,032.502	0.00E+00	2.37E-03	4.73E-03
Ra-226	1.4725E-10	6,516.251	13,032.502	0.00E+00	9.60E-07	1.92E-06
Ra-228	8.9760E-15	6,516.251	13,032.502	0.00E+00	5.85E-11	1.17E-10
Ru-106	1.9752E-04	6,516.251	13,032.502	0.00E+00	1.29E+00	2.57E+00
Se-79	1.2933E-05	6,516.251	13,032.502	0.00E+00	8.43E-02	1.69E-01
Sn-126	1.1574E-05	6,516.251	13,032.502	0.00E+00	7.54E-02	1.51E-01
Sr-90	2.1680E+00	6,516.251	13,032.502	0.00E+00	1.41E+04	2.83E+04
Tc-99	4.2239E-04	6,516.251	13,032.502	0.00E+00	2.75E+00	5.50E+00
Th-229	3.9270E-12	6,516.251	13,032.502	0.00E+00	2.56E-08	5.12E-08
Th-230	3.3578E-08	6,516.251	13,032.502	0.00E+00	2.19E-04	4.38E-04
Th-232	1.5452E-14	6,516.251	13,032.502	0.00E+00	1.01E-10	2.01E-10
Tl-208	4.6705E-08	6,516.251	13,032.502	0.00E+00	3.04E-04	6.09E-04
U-232	1.3045E-07	6,516.251	13,032.502	0.00E+00	8.50E-04	1.70E-03
U-233	2.3739E-09	6,516.251	13,032.502	0.00E+00	1.55E-05	3.09E-05
U-234	1.8423E-04	6,516.251	13,032.502	0.00E+00	1.20E+00	2.40E+00
U-235	-2.7235E-06	6,516.251	0.000	4.70E-02	2.92E-02	4.70E-02
U-236	1.5493E-05	6,516.251	13,032.502	0.00E+00	1.01E-01	2.02E-01
U-238	-4.2851E-09	6,516.251	0.000	5.63E-04	5.35E-04	5.63E-04
Y-90	2.1686E+00	6,516.251	13,032.502	0.00E+00	1.41E+04	2.83E+04
Other Radionuclides					1.42E+04	2.83E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.555E+15
0.0250	3.242E+14
0.0375	2.831E+14
0.0575	3.019E+14
0.0850	1.829E+14
0.1250	1.254E+14
0.2250	1.575E+14
0.3750	6.901E+13
0.5750	1.120E+15
0.8500	2.661E+13
1.2500	1.344E+13
1.7500	5.633E+11
2.2500	7.047E+08
2.7500	4.234E+07
3.5000	2.692E+06
5.0000	6.225E+03
7.0000	6.895E+02
11.0000	7.741E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.76E+02	3.53E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.84381755	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		6,516.251	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		13,032.502	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.88	
Bounding:	1.77	

Estimated EOL HM/Given EOL HM: 1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRG-1 (GERMANY)
SNF ID #: 741
Fuel Units & Descr: 109 - MTR TYPE
Heavy Metal Mass: BOL=161.56kg ; EOL=150.93kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1994
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 15 years

Estimated Canister usage: 18"x10'
4.54

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	4.5861E-10	10,064.449	20,128.897	0.00E+00	4.62E-06	9.23E-06
Am-241	1.7832E-03	10,064.449	20,128.897	0.00E+00	1.79E+01	3.59E+01
Am-242m	4.3410E-07	10,064.449	20,128.897	0.00E+00	4.37E-03	8.74E-03
Am-243	1.4907E-06	10,064.449	20,128.897	0.00E+00	1.50E-02	3.00E-02
C-14	5.7162E-09	10,064.449	20,128.897	0.00E+00	5.75E-05	1.15E-04
Cl-36	1.3124E-32	10,064.449	20,128.897	0.00E+00	1.32E-28	2.64E-28
Cm-243	1.8568E-07	10,064.449	20,128.897	0.00E+00	1.87E-03	3.74E-03
Cm-244	3.5512E-05	10,064.449	20,128.897	0.00E+00	3.57E-01	7.15E-01
Co-60	1.0261E-05	10,064.449	20,128.897	0.00E+00	1.03E-01	2.07E-01
Cs-134	1.6931E-02	10,064.449	20,128.897	0.00E+00	1.70E+02	3.41E+02
Cs-135	3.4477E-06	10,064.449	20,128.897	0.00E+00	3.47E-02	6.94E-02
Cs-137	2.2800E+00	10,064.449	20,128.897	0.00E+00	2.29E+04	4.59E+04
Eu-154	3.6656E-02	10,064.449	20,128.897	0.00E+00	3.69E+02	7.38E+02
Eu-155	9.6841E-03	10,064.449	20,128.897	0.00E+00	9.75E+01	1.95E+02
Fe-55	4.6977E-04	10,064.449	20,128.897	0.00E+00	4.73E+00	9.46E+00
H-3	6.0485E-03	10,064.449	20,128.897	0.00E+00	6.09E+01	1.22E+02
I-129	7.5300E-07	10,064.449	20,128.897	0.00E+00	7.58E-03	1.52E-02
Kr-85	1.4989E-01	10,064.449	20,128.897	0.00E+00	1.51E+03	3.02E+03
Np-237	9.5534E-06	10,064.449	20,128.897	0.00E+00	9.61E-02	1.92E-01
Pa-231	1.6550E-09	10,064.449	20,128.897	0.00E+00	1.67E-05	3.33E-05
Pb-210	2.6631E-11	10,064.449	20,128.897	0.00E+00	2.68E-07	5.36E-07
Pm-147	1.8156E-01	10,064.449	20,128.897	0.00E+00	1.83E+03	3.65E+03
Pu-238	1.8990E-02	10,064.449	20,128.897	0.00E+00	1.91E+02	3.82E+02
Pu-239	4.2838E-04	10,064.449	20,128.897	0.00E+00	4.31E+00	8.62E+00
Pu-240	2.4379E-04	10,064.449	20,128.897	0.00E+00	2.45E+00	4.91E+00
Pu-241	4.2511E-02	10,064.449	20,128.897	0.00E+00	4.28E+02	8.56E+02
Pu-242	3.6329E-07	10,064.449	20,128.897	0.00E+00	3.66E-03	7.31E-03
Ra-226	1.4725E-10	10,064.449	20,128.897	0.00E+00	1.48E-06	2.96E-06
Ra-228	8.9760E-15	10,064.449	20,128.897	0.00E+00	9.03E-11	1.81E-10
Ru-106	1.9752E-04	10,064.449	20,128.897	0.00E+00	1.99E+00	3.98E+00
Se-79	1.2933E-05	10,064.449	20,128.897	0.00E+00	1.30E-01	2.60E-01
Sn-126	1.1574E-05	10,064.449	20,128.897	0.00E+00	1.16E-01	2.33E-01
Sr-90	2.1680E+00	10,064.449	20,128.897	0.00E+00	2.18E+04	4.36E+04
Tc-99	4.2239E-04	10,064.449	20,128.897	0.00E+00	4.25E+00	8.50E+00
Th-229	3.9270E-12	10,064.449	20,128.897	0.00E+00	3.95E-08	7.90E-08
Th-230	3.3578E-08	10,064.449	20,128.897	0.00E+00	3.38E-04	6.76E-04
Th-232	1.5452E-14	10,064.449	20,128.897	0.00E+00	1.56E-10	3.11E-10
Tl-208	4.6705E-08	10,064.449	20,128.897	0.00E+00	4.70E-04	9.40E-04
U-232	1.3045E-07	10,064.449	20,128.897	0.00E+00	1.31E-03	2.63E-03
U-233	2.3739E-09	10,064.449	20,128.897	0.00E+00	2.39E-05	4.78E-05
U-234	1.8423E-04	10,064.449	20,128.897	0.00E+00	1.85E+00	3.71E+00
U-235	-2.7235E-06	10,064.449	0.000	6.92E-02	4.18E-02	6.92E-02
U-236	1.5493E-05	10,064.449	20,128.897	0.00E+00	1.56E-01	3.12E-01
U-238	-4.2851E-09	10,064.449	0.000	4.35E-02	4.35E-02	4.35E-02
Y-90	2.1686E+00	10,064.449	20,128.897	0.00E+00	2.18E+04	4.37E+04
Other Radionuclides					2.19E+04	4.38E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.401E+15
0.0250	5.008E+14
0.0375	4.373E+14
0.0575	4.663E+14
0.0850	2.824E+14
0.1250	1.936E+14
0.2250	2.433E+14
0.3750	1.066E+14
0.5750	1.730E+15
0.8500	4.110E+13
1.2500	2.076E+13
1.7500	8.700E+11
2.2500	1.088E+09
2.7500	6.540E+07
3.5000	4.158E+06
5.0000	9.712E+03
7.0000	1.076E+03
11.0000	1.209E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.72E+02	5.45E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	19.81106509	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		10,064.449
Bounding:		20,128.897

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.20	
Bounding:	0.40	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRJ (GERMANY)	**Fuel decay start date:**[1]	1995
SNF ID #:	933	**Estimates as of:**	2010
Fuel Units & Descr:	195 - CONCENTRIC TUBES	**Template:**	HFBR (Heavy Water, Alum., 40 to 100%, U)
Heavy Metal Mass:	BOL=39.31kg ; EOL=26.87kg	**Template Burnup(MWd):**[2]	164.6
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.000377
		Template Decay Time:	15 years

Estimated Canister usage:

18"x10'
5.42

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	2.1567E-10	11,459.442	22,918.885	0.00E+00	2.47E-06	4.94E-06
Am-241	7.1264E-03	11,459.442	22,918.885	0.00E+00	8.17E+01	1.63E+02
Am-242m	1.4010E-06	11,459.442	22,918.885	0.00E+00	1.61E-02	3.21E-02
Am-243	3.7114E-05	11,459.442	22,918.885	0.00E+00	4.25E-01	8.51E-01
C-14	2.6476E-08	11,459.442	22,918.885	0.00E+00	3.03E-04	6.07E-04
Cl-36	4.4441E-31	11,459.442	22,918.885	0.00E+00	5.09E-27	1.02E-26
Cm-243	6.4399E-06	11,459.442	22,918.885	0.00E+00	7.38E-02	1.48E-01
Cm-244	5.6367E-03	11,459.442	22,918.885	0.00E+00	6.46E+01	1.29E+02
Co-60	9.3864E-05	11,459.442	22,918.885	0.00E+00	1.08E+00	2.15E+00
Cs-134	5.7047E-02	11,459.442	22,918.885	0.00E+00	6.54E+02	1.31E+03
Cs-135	4.2564E-06	11,459.442	22,918.885	0.00E+00	4.88E-02	9.76E-02
Cs-137	2.2855E+00	11,459.442	22,918.885	0.00E+00	2.62E+04	5.24E+04
Eu-154	7.7704E-02	11,459.442	22,918.885	0.00E+00	8.90E+02	1.78E+03
Eu-155	2.8736E-02	11,459.442	22,918.885	0.00E+00	3.29E+02	6.59E+02
Fe-55	5.1379E-03	11,459.442	22,918.885	0.00E+00	5.89E+01	1.18E+02
H-3	6.1239E-03	11,459.442	22,918.885	0.00E+00	7.02E+01	1.40E+02
I-129	6.6403E-07	11,459.442	22,918.885	0.00E+00	7.61E-03	1.52E-02
Kr-85	1.4927E-01	11,459.442	22,918.885	0.00E+00	1.71E+03	3.42E+03
Np-237	3.1525E-05	11,459.442	22,918.885	0.00E+00	3.61E-01	7.23E-01
Pa-231	7.8676E-10	11,459.442	22,918.885	0.00E+00	9.02E-06	1.80E-05
Pb-210	6.1847E-12	11,459.442	22,918.885	0.00E+00	7.09E-08	1.42E-07
Pm-147	9.1373E-02	11,459.442	22,918.885	0.00E+00	1.05E+03	2.09E+03
Pu-238	1.5978E-01	11,459.442	22,918.885	0.00E+00	1.83E+03	3.66E+03
Pu-239	6.9502E-04	11,459.442	22,918.885	0.00E+00	7.96E+00	1.59E+01
Pu-240	3.7424E-04	11,459.442	22,918.885	0.00E+00	4.29E+00	8.58E+00
Pu-241	1.7090E-01	11,459.442	22,918.885	0.00E+00	1.96E+03	3.92E+03
Pu-242	3.0911E-06	11,459.442	22,918.885	0.00E+00	3.54E-02	7.08E-02
Ra-226	3.4848E-11	11,459.442	22,918.885	0.00E+00	3.99E-07	7.99E-07
Ra-228	9.6173E-15	11,459.442	22,918.885	0.00E+00	1.10E-10	2.20E-10
Ru-106	2.2789E-04	11,459.442	22,918.885	0.00E+00	2.61E+00	5.22E+00
Se-79	1.2339E-05	11,459.442	22,918.885	0.00E+00	1.41E-01	2.83E-01
Sn-126	1.0194E-05	11,459.442	22,918.885	0.00E+00	1.17E-01	2.34E-01
Sr-90	2.1476E+00	11,459.442	22,918.885	0.00E+00	2.46E+04	4.92E+04
Tc-99	3.8056E-04	11,459.442	22,918.885	0.00E+00	4.36E+00	8.72E+00
Th-229	3.3026E-12	11,459.442	22,918.885	0.00E+00	3.78E-08	7.57E-08
Th-230	8.2503E-09	11,459.442	22,918.885	0.00E+00	9.45E-05	1.89E-04
Th-232	1.6586E-14	11,459.442	22,918.885	0.00E+00	1.90E-10	3.80E-10
Tl-208	4.8827E-08	11,459.442	22,918.885	0.00E+00	5.60E-04	1.12E-03
U-232	1.3821E-07	11,459.442	22,918.885	0.00E+00	1.58E-03	3.17E-03
U-233	3.0790E-09	11,459.442	22,918.885	0.00E+00	3.53E-05	7.06E-05
U-234	4.9915E-05	11,459.442	22,918.885	0.00E+00	5.72E-01	1.14E+00
U-235	-2.8661E-06	11,459.442	0.000	6.79E-02	3.50E-02	6.79E-02
U-236	1.6701E-05	11,459.442	22,918.885	0.00E+00	1.91E-01	3.83E-01
U-238	-9.4194E-09	11,459.442	0.000	2.66E-03	2.55E-03	2.66E-03
Y-90	2.1482E+00	11,459.442	22,918.885	0.00E+00	2.46E+04	4.92E+04
Other Radionuclides					2.51E+04	5.02E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.740E+15
0.0250	5.664E+14
0.0375	5.074E+14
0.0575	5.316E+14
0.0850	3.245E+14
0.1250	2.357E+14
0.2250	2.776E+14
0.3750	1.205E+14
0.5750	2.020E+15
0.8500	9.317E+13
1.2500	4.404E+13
1.7500	1.536E+12
2.2500	1.340E+09
2.7500	8.389E+07
3.5000	7.371E+06
5.0000	8.266E+05
7.0000	9.495E+04
11.0000	1.088E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.76E+02	7.51E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	79.89992512	40 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		11,459.442
Bounding:		22,918.885

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.

Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.67	
Bounding:	1.34	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRJ (GERMANY)
SNF ID #: 1000
Fuel Units & Descr: 10 - CONCENTRIC TUBES
Heavy Metal Mass: BOL=3.78kg ; EOL=3.34kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 1993
Estimates as of: 2010
Template: HFBR (Heavy Water, Alum., 40 to 100%, U)
[2]**Template Burnup(MWd):** 164.6
Template BOL Heavy Metal Mass (MT): 0.000377
Template Decay Time: 15 years

Estimated Canister usage:
18"x10'
0.28

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	2.1567E-10	408.049	816.097	0.00E+00	8.80E-08	1.76E-07
Am-241	7.1264E-03	408.049	816.097	0.00E+00	2.91E+00	5.82E+00
Am-242m	1.4010E-06	408.049	816.097	0.00E+00	5.72E-04	1.14E-03
Am-243	3.7114E-05	408.049	816.097	0.00E+00	1.51E-02	3.03E-02
C-14	2.6476E-08	408.049	816.097	0.00E+00	1.08E-05	2.16E-05
Cl-36	4.4441E-31	408.049	816.097	0.00E+00	1.81E-28	3.63E-28
Cm-243	6.4399E-06	408.049	816.097	0.00E+00	2.63E-03	5.26E-03
Cm-244	5.6367E-03	408.049	816.097	0.00E+00	2.30E+00	4.60E+00
Co-60	9.3864E-05	408.049	816.097	0.00E+00	3.83E-02	7.66E-02
Cs-134	5.7047E-02	408.049	816.097	0.00E+00	2.33E+01	4.66E+01
Cs-135	4.2564E-06	408.049	816.097	0.00E+00	1.74E-03	3.47E-03
Cs-137	2.2855E+00	408.049	816.097	0.00E+00	9.33E+02	1.87E+03
Eu-154	7.7704E-02	408.049	816.097	0.00E+00	3.17E+01	6.34E+01
Eu-155	2.8736E-02	408.049	816.097	0.00E+00	1.17E+01	2.35E+01
Fe-55	5.1379E-03	408.049	816.097	0.00E+00	2.10E+00	4.19E+00
H-3	6.1239E-03	408.049	816.097	0.00E+00	2.50E+00	5.00E+00
I-129	6.6403E-07	408.049	816.097	0.00E+00	2.71E-04	5.42E-04
Kr-85	1.4927E-01	408.049	816.097	0.00E+00	6.09E+01	1.22E+02
Np-237	3.1525E-05	408.049	816.097	0.00E+00	1.29E-02	2.57E-02
Pa-231	7.8676E-10	408.049	816.097	0.00E+00	3.21E-07	6.42E-07
Pb-210	6.1847E-12	408.049	816.097	0.00E+00	2.52E-09	5.05E-09
Pm-147	9.1373E-02	408.049	816.097	0.00E+00	3.73E+01	7.46E+01
Pu-238	1.5978E-01	408.049	816.097	0.00E+00	6.52E+01	1.30E+02
Pu-239	6.9502E-04	408.049	816.097	0.00E+00	2.84E-01	5.67E-01
Pu-240	3.7424E-04	408.049	816.097	0.00E+00	1.53E-01	3.05E-01
Pu-241	1.7090E-01	408.049	816.097	0.00E+00	6.97E+01	1.39E+02
Pu-242	3.0911E-06	408.049	816.097	0.00E+00	1.26E-03	2.52E-03
Ra-226	3.4848E-11	408.049	816.097	0.00E+00	1.42E-08	2.84E-08
Ra-228	9.6173E-15	408.049	816.097	0.00E+00	3.92E-12	7.85E-12
Ru-106	2.2789E-04	408.049	816.097	0.00E+00	9.30E-02	1.86E-01
Se-79	1.2339E-05	408.049	816.097	0.00E+00	5.03E-03	1.01E-02
Sn-126	1.0194E-05	408.049	816.097	0.00E+00	4.16E-03	8.32E-03
Sr-90	2.1476E+00	408.049	816.097	0.00E+00	8.76E+02	1.75E+03
Tc-99	3.8056E-04	408.049	816.097	0.00E+00	1.55E-01	3.11E-01
Th-229	3.3026E-12	408.049	816.097	0.00E+00	1.35E-09	2.70E-09
Th-230	8.2503E-09	408.049	816.097	0.00E+00	3.37E-06	6.73E-06
Th-232	1.6586E-14	408.049	816.097	0.00E+00	6.77E-12	1.35E-11
Tl-208	4.8827E-08	408.049	816.097	0.00E+00	1.99E-05	3.98E-05
U-232	1.3821E-07	408.049	816.097	0.00E+00	5.64E-05	1.13E-04
U-233	3.0790E-09	408.049	816.097	0.00E+00	1.26E-06	2.51E-06
U-234	4.9915E-05	408.049	816.097	0.00E+00	2.04E-02	4.07E-02
U-235	-2.8661E-06	408.049	0.000	3.67E-03	2.50E-03	3.67E-03
U-236	1.6701E-05	408.049	816.097	0.00E+00	6.81E-03	1.36E-02
U-238	-9.4194E-09	408.049	0.000	7.00E-04	6.97E-04	7.00E-04
Y-90	2.1482E+00	408.049	816.097	0.00E+00	8.77E+02	1.75E+03
Other Radionuclides					8.93E+02	1.79E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	9.756E+13
0.0250	2.017E+13
0.0375	1.807E+13
0.0575	1.893E+13
0.0850	1.156E+13
0.1250	8.393E+12
0.2250	9.884E+12
0.3750	4.292E+12
0.5750	7.192E+13
0.8500	3.318E+12
1.2500	1.568E+12
1.7500	5.469E+10
2.2500	4.772E+07
2.7500	2.987E+06
3.5000	2.625E+05
5.0000	2.943E+04
7.0000	3.381E+03
11.0000	3.876E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.34E+01	2.67E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	44.88296013	40 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		408.049	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		816.097	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.25	
Bounding:	0.49	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRJ TUBES (GERMANY)	[1]**Fuel decay start date:**	1998
SNF ID #:	999	**Estimates as of:**	2010
Fuel Units & Descr:	3 - CONCENTRIC TUBES	**Template:**	HFBR (Heavy Water, Alum., 10 to 20%, U)
Heavy Metal Mass:	BOL=3.04kg ; EOL=3.01kg	[2]**Template Burnup(MWd):**	15
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00034251
		Template Decay Time:	10 years

Estimated Canister usage: 18"x10'

0.13

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	3.5433E-10	28.229	56.458	0.00E+00	1.00E-08	2.00E-08
Am-241	1.6993E-02	28.229	56.458	0.00E+00	4.80E-01	9.59E-01
Am-242m	9.3333E-06	28.229	56.458	0.00E+00	2.63E-04	5.27E-04
Am-243	6.4067E-06	28.229	56.458	0.00E+00	1.81E-04	3.62E-04
C-14	2.9653E-08	28.229	56.458	0.00E+00	8.37E-07	1.67E-06
Cl-36	5.9513E-35	28.229	56.458	0.00E+00	1.68E-33	3.36E-33
Cm-243	2.8167E-06	28.229	56.458	0.00E+00	7.95E-05	1.59E-04
Cm-244	1.6140E-04	28.229	56.458	0.00E+00	4.56E-03	9.11E-03
Co-60	6.0893E-05	28.229	56.458	0.00E+00	1.72E-03	3.44E-03
Cs-134	6.1567E-02	28.229	56.458	0.00E+00	1.74E+00	3.48E+00
Cs-135	4.8607E-06	28.229	56.458	0.00E+00	1.37E-04	2.74E-04
Cs-137	2.5487E+00	28.229	56.458	0.00E+00	7.19E+01	1.44E+02
Eu-154	4.6760E-02	28.229	56.458	0.00E+00	1.32E+00	2.64E+00
Eu-155	1.6533E-02	28.229	56.458	0.00E+00	4.67E-01	9.33E-01
Fe-55	2.0373E-02	28.229	56.458	0.00E+00	5.75E-01	1.15E+00
H-3	8.1800E-03	28.229	56.458	0.00E+00	2.31E-01	4.62E-01
I-129	7.1600E-07	28.229	56.458	0.00E+00	2.02E-05	4.04E-05
Kr-85	1.9547E-01	28.229	56.458	0.00E+00	5.52E+00	1.10E+01
Np-237	3.6573E-06	28.229	56.458	0.00E+00	1.03E-04	2.06E-04
Pa-231	1.6420E-09	28.229	56.458	0.00E+00	4.64E-08	9.27E-08
Pb-210	7.4600E-15	28.229	56.458	0.00E+00	2.11E-13	4.21E-13
Pm-147	6.5033E-01	28.229	56.458	0.00E+00	1.84E+01	3.67E+01
Pu-238	5.9807E-03	28.229	56.458	0.00E+00	1.69E-01	3.38E-01
Pu-239	1.0320E-02	28.229	56.458	0.00E+00	2.91E-01	5.83E-01
Pu-240	5.4233E-03	28.229	56.458	0.00E+00	1.53E-01	3.06E-01
Pu-241	6.0807E-01	28.229	56.458	0.00E+00	1.72E+01	3.43E+01
Pu-242	3.0713E-06	28.229	56.458	0.00E+00	8.67E-05	1.73E-04
Ra-226	6.1580E-14	28.229	56.458	0.00E+00	1.74E-12	3.48E-12
Ra-228	4.9953E-15	28.229	56.458	0.00E+00	1.41E-13	2.82E-13
Ru-106	8.2133E-03	28.229	56.458	0.00E+00	2.32E-01	4.64E-01
Se-79	1.2540E-05	28.229	56.458	0.00E+00	3.54E-04	7.08E-04
Sn-126	1.1393E-05	28.229	56.458	0.00E+00	3.22E-04	6.43E-04
Sr-90	2.3340E+00	28.229	56.458	0.00E+00	6.59E+01	1.32E+02
Tc-99	4.3540E-04	28.229	56.458	0.00E+00	1.23E-02	2.46E-02
Th-229	2.4973E-13	28.229	56.458	0.00E+00	7.05E-12	1.41E-11
Th-230	2.4613E-11	28.229	56.458	0.00E+00	6.95E-10	1.39E-09
Th-232	9.9467E-15	28.229	56.458	0.00E+00	2.81E-13	5.62E-13
Tl-208	7.7667E-09	28.229	56.458	0.00E+00	2.19E-07	4.38E-07
U-232	2.1927E-08	28.229	56.458	0.00E+00	6.19E-07	1.24E-06
U-233	2.7887E-10	28.229	56.458	0.00E+00	7.87E-09	1.57E-08
U-234	3.0807E-07	28.229	56.458	0.00E+00	8.70E-06	1.74E-05
U-235	-2.5341E-06	28.229	0.000	1.30E-03	1.22E-03	1.30E-03
U-236	1.3000E-05	28.229	56.458	0.00E+00	3.67E-04	7.34E-04
U-238	-1.4207E-08	28.229	0.000	8.20E-04	8.19E-04	8.20E-04
Y-90	2.3347E+00	28.229	56.458	0.00E+00	6.59E+01	1.32E+02
Other Radionuclides					6.96E+01	1.39E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.361E+12
0.0250	1.548E+12
0.0375	1.357E+12
0.0575	1.436E+12
0.0850	8.652E+11
0.1250	6.000E+11
0.2250	7.429E+11
0.3750	3.330E+11
0.5750	5.550E+12
0.8500	2.117E+11
1.2500	7.682E+10
1.7500	2.967E+09
2.2500	1.794E+08
2.7500	3.843E+06
3.5000	4.826E+05
5.0000	1.371E+02
7.0000	1.559E+01
11.0000	1.778E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.76E-01	1.75E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	19.72968438	10 to 20

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	0.249	28.229
Bounding:		56.458

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.

Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.21	113.31
Bounding:	0.42	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRM (GERMANY)	**[1]Fuel decay start date:**	1995
SNF ID #:	806	**Estimates as of:**	2010
Fuel Units & Descr:	31 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=6.40kg ; EOL=3.17kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	15 years

Estimated Canister usage: 18"x10'

1.29

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	4.5861E-10	3,053.191	6,056.473	0.00E+00	1.40E-06	2.78E-06
Am-241	1.7832E-03	3,053.191	6,056.473	0.00E+00	5.44E+00	1.08E+01
Am-242m	4.3410E-07	3,053.191	6,056.473	0.00E+00	1.33E-03	2.63E-03
Am-243	1.4907E-06	3,053.191	6,056.473	0.00E+00	4.55E-03	9.03E-03
C-14	5.7162E-09	3,053.191	6,056.473	0.00E+00	1.75E-05	3.46E-05
Cl-36	1.3124E-32	3,053.191	6,056.473	0.00E+00	4.01E-29	7.95E-29
Cm-243	1.8568E-07	3,053.191	6,056.473	0.00E+00	5.67E-04	1.12E-03
Cm-244	3.5512E-05	3,053.191	6,056.473	0.00E+00	1.08E-01	2.15E-01
Co-60	1.0261E-05	3,053.191	6,056.473	0.00E+00	3.13E-02	6.21E-02
Cs-134	1.6931E-02	3,053.191	6,056.473	0.00E+00	5.17E+01	1.03E+02
Cs-135	3.4477E-06	3,053.191	6,056.473	0.00E+00	1.05E-02	2.09E-02
Cs-137	2.2800E+00	3,053.191	6,056.473	0.00E+00	6.96E+03	1.38E+04
Eu-154	3.6656E-02	3,053.191	6,056.473	0.00E+00	1.12E+02	2.22E+02
Eu-155	9.6841E-03	3,053.191	6,056.473	0.00E+00	2.96E+01	5.87E+01
Fe-55	4.6977E-04	3,053.191	6,056.473	0.00E+00	1.43E+00	2.85E+00
H-3	6.0485E-03	3,053.191	6,056.473	0.00E+00	1.85E+01	3.66E+01
I-129	7.5300E-07	3,053.191	6,056.473	0.00E+00	2.30E-03	4.56E-03
Kr-85	1.4989E-01	3,053.191	6,056.473	0.00E+00	4.58E+02	9.08E+02
Np-237	9.5534E-06	3,053.191	6,056.473	0.00E+00	2.92E-02	5.79E-02
Pa-231	1.6550E-09	3,053.191	6,056.473	0.00E+00	5.05E-06	1.00E-05
Pb-210	2.6631E-11	3,053.191	6,056.473	0.00E+00	8.13E-08	1.61E-07
Pm-147	1.8156E-01	3,053.191	6,056.473	0.00E+00	5.54E+02	1.10E+03
Pu-238	1.8990E-02	3,053.191	6,056.473	0.00E+00	5.80E+01	1.15E+02
Pu-239	4.2838E-04	3,053.191	6,056.473	0.00E+00	1.31E+00	2.59E+00
Pu-240	2.4379E-04	3,053.191	6,056.473	0.00E+00	7.44E-01	1.48E+00
Pu-241	4.2511E-02	3,053.191	6,056.473	0.00E+00	1.30E+02	2.57E+02
Pu-242	3.6329E-07	3,053.191	6,056.473	0.00E+00	1.11E-03	2.20E-03
Ra-226	1.4725E-10	3,053.191	6,056.473	0.00E+00	4.50E-07	8.92E-07
Ra-228	8.9760E-15	3,053.191	6,056.473	0.00E+00	2.74E-11	5.44E-11
Ru-106	1.9752E-04	3,053.191	6,056.473	0.00E+00	6.03E-01	1.20E+00
Se-79	1.2933E-05	3,053.191	6,056.473	0.00E+00	3.95E-02	7.83E-02
Sn-126	1.1574E-05	3,053.191	6,056.473	0.00E+00	3.53E-02	7.01E-02
Sr-90	2.1680E+00	3,053.191	6,056.473	0.00E+00	6.62E+03	1.31E+04
Tc-99	4.2239E-04	3,053.191	6,056.473	0.00E+00	1.29E+00	2.56E+00
Th-229	3.9270E-12	3,053.191	6,056.473	0.00E+00	1.20E-08	2.38E-08
Th-230	3.3578E-08	3,053.191	6,056.473	0.00E+00	1.03E-04	2.03E-04
Th-232	1.5452E-14	3,053.191	6,056.473	0.00E+00	4.72E-11	9.36E-11
Tl-208	4.6705E-08	3,053.191	6,056.473	0.00E+00	1.43E-04	2.83E-04
U-232	1.3045E-07	3,053.191	6,056.473	0.00E+00	3.98E-04	7.90E-04
U-233	2.3739E-09	3,053.191	6,056.473	0.00E+00	7.25E-06	1.44E-05
U-234	1.8423E-04	3,053.191	6,056.473	0.00E+00	5.62E-01	1.12E+00
U-235	-2.7235E-06	3,053.191	0.000	1.26E-02	4.28E-03	1.26E-02
U-236	1.5493E-05	3,053.191	6,056.473	0.00E+00	4.73E-02	9.38E-02
U-238	-4.2851E-09	3,053.191	0.000	1.91E-04	1.78E-04	1.91E-04
Y-90	2.1686E+00	3,053.191	6,056.473	0.00E+00	6.62E+03	1.31E+04
Other Radionuclides					6.64E+03	1.32E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.225E+14
0.0250	1.507E+14
0.0375	1.316E+14
0.0575	1.403E+14
0.0850	8.498E+13
0.1250	5.826E+13
0.2250	7.321E+13
0.3750	3.207E+13
0.5750	5.206E+14
0.8500	1.237E+13
1.2500	6.247E+12
1.7500	2.618E+11
2.2500	3.275E+08
2.7500	1.968E+07
3.5000	1.251E+06
5.0000	2.892E+03
7.0000	3.204E+02
11.0000	3.597E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.26E+01	1.64E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	91.10863593	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		3,053.191	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		6,056.473	Bounding burnup calculated assuming all BOL heavy metal burned.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.52	
Bounding:	3.01	

Estimated EOL HM/Given EOL HM

1.06

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRM (GERMANY)	**[1]Fuel decay start date:**	1995
SNF ID #:	805	**Estimates as of:**	2010
Fuel Units & Descr:	50 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=28.18kg ; EOL=23.47kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	15 years

Estimated Canister usage:

18"x10'
2.08

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	4.5861E-10	4,460.461	8,920.923	0.00E+00	2.05E-06	4.09E-06
Am-241	1.7832E-03	4,460.461	8,920.923	0.00E+00	7.95E+00	1.59E+01
Am-242m	4.3410E-07	4,460.461	8,920.923	0.00E+00	1.94E-03	3.87E-03
Am-243	1.4907E-06	4,460.461	8,920.923	0.00E+00	6.65E-03	1.33E-02
C-14	5.7162E-09	4,460.461	8,920.923	0.00E+00	2.55E-05	5.10E-05
Cl-36	1.3124E-32	4,460.461	8,920.923	0.00E+00	5.85E-29	1.17E-28
Cm-243	1.8568E-07	4,460.461	8,920.923	0.00E+00	8.28E-04	1.66E-03
Cm-244	3.5512E-05	4,460.461	8,920.923	0.00E+00	1.58E-01	3.17E-01
Co-60	1.0261E-05	4,460.461	8,920.923	0.00E+00	4.58E-02	9.15E-02
Cs-134	1.6931E-02	4,460.461	8,920.923	0.00E+00	7.55E+01	1.51E+02
Cs-135	3.4477E-06	4,460.461	8,920.923	0.00E+00	1.54E-02	3.08E-02
Cs-137	2.2800E+00	4,460.461	8,920.923	0.00E+00	1.02E+04	2.03E+04
Eu-154	3.6656E-02	4,460.461	8,920.923	0.00E+00	1.64E+02	3.27E+02
Eu-155	9.6841E-03	4,460.461	8,920.923	0.00E+00	4.32E+01	8.64E+01
Fe-55	4.6977E-04	4,460.461	8,920.923	0.00E+00	2.10E+00	4.19E+00
H-3	6.0485E-03	4,460.461	8,920.923	0.00E+00	2.70E+01	5.40E+01
I-129	7.5300E-07	4,460.461	8,920.923	0.00E+00	3.36E-03	6.72E-03
Kr-85	1.4989E-01	4,460.461	8,920.923	0.00E+00	6.69E+02	1.34E+03
Np-237	9.5534E-06	4,460.461	8,920.923	0.00E+00	4.26E-02	8.52E-02
Pa-231	1.6550E-09	4,460.461	8,920.923	0.00E+00	7.38E-06	1.48E-05
Pb-210	2.6631E-11	4,460.461	8,920.923	0.00E+00	1.19E-07	2.38E-07
Pm-147	1.8156E-01	4,460.461	8,920.923	0.00E+00	8.10E+02	1.62E+03
Pu-238	1.8990E-02	4,460.461	8,920.923	0.00E+00	8.47E+01	1.69E+02
Pu-239	4.2838E-04	4,460.461	8,920.923	0.00E+00	1.91E+00	3.82E+00
Pu-240	2.4379E-04	4,460.461	8,920.923	0.00E+00	1.09E+00	2.17E+00
Pu-241	4.2511E-02	4,460.461	8,920.923	0.00E+00	1.90E+02	3.79E+02
Pu-242	3.6329E-07	4,460.461	8,920.923	0.00E+00	1.62E-03	3.24E-03
Ra-226	1.4725E-10	4,460.461	8,920.923	0.00E+00	6.57E-07	1.31E-06
Ra-228	8.9760E-15	4,460.461	8,920.923	0.00E+00	4.00E-11	8.01E-11
Ru-106	1.9752E-04	4,460.461	8,920.923	0.00E+00	8.81E-01	1.76E+00
Se-79	1.2933E-05	4,460.461	8,920.923	0.00E+00	5.77E-02	1.15E-01
Sn-126	1.1574E-05	4,460.461	8,920.923	0.00E+00	5.16E-02	1.03E-01
Sr-90	2.1680E+00	4,460.461	8,920.923	0.00E+00	9.67E+03	1.93E+04
Tc-99	4.2239E-04	4,460.461	8,920.923	0.00E+00	1.88E+00	3.77E+00
Th-229	3.9270E-12	4,460.461	8,920.923	0.00E+00	1.75E-08	3.50E-08
Th-230	3.3578E-08	4,460.461	8,920.923	0.00E+00	1.50E-04	3.00E-04
Th-232	1.5452E-14	4,460.461	8,920.923	0.00E+00	6.89E-11	1.38E-10
Tl-208	4.6705E-08	4,460.461	8,920.923	0.00E+00	2.08E-04	4.17E-04
U-232	1.3045E-07	4,460.461	8,920.923	0.00E+00	5.82E-04	1.16E-03
U-233	2.3739E-09	4,460.461	8,920.923	0.00E+00	1.06E-05	2.12E-05
U-234	1.8423E-04	4,460.461	8,920.923	0.00E+00	8.22E-01	1.64E+00
U-235	-2.7235E-06	4,460.461	0.000	2.74E-02	1.52E-02	2.74E-02
U-236	1.5493E-05	4,460.461	8,920.923	0.00E+00	6.91E-02	1.38E-01
U-238	-4.2851E-09	4,460.461	0.000	5.21E-03	5.19E-03	5.21E-03
Y-90	2.1686E+00	4,460.461	8,920.923	0.00E+00	9.67E+03	1.93E+04
Other Radionuclides					9.70E+03	1.94E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.064E+15
0.0250	2.219E+14
0.0375	1.938E+14
0.0575	2.066E+14
0.0850	1.252E+14
0.1250	8.581E+13
0.2250	1.078E+14
0.3750	4.724E+13
0.5750	7.668E+14
0.8500	1.821E+13
1.2500	9.201E+12
1.7500	3.856E+11
2.2500	4.824E+08
2.7500	2.898E+07
3.5000	1.843E+06
5.0000	4.272E+03
7.0000	4.732E+02
11.0000	5.314E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.21E+02	2.41E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	44.97952648	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:	686.606	4,460.461
Bounding:		8,920.923

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.50	6.50
Bounding:	1.01	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR ASTRA (AUSTRIA)	**[1]Fuel decay start date:**	2010	Estimated Canister usage: 18"x10'
SNF ID #:	738	**Estimates as of:**	2010	0.58
Fuel Units & Descr:	14 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)	
Heavy Metal Mass:	BOL=5.60kg ; EOL=4.86kg	**[2]Template Burnup(MWd):**	367.2	
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689	
		Template Decay Time:	5 years	

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	702.688	1,405.377	0.00E+00	1.02E-07	2.04E-07
Am-241	1.1190E-03	702.688	1,405.377	0.00E+00	7.86E-01	1.57E+00
Am-242m	4.5425E-07	702.688	1,405.377	0.00E+00	3.19E-04	6.38E-04
Am-243	1.4921E-06	702.688	1,405.377	0.00E+00	1.05E-03	2.10E-03
C-14	5.7244E-09	702.688	1,405.377	0.00E+00	4.02E-06	8.04E-06
Cl-36	1.3124E-32	702.688	1,405.377	0.00E+00	9.22E-30	1.84E-29
Cm-243	2.3676E-07	702.688	1,405.377	0.00E+00	1.66E-04	3.33E-04
Cm-244	5.2042E-05	702.688	1,405.377	0.00E+00	3.66E-02	7.31E-02
Co-60	3.8208E-05	702.688	1,405.377	0.00E+00	2.68E-02	5.37E-02
Cs-134	4.8693E-01	702.688	1,405.377	0.00E+00	3.42E+02	6.84E+02
Cs-135	3.4477E-06	702.688	1,405.377	0.00E+00	2.42E-03	4.85E-03
Cs-137	2.8731E+00	702.688	1,405.377	0.00E+00	2.02E+03	4.04E+03
Eu-154	8.2053E-02	702.688	1,405.377	0.00E+00	5.77E+01	1.15E+02
Eu-155	3.9134E-02	702.688	1,405.377	0.00E+00	2.75E+01	5.50E+01
Fe-55	6.7429E-03	702.688	1,405.377	0.00E+00	4.74E+00	9.48E+00
H-3	1.0599E-02	702.688	1,405.377	0.00E+00	7.45E+00	1.49E+01
I-129	7.5300E-07	702.688	1,405.377	0.00E+00	5.29E-04	1.06E-03
Kr-85	2.8595E-01	702.688	1,405.377	0.00E+00	2.01E+02	4.02E+02
Np-237	9.5479E-06	702.688	1,405.377	0.00E+00	6.71E-03	1.34E-02
Pa-231	8.9297E-10	702.688	1,405.377	0.00E+00	6.27E-07	1.25E-06
Pb-210	3.7609E-12	702.688	1,405.377	0.00E+00	2.64E-09	5.29E-09
Pm-147	2.5452E+00	702.688	1,405.377	0.00E+00	1.79E+03	3.58E+03
Pu-238	2.0550E-02	702.688	1,405.377	0.00E+00	1.44E+01	2.89E+01
Pu-239	4.2838E-04	702.688	1,405.377	0.00E+00	3.01E-01	6.02E-01
Pu-240	2.4401E-04	702.688	1,405.377	0.00E+00	1.71E-01	3.43E-01
Pu-241	6.8764E-02	702.688	1,405.377	0.00E+00	4.83E+01	9.66E+01
Pu-242	3.6329E-07	702.688	1,405.377	0.00E+00	2.55E-04	5.11E-04
Ra-226	3.8045E-11	702.688	1,405.377	0.00E+00	2.67E-08	5.35E-08
Ra-228	2.9902E-15	702.688	1,405.377	0.00E+00	2.10E-12	4.20E-12
Ru-106	1.9055E-01	702.688	1,405.377	0.00E+00	1.34E+02	2.68E+02
Se-79	1.2936E-05	702.688	1,405.377	0.00E+00	9.09E-03	1.82E-02
Sn-126	1.1574E-05	702.688	1,405.377	0.00E+00	8.13E-03	1.63E-02
Sr-90	2.7505E+00	702.688	1,405.377	0.00E+00	1.93E+03	3.87E+03
Tc-99	4.2239E-04	702.688	1,405.377	0.00E+00	2.97E-01	5.94E-01
Th-229	1.8848E-12	702.688	1,405.377	0.00E+00	1.32E-09	2.65E-09
Th-230	1.7042E-08	702.688	1,405.377	0.00E+00	1.20E-05	2.40E-05
Th-232	7.8132E-15	702.688	1,405.377	0.00E+00	5.49E-12	1.10E-11
Tl-208	4.4063E-08	702.688	1,405.377	0.00E+00	3.10E-05	6.19E-05
U-232	1.3151E-07	702.688	1,405.377	0.00E+00	9.24E-05	1.85E-04
U-233	1.9564E-09	702.688	1,405.377	0.00E+00	1.37E-06	2.75E-06
U-234	1.8371E-04	702.688	1,405.377	0.00E+00	1.29E-01	2.58E-01
U-235	-2.7235E-06	702.688	0.000	1.13E-02	9.36E-03	1.13E-02
U-236	1.5493E-05	702.688	1,405.377	0.00E+00	1.09E-02	2.18E-02
U-238	-4.2851E-09	702.688	0.000	1.29E-04	1.26E-04	1.29E-04
Y-90	2.7505E+00	702.688	1,405.377	0.00E+00	1.93E+03	3.87E+03
Other Radionuclides					3.61E+03	7.23E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	2.711E+14
0.0250	5.841E+13
0.0375	5.390E+13
0.0575	5.300E+13
0.0850	3.379E+13
0.1250	2.926E+13
0.2250	2.864E+13
0.3750	1.386E+13
0.5750	1.904E+14
0.8500	2.666E+13
1.2500	4.961E+12
1.7500	2.081E+11
2.2500	4.364E+11
2.7500	2.510E+09
3.5000	2.785E+08
5.0000	8.327E+02
7.0000	9.284E+01
11.0000	1.046E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.56E+01	7.13E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.15	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		702.688	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,405.377	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.40	
Bounding:	0.80	

Estimated EOL HM/Given EOL HM: 1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR ASTRA (AUSTRIA)
SNF ID #: 654
Fuel Units & Descr: 2 - MTR TYPE
Heavy Metal Mass: BOL=.14kg ; EOL=.12kg
ROD Storage Site: SRS

Fuel decay start date[1]: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
Template Burnup(MWd)[2]: 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'

0.08

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	18.940	37.881	0.00E+00	2.75E-09	5.51E-09
Am-241	1.1190E-03	18.940	37.881	0.00E+00	2.12E-02	4.24E-02
Am-242m	4.5425E-07	18.940	37.881	0.00E+00	8.60E-06	1.72E-05
Am-243	1.4921E-06	18.940	37.881	0.00E+00	2.83E-05	5.65E-05
C-14	5.7244E-09	18.940	37.881	0.00E+00	1.08E-07	2.17E-07
Cl-36	1.3124E-32	18.940	37.881	0.00E+00	2.49E-31	4.97E-31
Cm-243	2.3676E-07	18.940	37.881	0.00E+00	4.48E-06	8.97E-06
Cm-244	5.2042E-05	18.940	37.881	0.00E+00	9.86E-04	1.97E-03
Co-60	3.8208E-05	18.940	37.881	0.00E+00	7.24E-04	1.45E-03
Cs-134	4.8693E-01	18.940	37.881	0.00E+00	9.22E+00	1.84E+01
Cs-135	3.4477E-06	18.940	37.881	0.00E+00	6.53E-05	1.31E-04
Cs-137	2.8731E+00	18.940	37.881	0.00E+00	5.44E+01	1.09E+02
Eu-154	8.2053E-02	18.940	37.881	0.00E+00	1.55E+00	3.11E+00
Eu-155	3.9134E-02	18.940	37.881	0.00E+00	7.41E-01	1.48E+00
Fe-55	6.7429E-03	18.940	37.881	0.00E+00	1.28E-01	2.55E-01
H-3	1.0599E-02	18.940	37.881	0.00E+00	2.01E-01	4.02E-01
I-129	7.5300E-07	18.940	37.881	0.00E+00	1.43E-05	2.85E-05
Kr-85	2.8595E-01	18.940	37.881	0.00E+00	5.42E+00	1.08E+01
Np-237	9.5479E-06	18.940	37.881	0.00E+00	1.81E-04	3.62E-04
Pa-231	8.9297E-10	18.940	37.881	0.00E+00	1.69E-08	3.38E-08
Pb-210	3.7609E-12	18.940	37.881	0.00E+00	7.12E-11	1.42E-10
Pm-147	2.5452E+00	18.940	37.881	0.00E+00	4.82E+01	9.64E+01
Pu-238	2.0550E-02	18.940	37.881	0.00E+00	3.89E-01	7.78E-01
Pu-239	4.2838E-04	18.940	37.881	0.00E+00	8.11E-03	1.62E-02
Pu-240	2.4401E-04	18.940	37.881	0.00E+00	4.62E-03	9.24E-03
Pu-241	6.8764E-02	18.940	37.881	0.00E+00	1.30E+00	2.60E+00
Pu-242	3.6329E-07	18.940	37.881	0.00E+00	6.88E-06	1.38E-05
Ra-226	3.8045E-11	18.940	37.881	0.00E+00	7.21E-10	1.44E-09
Ra-228	2.9902E-15	18.940	37.881	0.00E+00	5.66E-14	1.13E-13
Ru-106	1.9055E-01	18.940	37.881	0.00E+00	3.61E+00	7.22E+00
Se-79	1.2936E-05	18.940	37.881	0.00E+00	2.45E-04	4.90E-04
Sn-126	1.1574E-05	18.940	37.881	0.00E+00	2.19E-04	4.38E-04
Sr-90	2.7505E+00	18.940	37.881	0.00E+00	5.21E+01	1.04E+02
Tc-99	4.2239E-04	18.940	37.881	0.00E+00	8.00E-03	1.60E-02
Th-229	1.8848E-12	18.940	37.881	0.00E+00	3.57E-11	7.14E-11
Th-230	1.7042E-08	18.940	37.881	0.00E+00	3.23E-07	6.46E-07
Th-232	7.8132E-15	18.940	37.881	0.00E+00	1.48E-13	2.96E-13
Tl-208	4.4063E-08	18.940	37.881	0.00E+00	8.35E-07	1.67E-06
U-232	1.3151E-07	18.940	37.881	0.00E+00	2.49E-06	4.98E-06
U-233	1.9564E-09	18.940	37.881	0.00E+00	3.71E-08	7.41E-08
U-234	1.8371E-04	18.940	37.881	0.00E+00	3.48E-03	6.96E-03
U-235	-2.7235E-06	18.940	0.000	2.82E-04	2.30E-04	2.82E-04
U-236	1.5493E-05	18.940	37.881	0.00E+00	2.93E-04	5.87E-04
U-238	-4.2851E-09	18.940	0.000	3.22E-06	3.14E-06	3.22E-06
Y-90	2.7505E+00	18.940	37.881	0.00E+00	5.21E+01	1.04E+02
Other Radionuclides					9.74E+01	1.95E+02

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	7.308E+12
0.0250	1.574E+12
0.0375	1.453E+12
0.0575	1.429E+12
0.0850	9.107E+11
0.1250	7.887E+11
0.2250	7.719E+11
0.3750	3.736E+11
0.5750	5.132E+12
0.8500	7.187E+11
1.2500	1.337E+11
1.7500	5.608E+09
2.2500	1.176E+10
2.7500	6.767E+07
3.5000	7.507E+06
5.0000	2.244E+01
7.0000	2.502E+00
11.0000	2.820E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.60E-01	1.92E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.15	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		18.940	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		37.881	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.43	
Bounding:	0.86	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR ASTRA (AUSTRIA)
SNF ID #: 556
Fuel Units & Descr: 4 - MTR TYPE
Heavy Metal Mass: BOL= ; EOL=6.96kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.11

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	6,591.255	6,591.255	0.00E+00	9.59E-07	9.59E-07
Am-241	1.1190E-03	6,591.255	6,591.255	0.00E+00	7.38E+00	7.38E+00
Am-242m	4.5425E-07	6,591.255	6,591.255	0.00E+00	2.99E-03	2.99E-03
Am-243	1.4921E-06	6,591.255	6,591.255	0.00E+00	9.83E-03	9.83E-03
C-14	5.7244E-09	6,591.255	6,591.255	0.00E+00	3.77E-05	3.77E-05
Cl-36	1.3124E-32	6,591.255	6,591.255	0.00E+00	8.65E-29	8.65E-29
Cm-243	2.3676E-07	6,591.255	6,591.255	0.00E+00	1.56E-03	1.56E-03
Cm-244	5.2042E-05	6,591.255	6,591.255	0.00E+00	3.43E-01	3.43E-01
Co-60	3.8208E-05	6,591.255	6,591.255	0.00E+00	2.52E-01	2.52E-01
Cs-134	4.8693E-01	6,591.255	6,591.255	0.00E+00	3.21E+03	3.21E+03
Cs-135	3.4477E-06	6,591.255	6,591.255	0.00E+00	2.27E-02	2.27E-02
Cs-137	2.8731E+00	6,591.255	6,591.255	0.00E+00	1.89E+04	1.89E+04
Eu-154	8.2053E-02	6,591.255	6,591.255	0.00E+00	5.41E+02	5.41E+02
Eu-155	3.9134E-02	6,591.255	6,591.255	0.00E+00	2.58E+02	2.58E+02
Fe-55	6.7429E-03	6,591.255	6,591.255	0.00E+00	4.44E+01	4.44E+01
H-3	1.0599E-02	6,591.255	6,591.255	0.00E+00	6.99E+01	6.99E+01
I-129	7.5300E-07	6,591.255	6,591.255	0.00E+00	4.96E-03	4.96E-03
Kr-85	2.8595E-01	6,591.255	6,591.255	0.00E+00	1.88E+03	1.88E+03
Np-237	9.5479E-06	6,591.255	6,591.255	0.00E+00	6.29E-02	6.29E-02
Pa-231	8.9297E-10	6,591.255	6,591.255	0.00E+00	5.89E-06	5.89E-06
Pb-210	3.7609E-12	6,591.255	6,591.255	0.00E+00	2.48E-08	2.48E-08
Pm-147	2.5452E+00	6,591.255	6,591.255	0.00E+00	1.68E+04	1.68E+04
Pu-238	2.0550E-02	6,591.255	6,591.255	0.00E+00	1.35E+02	1.35E+02
Pu-239	4.2838E-04	6,591.255	6,591.255	0.00E+00	2.82E+00	2.82E+00
Pu-240	2.4401E-04	6,591.255	6,591.255	0.00E+00	1.61E+00	1.61E+00
Pu-241	6.8764E-02	6,591.255	6,591.255	0.00E+00	4.53E+02	4.53E+02
Pu-242	3.6329E-07	6,591.255	6,591.255	0.00E+00	2.39E-03	2.39E-03
Ra-226	3.8045E-11	6,591.255	6,591.255	0.00E+00	2.51E-07	2.51E-07
Ra-228	2.9902E-15	6,591.255	6,591.255	0.00E+00	1.97E-11	1.97E-11
Ru-106	1.9055E-01	6,591.255	6,591.255	0.00E+00	1.26E+03	1.26E+03
Se-79	1.2936E-05	6,591.255	6,591.255	0.00E+00	8.53E-02	8.53E-02
Sn-126	1.1574E-05	6,591.255	6,591.255	0.00E+00	7.63E-02	7.63E-02
Sr-90	2.7505E+00	6,591.255	6,591.255	0.00E+00	1.81E+04	1.81E+04
Tc-99	4.2239E-04	6,591.255	6,591.255	0.00E+00	2.78E+00	2.78E+00
Th-229	1.8848E-12	6,591.255	6,591.255	0.00E+00	1.24E-08	1.24E-08
Th-230	1.7042E-08	6,591.255	6,591.255	0.00E+00	1.12E-04	1.12E-04
Th-232	7.8132E-15	6,591.255	6,591.255	0.00E+00	5.15E-11	5.15E-11
Tl-208	4.4063E-08	6,591.255	6,591.255	0.00E+00	2.90E-04	2.90E-04
U-232	1.3151E-07	6,591.255	6,591.255	0.00E+00	8.67E-04	8.67E-04
U-233	1.9564E-09	6,591.255	6,591.255	0.00E+00	1.29E-05	1.29E-05
U-234	1.8371E-04	6,591.255	6,591.255	0.00E+00	1.21E+00	1.21E+00
U-235	-2.7235E-06	6,591.255	0.000	2.77E-02	9.76E-03	2.77E-02
U-236	1.5493E-05	6,591.255	6,591.255	0.00E+00	1.02E-01	1.02E-01
U-238	-4.2851E-09	6,591.255	0.000	2.80E-04	2.52E-04	2.80E-04
Y-90	2.7505E+00	6,591.255	6,591.255	0.00E+00	1.81E+04	1.81E+04
Other Radionuclides					3.39E+04	3.39E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.272E+15
0.0250	2.740E+14
0.0375	2.528E+14
0.0575	2.486E+14
0.0850	1.585E+14
0.1250	1.372E+14
0.2250	1.343E+14
0.3750	6.501E+13
0.5750	8.930E+14
0.8500	1.250E+14
1.2500	2.327E+13
1.7500	9.758E+11
2.2500	2.047E+12
2.7500	1.177E+10
3.5000	1.306E+09
5.0000	3.904E+03
7.0000	4.353E+02
11.0000	4.906E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.34E+02	3.34E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3O8	U
BOL Enrichment %:		60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment (unknown).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		6,591.255
Bounding:		6,591.255

Basis for burnup used in estimate:

Nominal burnup set equal to bounding burnup.
Bounding burnup estimated by assuming BOL heavy metal mass was twice EOL.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.50	
Bounding:	1.50	

Estimated EOL HM/Given EOL HM: 1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR ASTRA (AUSTRIA)
SNF ID #: 515
Fuel Units & Descr: 49 - MTR TYPE
Heavy Metal Mass: BOL=78.40kg ; EOL=74.60kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
2.04

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	3,596.306	7,192.612	0.00E+00	5.23E-07	1.05E-06
Am-241	1.1190E-03	3,596.306	7,192.612	0.00E+00	4.02E+00	8.05E+00
Am-242m	4.5425E-07	3,596.306	7,192.612	0.00E+00	1.63E-03	3.27E-03
Am-243	1.4921E-06	3,596.306	7,192.612	0.00E+00	5.37E-03	1.07E-02
C-14	5.7244E-09	3,596.306	7,192.612	0.00E+00	2.06E-05	4.12E-05
Cl-36	1.3124E-32	3,596.306	7,192.612	0.00E+00	4.72E-29	9.44E-29
Cm-243	2.3676E-07	3,596.306	7,192.612	0.00E+00	8.51E-04	1.70E-03
Cm-244	5.2042E-05	3,596.306	7,192.612	0.00E+00	1.87E-01	3.74E-01
Co-60	3.8208E-05	3,596.306	7,192.612	0.00E+00	1.37E-01	2.75E-01
Cs-134	4.8693E-01	3,596.306	7,192.612	0.00E+00	1.75E+03	3.50E+03
Cs-135	3.4477E-06	3,596.306	7,192.612	0.00E+00	1.24E-02	2.48E-02
Cs-137	2.8731E+00	3,596.306	7,192.612	0.00E+00	1.03E+04	2.07E+04
Eu-154	8.2053E-02	3,596.306	7,192.612	0.00E+00	2.95E+02	5.90E+02
Eu-155	3.9134E-02	3,596.306	7,192.612	0.00E+00	1.41E+02	2.81E+02
Fe-55	6.7429E-03	3,596.306	7,192.612	0.00E+00	2.42E+01	4.85E+01
H-3	1.0599E-02	3,596.306	7,192.612	0.00E+00	3.81E+01	7.62E+01
I-129	7.5300E-07	3,596.306	7,192.612	0.00E+00	2.71E-03	5.42E-03
Kr-85	2.8595E-01	3,596.306	7,192.612	0.00E+00	1.03E+03	2.06E+03
Np-237	9.5479E-06	3,596.306	7,192.612	0.00E+00	3.43E-02	6.87E-02
Pa-231	8.9297E-10	3,596.306	7,192.612	0.00E+00	3.21E-06	6.42E-06
Pb-210	3.7609E-12	3,596.306	7,192.612	0.00E+00	1.35E-08	2.71E-08
Pm-147	2.5452E+00	3,596.306	7,192.612	0.00E+00	9.15E+03	1.83E+04
Pu-238	2.0550E-02	3,596.306	7,192.612	0.00E+00	7.39E+01	1.48E+02
Pu-239	4.2838E-04	3,596.306	7,192.612	0.00E+00	1.54E+00	3.08E+00
Pu-240	2.4401E-04	3,596.306	7,192.612	0.00E+00	8.78E-01	1.76E+00
Pu-241	6.8764E-02	3,596.306	7,192.612	0.00E+00	2.47E+02	4.95E+02
Pu-242	3.6329E-07	3,596.306	7,192.612	0.00E+00	1.31E-03	2.61E-03
Ra-226	3.8045E-11	3,596.306	7,192.612	0.00E+00	1.37E-07	2.74E-07
Ra-228	2.9902E-15	3,596.306	7,192.612	0.00E+00	1.08E-11	2.15E-11
Ru-106	1.9055E-01	3,596.306	7,192.612	0.00E+00	6.85E+02	1.37E+03
Se-79	1.2936E-05	3,596.306	7,192.612	0.00E+00	4.65E-02	9.30E-02
Sn-126	1.1574E-05	3,596.306	7,192.612	0.00E+00	4.16E-02	8.32E-02
Sr-90	2.7505E+00	3,596.306	7,192.612	0.00E+00	9.89E+03	1.98E+04
Tc-99	4.2239E-04	3,596.306	7,192.612	0.00E+00	1.52E+00	3.04E+00
Th-229	1.8848E-12	3,596.306	7,192.612	0.00E+00	6.78E-09	1.36E-08
Th-230	1.7042E-08	3,596.306	7,192.612	0.00E+00	6.13E-05	1.23E-04
Th-232	7.8132E-15	3,596.306	7,192.612	0.00E+00	2.81E-11	5.62E-11
Tl-208	4.4063E-08	3,596.306	7,192.612	0.00E+00	1.58E-04	3.17E-04
U-232	1.3151E-07	3,596.306	7,192.612	0.00E+00	4.73E-04	9.46E-04
U-233	1.9564E-09	3,596.306	7,192.612	0.00E+00	7.04E-06	1.41E-05
U-234	1.8371E-04	3,596.306	7,192.612	0.00E+00	6.61E-01	1.32E+00
U-235	-2.7235E-06	3,596.306	0.000	1.43E-02	4.50E-03	1.43E-02
U-236	1.5493E-05	3,596.306	7,192.612	0.00E+00	5.57E-02	1.11E-01
U-238	-4.2851E-09	3,596.306	0.000	2.41E-02	2.41E-02	2.41E-02
Y-90	2.7505E+00	3,596.306	7,192.612	0.00E+00	9.89E+03	1.98E+04
Other Radionuclides					1.85E+04	3.70E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.388E+15
0.0250	2.989E+14
0.0375	2.759E+14
0.0575	2.713E+14
0.0850	1.729E+14
0.1250	1.498E+14
0.2250	1.466E+14
0.3750	7.095E+13
0.5750	9.745E+14
0.8500	1.365E+14
1.2500	2.539E+13
1.7500	1.065E+12
2.2500	2.233E+12
2.7500	1.285E+10
3.5000	1.425E+09
5.0000	4.315E+03
7.0000	4.813E+02
11.0000	5.426E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.82E+02	3.65E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	8.4375	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		3,596.306
Bounding:		7,192.612

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.15	
Bounding:	0.29	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR FMRB (GERMANY)
SNF ID #: 1066
Fuel Units & Descr: 18 - MTR TYPE
Heavy Metal Mass: BOL=2.57kg ; EOL=2.28kg
ROD Storage Site: SRS

[1]Fuel decay start date: 1994
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 15 years

Estimated Canister usage: 18"x10'

0.75

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	4.5861E-10	272.742	545.483	0.00E+00	1.25E-07	2.50E-07
Am-241	1.7832E-03	272.742	545.483	0.00E+00	4.86E-01	9.73E-01
Am-242m	4.3410E-07	272.742	545.483	0.00E+00	1.18E-04	2.37E-04
Am-243	1.4907E-06	272.742	545.483	0.00E+00	4.07E-04	8.13E-04
C-14	5.7162E-09	272.742	545.483	0.00E+00	1.56E-06	3.12E-06
Cl-36	1.3124E-32	272.742	545.483	0.00E+00	3.58E-30	7.16E-30
Cm-243	1.8568E-07	272.742	545.483	0.00E+00	5.06E-05	1.01E-04
Cm-244	3.5512E-05	272.742	545.483	0.00E+00	9.69E-03	1.94E-02
Co-60	1.0261E-05	272.742	545.483	0.00E+00	2.80E-03	5.60E-03
Cs-134	1.6931E-02	272.742	545.483	0.00E+00	4.62E+00	9.24E+00
Cs-135	3.4477E-06	272.742	545.483	0.00E+00	9.40E-04	1.88E-03
Cs-137	2.2800E+00	272.742	545.483	0.00E+00	6.22E+02	1.24E+03
Eu-154	3.6656E-02	272.742	545.483	0.00E+00	1.00E+01	2.00E+01
Eu-155	9.6841E-03	272.742	545.483	0.00E+00	2.64E+00	5.28E+00
Fe-55	4.6977E-04	272.742	545.483	0.00E+00	1.28E-01	2.56E-01
H-3	6.0485E-03	272.742	545.483	0.00E+00	1.65E+00	3.30E+00
I-129	7.5300E-07	272.742	545.483	0.00E+00	2.05E-04	4.11E-04
Kr-85	1.4989E-01	272.742	545.483	0.00E+00	4.09E+01	8.18E+01
Np-237	9.5534E-06	272.742	545.483	0.00E+00	2.61E-03	5.21E-03
Pa-231	1.6550E-09	272.742	545.483	0.00E+00	4.51E-07	9.03E-07
Pb-210	2.6631E-11	272.742	545.483	0.00E+00	7.26E-09	1.45E-08
Pm-147	1.8156E-01	272.742	545.483	0.00E+00	4.95E+01	9.90E+01
Pu-238	1.8990E-02	272.742	545.483	0.00E+00	5.18E+00	1.04E+01
Pu-239	4.2838E-04	272.742	545.483	0.00E+00	1.17E-01	2.34E-01
Pu-240	2.4379E-04	272.742	545.483	0.00E+00	6.65E-02	1.33E-01
Pu-241	4.2511E-02	272.742	545.483	0.00E+00	1.16E+01	2.32E+01
Pu-242	3.6329E-07	272.742	545.483	0.00E+00	9.91E-05	1.98E-04
Ra-226	1.4725E-10	272.742	545.483	0.00E+00	4.02E-08	8.03E-08
Ra-228	8.9760E-15	272.742	545.483	0.00E+00	2.45E-12	4.90E-12
Ru-106	1.9752E-04	272.742	545.483	0.00E+00	5.39E-02	1.08E-01
Se-79	1.2933E-05	272.742	545.483	0.00E+00	3.53E-03	7.05E-03
Sn-126	1.1574E-05	272.742	545.483	0.00E+00	3.16E-03	6.31E-03
Sr-90	2.1680E+00	272.742	545.483	0.00E+00	5.91E+02	1.18E+03
Tc-99	4.2239E-04	272.742	545.483	0.00E+00	1.15E-01	2.30E-01
Th-229	3.9270E-12	272.742	545.483	0.00E+00	1.07E-09	2.14E-09
Th-230	3.3578E-08	272.742	545.483	0.00E+00	9.16E-06	1.83E-05
Th-232	1.5452E-14	272.742	545.483	0.00E+00	4.21E-12	8.43E-12
Tl-208	4.6705E-08	272.742	545.483	0.00E+00	1.27E-05	2.55E-05
U-232	1.3045E-07	272.742	545.483	0.00E+00	3.56E-05	7.12E-05
U-233	2.3739E-09	272.742	545.483	0.00E+00	6.47E-07	1.29E-06
U-234	1.8423E-04	272.742	545.483	0.00E+00	5.02E-02	1.00E-01
U-235	-2.7235E-06	272.742	0.000	5.07E-03	4.33E-03	5.07E-03
U-236	1.5493E-05	272.742	545.483	0.00E+00	4.23E-03	8.45E-03
U-238	-4.2851E-09	272.742	0.000	7.55E-05	7.44E-05	7.55E-05
Y-90	2.1686E+00	272.742	545.483	0.00E+00	5.91E+02	1.18E+03
Other Radionuclides					5.93E+02	1.19E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.507E+13
0.0250	1.357E+13
0.0375	1.185E+13
0.0575	1.264E+13
0.0850	7.654E+12
0.1250	5.247E+12
0.2250	6.594E+12
0.3750	2.888E+12
0.5750	4.689E+13
0.8500	1.114E+12
1.2500	5.626E+11
1.7500	2.358E+10
2.2500	2.949E+07
2.7500	1.772E+06
3.5000	1.127E+05
5.0000	2.607E+02
7.0000	2.888E+01
11.0000	3.242E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
7.38E+00	1.48E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	91.25787542	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		272.742	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		545.483	Bounding burnup assumed to be twice nominal burnup.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.34	
Bounding:	0.67	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR (ARGENTINA)
SNF ID #: 547
Fuel Units & Descr: 30 - ASSEMBLY
Heavy Metal Mass: BOL=18.75kg ; EOL=18.71kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
1.25

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	34.093	68.186	0.00E+00	4.96E-09	9.92E-09
Am-241	1.1190E-03	34.093	68.186	0.00E+00	3.82E-02	7.63E-02
Am-242m	4.5425E-07	34.093	68.186	0.00E+00	1.55E-05	3.10E-05
Am-243	1.4921E-06	34.093	68.186	0.00E+00	5.09E-05	1.02E-04
C-14	5.7244E-09	34.093	68.186	0.00E+00	1.95E-07	3.90E-07
Cl-36	1.3124E-32	34.093	68.186	0.00E+00	4.47E-31	8.95E-31
Cm-243	2.3676E-07	34.093	68.186	0.00E+00	8.07E-06	1.61E-05
Cm-244	5.2042E-05	34.093	68.186	0.00E+00	1.77E-03	3.55E-03
Co-60	3.8208E-05	34.093	68.186	0.00E+00	1.30E-03	2.61E-03
Cs-134	4.8693E-01	34.093	68.186	0.00E+00	1.66E+01	3.32E+01
Cs-135	3.4477E-06	34.093	68.186	0.00E+00	1.18E-04	2.35E-04
Cs-137	2.8731E+00	34.093	68.186	0.00E+00	9.80E+01	1.96E+02
Eu-154	8.2053E-02	34.093	68.186	0.00E+00	2.80E+00	5.59E+00
Eu-155	3.9134E-02	34.093	68.186	0.00E+00	1.33E+00	2.67E+00
Fe-55	6.7429E-03	34.093	68.186	0.00E+00	2.30E-01	4.60E-01
H-3	1.0599E-02	34.093	68.186	0.00E+00	3.61E-01	7.23E-01
I-129	7.5300E-07	34.093	68.186	0.00E+00	2.57E-05	5.13E-05
Kr-85	2.8595E-01	34.093	68.186	0.00E+00	9.75E+00	1.95E+01
Np-237	9.5479E-06	34.093	68.186	0.00E+00	3.26E-04	6.51E-04
Pa-231	8.9297E-10	34.093	68.186	0.00E+00	3.04E-08	6.09E-08
Pb-210	3.7609E-12	34.093	68.186	0.00E+00	1.28E-10	2.56E-10
Pm-147	2.5452E+00	34.093	68.186	0.00E+00	8.68E+01	1.74E+02
Pu-238	2.0550E-02	34.093	68.186	0.00E+00	7.01E-01	1.40E+00
Pu-239	4.2838E-04	34.093	68.186	0.00E+00	1.46E-02	2.92E-02
Pu-240	2.4401E-04	34.093	68.186	0.00E+00	8.32E-03	1.66E-02
Pu-241	6.8764E-02	34.093	68.186	0.00E+00	2.34E+00	4.69E+00
Pu-242	3.6329E-07	34.093	68.186	0.00E+00	1.24E-05	2.48E-05
Ra-226	3.8045E-11	34.093	68.186	0.00E+00	1.30E-09	2.59E-09
Ra-228	2.9902E-15	34.093	68.186	0.00E+00	1.02E-13	2.04E-13
Ru-106	1.9055E-01	34.093	68.186	0.00E+00	6.50E+00	1.30E+01
Se-79	1.2936E-05	34.093	68.186	0.00E+00	4.41E-04	8.82E-04
Sn-126	1.1574E-05	34.093	68.186	0.00E+00	3.95E-04	7.89E-04
Sr-90	2.7505E+00	34.093	68.186	0.00E+00	9.38E+01	1.88E+02
Tc-99	4.2239E-04	34.093	68.186	0.00E+00	1.44E-02	2.88E-02
Th-229	1.8848E-12	34.093	68.186	0.00E+00	6.43E-11	1.29E-10
Th-230	1.7042E-08	34.093	68.186	0.00E+00	5.81E-07	1.16E-06
Th-232	7.8132E-15	34.093	68.186	0.00E+00	2.66E-13	5.33E-13
Tl-208	4.4063E-08	34.093	68.186	0.00E+00	1.50E-06	3.00E-06
U-232	1.3151E-07	34.093	68.186	0.00E+00	4.48E-06	8.97E-06
U-233	1.9564E-09	34.093	68.186	0.00E+00	6.67E-08	1.33E-07
U-234	1.8371E-04	34.093	68.186	0.00E+00	6.26E-03	1.25E-02
U-235	-2.7235E-06	34.093	0.000	8.10E-03	8.01E-03	8.10E-03
U-236	1.5493E-05	34.093	68.186	0.00E+00	5.28E-04	1.06E-03
U-238	-4.2851E-09	34.093	0.000	5.04E-03	5.04E-03	5.04E-03
Y-90	2.7505E+00	34.093	68.186	0.00E+00	9.38E+01	1.88E+02
Other Radionuclides					1.75E+02	3.51E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.316E+13
0.0250	2.834E+12
0.0375	2.615E+12
0.0575	2.572E+12
0.0850	1.639E+12
0.1250	1.420E+12
0.2250	1.390E+12
0.3750	6.726E+11
0.5750	9.238E+12
0.8500	1.294E+12
1.2500	2.407E+11
1.7500	1.009E+10
2.2500	2.117E+10
2.7500	1.218E+08
3.5000	1.351E+07
5.0000	5.203E+01
7.0000	5.844E+00
11.0000	6.617E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.73E+00	3.46E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		34.093
Bounding:		68.186

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.01	
Bounding:	0.01	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR (AUSTRALIA)
SNF ID #: 649
Fuel Units & Descr: 12 - ASSEMBLY
Heavy Metal Mass: BOL=3.32kg ; EOL=3.32kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.50

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	3.409	6.819	0.00E+00	4.96E-10	9.92E-10
Am-241	1.1190E-03	3.409	6.819	0.00E+00	3.82E-03	7.63E-03
Am-242m	4.5425E-07	3.409	6.819	0.00E+00	1.55E-06	3.10E-06
Am-243	1.4921E-06	3.409	6.819	0.00E+00	5.09E-06	1.02E-05
C-14	5.7244E-09	3.409	6.819	0.00E+00	1.95E-08	3.90E-08
Cl-36	1.3124E-32	3.409	6.819	0.00E+00	4.47E-32	8.95E-32
Cm-243	2.3676E-07	3.409	6.819	0.00E+00	8.07E-07	1.61E-06
Cm-244	5.2042E-05	3.409	6.819	0.00E+00	1.77E-04	3.55E-04
Co-60	3.8208E-05	3.409	6.819	0.00E+00	1.30E-04	2.61E-04
Cs-134	4.8693E-01	3.409	6.819	0.00E+00	1.66E+00	3.32E+00
Cs-135	3.4477E-06	3.409	6.819	0.00E+00	1.18E-05	2.35E-05
Cs-137	2.8731E+00	3.409	6.819	0.00E+00	9.80E+00	1.96E+01
Eu-154	8.2053E-02	3.409	6.819	0.00E+00	2.80E-01	5.59E-01
Eu-155	3.9134E-02	3.409	6.819	0.00E+00	1.33E-01	2.67E-01
Fe-55	6.7429E-03	3.409	6.819	0.00E+00	2.30E-02	4.60E-02
H-3	1.0599E-02	3.409	6.819	0.00E+00	3.61E-02	7.23E-02
I-129	7.5300E-07	3.409	6.819	0.00E+00	2.57E-06	5.13E-06
Kr-85	2.8595E-01	3.409	6.819	0.00E+00	9.75E-01	1.95E+00
Np-237	9.5479E-06	3.409	6.819	0.00E+00	3.26E-05	6.51E-05
Pa-231	8.9297E-10	3.409	6.819	0.00E+00	3.04E-09	6.09E-09
Pb-210	3.7609E-12	3.409	6.819	0.00E+00	1.28E-11	2.56E-11
Pm-147	2.5452E+00	3.409	6.819	0.00E+00	8.68E+00	1.74E+01
Pu-238	2.0550E-02	3.409	6.819	0.00E+00	7.01E-02	1.40E-01
Pu-239	4.2838E-04	3.409	6.819	0.00E+00	1.46E-03	2.92E-03
Pu-240	2.4401E-04	3.409	6.819	0.00E+00	8.32E-04	1.66E-03
Pu-241	6.8764E-02	3.409	6.819	0.00E+00	2.34E-01	4.69E-01
Pu-242	3.6329E-07	3.409	6.819	0.00E+00	1.24E-06	2.48E-06
Ra-226	3.8045E-11	3.409	6.819	0.00E+00	1.30E-10	2.59E-10
Ra-228	2.9902E-15	3.409	6.819	0.00E+00	1.02E-14	2.04E-14
Ru-106	1.9055E-01	3.409	6.819	0.00E+00	6.50E-01	1.30E+00
Se-79	1.2936E-05	3.409	6.819	0.00E+00	4.41E-05	8.82E-05
Sn-126	1.1574E-05	3.409	6.819	0.00E+00	3.95E-05	7.89E-05
Sr-90	2.7505E+00	3.409	6.819	0.00E+00	9.38E+00	1.88E+01
Tc-99	4.2239E-04	3.409	6.819	0.00E+00	1.44E-03	2.88E-03
Th-229	1.8848E-12	3.409	6.819	0.00E+00	6.43E-12	1.29E-11
Th-230	1.7042E-08	3.409	6.819	0.00E+00	5.81E-08	1.16E-07
Th-232	7.8132E-15	3.409	6.819	0.00E+00	2.66E-14	5.33E-14
Tl-208	4.4063E-08	3.409	6.819	0.00E+00	1.50E-07	3.00E-07
U-232	1.3151E-07	3.409	6.819	0.00E+00	4.48E-07	8.97E-07
U-233	1.9564E-09	3.409	6.819	0.00E+00	6.67E-09	1.33E-08
U-234	1.8371E-04	3.409	6.819	0.00E+00	6.26E-04	1.25E-03
U-235	-2.7235E-06	3.409	0.000	6.46E-03	6.45E-03	6.46E-03
U-236	1.5493E-05	3.409	6.819	0.00E+00	5.28E-05	1.06E-04
U-238	-4.2851E-09	3.409	0.000	1.12E-04	1.12E-04	1.12E-04
Y-90	2.7505E+00	3.409	6.819	0.00E+00	9.38E+00	1.88E+01
Other Radionuclides					1.75E+01	3.51E+01

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	1.316E+12
0.0250	2.834E+11
0.0375	2.615E+11
0.0575	2.572E+11
0.0850	1.640E+11
0.1250	1.420E+11
0.2250	1.391E+11
0.3750	6.726E+10
0.5750	9.238E+11
0.8500	1.294E+11
1.2500	2.407E+10
1.7500	1.009E+09
2.2500	2.117E+09
2.7500	1.218E+07
3.5000	1.351E+06
5.0000	4.381E+00
7.0000	4.891E-01
11.0000	5.518E-02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.73E-01	**3.46E-01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	89.99998815	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		3.409
Bounding:		6.819

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	
Bounding:	0.01	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR (CANADA)	**[1]Fuel decay start date:**	2010
SNF ID #:	294	**Estimates as of:**	2010
Fuel Units & Descr:	14 - MULTI-PIN CLUSTER	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=2.20kg ; EOL=2.19kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.58

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	1.4545E-10	10.607	21.213	0.00E+00	1.54E-09	3.09E-09
Am-241	1.1190E-03	10.607	21.213	0.00E+00	1.19E-02	2.37E-02
Am-242m	4.5425E-07	10.607	21.213	0.00E+00	4.82E-06	9.64E-06
Am-243	1.4921E-06	10.607	21.213	0.00E+00	1.58E-05	3.17E-05
C-14	5.7244E-09	10.607	21.213	0.00E+00	6.07E-08	1.21E-07
Cl-36	1.3124E-32	10.607	21.213	0.00E+00	1.39E-31	2.78E-31
Cm-243	2.3676E-07	10.607	21.213	0.00E+00	2.51E-06	5.02E-06
Cm-244	5.2042E-05	10.607	21.213	0.00E+00	5.52E-04	1.10E-03
Co-60	3.8208E-05	10.607	21.213	0.00E+00	4.05E-04	8.11E-04
Cs-134	4.8693E-01	10.607	21.213	0.00E+00	5.16E+00	1.03E+01
Cs-135	3.4477E-06	10.607	21.213	0.00E+00	3.66E-05	7.31E-05
Cs-137	2.8731E+00	10.607	21.213	0.00E+00	3.05E+01	6.09E+01
Eu-154	8.2053E-02	10.607	21.213	0.00E+00	8.70E-01	1.74E+00
Eu-155	3.9134E-02	10.607	21.213	0.00E+00	4.15E-01	8.30E-01
Fe-55	6.7429E-03	10.607	21.213	0.00E+00	7.15E-02	1.43E-01
H-3	1.0599E-02	10.607	21.213	0.00E+00	1.12E-01	2.25E-01
I-129	7.5300E-07	10.607	21.213	0.00E+00	7.99E-06	1.60E-05
Kr-85	2.8595E-01	10.607	21.213	0.00E+00	3.03E+00	6.07E+00
Np-237	9.5479E-06	10.607	21.213	0.00E+00	1.01E-04	2.03E-04
Pa-231	8.9297E-10	10.607	21.213	0.00E+00	9.47E-09	1.89E-08
Pb-210	3.7609E-12	10.607	21.213	0.00E+00	3.99E-11	7.98E-11
Pm-147	2.5452E+00	10.607	21.213	0.00E+00	2.70E+01	5.40E+01
Pu-238	2.0550E-02	10.607	21.213	0.00E+00	2.18E-01	4.36E-01
Pu-239	4.2838E-04	10.607	21.213	0.00E+00	4.54E-03	9.09E-03
Pu-240	2.4401E-04	10.607	21.213	0.00E+00	2.59E-03	5.18E-03
Pu-241	6.8764E-02	10.607	21.213	0.00E+00	7.29E-01	1.46E+00
Pu-242	3.6329E-07	10.607	21.213	0.00E+00	3.85E-06	7.71E-06
Ra-226	3.8045E-11	10.607	21.213	0.00E+00	4.04E-10	8.07E-10
Ra-228	2.9902E-15	10.607	21.213	0.00E+00	3.17E-14	6.34E-14
Ru-106	1.9055E-01	10.607	21.213	0.00E+00	2.02E+00	4.04E+00
Se-79	1.2936E-05	10.607	21.213	0.00E+00	1.37E-04	2.74E-04
Sn-126	1.1574E-05	10.607	21.213	0.00E+00	1.23E-04	2.46E-04
Sr-90	2.7505E+00	10.607	21.213	0.00E+00	2.92E+01	5.83E+01
Tc-99	4.2239E-04	10.607	21.213	0.00E+00	4.48E-03	8.96E-03
Th-229	1.8848E-12	10.607	21.213	0.00E+00	2.00E-11	4.00E-11
Th-230	1.7042E-08	10.607	21.213	0.00E+00	1.81E-07	3.62E-07
Th-232	7.8132E-15	10.607	21.213	0.00E+00	8.29E-14	1.66E-13
Tl-208	4.4063E-08	10.607	21.213	0.00E+00	4.67E-07	9.35E-07
U-232	1.3151E-07	10.607	21.213	0.00E+00	1.39E-06	2.79E-06
U-233	1.9564E-09	10.607	21.213	0.00E+00	2.08E-08	4.15E-08
U-234	1.8371E-04	10.607	21.213	0.00E+00	1.95E-03	3.90E-03
U-235	-2.7235E-06	10.607	0.000	4.43E-03	4.40E-03	4.43E-03
U-236	1.5493E-05	10.607	21.213	0.00E+00	1.64E-04	3.29E-04
U-238	-4.2851E-09	10.607	0.000	5.11E-05	5.11E-05	5.11E-05
Y-90	2.7505E+00	10.607	21.213	0.00E+00	2.92E+01	5.83E+01
Other Radionuclides					5.46E+01	1.09E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.093E+12
0.0250	8.817E+11
0.0375	8.136E+11
0.0575	8.000E+11
0.0850	5.100E+11
0.1250	4.417E+11
0.2250	4.324E+11
0.3750	2.092E+11
0.5750	2.874E+12
0.8500	4.025E+11
1.2500	7.489E+10
1.7500	3.141E+09
2.2500	6.587E+09
2.7500	3.789E+07
3.5000	4.204E+06
5.0000	1.274E+01
7.0000	1.421E+00
11.0000	1.601E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.38E-01	1.08E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.09999644	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		10.607	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		21.213	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.02	
Bounding:	0.03	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR (JAPAN)
SNF ID #: 551
Fuel Units & Descr: 27 - ASSEMBLY
Heavy Metal Mass: BOL=17.48kg ; EOL=17.47kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:

18"x10'
1.13

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	12.785	25.570	0.00E+00	1.86E-09	3.72E-09
Am-241	1.1190E-03	12.785	25.570	0.00E+00	1.43E-02	2.86E-02
Am-242m	4.5425E-07	12.785	25.570	0.00E+00	5.81E-06	1.16E-05
Am-243	1.4921E-06	12.785	25.570	0.00E+00	1.91E-05	3.82E-05
C-14	5.7244E-09	12.785	25.570	0.00E+00	7.32E-08	1.46E-07
Cl-36	1.3124E-32	12.785	25.570	0.00E+00	1.68E-31	3.36E-31
Cm-243	2.3676E-07	12.785	25.570	0.00E+00	3.03E-06	6.05E-06
Cm-244	5.2042E-05	12.785	25.570	0.00E+00	6.65E-04	1.33E-03
Co-60	3.8208E-05	12.785	25.570	0.00E+00	4.88E-04	9.77E-04
Cs-134	4.8693E-01	12.785	25.570	0.00E+00	6.23E+00	1.25E+01
Cs-135	3.4477E-06	12.785	25.570	0.00E+00	4.41E-05	8.82E-05
Cs-137	2.8731E+00	12.785	25.570	0.00E+00	3.67E+01	7.35E+01
Eu-154	8.2053E-02	12.785	25.570	0.00E+00	1.05E+00	2.10E+00
Eu-155	3.9134E-02	12.785	25.570	0.00E+00	5.00E-01	1.00E+00
Fe-55	6.7429E-03	12.785	25.570	0.00E+00	8.62E-02	1.72E-01
H-3	1.0599E-02	12.785	25.570	0.00E+00	1.36E-01	2.71E-01
I-129	7.5300E-07	12.785	25.570	0.00E+00	9.63E-06	1.93E-05
Kr-85	2.8595E-01	12.785	25.570	0.00E+00	3.66E+00	7.31E+00
Np-237	9.5479E-06	12.785	25.570	0.00E+00	1.22E-04	2.44E-04
Pa-231	8.9297E-10	12.785	25.570	0.00E+00	1.14E-08	2.28E-08
Pb-210	3.7609E-12	12.785	25.570	0.00E+00	4.81E-11	9.62E-11
Pm-147	2.5452E+00	12.785	25.570	0.00E+00	3.25E+01	6.51E+01
Pu-238	2.0550E-02	12.785	25.570	0.00E+00	2.63E-01	5.25E-01
Pu-239	4.2838E-04	12.785	25.570	0.00E+00	5.48E-03	1.10E-02
Pu-240	2.4401E-04	12.785	25.570	0.00E+00	3.12E-03	6.24E-03
Pu-241	6.8764E-02	12.785	25.570	0.00E+00	8.79E-01	1.76E+00
Pu-242	3.6329E-07	12.785	25.570	0.00E+00	4.64E-06	9.29E-06
Ra-226	3.8045E-11	12.785	25.570	0.00E+00	4.86E-10	9.73E-10
Ra-228	2.9902E-15	12.785	25.570	0.00E+00	3.82E-14	7.65E-14
Ru-106	1.9055E-01	12.785	25.570	0.00E+00	2.44E+00	4.87E+00
Se-79	1.2936E-05	12.785	25.570	0.00E+00	1.65E-04	3.31E-04
Sn-126	1.1574E-05	12.785	25.570	0.00E+00	1.48E-04	2.96E-04
Sr-90	2.7505E+00	12.785	25.570	0.00E+00	3.52E+01	7.03E+01
Tc-99	4.2239E-04	12.785	25.570	0.00E+00	5.40E-03	1.08E-02
Th-229	1.8848E-12	12.785	25.570	0.00E+00	2.41E-11	4.82E-11
Th-230	1.7042E-08	12.785	25.570	0.00E+00	2.18E-07	4.36E-07
Th-232	7.8132E-15	12.785	25.570	0.00E+00	9.99E-14	2.00E-13
Tl-208	4.4063E-08	12.785	25.570	0.00E+00	5.63E-07	1.13E-06
U-232	1.3151E-07	12.785	25.570	0.00E+00	1.68E-06	3.36E-06
U-233	1.9564E-09	12.785	25.570	0.00E+00	2.50E-08	5.00E-08
U-234	1.8371E-04	12.785	25.570	0.00E+00	2.35E-03	4.70E-03
U-235	-2.7235E-06	12.785	0.000	7.56E-03	7.52E-03	7.56E-03
U-236	1.5493E-05	12.785	25.570	0.00E+00	1.98E-04	3.96E-04
U-238	-4.2851E-09	12.785	0.000	4.70E-03	4.70E-03	4.70E-03
Y-90	2.7505E+00	12.785	25.570	0.00E+00	3.52E+01	7.03E+01
Other Radionuclides					6.58E+01	1.32E+02

Gamma Sources

Photon Energy Group (Avg. MeV)	Total Photons/sec (bounding)
0.0150	4.933E+12
0.0250	1.063E+12
0.0375	9.807E+11
0.0575	9.643E+11
0.0850	6.148E+11
0.1250	5.324E+11
0.2250	5.212E+11
0.3750	2.522E+11
0.5750	3.464E+12
0.8500	4.851E+11
1.2500	9.026E+10
1.7500	3.785E+09
2.2500	7.940E+09
2.7500	4.568E+07
3.5000	5.067E+06
5.0000	2.601E+01
7.0000	2.939E+00
11.0000	3.341E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.49E-01	1.30E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20.00000092	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		12.785	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		25.570	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	
Bounding:	0.00	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR (JAPAN)	**Fuel decay start date:**[1]	2010
SNF ID #:	605	**Estimates as of:**	2010
Fuel Units & Descr:	81 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=24.82kg ; EOL=24.79kg	**Template Burnup(MWd):**[2]	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage: 18"x10'

3.38

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	30.684	61.367	0.00E+00	4.46E-09	8.93E-09
Am-241	1.1190E-03	30.684	61.367	0.00E+00	3.43E-02	6.87E-02
Am-242m	4.5425E-07	30.684	61.367	0.00E+00	1.39E-05	2.79E-05
Am-243	1.4921E-06	30.684	61.367	0.00E+00	4.58E-05	9.16E-05
C-14	5.7244E-09	30.684	61.367	0.00E+00	1.76E-07	3.51E-07
Cl-36	1.3124E-32	30.684	61.367	0.00E+00	4.03E-31	8.05E-31
Cm-243	2.3676E-07	30.684	61.367	0.00E+00	7.26E-06	1.45E-05
Cm-244	5.2042E-05	30.684	61.367	0.00E+00	1.60E-03	3.19E-03
Co-60	3.8208E-05	30.684	61.367	0.00E+00	1.17E-03	2.34E-03
Cs-134	4.8693E-01	30.684	61.367	0.00E+00	1.49E+01	2.99E+01
Cs-135	3.4477E-06	30.684	61.367	0.00E+00	1.06E-04	2.12E-04
Cs-137	2.8731E+00	30.684	61.367	0.00E+00	8.82E+01	1.76E+02
Eu-154	8.2053E-02	30.684	61.367	0.00E+00	2.52E+00	5.04E+00
Eu-155	3.9134E-02	30.684	61.367	0.00E+00	1.20E+00	2.40E+00
Fe-55	6.7429E-03	30.684	61.367	0.00E+00	2.07E-01	4.14E-01
H-3	1.0599E-02	30.684	61.367	0.00E+00	3.25E-01	6.50E-01
I-129	7.5300E-07	30.684	61.367	0.00E+00	2.31E-05	4.62E-05
Kr-85	2.8595E-01	30.684	61.367	0.00E+00	8.77E+00	1.75E+01
Np-237	9.5479E-06	30.684	61.367	0.00E+00	2.93E-04	5.86E-04
Pa-231	8.9297E-10	30.684	61.367	0.00E+00	2.74E-08	5.48E-08
Pb-210	3.7609E-12	30.684	61.367	0.00E+00	1.15E-10	2.31E-10
Pm-147	2.5452E+00	30.684	61.367	0.00E+00	7.81E+01	1.56E+02
Pu-238	2.0550E-02	30.684	61.367	0.00E+00	6.31E-01	1.26E+00
Pu-239	4.2838E-04	30.684	61.367	0.00E+00	1.31E-02	2.63E-02
Pu-240	2.4401E-04	30.684	61.367	0.00E+00	7.49E-03	1.50E-02
Pu-241	6.8764E-02	30.684	61.367	0.00E+00	2.11E+00	4.22E+00
Pu-242	3.6329E-07	30.684	61.367	0.00E+00	1.11E-05	2.23E-05
Ra-226	3.8045E-11	30.684	61.367	0.00E+00	1.17E-09	2.33E-09
Ra-228	2.9902E-15	30.684	61.367	0.00E+00	9.18E-14	1.84E-13
Ru-106	1.9055E-01	30.684	61.367	0.00E+00	5.85E+00	1.17E+01
Se-79	1.2936E-05	30.684	61.367	0.00E+00	3.97E-04	7.94E-04
Sn-126	1.1574E-05	30.684	61.367	0.00E+00	3.55E-04	7.10E-04
Sr-90	2.7505E+00	30.684	61.367	0.00E+00	8.44E+01	1.69E+02
Tc-99	4.2239E-04	30.684	61.367	0.00E+00	1.30E-02	2.59E-02
Th-229	1.8848E-12	30.684	61.367	0.00E+00	5.78E-11	1.16E-10
Th-230	1.7042E-08	30.684	61.367	0.00E+00	5.23E-07	1.05E-06
Th-232	7.8132E-15	30.684	61.367	0.00E+00	2.40E-13	4.79E-13
Tl-208	4.4063E-08	30.684	61.367	0.00E+00	1.35E-06	2.70E-06
U-232	1.3151E-07	30.684	61.367	0.00E+00	4.04E-06	8.07E-06
U-233	1.9564E-09	30.684	61.367	0.00E+00	6.00E-08	1.20E-07
U-234	1.8371E-04	30.684	61.367	0.00E+00	5.64E-03	1.13E-02
U-235	-2.7235E-06	30.684	0.000	4.99E-02	4.98E-02	4.99E-02
U-236	1.5493E-05	30.684	61.367	0.00E+00	4.75E-04	9.51E-04
U-238	-4.2851E-09	30.684	0.000	5.84E-04	5.84E-04	5.84E-04
Y-90	2.7505E+00	30.684	61.367	0.00E+00	8.44E+01	1.69E+02
Other Radionuclides					1.58E+02	3.16E+02

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	1.184E+13
0.0250	2.551E+12
0.0375	2.354E+12
0.0575	2.314E+12
0.0850	1.476E+12
0.1250	1.278E+12
0.2250	1.252E+12
0.3750	6.053E+11
0.5750	8.315E+12
0.8500	1.164E+12
1.2500	2.166E+11
1.7500	9.085E+09
2.2500	1.906E+10
2.7500	1.096E+08
3.5000	1.216E+07
5.0000	3.836E+01
7.0000	4.279E+00
11.0000	4.825E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.56E+00	3.11E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.00000613	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		30.684	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		61.367	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	
Bounding:	0.01	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR (JAPAN)
SNF ID #: 565
Fuel Units & Descr: 30 - MTR TYPE
Heavy Metal Mass: BOL=21.54kg ; EOL=21.52kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:

18"x10'
1.25

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	17.046	34.093	0.00E+00	2.48E-09	4.96E-09
Am-241	1.1190E-03	17.046	34.093	0.00E+00	1.91E-02	3.82E-02
Am-242m	4.5425E-07	17.046	34.093	0.00E+00	7.74E-06	1.55E-05
Am-243	1.4921E-06	17.046	34.093	0.00E+00	2.54E-05	5.09E-05
C-14	5.7244E-09	17.046	34.093	0.00E+00	9.76E-08	1.95E-07
Cl-36	1.3124E-32	17.046	34.093	0.00E+00	2.24E-31	4.47E-31
Cm-243	2.3676E-07	17.046	34.093	0.00E+00	4.04E-06	8.07E-06
Cm-244	5.2042E-05	17.046	34.093	0.00E+00	8.87E-04	1.77E-03
Co-60	3.8208E-05	17.046	34.093	0.00E+00	6.51E-04	1.30E-03
Cs-134	4.8693E-01	17.046	34.093	0.00E+00	8.30E+00	1.66E+01
Cs-135	3.4477E-06	17.046	34.093	0.00E+00	5.88E-05	1.18E-04
Cs-137	2.8731E+00	17.046	34.093	0.00E+00	4.90E+01	9.80E+01
Eu-154	8.2053E-02	17.046	34.093	0.00E+00	1.40E+00	2.80E+00
Eu-155	3.9134E-02	17.046	34.093	0.00E+00	6.67E-01	1.33E+00
Fe-55	6.7429E-03	17.046	34.093	0.00E+00	1.15E-01	2.30E-01
H-3	1.0599E-02	17.046	34.093	0.00E+00	1.81E-01	3.61E-01
I-129	7.5300E-07	17.046	34.093	0.00E+00	1.28E-05	2.57E-05
Kr-85	2.8595E-01	17.046	34.093	0.00E+00	4.87E+00	9.75E+00
Np-237	9.5479E-06	17.046	34.093	0.00E+00	1.63E-04	3.26E-04
Pa-231	8.9297E-10	17.046	34.093	0.00E+00	1.52E-08	3.04E-08
Pb-210	3.7609E-12	17.046	34.093	0.00E+00	6.41E-11	1.28E-10
Pm-147	2.5452E+00	17.046	34.093	0.00E+00	4.34E+01	8.68E+01
Pu-238	2.0550E-02	17.046	34.093	0.00E+00	3.50E-01	7.01E-01
Pu-239	4.2838E-04	17.046	34.093	0.00E+00	7.30E-03	1.46E-02
Pu-240	2.4401E-04	17.046	34.093	0.00E+00	4.16E-03	8.32E-03
Pu-241	6.8764E-02	17.046	34.093	0.00E+00	1.17E+00	2.34E+00
Pu-242	3.6329E-07	17.046	34.093	0.00E+00	6.19E-06	1.24E-05
Ra-226	3.8045E-11	17.046	34.093	0.00E+00	6.49E-10	1.30E-09
Ra-228	2.9902E-15	17.046	34.093	0.00E+00	5.10E-14	1.02E-13
Ru-106	1.9055E-01	17.046	34.093	0.00E+00	3.25E+00	6.50E+00
Se-79	1.2936E-05	17.046	34.093	0.00E+00	2.21E-04	4.41E-04
Sn-126	1.1574E-05	17.046	34.093	0.00E+00	1.97E-04	3.95E-04
Sr-90	2.7505E+00	17.046	34.093	0.00E+00	4.69E+01	9.38E+01
Tc-99	4.2239E-04	17.046	34.093	0.00E+00	7.20E-03	1.44E-02
Th-229	1.8848E-12	17.046	34.093	0.00E+00	3.21E-11	6.43E-11
Th-230	1.7042E-08	17.046	34.093	0.00E+00	2.91E-07	5.81E-07
Th-232	7.8132E-15	17.046	34.093	0.00E+00	1.33E-13	2.66E-13
Tl-208	4.4063E-08	17.046	34.093	0.00E+00	7.51E-07	1.50E-06
U-232	1.3151E-07	17.046	34.093	0.00E+00	2.24E-06	4.48E-06
U-233	1.9564E-09	17.046	34.093	0.00E+00	3.34E-08	6.67E-08
U-234	1.8371E-04	17.046	34.093	0.00E+00	3.13E-03	6.26E-03
U-235	-2.7235E-06	17.046	0.000	2.09E-02	2.09E-02	2.09E-02
U-236	1.5493E-05	17.046	34.093	0.00E+00	2.64E-04	5.28E-04
U-238	-4.2851E-09	17.046	0.000	3.98E-03	3.98E-03	3.98E-03
Y-90	2.7505E+00	17.046	34.093	0.00E+00	4.69E+01	9.38E+01
Other Radionuclides					8.77E+01	1.75E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.578E+12
0.0250	1.417E+12
0.0375	1.308E+12
0.0575	1.286E+12
0.0850	8.197E+11
0.1250	7.099E+11
0.2250	6.951E+11
0.3750	3.363E+11
0.5750	4.619E+12
0.8500	6.468E+11
1.2500	1.204E+11
1.7500	5.047E+09
2.2500	1.059E+10
2.7500	6.090E+07
3.5000	6.756E+06
5.0000	2.960E+01
7.0000	3.333E+00
11.0000	3.780E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.65E-01	1.73E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	44.97911463	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		17.046
Bounding:		34.093

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	
Bounding:	0.01	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR (JAPAN)
SNF ID #: 603
Fuel Units & Descr: 12 - MTR TYPE
Heavy Metal Mass: BOL=3.55kg ; EOL=3.55kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.40

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	67.299	134.598	0.00E+00	9.79E-09	1.96E-08
Am-241	1.1190E-03	67.299	134.598	0.00E+00	7.53E-02	1.51E-01
Am-242m	4.5425E-07	67.299	134.598	0.00E+00	3.06E-05	6.11E-05
Am-243	1.4921E-06	67.299	134.598	0.00E+00	1.00E-04	2.01E-04
C-14	5.7244E-09	67.299	134.598	0.00E+00	3.85E-07	7.70E-07
Cl-36	1.3124E-32	67.299	134.598	0.00E+00	8.83E-31	1.77E-30
Cm-243	2.3676E-07	67.299	134.598	0.00E+00	1.59E-05	3.19E-05
Cm-244	5.2042E-05	67.299	134.598	0.00E+00	3.50E-03	7.00E-03
Co-60	3.8208E-05	67.299	134.598	0.00E+00	2.57E-03	5.14E-03
Cs-134	4.8693E-01	67.299	134.598	0.00E+00	3.28E+01	6.55E+01
Cs-135	3.4477E-06	67.299	134.598	0.00E+00	2.32E-04	4.64E-04
Cs-137	2.8731E+00	67.299	134.598	0.00E+00	1.93E+02	3.87E+02
Eu-154	8.2053E-02	67.299	134.598	0.00E+00	5.52E+00	1.10E+01
Eu-155	3.9134E-02	67.299	134.598	0.00E+00	2.63E+00	5.27E+00
Fe-55	6.7429E-03	67.299	134.598	0.00E+00	4.54E-01	9.08E-01
H-3	1.0599E-02	67.299	134.598	0.00E+00	7.13E-01	1.43E+00
I-129	7.5300E-07	67.299	134.598	0.00E+00	5.07E-05	1.01E-04
Kr-85	2.8595E-01	67.299	134.598	0.00E+00	1.92E+01	3.85E+01
Np-237	9.5479E-06	67.299	134.598	0.00E+00	6.43E-04	1.29E-03
Pa-231	8.9297E-10	67.299	134.598	0.00E+00	6.01E-08	1.20E-07
Pb-210	3.7609E-12	67.299	134.598	0.00E+00	2.53E-10	5.06E-10
Pm-147	2.5452E+00	67.299	134.598	0.00E+00	1.71E+02	3.43E+02
Pu-238	2.0550E-02	67.299	134.598	0.00E+00	1.38E+00	2.77E+00
Pu-239	4.2838E-04	67.299	134.598	0.00E+00	2.88E-02	5.77E-02
Pu-240	2.4401E-04	67.299	134.598	0.00E+00	1.64E-02	3.28E-02
Pu-241	6.8764E-02	67.299	134.598	0.00E+00	4.63E+00	9.26E+00
Pu-242	3.6329E-07	67.299	134.598	0.00E+00	2.44E-05	4.89E-05
Ra-226	3.8045E-11	67.299	134.598	0.00E+00	2.56E-09	5.12E-09
Ra-228	2.9902E-15	67.299	134.598	0.00E+00	2.01E-13	4.02E-13
Ru-106	1.9055E-01	67.299	134.598	0.00E+00	1.28E+01	2.56E+01
Se-79	1.2936E-05	67.299	134.598	0.00E+00	8.71E-04	1.74E-03
Sn-126	1.1574E-05	67.299	134.598	0.00E+00	7.79E-04	1.56E-03
Sr-90	2.7505E+00	67.299	134.598	0.00E+00	1.85E+02	3.70E+02
Tc-99	4.2239E-04	67.299	134.598	0.00E+00	2.84E-02	5.69E-02
Th-229	1.8848E-12	67.299	134.598	0.00E+00	1.27E-10	2.54E-10
Th-230	1.7042E-08	67.299	134.598	0.00E+00	1.15E-06	2.29E-06
Th-232	7.8132E-15	67.299	134.598	0.00E+00	5.26E-13	1.05E-12
Tl-208	4.4063E-08	67.299	134.598	0.00E+00	2.97E-06	5.93E-06
U-232	1.3151E-07	67.299	134.598	0.00E+00	8.85E-06	1.77E-05
U-233	1.9564E-09	67.299	134.598	0.00E+00	1.32E-07	2.63E-07
U-234	1.8371E-04	67.299	134.598	0.00E+00	1.24E-02	2.47E-02
U-235	-2.7235E-06	67.299	0.000	6.90E-03	6.71E-03	6.90E-03
U-236	1.5493E-05	67.299	134.598	0.00E+00	1.04E-03	2.09E-03
U-238	-4.2851E-09	67.299	0.000	1.22E-04	1.21E-04	1.22E-04
Y-90	2.7505E+00	67.299	134.598	0.00E+00	1.85E+02	3.70E+02
Other Radionuclides					3.46E+02	6.92E+02

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	2.597E+13
0.0250	5.594E+12
0.0375	5.163E+12
0.0575	5.076E+12
0.0850	3.236E+12
0.1250	2.802E+12
0.2250	2.743E+12
0.3750	1.328E+12
0.5750	1.824E+13
0.8500	2.554E+12
1.2500	4.751E+11
1.7500	1.993E+10
2.2500	4.180E+10
2.7500	2.404E+08
3.5000	2.667E+07
5.0000	8.008E+01
7.0000	8.929E+00
11.0000	1.006E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.41E+00	6.82E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	89.81998522	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		67.299	Nominal burnup assumed to be 2% of BOL heavy metal mass.
Bounding:		134.598	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.06	
Bounding:	0.12	

Estimated EOL HM/Given EOL HM
0.98

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR (NETHERLANDS)	[1]Fuel decay start date:	2010
SNF ID #:	609	Estimates as of:	2010
Fuel Units & Descr:	14 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=3.19kg ; EOL=3.19kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.58

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	3.978	7.955	0.00E+00	5.79E-10	1.16E-09
Am-241	1.1190E-03	3.978	7.955	0.00E+00	4.45E-03	8.90E-03
Am-242m	4.5425E-07	3.978	7.955	0.00E+00	1.81E-06	3.61E-06
Am-243	1.4921E-06	3.978	7.955	0.00E+00	5.93E-06	1.19E-05
C-14	5.7244E-09	3.978	7.955	0.00E+00	2.28E-08	4.55E-08
Cl-36	1.3124E-32	3.978	7.955	0.00E+00	5.22E-32	1.04E-31
Cm-243	2.3676E-07	3.978	7.955	0.00E+00	9.42E-07	1.88E-06
Cm-244	5.2042E-05	3.978	7.955	0.00E+00	2.07E-04	4.14E-04
Co-60	3.8208E-05	3.978	7.955	0.00E+00	1.52E-04	3.04E-04
Cs-134	4.8693E-01	3.978	7.955	0.00E+00	1.94E+00	3.87E+00
Cs-135	3.4477E-06	3.978	7.955	0.00E+00	1.37E-05	2.74E-05
Cs-137	2.8731E+00	3.978	7.955	0.00E+00	1.14E+01	2.29E+01
Eu-154	8.2053E-02	3.978	7.955	0.00E+00	3.26E-01	6.53E-01
Eu-155	3.9134E-02	3.978	7.955	0.00E+00	1.56E-01	3.11E-01
Fe-55	6.7429E-03	3.978	7.955	0.00E+00	2.68E-02	5.36E-02
H-3	1.0599E-02	3.978	7.955	0.00E+00	4.22E-02	8.43E-02
I-129	7.5300E-07	3.978	7.955	0.00E+00	3.00E-06	5.99E-06
Kr-85	2.8595E-01	3.978	7.955	0.00E+00	1.14E+00	2.27E+00
Np-237	9.5479E-06	3.978	7.955	0.00E+00	3.80E-05	7.60E-05
Pa-231	8.9297E-10	3.978	7.955	0.00E+00	3.55E-09	7.10E-09
Pb-210	3.7609E-12	3.978	7.955	0.00E+00	1.50E-11	2.99E-11
Pm-147	2.5452E+00	3.978	7.955	0.00E+00	1.01E+01	2.02E+01
Pu-238	2.0550E-02	3.978	7.955	0.00E+00	8.17E-02	1.63E-01
Pu-239	4.2838E-04	3.978	7.955	0.00E+00	1.70E-03	3.41E-03
Pu-240	2.4401E-04	3.978	7.955	0.00E+00	9.71E-04	1.94E-03
Pu-241	6.8764E-02	3.978	7.955	0.00E+00	2.74E-01	5.47E-01
Pu-242	3.6329E-07	3.978	7.955	0.00E+00	1.44E-06	2.89E-06
Ra-226	3.8045E-11	3.978	7.955	0.00E+00	1.51E-10	3.03E-10
Ra-228	2.9902E-15	3.978	7.955	0.00E+00	1.19E-14	2.38E-14
Ru-106	1.9055E-01	3.978	7.955	0.00E+00	7.58E-01	1.52E+00
Se-79	1.2936E-05	3.978	7.955	0.00E+00	5.15E-05	1.03E-04
Sn-126	1.1574E-05	3.978	7.955	0.00E+00	4.60E-05	9.21E-05
Sr-90	2.7505E+00	3.978	7.955	0.00E+00	1.09E+01	2.19E+01
Tc-99	4.2239E-04	3.978	7.955	0.00E+00	1.68E-03	3.36E-03
Th-229	1.8848E-12	3.978	7.955	0.00E+00	7.50E-12	1.50E-11
Th-230	1.7042E-08	3.978	7.955	0.00E+00	6.78E-08	1.36E-07
Th-232	7.8132E-15	3.978	7.955	0.00E+00	3.11E-14	6.22E-14
Tl-208	4.4063E-08	3.978	7.955	0.00E+00	1.75E-07	3.51E-07
U-232	1.3151E-07	3.978	7.955	0.00E+00	5.23E-07	1.05E-06
U-233	1.9564E-09	3.978	7.955	0.00E+00	7.78E-09	1.56E-08
U-234	1.8371E-04	3.978	7.955	0.00E+00	7.31E-04	1.46E-03
U-235	-2.7235E-06	3.978	0.000	6.42E-03	6.40E-03	6.42E-03
U-236	1.5493E-05	3.978	7.955	0.00E+00	6.16E-05	1.23E-04
U-238	-4.2851E-09	3.978	0.000	7.51E-05	7.51E-05	7.51E-05
Y-90	2.7505E+00	3.978	7.955	0.00E+00	1.09E+01	2.19E+01
Other Radionuclides					2.05E+01	4.09E+01

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.535E+12
0.0250	3.306E+11
0.0375	3.051E+11
0.0575	3.000E+11
0.0850	1.913E+11
0.1250	1.657E+11
0.2250	1.622E+11
0.3750	7.847E+10
0.5750	1.078E+12
0.8500	1.509E+11
1.2500	2.808E+10
1.7500	1.178E+09
2.2500	2.470E+09
2.7500	1.421E+07
3.5000	1.576E+06
5.0000	4.970E+00
7.0000	5.545E-01
11.0000	6.252E-02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.02E-01	4.04E-01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.9999964	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		3.978	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		7.955	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	
Bounding:	0.01	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR (TAIWAN)	[1]Fuel decay start date:	2010	Estimated Canister usage:	
SNF ID #:	628	Estimates as of:	2010	18"x10'	
Fuel Units & Descr:	35 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)	1.46	
Heavy Metal Mass:	BOL=4.76kg ; EOL=4.76kg	[2]Template Burnup(MWd):	367.2		
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689		
		Template Decay Time:	5 years		

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	3.315	6.629	0.00E+00	4.82E-10	9.64E-10
Am-241	1.1190E-03	3.315	6.629	0.00E+00	3.71E-03	7.42E-03
Am-242m	4.5425E-07	3.315	6.629	0.00E+00	1.51E-06	3.01E-06
Am-243	1.4921E-06	3.315	6.629	0.00E+00	4.95E-06	9.89E-06
C-14	5.7244E-09	3.315	6.629	0.00E+00	1.90E-08	3.79E-08
Cl-36	1.3124E-32	3.315	6.629	0.00E+00	4.35E-32	8.70E-32
Cm-243	2.3676E-07	3.315	6.629	0.00E+00	7.85E-07	1.57E-06
Cm-244	5.2042E-05	3.315	6.629	0.00E+00	1.72E-04	3.45E-04
Co-60	3.8208E-05	3.315	6.629	0.00E+00	1.27E-04	2.53E-04
Cs-134	4.8693E-01	3.315	6.629	0.00E+00	1.61E+00	3.23E+00
Cs-135	3.4477E-06	3.315	6.629	0.00E+00	1.14E-05	2.29E-05
Cs-137	2.8731E+00	3.315	6.629	0.00E+00	9.52E+00	1.90E+01
Eu-154	8.2053E-02	3.315	6.629	0.00E+00	2.72E-01	5.44E-01
Eu-155	3.9134E-02	3.315	6.629	0.00E+00	1.30E-01	2.59E-01
Fe-55	6.7429E-03	3.315	6.629	0.00E+00	2.24E-02	4.47E-02
H-3	1.0599E-02	3.315	6.629	0.00E+00	3.51E-02	7.03E-02
I-129	7.5300E-07	3.315	6.629	0.00E+00	2.50E-06	4.99E-06
Kr-85	2.8595E-01	3.315	6.629	0.00E+00	9.48E-01	1.90E+00
Np-237	9.5479E-06	3.315	6.629	0.00E+00	3.16E-05	6.33E-05
Pa-231	8.9297E-10	3.315	6.629	0.00E+00	2.96E-09	5.92E-09
Pb-210	3.7609E-12	3.315	6.629	0.00E+00	1.25E-11	2.49E-11
Pm-147	2.5452E+00	3.315	6.629	0.00E+00	8.44E+00	1.69E+01
Pu-238	2.0550E-02	3.315	6.629	0.00E+00	6.81E-02	1.36E-01
Pu-239	4.2838E-04	3.315	6.629	0.00E+00	1.42E-03	2.84E-03
Pu-240	2.4401E-04	3.315	6.629	0.00E+00	8.09E-04	1.62E-03
Pu-241	6.8764E-02	3.315	6.629	0.00E+00	2.28E-01	4.56E-01
Pu-242	3.6329E-07	3.315	6.629	0.00E+00	1.20E-06	2.41E-06
Ra-226	3.8045E-11	3.315	6.629	0.00E+00	1.26E-10	2.52E-10
Ra-228	2.9902E-15	3.315	6.629	0.00E+00	9.91E-15	1.98E-14
Ru-106	1.9055E-01	3.315	6.629	0.00E+00	6.32E-01	1.26E+00
Se-79	1.2936E-05	3.315	6.629	0.00E+00	4.29E-05	8.58E-05
Sn-126	1.1574E-05	3.315	6.629	0.00E+00	3.84E-05	7.67E-05
Sr-90	2.7505E+00	3.315	6.629	0.00E+00	9.12E+00	1.82E+01
Tc-99	4.2239E-04	3.315	6.629	0.00E+00	1.40E-03	2.80E-03
Th-229	1.8848E-12	3.315	6.629	0.00E+00	6.25E-12	1.25E-11
Th-230	1.7042E-08	3.315	6.629	0.00E+00	5.65E-08	1.13E-07
Th-232	7.8132E-15	3.315	6.629	0.00E+00	2.59E-14	5.18E-14
Tl-208	4.4063E-08	3.315	6.629	0.00E+00	1.46E-07	2.92E-07
U-232	1.3151E-07	3.315	6.629	0.00E+00	4.36E-07	8.72E-07
U-233	1.9564E-09	3.315	6.629	0.00E+00	6.48E-09	1.30E-08
U-234	1.8371E-04	3.315	6.629	0.00E+00	6.09E-04	1.22E-03
U-235	-2.7235E-06	3.315	0.000	9.59E-03	9.58E-03	9.59E-03
U-236	1.5493E-05	3.315	6.629	0.00E+00	5.14E-05	1.03E-04
U-238	-4.2851E-09	3.315	0.000	1.09E-04	1.09E-04	1.09E-04
Y-90	2.7505E+00	3.315	6.629	0.00E+00	9.12E+00	1.82E+01
Other Radionuclides					1.70E+01	3.41E+01

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.279E+12
0.0250	2.755E+11
0.0375	2.543E+11
0.0575	2.500E+11
0.0850	1.594E+11
0.1250	1.381E+11
0.2250	1.353E+11
0.3750	6.539E+10
0.5750	8.982E+11
0.8500	1.258E+11
1.2500	2.340E+10
1.7500	9.814E+08
2.2500	2.059E+09
2.7500	1.184E+07
3.5000	1.314E+06
5.0000	4.306E+00
7.0000	4.805E-01
11.0000	5.420E-02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.68E-01	3.36E-01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.19000561	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		3.315	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		6.629	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.00	
Bounding:	0.00	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR (TAIWAN)	[1]Fuel decay start date:	2010
SNF ID #:	555	Estimates as of:	2010
Fuel Units & Descr:	23 - ASSEMBLY	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=34.80kg ; EOL=34.80kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage: 18"x10'

0.96

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	659.063	1,318.126	0.00E+00	9.59E-08	1.92E-07
Am-241	1.1190E-03	659.063	1,318.126	0.00E+00	7.37E-01	1.47E+00
Am-242m	4.5425E-07	659.063	1,318.126	0.00E+00	2.99E-04	5.99E-04
Am-243	1.4921E-06	659.063	1,318.126	0.00E+00	9.83E-04	1.97E-03
C-14	5.7244E-09	659.063	1,318.126	0.00E+00	3.77E-06	7.55E-06
Cl-36	1.3124E-32	659.063	1,318.126	0.00E+00	8.65E-30	1.73E-29
Cm-243	2.3676E-07	659.063	1,318.126	0.00E+00	1.56E-04	3.12E-04
Cm-244	5.2042E-05	659.063	1,318.126	0.00E+00	3.43E-02	6.86E-02
Co-60	3.8208E-05	659.063	1,318.126	0.00E+00	2.52E-02	5.04E-02
Cs-134	4.8693E-01	659.063	1,318.126	0.00E+00	3.21E+02	6.42E+02
Cs-135	3.4477E-06	659.063	1,318.126	0.00E+00	2.27E-03	4.54E-03
Cs-137	2.8731E+00	659.063	1,318.126	0.00E+00	1.89E+03	3.79E+03
Eu-154	8.2053E-02	659.063	1,318.126	0.00E+00	5.41E+01	1.08E+02
Eu-155	3.9134E-02	659.063	1,318.126	0.00E+00	2.58E+01	5.16E+01
Fe-55	6.7429E-03	659.063	1,318.126	0.00E+00	4.44E+00	8.89E+00
H-3	1.0599E-02	659.063	1,318.126	0.00E+00	6.99E+00	1.40E+01
I-129	7.5300E-07	659.063	1,318.126	0.00E+00	4.96E-04	9.93E-04
Kr-85	2.8595E-01	659.063	1,318.126	0.00E+00	1.88E+02	3.77E+02
Np-237	9.5479E-06	659.063	1,318.126	0.00E+00	6.29E-03	1.26E-02
Pa-231	8.9297E-10	659.063	1,318.126	0.00E+00	5.89E-07	1.18E-06
Pb-210	3.7609E-12	659.063	1,318.126	0.00E+00	2.48E-09	4.96E-09
Pm-147	2.5452E+00	659.063	1,318.126	0.00E+00	1.68E+03	3.35E+03
Pu-238	2.0550E-02	659.063	1,318.126	0.00E+00	1.35E+01	2.71E+01
Pu-239	4.2838E-04	659.063	1,318.126	0.00E+00	2.82E-01	5.65E-01
Pu-240	2.4401E-04	659.063	1,318.126	0.00E+00	1.61E-01	3.22E-01
Pu-241	6.8764E-02	659.063	1,318.126	0.00E+00	4.53E+01	9.06E+01
Pu-242	3.6329E-07	659.063	1,318.126	0.00E+00	2.39E-04	4.79E-04
Ra-226	3.8045E-11	659.063	1,318.126	0.00E+00	2.51E-08	5.01E-08
Ra-228	2.9902E-15	659.063	1,318.126	0.00E+00	1.97E-12	3.94E-12
Ru-106	1.9055E-01	659.063	1,318.126	0.00E+00	1.26E+02	2.51E+02
Se-79	1.2936E-05	659.063	1,318.126	0.00E+00	8.53E-03	1.71E-02
Sn-126	1.1574E-05	659.063	1,318.126	0.00E+00	7.63E-03	1.53E-02
Sr-90	2.7505E+00	659.063	1,318.126	0.00E+00	1.81E+03	3.63E+03
Tc-99	4.2239E-04	659.063	1,318.126	0.00E+00	2.78E-01	5.57E-01
Th-229	1.8848E-12	659.063	1,318.126	0.00E+00	1.24E-09	2.48E-09
Th-230	1.7042E-08	659.063	1,318.126	0.00E+00	1.12E-05	2.25E-05
Th-232	7.8132E-15	659.063	1,318.126	0.00E+00	5.15E-12	1.03E-11
Tl-208	4.4063E-08	659.063	1,318.126	0.00E+00	2.90E-05	5.81E-05
U-232	1.3151E-07	659.063	1,318.126	0.00E+00	8.67E-05	1.73E-04
U-233	1.9564E-09	659.063	1,318.126	0.00E+00	1.29E-06	2.58E-06
U-234	1.8371E-04	659.063	1,318.126	0.00E+00	1.21E-01	2.42E-01
U-235	-2.7235E-06	659.063	0.000	1.49E-02	1.31E-02	1.49E-02
U-236	1.5493E-05	659.063	1,318.126	0.00E+00	1.02E-02	2.04E-02
U-238	-4.2851E-09	659.063	0.000	9.38E-03	9.37E-03	9.38E-03
Y-90	2.7505E+00	659.063	1,318.126	0.00E+00	1.81E+03	3.63E+03
Other Radionuclides					3.39E+03	6.78E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.543E+14
0.0250	5.479E+13
0.0375	5.056E+13
0.0575	4.971E+13
0.0850	3.169E+13
0.1250	2.744E+13
0.2250	2.686E+13
0.3750	1.300E+13
0.5750	1.786E+14
0.8500	2.501E+13
1.2500	4.653E+12
1.7500	1.951E+11
2.2500	4.093E+11
2.7500	2.355E+09
3.5000	2.612E+08
5.0000	8.022E+02
7.0000	8.952E+01
11.0000	1.010E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.34E+01	6.68E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	19.83000026	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:

This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		659.063
Bounding:		1,318.126

Basis for burnup used in estimate:

Nominal burnup assumed to be 2% of BOL heavy metal mass.

Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.06	
Bounding:	0.12	

Estimated EOL HM/Given EOL HM

0.98

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR (VENEZUELA)	**[1]Fuel decay start date:**	2010
SNF ID #:	559	**Estimates as of:**	2010
Fuel Units & Descr:	64 - ASSEMBLY	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=43.20kg ; EOL=39.05kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
2.67

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	3,933.540	7,867.080	0.00E+00	5.72E-07	1.14E-06
Am-241	1.1190E-03	3,933.540	7,867.080	0.00E+00	4.40E+00	8.80E+00
Am-242m	4.5425E-07	3,933.540	7,867.080	0.00E+00	1.79E-03	3.57E-03
Am-243	1.4921E-06	3,933.540	7,867.080	0.00E+00	5.87E-03	1.17E-02
C-14	5.7244E-09	3,933.540	7,867.080	0.00E+00	2.25E-05	4.50E-05
Cl-36	1.3124E-32	3,933.540	7,867.080	0.00E+00	5.16E-29	1.03E-28
Cm-243	2.3676E-07	3,933.540	7,867.080	0.00E+00	9.31E-04	1.86E-03
Cm-244	5.2042E-05	3,933.540	7,867.080	0.00E+00	2.05E-01	4.09E-01
Co-60	3.8208E-05	3,933.540	7,867.080	0.00E+00	1.50E-01	3.01E-01
Cs-134	4.8693E-01	3,933.540	7,867.080	0.00E+00	1.92E+03	3.83E+03
Cs-135	3.4477E-06	3,933.540	7,867.080	0.00E+00	1.36E-02	2.71E-02
Cs-137	2.8731E+00	3,933.540	7,867.080	0.00E+00	1.13E+04	2.26E+04
Eu-154	8.2053E-02	3,933.540	7,867.080	0.00E+00	3.23E+02	6.46E+02
Eu-155	3.9134E-02	3,933.540	7,867.080	0.00E+00	1.54E+02	3.08E+02
Fe-55	6.7429E-03	3,933.540	7,867.080	0.00E+00	2.65E+01	5.30E+01
H-3	1.0599E-02	3,933.540	7,867.080	0.00E+00	4.17E+01	8.34E+01
I-129	7.5300E-07	3,933.540	7,867.080	0.00E+00	2.96E-03	5.92E-03
Kr-85	2.8595E-01	3,933.540	7,867.080	0.00E+00	1.12E+03	2.25E+03
Np-237	9.5479E-06	3,933.540	7,867.080	0.00E+00	3.76E-02	7.51E-02
Pa-231	8.9297E-10	3,933.540	7,867.080	0.00E+00	3.51E-06	7.03E-06
Pb-210	3.7609E-12	3,933.540	7,867.080	0.00E+00	1.48E-08	2.96E-08
Pm-147	2.5452E+00	3,933.540	7,867.080	0.00E+00	1.00E+04	2.00E+04
Pu-238	2.0550E-02	3,933.540	7,867.080	0.00E+00	8.08E+01	1.62E+02
Pu-239	4.2838E-04	3,933.540	7,867.080	0.00E+00	1.69E+00	3.37E+00
Pu-240	2.4401E-04	3,933.540	7,867.080	0.00E+00	9.60E-01	1.92E+00
Pu-241	6.8764E-02	3,933.540	7,867.080	0.00E+00	2.70E+02	5.41E+02
Pu-242	3.6329E-07	3,933.540	7,867.080	0.00E+00	1.43E-03	2.86E-03
Ra-226	3.8045E-11	3,933.540	7,867.080	0.00E+00	1.50E-07	2.99E-07
Ra-228	2.9902E-15	3,933.540	7,867.080	0.00E+00	1.18E-11	2.35E-11
Ru-106	1.9055E-01	3,933.540	7,867.080	0.00E+00	7.50E+02	1.50E+03
Se-79	1.2936E-05	3,933.540	7,867.080	0.00E+00	5.09E-02	1.02E-01
Sn-126	1.1574E-05	3,933.540	7,867.080	0.00E+00	4.55E-02	9.11E-02
Sr-90	2.7505E+00	3,933.540	7,867.080	0.00E+00	1.08E+04	2.16E+04
Tc-99	4.2239E-04	3,933.540	7,867.080	0.00E+00	1.66E+00	3.32E+00
Th-229	1.8848E-12	3,933.540	7,867.080	0.00E+00	7.41E-09	1.48E-08
Th-230	1.7042E-08	3,933.540	7,867.080	0.00E+00	6.70E-05	1.34E-04
Th-232	7.8132E-15	3,933.540	7,867.080	0.00E+00	3.07E-11	6.15E-11
Tl-208	4.4063E-08	3,933.540	7,867.080	0.00E+00	1.73E-04	3.47E-04
U-232	1.3151E-07	3,933.540	7,867.080	0.00E+00	5.17E-04	1.03E-03
U-233	1.9564E-09	3,933.540	7,867.080	0.00E+00	7.70E-06	1.54E-05
U-234	1.8371E-04	3,933.540	7,867.080	0.00E+00	7.23E-01	1.45E+00
U-235	-2.7235E-06	3,933.540	0.000	1.87E-02	7.96E-03	1.87E-02
U-236	1.5493E-05	3,933.540	7,867.080	0.00E+00	6.09E-02	1.22E-01
U-238	-4.2851E-09	3,933.540	0.000	1.16E-02	1.16E-02	1.16E-02
Y-90	2.7505E+00	3,933.540	7,867.080	0.00E+00	1.08E+04	2.16E+04
Other Radionuclides					2.02E+04	4.05E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.518E+15
0.0250	3.270E+14
0.0375	3.017E+14
0.0575	2.967E+14
0.0850	1.891E+14
0.1250	1.638E+14
0.2250	1.603E+14
0.3750	7.760E+13
0.5750	1.066E+15
0.8500	1.493E+14
1.2500	2.777E+13
1.7500	1.165E+12
2.2500	2.443E+12
2.7500	1.405E+10
3.5000	1.559E+09
5.0000	4.686E+03
7.0000	5.225E+02
11.0000	5.890E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.99E+02	3.99E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		3,933.540	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		7,867.080	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.29	
Bounding:	0.58	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (ARGENTINA)
SNF ID #: 635
Fuel Units & Descr: 14 - MTR TYPE
Heavy Metal Mass: BOL=2.40kg ; EOL=1.75kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.58

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	612.532	1,225.064	0.00E+00	8.91E-08	1.78E-07
Am-241	1.1190E-03	612.532	1,225.064	0.00E+00	6.85E-01	1.37E+00
Am-242m	4.5425E-07	612.532	1,225.064	0.00E+00	2.78E-04	5.56E-04
Am-243	1.4921E-06	612.532	1,225.064	0.00E+00	9.14E-04	1.83E-03
C-14	5.7244E-09	612.532	1,225.064	0.00E+00	3.51E-06	7.01E-06
Cl-36	1.3124E-32	612.532	1,225.064	0.00E+00	8.04E-30	1.61E-29
Cm-243	2.3676E-07	612.532	1,225.064	0.00E+00	1.45E-04	2.90E-04
Cm-244	5.2042E-05	612.532	1,225.064	0.00E+00	3.19E-02	6.38E-02
Co-60	3.8208E-05	612.532	1,225.064	0.00E+00	2.34E-02	4.68E-02
Cs-134	4.8693E-01	612.532	1,225.064	0.00E+00	2.98E+02	5.97E+02
Cs-135	3.4477E-06	612.532	1,225.064	0.00E+00	2.11E-03	4.22E-03
Cs-137	2.8731E+00	612.532	1,225.064	0.00E+00	1.76E+03	3.52E+03
Eu-154	8.2053E-02	612.532	1,225.064	0.00E+00	5.03E+01	1.01E+02
Eu-155	3.9134E-02	612.532	1,225.064	0.00E+00	2.40E+01	4.79E+01
Fe-55	6.7429E-03	612.532	1,225.064	0.00E+00	4.13E+00	8.26E+00
H-3	1.0599E-02	612.532	1,225.064	0.00E+00	6.49E+00	1.30E+01
I-129	7.5300E-07	612.532	1,225.064	0.00E+00	4.61E-04	9.22E-04
Kr-85	2.8595E-01	612.532	1,225.064	0.00E+00	1.75E+02	3.50E+02
Np-237	9.5479E-06	612.532	1,225.064	0.00E+00	5.85E-03	1.17E-02
Pa-231	8.9297E-10	612.532	1,225.064	0.00E+00	5.47E-07	1.09E-06
Pb-210	3.7609E-12	612.532	1,225.064	0.00E+00	2.30E-09	4.61E-09
Pm-147	2.5452E+00	612.532	1,225.064	0.00E+00	1.56E+03	3.12E+03
Pu-238	2.0550E-02	612.532	1,225.064	0.00E+00	1.26E+01	2.52E+01
Pu-239	4.2838E-04	612.532	1,225.064	0.00E+00	2.62E-01	5.25E-01
Pu-240	2.4401E-04	612.532	1,225.064	0.00E+00	1.49E-01	2.99E-01
Pu-241	6.8764E-02	612.532	1,225.064	0.00E+00	4.21E+01	8.42E+01
Pu-242	3.6329E-07	612.532	1,225.064	0.00E+00	2.23E-04	4.45E-04
Ra-226	3.8045E-11	612.532	1,225.064	0.00E+00	2.33E-08	4.66E-08
Ra-228	2.9902E-15	612.532	1,225.064	0.00E+00	1.83E-12	3.66E-12
Ru-106	1.9055E-01	612.532	1,225.064	0.00E+00	1.17E+02	2.33E+02
Se-79	1.2936E-05	612.532	1,225.064	0.00E+00	7.92E-03	1.58E-02
Sn-126	1.1574E-05	612.532	1,225.064	0.00E+00	7.09E-03	1.42E-02
Sr-90	2.7505E+00	612.532	1,225.064	0.00E+00	1.68E+03	3.37E+03
Tc-99	4.2239E-04	612.532	1,225.064	0.00E+00	2.59E-01	5.17E-01
Th-229	1.8848E-12	612.532	1,225.064	0.00E+00	1.15E-09	2.31E-09
Th-230	1.7042E-08	612.532	1,225.064	0.00E+00	1.04E-05	2.09E-05
Th-232	7.8132E-15	612.532	1,225.064	0.00E+00	4.79E-12	9.57E-12
Tl-208	4.4063E-08	612.532	1,225.064	0.00E+00	2.70E-05	5.40E-05
U-232	1.3151E-07	612.532	1,225.064	0.00E+00	8.06E-05	1.61E-04
U-233	1.9564E-09	612.532	1,225.064	0.00E+00	1.20E-06	2.40E-06
U-234	1.8371E-04	612.532	1,225.064	0.00E+00	1.13E-01	2.25E-01
U-235	-2.7235E-06	612.532	0.000	4.66E-03	2.99E-03	4.66E-03
U-236	1.5493E-05	612.532	1,225.064	0.00E+00	9.49E-03	1.90E-02
U-238	-4.2851E-09	612.532	0.000	8.05E-05	7.79E-05	8.05E-05
Y-90	2.7505E+00	612.532	1,225.064	0.00E+00	1.68E+03	3.37E+03
Other Radionuclides					3.15E+03	6.30E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.364E+14
0.0250	5.092E+13
0.0375	4.699E+13
0.0575	4.620E+13
0.0850	2.945E+13
0.1250	2.551E+13
0.2250	2.496E+13
0.3750	1.208E+13
0.5750	1.660E+14
0.8500	2.324E+13
1.2500	4.325E+12
1.7500	1.814E+11
2.2500	3.804E+11
2.7500	2.188E+09
3.5000	2.428E+08
5.0000	7.257E+02
7.0000	8.091E+01
11.0000	9.120E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.11E+01	6.21E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	90.00000174	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		612.532	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,225.064	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.81	
Bounding:	1.63	

Estimated EOL HM/Given EOL HM
1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (CANADA)
SNF ID #: 512
Fuel Units & Descr: 8 - ASSEMBLY
Heavy Metal Mass: BOL=6.52kg ; EOL=5.87kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'
0.33

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	617.456	1,234.913	0.00E+00	8.98E-08	1.80E-07
Am-241	1.1190E-03	617.456	1,234.913	0.00E+00	6.91E-01	1.38E+00
Am-242m	4.5425E-07	617.456	1,234.913	0.00E+00	2.80E-04	5.61E-04
Am-243	1.4921E-06	617.456	1,234.913	0.00E+00	9.21E-04	1.84E-03
C-14	5.7244E-09	617.456	1,234.913	0.00E+00	3.53E-06	7.07E-06
Cl-36	1.3124E-32	617.456	1,234.913	0.00E+00	8.10E-30	1.62E-29
Cm-243	2.3676E-07	617.456	1,234.913	0.00E+00	1.46E-04	2.92E-04
Cm-244	5.2042E-05	617.456	1,234.913	0.00E+00	3.21E-02	6.43E-02
Co-60	3.8208E-05	617.456	1,234.913	0.00E+00	2.36E-02	4.72E-02
Cs-134	4.8693E-01	617.456	1,234.913	0.00E+00	3.01E+02	6.01E+02
Cs-135	3.4477E-06	617.456	1,234.913	0.00E+00	2.13E-03	4.26E-03
Cs-137	2.8731E+00	617.456	1,234.913	0.00E+00	1.77E+03	3.55E+03
Eu-154	8.2053E-02	617.456	1,234.913	0.00E+00	5.07E+01	1.01E+02
Eu-155	3.9134E-02	617.456	1,234.913	0.00E+00	2.42E+01	4.83E+01
Fe-55	6.7429E-03	617.456	1,234.913	0.00E+00	4.16E+00	8.33E+00
H-3	1.0599E-02	617.456	1,234.913	0.00E+00	6.54E+00	1.31E+01
I-129	7.5300E-07	617.456	1,234.913	0.00E+00	4.65E-04	9.30E-04
Kr-85	2.8595E-01	617.456	1,234.913	0.00E+00	1.77E+02	3.53E+02
Np-237	9.5479E-06	617.456	1,234.913	0.00E+00	5.90E-03	1.18E-02
Pa-231	8.9297E-10	617.456	1,234.913	0.00E+00	5.51E-07	1.10E-06
Pb-210	3.7609E-12	617.456	1,234.913	0.00E+00	2.32E-09	4.64E-09
Pm-147	2.5452E+00	617.456	1,234.913	0.00E+00	1.57E+03	3.14E+03
Pu-238	2.0550E-02	617.456	1,234.913	0.00E+00	1.27E+01	2.54E+01
Pu-239	4.2838E-04	617.456	1,234.913	0.00E+00	2.65E-01	5.29E-01
Pu-240	2.4401E-04	617.456	1,234.913	0.00E+00	1.51E-01	3.01E-01
Pu-241	6.8764E-02	617.456	1,234.913	0.00E+00	4.25E+01	8.49E+01
Pu-242	3.6329E-07	617.456	1,234.913	0.00E+00	2.24E-04	4.49E-04
Ra-226	3.8045E-11	617.456	1,234.913	0.00E+00	2.35E-08	4.70E-08
Ra-228	2.9902E-15	617.456	1,234.913	0.00E+00	1.85E-12	3.69E-12
Ru-106	1.9055E-01	617.456	1,234.913	0.00E+00	1.18E+02	2.35E+02
Se-79	1.2936E-05	617.456	1,234.913	0.00E+00	7.99E-03	1.60E-02
Sn-126	1.1574E-05	617.456	1,234.913	0.00E+00	7.15E-03	1.43E-02
Sr-90	2.7505E+00	617.456	1,234.913	0.00E+00	1.70E+03	3.40E+03
Tc-99	4.2239E-04	617.456	1,234.913	0.00E+00	2.61E-01	5.22E-01
Th-229	1.8848E-12	617.456	1,234.913	0.00E+00	1.16E-09	2.33E-09
Th-230	1.7042E-08	617.456	1,234.913	0.00E+00	1.05E-05	2.10E-05
Th-232	7.8132E-15	617.456	1,234.913	0.00E+00	4.82E-12	9.65E-12
Tl-208	4.4063E-08	617.456	1,234.913	0.00E+00	2.72E-05	5.44E-05
U-232	1.3151E-07	617.456	1,234.913	0.00E+00	8.12E-05	1.62E-04
U-233	1.9564E-09	617.456	1,234.913	0.00E+00	1.21E-06	2.42E-06
U-234	1.8371E-04	617.456	1,234.913	0.00E+00	1.13E-01	2.27E-01
U-235	-2.7235E-06	617.456	0.000	2.82E-03	1.14E-03	2.82E-03
U-236	1.5493E-05	617.456	1,234.913	0.00E+00	9.57E-03	1.91E-02
U-238	-4.2851E-09	617.456	0.000	1.75E-03	1.75E-03	1.75E-03
Y-90	2.7505E+00	617.456	1,234.913	0.00E+00	1.70E+03	3.40E+03
Other Radionuclides					3.18E+03	6.35E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.383E+14
0.0250	5.133E+13
0.0375	4.737E+13
0.0575	4.657E+13
0.0850	2.969E+13
0.1250	2.571E+13
0.2250	2.516E+13
0.3750	1.218E+13
0.5750	1.673E+14
0.8500	2.343E+13
1.2500	4.359E+12
1.7500	1.828E+11
2.2500	3.835E+11
2.7500	2.206E+09
3.5000	2.447E+08
5.0000	7.353E+02
7.0000	8.200E+01
11.0000	9.244E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.13E+01	6.26E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20.00000037	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		617.456	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,234.913	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.30	
Bounding:	0.60	

Estimated EOL HM/Given EOL HM
1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (CANADA)
SNF ID #: 612
Fuel Units & Descr: 23 - MTR TYPE
Heavy Metal Mass: BOL=2.72kg ; EOL=1.76kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'
0.96

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	910.464	1,820.929	0.00E+00	1.32E-07	2.65E-07
Am-241	1.1190E-03	910.464	1,820.929	0.00E+00	1.02E+00	2.04E+00
Am-242m	4.5425E-07	910.464	1,820.929	0.00E+00	4.14E-04	8.27E-04
Am-243	1.4921E-06	910.464	1,820.929	0.00E+00	1.36E-03	2.72E-03
C-14	5.7244E-09	910.464	1,820.929	0.00E+00	5.21E-06	1.04E-05
Cl-36	1.3124E-32	910.464	1,820.929	0.00E+00	1.19E-29	2.39E-29
Cm-243	2.3676E-07	910.464	1,820.929	0.00E+00	2.16E-04	4.31E-04
Cm-244	5.2042E-05	910.464	1,820.929	0.00E+00	4.74E-02	9.48E-02
Co-60	3.8208E-05	910.464	1,820.929	0.00E+00	3.48E-02	6.96E-02
Cs-134	4.8693E-01	910.464	1,820.929	0.00E+00	4.43E+02	8.87E+02
Cs-135	3.4477E-06	910.464	1,820.929	0.00E+00	3.14E-03	6.28E-03
Cs-137	2.8731E+00	910.464	1,820.929	0.00E+00	2.62E+03	5.23E+03
Eu-154	8.2053E-02	910.464	1,820.929	0.00E+00	7.47E+01	1.49E+02
Eu-155	3.9134E-02	910.464	1,820.929	0.00E+00	3.56E+01	7.13E+01
Fe-55	6.7429E-03	910.464	1,820.929	0.00E+00	6.14E+00	1.23E+01
H-3	1.0599E-02	910.464	1,820.929	0.00E+00	9.65E+00	1.93E+01
I-129	7.5300E-07	910.464	1,820.929	0.00E+00	6.86E-04	1.37E-03
Kr-85	2.8595E-01	910.464	1,820.929	0.00E+00	2.60E+02	5.21E+02
Np-237	9.5479E-06	910.464	1,820.929	0.00E+00	8.69E-03	1.74E-02
Pa-231	8.9297E-10	910.464	1,820.929	0.00E+00	8.13E-07	1.63E-06
Pb-210	3.7609E-12	910.464	1,820.929	0.00E+00	3.42E-09	6.85E-09
Pm-147	2.5452E+00	910.464	1,820.929	0.00E+00	2.32E+03	4.63E+03
Pu-238	2.0550E-02	910.464	1,820.929	0.00E+00	1.87E+01	3.74E+01
Pu-239	4.2838E-04	910.464	1,820.929	0.00E+00	3.90E-01	7.80E-01
Pu-240	2.4401E-04	910.464	1,820.929	0.00E+00	2.22E-01	4.44E-01
Pu-241	6.8764E-02	910.464	1,820.929	0.00E+00	6.26E+01	1.25E+02
Pu-242	3.6329E-07	910.464	1,820.929	0.00E+00	3.31E-04	6.62E-04
Ra-226	3.8045E-11	910.464	1,820.929	0.00E+00	3.46E-08	6.93E-08
Ra-228	2.9902E-15	910.464	1,820.929	0.00E+00	2.72E-12	5.44E-12
Ru-106	1.9055E-01	910.464	1,820.929	0.00E+00	1.73E+02	3.47E+02
Se-79	1.2936E-05	910.464	1,820.929	0.00E+00	1.18E-02	2.36E-02
Sn-126	1.1574E-05	910.464	1,820.929	0.00E+00	1.05E-02	2.11E-02
Sr-90	2.7505E+00	910.464	1,820.929	0.00E+00	2.50E+03	5.01E+03
Tc-99	4.2239E-04	910.464	1,820.929	0.00E+00	3.85E-01	7.69E-01
Th-229	1.8848E-12	910.464	1,820.929	0.00E+00	1.72E-09	3.43E-09
Th-230	1.7042E-08	910.464	1,820.929	0.00E+00	1.55E-05	3.10E-05
Th-232	7.8132E-15	910.464	1,820.929	0.00E+00	7.11E-12	1.42E-11
Tl-208	4.4063E-08	910.464	1,820.929	0.00E+00	4.01E-05	8.02E-05
U-232	1.3151E-07	910.464	1,820.929	0.00E+00	1.20E-04	2.39E-04
U-233	1.9564E-09	910.464	1,820.929	0.00E+00	1.78E-06	3.56E-06
U-234	1.8371E-04	910.464	1,820.929	0.00E+00	1.67E-01	3.35E-01
U-235	-2.7235E-06	910.464	0.000	5.47E-03	2.99E-03	5.47E-03
U-236	1.5493E-05	910.464	1,820.929	0.00E+00	1.41E-02	2.82E-02
U-238	-4.2851E-09	910.464	0.000	6.40E-05	6.01E-05	6.40E-05
Y-90	2.7505E+00	910.464	1,820.929	0.00E+00	2.50E+03	5.01E+03
Other Radionuclides					4.68E+03	9.37E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.513E+14
0.0250	7.568E+13
0.0375	6.984E+13
0.0575	6.867E+13
0.0850	4.378E+13
0.1250	3.791E+13
0.2250	3.711E+13
0.3750	1.796E+13
0.5750	2.467E+14
0.8500	3.455E+13
1.2500	6.428E+12
1.7500	2.696E+11
2.2500	5.654E+11
2.7500	3.253E+09
3.5000	3.609E+08
5.0000	1.079E+03
7.0000	1.203E+02
11.0000	1.355E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
4.62E+01	9.23E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99997633	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		910.464	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,820.929	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.06	
Bounding:	2.13	

Estimated EOL HM/Given EOL HM
1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (GERMANY)
SNF ID #: 579
Fuel Units & Descr: 33 - MTR TYPE
Heavy Metal Mass: BOL=3.34kg ; EOL=2.06kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
1.38

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	1,206.313	2,412.627	0.00E+00	1.75E-07	3.51E-07
Am-241	1.1190E-03	1,206.313	2,412.627	0.00E+00	1.35E+00	2.70E+00
Am-242m	4.5425E-07	1,206.313	2,412.627	0.00E+00	5.48E-04	1.10E-03
Am-243	1.4921E-06	1,206.313	2,412.627	0.00E+00	1.80E-03	3.60E-03
C-14	5.7244E-09	1,206.313	2,412.627	0.00E+00	6.91E-06	1.38E-05
Cl-36	1.3124E-32	1,206.313	2,412.627	0.00E+00	1.58E-29	3.17E-29
Cm-243	2.3676E-07	1,206.313	2,412.627	0.00E+00	2.86E-04	5.71E-04
Cm-244	5.2042E-05	1,206.313	2,412.627	0.00E+00	6.28E-02	1.26E-01
Co-60	3.8208E-05	1,206.313	2,412.627	0.00E+00	4.61E-02	9.22E-02
Cs-134	4.8693E-01	1,206.313	2,412.627	0.00E+00	5.87E+02	1.17E+03
Cs-135	3.4477E-06	1,206.313	2,412.627	0.00E+00	4.16E-03	8.32E-03
Cs-137	2.8731E+00	1,206.313	2,412.627	0.00E+00	3.47E+03	6.93E+03
Eu-154	8.2053E-02	1,206.313	2,412.627	0.00E+00	9.90E+01	1.98E+02
Eu-155	3.9134E-02	1,206.313	2,412.627	0.00E+00	4.72E+01	9.44E+01
Fe-55	6.7429E-03	1,206.313	2,412.627	0.00E+00	8.13E+00	1.63E+01
H-3	1.0599E-02	1,206.313	2,412.627	0.00E+00	1.28E+01	2.56E+01
I-129	7.5300E-07	1,206.313	2,412.627	0.00E+00	9.08E-04	1.82E-03
Kr-85	2.8595E-01	1,206.313	2,412.627	0.00E+00	3.45E+02	6.90E+02
Np-237	9.5479E-06	1,206.313	2,412.627	0.00E+00	1.15E-02	2.30E-02
Pa-231	8.9297E-10	1,206.313	2,412.627	0.00E+00	1.08E-06	2.15E-06
Pb-210	3.7609E-12	1,206.313	2,412.627	0.00E+00	4.54E-09	9.07E-09
Pm-147	2.5452E+00	1,206.313	2,412.627	0.00E+00	3.07E+03	6.14E+03
Pu-238	2.0550E-02	1,206.313	2,412.627	0.00E+00	2.48E+01	4.96E+01
Pu-239	4.2838E-04	1,206.313	2,412.627	0.00E+00	5.17E-01	1.03E+00
Pu-240	2.4401E-04	1,206.313	2,412.627	0.00E+00	2.94E-01	5.89E-01
Pu-241	6.8764E-02	1,206.313	2,412.627	0.00E+00	8.30E+01	1.66E+02
Pu-242	3.6329E-07	1,206.313	2,412.627	0.00E+00	4.38E-04	8.76E-04
Ra-226	3.8045E-11	1,206.313	2,412.627	0.00E+00	4.59E-08	9.18E-08
Ra-228	2.9902E-15	1,206.313	2,412.627	0.00E+00	3.61E-12	7.21E-12
Ru-106	1.9055E-01	1,206.313	2,412.627	0.00E+00	2.30E+02	4.60E+02
Se-79	1.2936E-05	1,206.313	2,412.627	0.00E+00	1.56E-02	3.12E-02
Sn-126	1.1574E-05	1,206.313	2,412.627	0.00E+00	1.40E-02	2.79E-02
Sr-90	2.7505E+00	1,206.313	2,412.627	0.00E+00	3.32E+03	6.64E+03
Tc-99	4.2239E-04	1,206.313	2,412.627	0.00E+00	5.10E-01	1.02E+00
Th-229	1.8848E-12	1,206.313	2,412.627	0.00E+00	2.27E-09	4.55E-09
Th-230	1.7042E-08	1,206.313	2,412.627	0.00E+00	2.06E-05	4.11E-05
Th-232	7.8132E-15	1,206.313	2,412.627	0.00E+00	9.43E-12	1.89E-11
Tl-208	4.4063E-08	1,206.313	2,412.627	0.00E+00	5.32E-05	1.06E-04
U-232	1.3151E-07	1,206.313	2,412.627	0.00E+00	1.59E-04	3.17E-04
U-233	1.9564E-09	1,206.313	2,412.627	0.00E+00	2.36E-06	4.72E-06
U-234	1.8371E-04	1,206.313	2,412.627	0.00E+00	2.22E-01	4.43E-01
U-235	-2.7235E-06	1,206.313	0.000	6.71E-03	3.42E-03	6.71E-03
U-236	1.5493E-05	1,206.313	2,412.627	0.00E+00	1.87E-02	3.74E-02
U-238	-4.2851E-09	1,206.313	0.000	7.85E-05	7.33E-05	7.85E-05
Y-90	2.7505E+00	1,206.313	2,412.627	0.00E+00	3.32E+03	6.64E+03
Other Radionuclides					6.20E+03	1.24E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.655E+14
0.0250	1.003E+14
0.0375	9.254E+13
0.0575	9.099E+13
0.0850	5.801E+13
0.1250	5.023E+13
0.2250	4.916E+13
0.3750	2.380E+13
0.5750	3.269E+14
0.8500	4.577E+13
1.2500	8.517E+12
1.7500	3.572E+11
2.2500	7.492E+11
2.7500	4.310E+09
3.5000	4.781E+08
5.0000	1.429E+03
7.0000	1.593E+02
11.0000	1.796E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.12E+01	1.22E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99997131	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,206.313	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		2,412.627	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.15	
Bounding:	2.30	

Estimated EOL HM/Given EOL HM: 1.04

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (GERMANY)
SNF ID #: 517
Fuel Units & Descr: 26 - ASSEMBLY
Heavy Metal Mass: BOL=30.94kg ; EOL=26.11kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: TRIGA-Al (LW/U-Zrx, Alum., 10 to 20%, U)
[2]Template Burnup(MWd): 6.65
Template BOL Heavy Metal Mass (MT): 0.00018
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'
1.08

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.0632E-10	4,606.125	9,212.251	0.00E+00	3.71E-06	7.43E-06
Am-241	2.2586E-03	4,606.125	9,212.251	0.00E+00	1.04E+01	2.08E+01
Am-242m	1.9925E-06	4,606.125	9,212.251	0.00E+00	9.18E-03	1.84E-02
Am-243	2.3323E-07	4,606.125	9,212.251	0.00E+00	1.07E-03	2.15E-03
C-14	4.3308E-05	4,606.125	9,212.251	0.00E+00	1.99E-01	3.99E-01
Cl-36	4.3023E-08	4,606.125	9,212.251	0.00E+00	1.98E-04	3.96E-04
Cm-243	2.7429E-07	4,606.125	9,212.251	0.00E+00	1.26E-03	2.53E-03
Cm-244	3.1504E-06	4,606.125	9,212.251	0.00E+00	1.45E-02	2.90E-02
Co-60	3.1008E-02	4,606.125	9,212.251	0.00E+00	1.43E+02	2.86E+02
Cs-134	1.0367E-01	4,606.125	9,212.251	0.00E+00	4.78E+02	9.55E+02
Cs-135	3.1549E-05	4,606.125	9,212.251	0.00E+00	1.45E-01	2.91E-01
Cs-137	2.7564E+00	4,606.125	9,212.251	0.00E+00	1.27E+04	2.54E+04
Eu-154	1.3490E+00	4,606.125	9,212.251	0.00E+00	6.21E+03	1.24E+04
Eu-155	4.3880E-01	4,606.125	9,212.251	0.00E+00	2.02E+03	4.04E+03
Fe-55	8.6782E-03	4,606.125	9,212.251	0.00E+00	4.00E+01	7.99E+01
H-3	1.0805E-02	4,606.125	9,212.251	0.00E+00	4.98E+01	9.95E+01
I-129	7.3805E-07	4,606.125	9,212.251	0.00E+00	3.40E-03	6.80E-03
Kr-85	2.5218E-01	4,606.125	9,212.251	0.00E+00	1.16E+03	2.32E+03
Np-237	1.4463E-06	4,606.125	9,212.251	0.00E+00	6.66E-03	1.33E-02
Pa-231	3.5970E-09	4,606.125	9,212.251	0.00E+00	1.66E-05	3.31E-05
Pb-210	8.2511E-15	4,606.125	9,212.251	0.00E+00	3.80E-11	7.60E-11
Pm-147	2.0767E+00	4,606.125	9,212.251	0.00E+00	9.57E+03	1.91E+04
Pu-238	1.3514E-03	4,606.125	9,212.251	0.00E+00	6.22E+00	1.24E+01
Pu-239	5.6947E-03	4,606.125	9,212.251	0.00E+00	2.62E+01	5.25E+01
Pu-240	2.2647E-03	4,606.125	9,212.251	0.00E+00	1.04E+01	2.09E+01
Pu-241	1.2574E-01	4,606.125	9,212.251	0.00E+00	5.79E+02	1.16E+03
Pu-242	3.0602E-07	4,606.125	9,212.251	0.00E+00	1.41E-03	2.82E-03
Ra-226	5.7353E-14	4,606.125	9,212.251	0.00E+00	2.64E-10	5.28E-10
Ra-228	1.8150E-10	4,606.125	9,212.251	0.00E+00	8.36E-07	1.67E-06
Ru-106	9.3744E-02	4,606.125	9,212.251	0.00E+00	4.32E+02	8.64E+02
Se-79	1.2938E-05	4,606.125	9,212.251	0.00E+00	5.96E-02	1.19E-01
Sn-126	1.2239E-05	4,606.125	9,212.251	0.00E+00	5.64E-02	1.13E-01
Sr-90	2.6000E+00	4,606.125	9,212.251	0.00E+00	1.20E+04	2.40E+04
Tc-99	4.4120E-04	4,606.125	9,212.251	0.00E+00	2.03E+00	4.06E+00
Th-229	1.4749E-10	4,606.125	9,212.251	0.00E+00	6.79E-07	1.36E-06
Th-230	1.9549E-11	4,606.125	9,212.251	0.00E+00	9.00E-08	1.80E-07
Th-232	2.3744E-10	4,606.125	9,212.251	0.00E+00	1.09E-06	2.19E-06
Tl-208	1.9459E-08	4,606.125	9,212.251	0.00E+00	8.96E-05	1.79E-04
U-232	5.6015E-08	4,606.125	9,212.251	0.00E+00	2.58E-04	5.16E-04
U-233	1.3132E-07	4,606.125	9,212.251	0.00E+00	6.05E-04	1.21E-03
U-234	1.7323E-07	4,606.125	9,212.251	0.00E+00	7.98E-04	1.60E-03
U-235	-2.6159E-06	4,606.125	0.000	1.34E-02	1.32E-03	1.34E-02
U-236	1.2717E-05	4,606.125	9,212.251	0.00E+00	5.86E-02	1.17E-01
U-238	-3.8857E-08	4,606.125	0.000	8.32E-03	8.14E-03	8.32E-03
Y-90	2.6015E+00	4,606.125	9,212.251	0.00E+00	1.20E+04	2.40E+04
Other Radionuclides					1.75E+04	3.50E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.559E+15
0.0250	3.384E+14
0.0375	4.215E+14
0.0575	3.232E+14
0.0850	2.262E+14
0.1250	3.383E+14
0.2250	1.888E+14
0.3750	8.404E+13
0.5750	1.066E+15
0.8500	2.623E+14
1.2500	2.719E+14
1.7500	7.781E+12
2.2500	9.459E+11
2.7500	7.682E+09
3.5000	8.982E+08
5.0000	5.274E+03
7.0000	5.968E+02
11.0000	6.798E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.31E+02	4.63E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LW AND U ZIRC HYDRIDE	LW AND U ZIRC HYDRIDE
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	19.9999995	10 to 20

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		4,606.125	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		9,212.251	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	4.03	
Bounding:	8.06	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (GREECE)
SNF ID #: 531
Fuel Units & Descr: 18 - ASSEMBLY
Heavy Metal Mass: BOL=11.07kg ; EOL=10.29kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'

0.75

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	734.698	1,469.397	0.00E+00	1.07E-07	2.14E-07
Am-241	1.1190E-03	734.698	1,469.397	0.00E+00	8.22E-01	1.64E+00
Am-242m	4.5425E-07	734.698	1,469.397	0.00E+00	3.34E-04	6.67E-04
Am-243	1.4921E-06	734.698	1,469.397	0.00E+00	1.10E-03	2.19E-03
C-14	5.7244E-09	734.698	1,469.397	0.00E+00	4.21E-06	8.41E-06
Cl-36	1.3124E-32	734.698	1,469.397	0.00E+00	9.64E-30	1.93E-29
Cm-243	2.3676E-07	734.698	1,469.397	0.00E+00	1.74E-04	3.48E-04
Cm-244	5.2042E-05	734.698	1,469.397	0.00E+00	3.82E-02	7.65E-02
Co-60	3.8208E-05	734.698	1,469.397	0.00E+00	2.81E-02	5.61E-02
Cs-134	4.8693E-01	734.698	1,469.397	0.00E+00	3.58E+02	7.15E+02
Cs-135	3.4477E-06	734.698	1,469.397	0.00E+00	2.53E-03	5.07E-03
Cs-137	2.8731E+00	734.698	1,469.397	0.00E+00	2.11E+03	4.22E+03
Eu-154	8.2053E-02	734.698	1,469.397	0.00E+00	6.03E+01	1.21E+02
Eu-155	3.9134E-02	734.698	1,469.397	0.00E+00	2.88E+01	5.75E+01
Fe-55	6.7429E-03	734.698	1,469.397	0.00E+00	4.95E+00	9.91E+00
H-3	1.0599E-02	734.698	1,469.397	0.00E+00	7.79E+00	1.56E+01
I-129	7.5300E-07	734.698	1,469.397	0.00E+00	5.53E-04	1.11E-03
Kr-85	2.8595E-01	734.698	1,469.397	0.00E+00	2.10E+02	4.20E+02
Np-237	9.5479E-06	734.698	1,469.397	0.00E+00	7.01E-03	1.40E-02
Pa-231	8.9297E-10	734.698	1,469.397	0.00E+00	6.56E-07	1.31E-06
Pb-210	3.7609E-12	734.698	1,469.397	0.00E+00	2.76E-09	5.53E-09
Pm-147	2.5452E+00	734.698	1,469.397	0.00E+00	1.87E+03	3.74E+03
Pu-238	2.0550E-02	734.698	1,469.397	0.00E+00	1.51E+01	3.02E+01
Pu-239	4.2838E-04	734.698	1,469.397	0.00E+00	3.15E-01	6.29E-01
Pu-240	2.4401E-04	734.698	1,469.397	0.00E+00	1.79E-01	3.59E-01
Pu-241	6.8764E-02	734.698	1,469.397	0.00E+00	5.05E+01	1.01E+02
Pu-242	3.6329E-07	734.698	1,469.397	0.00E+00	2.67E-04	5.34E-04
Ra-226	3.8045E-11	734.698	1,469.397	0.00E+00	2.80E-08	5.59E-08
Ra-228	2.9902E-15	734.698	1,469.397	0.00E+00	2.20E-12	4.39E-12
Ru-106	1.9055E-01	734.698	1,469.397	0.00E+00	1.40E+02	2.80E+02
Se-79	1.2936E-05	734.698	1,469.397	0.00E+00	9.50E-03	1.90E-02
Sn-126	1.1574E-05	734.698	1,469.397	0.00E+00	8.50E-03	1.70E-02
Sr-90	2.7505E+00	734.698	1,469.397	0.00E+00	2.02E+03	4.04E+03
Tc-99	4.2239E-04	734.698	1,469.397	0.00E+00	3.10E-01	6.21E-01
Th-229	1.8848E-12	734.698	1,469.397	0.00E+00	1.38E-09	2.77E-09
Th-230	1.7042E-08	734.698	1,469.397	0.00E+00	1.25E-05	2.50E-05
Th-232	7.8132E-15	734.698	1,469.397	0.00E+00	5.74E-12	1.15E-11
Tl-208	4.4063E-08	734.698	1,469.397	0.00E+00	3.24E-05	6.47E-05
U-232	1.3151E-07	734.698	1,469.397	0.00E+00	9.66E-05	1.93E-04
U-233	1.9564E-09	734.698	1,469.397	0.00E+00	1.44E-06	2.87E-06
U-234	1.8371E-04	734.698	1,469.397	0.00E+00	1.35E-01	2.70E-01
U-235	-2.7235E-06	734.698	0.000	4.78E-03	2.78E-03	4.78E-03
U-236	1.5493E-05	734.698	1,469.397	0.00E+00	1.14E-02	2.28E-02
U-238	-4.2851E-09	734.698	0.000	2.98E-03	2.97E-03	2.98E-03
Y-90	2.7505E+00	734.698	1,469.397	0.00E+00	2.02E+03	4.04E+03
Other Radionuclides					3.78E+03	7.56E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.835E+14
0.0250	6.107E+13
0.0375	5.636E+13
0.0575	5.542E+13
0.0850	3.533E+13
0.1250	3.059E+13
0.2250	2.994E+13
0.3750	1.449E+13
0.5750	1.991E+14
0.8500	2.788E+13
1.2500	5.187E+12
1.7500	2.175E+11
2.2500	4.563E+11
2.7500	2.625E+09
3.5000	2.912E+08
5.0000	8.770E+02
7.0000	9.781E+01
11.0000	1.103E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.73E+01	7.45E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20.00000024	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		734.698
Bounding:		1,469.397

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.21	
Bounding:	0.42	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (JAPAN)
SNF ID #: 552
Fuel Units & Descr: 99 - ASSEMBLY
Heavy Metal Mass: BOL=94.05kg ; EOL=84.64kg
ROD Storage Site: SRS

Fuel decay start date:[1] 2010
Estimates as of: 2010
Template: HFBR (Heavy Water, Alum., 10 to 20%, U)
Template Burnup(MWd):[2] 15
Template BOL Heavy Metal Mass (MT): 0.00034251
Template Decay Time: 5 years

Estimated Canister usage:

18"x10'
4.13

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.7533E-10	8,939.124	17,878.248	0.00E+00	1.57E-06	3.13E-06
Am-241	1.2780E-02	8,939.124	17,878.248	0.00E+00	1.14E+02	2.28E+02
Am-242m	9.5467E-06	8,939.124	17,878.248	0.00E+00	8.53E-02	1.71E-01
Am-243	6.4100E-06	8,939.124	17,878.248	0.00E+00	5.73E-02	1.15E-01
C-14	2.9673E-08	8,939.124	17,878.248	0.00E+00	2.65E-04	5.31E-04
Cl-36	5.9513E-35	8,939.124	17,878.248	0.00E+00	5.32E-31	1.06E-30
Cm-243	3.1807E-06	8,939.124	17,878.248	0.00E+00	2.84E-02	5.69E-02
Cm-244	1.9540E-04	8,939.124	17,878.248	0.00E+00	1.75E+00	3.49E+00
Co-60	1.1753E-04	8,939.124	17,878.248	0.00E+00	1.05E+00	2.10E+00
Cs-134	3.3060E-01	8,939.124	17,878.248	0.00E+00	2.96E+03	5.91E+03
Cs-135	4.8607E-06	8,939.124	17,878.248	0.00E+00	4.35E-02	8.69E-02
Cs-137	2.8607E+00	8,939.124	17,878.248	0.00E+00	2.56E+04	5.11E+04
Eu-154	6.9933E-02	8,939.124	17,878.248	0.00E+00	6.25E+02	1.25E+03
Eu-155	3.3253E-02	8,939.124	17,878.248	0.00E+00	2.97E+02	5.95E+02
Fe-55	7.7267E-02	8,939.124	17,878.248	0.00E+00	6.91E+02	1.38E+03
H-3	1.0827E-02	8,939.124	17,878.248	0.00E+00	9.68E+01	1.94E+02
I-129	7.1600E-07	8,939.124	17,878.248	0.00E+00	6.40E-03	1.28E-02
Kr-85	2.7007E-01	8,939.124	17,878.248	0.00E+00	2.41E+03	4.83E+03
Np-237	3.6327E-06	8,939.124	17,878.248	0.00E+00	3.25E-02	6.49E-02
Pa-231	1.1267E-09	8,939.124	17,878.248	0.00E+00	1.01E-05	2.01E-05
Pb-210	1.9773E-15	8,939.124	17,878.248	0.00E+00	1.77E-11	3.54E-11
Pm-147	2.4367E+00	8,939.124	17,878.248	0.00E+00	2.18E+04	4.36E+04
Pu-238	6.2213E-03	8,939.124	17,878.248	0.00E+00	5.56E+01	1.11E+02
Pu-239	1.0320E-02	8,939.124	17,878.248	0.00E+00	9.23E+01	1.85E+02
Pu-240	5.4260E-03	8,939.124	17,878.248	0.00E+00	4.85E+01	9.70E+01
Pu-241	7.7333E-01	8,939.124	17,878.248	0.00E+00	6.91E+03	1.38E+04
Pu-242	3.0713E-06	8,939.124	17,878.248	0.00E+00	2.75E-02	5.49E-02
Ra-226	2.2027E-14	8,939.124	17,878.248	0.00E+00	1.97E-10	3.94E-10
Ra-228	2.6333E-15	8,939.124	17,878.248	0.00E+00	2.35E-11	4.71E-11
Ru-106	2.5580E-01	8,939.124	17,878.248	0.00E+00	2.29E+03	4.57E+03
Se-79	1.2540E-05	8,939.124	17,878.248	0.00E+00	1.12E-01	2.24E-01
Sn-126	1.1393E-05	8,939.124	17,878.248	0.00E+00	1.02E-01	2.04E-01
Sr-90	2.6293E+00	8,939.124	17,878.248	0.00E+00	2.35E+04	4.70E+04
Tc-99	4.3540E-04	8,939.124	17,878.248	0.00E+00	3.89E+00	7.78E+00
Th-229	1.3653E-13	8,939.124	17,878.248	0.00E+00	1.22E-09	2.44E-09
Th-230	1.2607E-11	8,939.124	17,878.248	0.00E+00	1.13E-07	2.25E-07
Th-232	6.7400E-15	8,939.124	17,878.248	0.00E+00	6.02E-11	1.20E-10
Tl-208	7.4667E-09	8,939.124	17,878.248	0.00E+00	6.67E-05	1.33E-04
U-232	2.1927E-08	8,939.124	17,878.248	0.00E+00	1.96E-04	3.92E-04
U-233	1.9920E-10	8,939.124	17,878.248	0.00E+00	1.78E-06	3.56E-06
U-234	2.2487E-07	8,939.124	17,878.248	0.00E+00	2.01E-03	4.02E-03
U-235	-2.5341E-06	8,939.124	0.000	4.06E-02	1.80E-02	4.06E-02
U-236	1.3000E-05	8,939.124	17,878.248	0.00E+00	1.16E-01	2.32E-01
U-238	-1.4207E-08	8,939.124	0.000	2.53E-02	2.52E-02	2.53E-02
Y-90	2.6300E+00	8,939.124	17,878.248	0.00E+00	2.35E+04	4.70E+04
Other Radionuclides					4.22E+04	8.44E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.244E+15
0.0250	6.989E+14
0.0375	6.369E+14
0.0575	6.358E+14
0.0850	4.004E+14
0.1250	3.344E+14
0.2250	3.415E+14
0.3750	1.656E+14
0.5750	2.287E+15
0.8500	2.425E+14
1.2500	5.360E+13
1.7500	2.551E+12
2.2500	4.438E+12
2.7500	4.014E+10
3.5000	4.756E+09
5.0000	4.654E+04
7.0000	5.303E+03
11.0000	6.057E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
4.23E+02	8.46E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20	10 to 20

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		8,939.124	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		17,878.248	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	2.17	
Bounding:	4.34	

Estimated EOL HM/Given EOL HM

1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-C (JAPAN)	**[1]Fuel decay start date:**	2010
SNF ID #:	600	**Estimates as of:**	2010
Fuel Units & Descr:	54 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=5.23kg ; EOL=4.16kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
2.25

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	1,012.553	2,025.107	0.00E+00	1.47E-07	2.95E-07
Am-241	1.1190E-03	1,012.553	2,025.107	0.00E+00	1.13E+00	2.27E+00
Am-242m	4.5425E-07	1,012.553	2,025.107	0.00E+00	4.60E-04	9.20E-04
Am-243	1.4921E-06	1,012.553	2,025.107	0.00E+00	1.51E-03	3.02E-03
C-14	5.7244E-09	1,012.553	2,025.107	0.00E+00	5.80E-06	1.16E-05
Cl-36	1.3124E-32	1,012.553	2,025.107	0.00E+00	1.33E-29	2.66E-29
Cm-243	2.3676E-07	1,012.553	2,025.107	0.00E+00	2.40E-04	4.79E-04
Cm-244	5.2042E-05	1,012.553	2,025.107	0.00E+00	5.27E-02	1.05E-01
Co-60	3.8208E-05	1,012.553	2,025.107	0.00E+00	3.87E-02	7.74E-02
Cs-134	4.8693E-01	1,012.553	2,025.107	0.00E+00	4.93E+02	9.86E+02
Cs-135	3.4477E-06	1,012.553	2,025.107	0.00E+00	3.49E-03	6.98E-03
Cs-137	2.8731E+00	1,012.553	2,025.107	0.00E+00	2.91E+03	5.82E+03
Eu-154	8.2053E-02	1,012.553	2,025.107	0.00E+00	8.31E+01	1.66E+02
Eu-155	3.9134E-02	1,012.553	2,025.107	0.00E+00	3.96E+01	7.93E+01
Fe-55	6.7429E-03	1,012.553	2,025.107	0.00E+00	6.83E+00	1.37E+01
H-3	1.0599E-02	1,012.553	2,025.107	0.00E+00	1.07E+01	2.15E+01
I-129	7.5300E-07	1,012.553	2,025.107	0.00E+00	7.62E-04	1.52E-03
Kr-85	2.8595E-01	1,012.553	2,025.107	0.00E+00	2.90E+02	5.79E+02
Np-237	9.5479E-06	1,012.553	2,025.107	0.00E+00	9.67E-03	1.93E-02
Pa-231	8.9297E-10	1,012.553	2,025.107	0.00E+00	9.04E-07	1.81E-06
Pb-210	3.7609E-12	1,012.553	2,025.107	0.00E+00	3.81E-09	7.62E-09
Pm-147	2.5452E+00	1,012.553	2,025.107	0.00E+00	2.58E+03	5.15E+03
Pu-238	2.0550E-02	1,012.553	2,025.107	0.00E+00	2.08E+01	4.16E+01
Pu-239	4.2838E-04	1,012.553	2,025.107	0.00E+00	4.34E-01	8.68E-01
Pu-240	2.4401E-04	1,012.553	2,025.107	0.00E+00	2.47E-01	4.94E-01
Pu-241	6.8764E-02	1,012.553	2,025.107	0.00E+00	6.96E+01	1.39E+02
Pu-242	3.6329E-07	1,012.553	2,025.107	0.00E+00	3.68E-04	7.36E-04
Ra-226	3.8045E-11	1,012.553	2,025.107	0.00E+00	3.85E-08	7.70E-08
Ra-228	2.9902E-15	1,012.553	2,025.107	0.00E+00	3.03E-12	6.06E-12
Ru-106	1.9055E-01	1,012.553	2,025.107	0.00E+00	1.93E+02	3.86E+02
Se-79	1.2936E-05	1,012.553	2,025.107	0.00E+00	1.31E-02	2.62E-02
Sn-126	1.1574E-05	1,012.553	2,025.107	0.00E+00	1.17E-02	2.34E-02
Sr-90	2.7505E+00	1,012.553	2,025.107	0.00E+00	2.79E+03	5.57E+03
Tc-99	4.2239E-04	1,012.553	2,025.107	0.00E+00	4.28E-01	8.55E-01
Th-229	1.8848E-12	1,012.553	2,025.107	0.00E+00	1.91E-09	3.82E-09
Th-230	1.7042E-08	1,012.553	2,025.107	0.00E+00	1.73E-05	3.45E-05
Th-232	7.8132E-15	1,012.553	2,025.107	0.00E+00	7.91E-12	1.58E-11
Tl-208	4.4063E-08	1,012.553	2,025.107	0.00E+00	4.46E-05	8.92E-05
U-232	1.3151E-07	1,012.553	2,025.107	0.00E+00	1.33E-04	2.66E-04
U-233	1.9564E-09	1,012.553	2,025.107	0.00E+00	1.98E-06	3.96E-06
U-234	1.8371E-04	1,012.553	2,025.107	0.00E+00	1.86E-01	3.72E-01
U-235	-2.7235E-06	1,012.553	0.000	1.05E-02	7.75E-03	1.05E-02
U-236	1.5493E-05	1,012.553	2,025.107	0.00E+00	1.57E-02	3.14E-02
U-238	-4.2851E-09	1,012.553	0.000	1.23E-04	1.19E-04	1.23E-04
Y-90	2.7505E+00	1,012.553	2,025.107	0.00E+00	2.79E+03	5.57E+03
Other Radionuclides					5.21E+03	1.04E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.907E+14
0.0250	8.417E+13
0.0375	7.767E+13
0.0575	7.637E+13
0.0850	4.869E+13
0.1250	4.216E+13
0.2250	4.127E+13
0.3750	1.997E+13
0.5750	2.744E+14
0.8500	3.842E+13
1.2500	7.149E+12
1.7500	2.998E+11
2.2500	6.288E+11
2.7500	3.617E+09
3.5000	4.013E+08
5.0000	1.200E+03
7.0000	1.338E+02
11.0000	1.508E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.13E+01	1.03E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99999931	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,012.553	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		2,025.107	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.62	
Bounding:	1.23	

Estimated EOL HM/Given EOL HM

1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (JAPAN)
SNF ID #: 289
Fuel Units & Descr: 17 - ASSEMBLY
Heavy Metal Mass: BOL=8.92kg ; EOL=8.60kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: **18"x10'** 0.71

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	1.4545E-10	307.497	614.993	0.00E+00	4.47E-08	8.95E-08
Am-241	1.1190E-03	307.497	614.993	0.00E+00	3.44E-01	6.88E-01
Am-242m	4.5425E-07	307.497	614.993	0.00E+00	1.40E-04	2.79E-04
Am-243	1.4921E-06	307.497	614.993	0.00E+00	4.59E-04	9.18E-04
C-14	5.7244E-09	307.497	614.993	0.00E+00	1.76E-06	3.52E-06
Cl-36	1.3124E-32	307.497	614.993	0.00E+00	4.04E-30	8.07E-30
Cm-243	2.3676E-07	307.497	614.993	0.00E+00	7.28E-05	1.46E-04
Cm-244	5.2042E-05	307.497	614.993	0.00E+00	1.60E-02	3.20E-02
Co-60	3.8208E-05	307.497	614.993	0.00E+00	1.17E-02	2.35E-02
Cs-134	4.8693E-01	307.497	614.993	0.00E+00	1.50E+02	2.99E+02
Cs-135	3.4477E-06	307.497	614.993	0.00E+00	1.06E-03	2.12E-03
Cs-137	2.8731E+00	307.497	614.993	0.00E+00	8.83E+02	1.77E+03
Eu-154	8.2053E-02	307.497	614.993	0.00E+00	2.52E+01	5.05E+01
Eu-155	3.9134E-02	307.497	614.993	0.00E+00	1.20E+01	2.41E+01
Fe-55	6.7429E-03	307.497	614.993	0.00E+00	2.07E+00	4.15E+00
H-3	1.0599E-02	307.497	614.993	0.00E+00	3.26E+00	6.52E+00
I-129	7.5300E-07	307.497	614.993	0.00E+00	2.32E-04	4.63E-04
Kr-85	2.8595E-01	307.497	614.993	0.00E+00	8.79E+01	1.76E+02
Np-237	9.5479E-06	307.497	614.993	0.00E+00	2.94E-03	5.87E-03
Pa-231	8.9297E-10	307.497	614.993	0.00E+00	2.75E-07	5.49E-07
Pb-210	3.7609E-12	307.497	614.993	0.00E+00	1.16E-09	2.31E-09
Pm-147	2.5452E+00	307.497	614.993	0.00E+00	7.83E+02	1.57E+03
Pu-238	2.0550E-02	307.497	614.993	0.00E+00	6.32E+00	1.26E+01
Pu-239	4.2838E-04	307.497	614.993	0.00E+00	1.32E-01	2.63E-01
Pu-240	2.4401E-04	307.497	614.993	0.00E+00	7.50E-02	1.50E-01
Pu-241	6.8764E-02	307.497	614.993	0.00E+00	2.11E+01	4.23E+01
Pu-242	3.6329E-07	307.497	614.993	0.00E+00	1.12E-04	2.23E-04
Ra-226	3.8045E-11	307.497	614.993	0.00E+00	1.17E-08	2.34E-08
Ra-228	2.9902E-15	307.497	614.993	0.00E+00	9.19E-13	1.84E-12
Ru-106	1.9055E-01	307.497	614.993	0.00E+00	5.86E+01	1.17E+02
Se-79	1.2936E-05	307.497	614.993	0.00E+00	3.98E-03	7.96E-03
Sn-126	1.1574E-05	307.497	614.993	0.00E+00	3.56E-03	7.12E-03
Sr-90	2.7505E+00	307.497	614.993	0.00E+00	8.46E+02	1.69E+03
Tc-99	4.2239E-04	307.497	614.993	0.00E+00	1.30E-01	2.60E-01
Th-229	1.8848E-12	307.497	614.993	0.00E+00	5.80E-10	1.16E-09
Th-230	1.7042E-08	307.497	614.993	0.00E+00	5.24E-06	1.05E-05
Th-232	7.8132E-15	307.497	614.993	0.00E+00	2.40E-12	4.81E-12
Tl-208	4.4063E-08	307.497	614.993	0.00E+00	1.35E-05	2.71E-05
U-232	1.3151E-07	307.497	614.993	0.00E+00	4.04E-05	8.09E-05
U-233	1.9564E-09	307.497	614.993	0.00E+00	6.02E-07	1.20E-06
U-234	1.8371E-04	307.497	614.993	0.00E+00	5.65E-02	1.13E-01
U-235	-2.7235E-06	307.497	0.000	3.86E-03	3.02E-03	3.86E-03
U-236	1.5493E-05	307.497	614.993	0.00E+00	4.76E-03	9.53E-03
U-238	-4.2851E-09	307.497	0.000	2.40E-03	2.40E-03	2.40E-03
Y-90	2.7505E+00	307.497	614.993	0.00E+00	8.46E+02	1.69E+03
Other Radionuclides					1.58E+03	3.16E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.187E+14
0.0250	2.556E+13
0.0375	2.359E+13
0.0575	2.319E+13
0.0850	1.479E+13
0.1250	1.280E+13
0.2250	1.253E+13
0.3750	6.066E+12
0.5750	8.332E+13
0.8500	1.167E+13
1.2500	2.171E+12
1.7500	9.105E+10
2.2500	1.910E+11
2.7500	1.099E+09
3.5000	1.219E+08
5.0000	3.697E+02
7.0000	4.124E+01
11.0000	4.650E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.56E+01	**3.12E+01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20.00000028	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		307.497
Bounding:		614.993

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.11	
Bounding:	0.22	

Estimated EOL HM/Given EOL HM 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-C (NETHERLANDS)	**[1]Fuel decay start date:**	2010
SNF ID #:	509	**Estimates as of:**	2010
Fuel Units & Descr:	7 - ASSEMBLY	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=5.53kg ; EOL=4.87kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.29

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	628.442	1,256.884	0.00E+00	9.14E-08	1.83E-07
Am-241	1.1190E-03	628.442	1,256.884	0.00E+00	7.03E-01	1.41E+00
Am-242m	4.5425E-07	628.442	1,256.884	0.00E+00	2.85E-04	5.71E-04
Am-243	1.4921E-06	628.442	1,256.884	0.00E+00	9.38E-04	1.88E-03
C-14	5.7244E-09	628.442	1,256.884	0.00E+00	3.60E-06	7.19E-06
Cl-36	1.3124E-32	628.442	1,256.884	0.00E+00	8.25E-30	1.65E-29
Cm-243	2.3676E-07	628.442	1,256.884	0.00E+00	1.49E-04	2.98E-04
Cm-244	5.2042E-05	628.442	1,256.884	0.00E+00	3.27E-02	6.54E-02
Co-60	3.8208E-05	628.442	1,256.884	0.00E+00	2.40E-02	4.80E-02
Cs-134	4.8693E-01	628.442	1,256.884	0.00E+00	3.06E+02	6.12E+02
Cs-135	3.4477E-06	628.442	1,256.884	0.00E+00	2.17E-03	4.33E-03
Cs-137	2.8731E+00	628.442	1,256.884	0.00E+00	1.81E+03	3.61E+03
Eu-154	8.2053E-02	628.442	1,256.884	0.00E+00	5.16E+01	1.03E+02
Eu-155	3.9134E-02	628.442	1,256.884	0.00E+00	2.46E+01	4.92E+01
Fe-55	6.7429E-03	628.442	1,256.884	0.00E+00	4.24E+00	8.48E+00
H-3	1.0599E-02	628.442	1,256.884	0.00E+00	6.66E+00	1.33E+01
I-129	7.5300E-07	628.442	1,256.884	0.00E+00	4.73E-04	9.46E-04
Kr-85	2.8595E-01	628.442	1,256.884	0.00E+00	1.80E+02	3.59E+02
Np-237	9.5479E-06	628.442	1,256.884	0.00E+00	6.00E-03	1.20E-02
Pa-231	8.9297E-10	628.442	1,256.884	0.00E+00	5.61E-07	1.12E-06
Pb-210	3.7609E-12	628.442	1,256.884	0.00E+00	2.36E-09	4.73E-09
Pm-147	2.5452E+00	628.442	1,256.884	0.00E+00	1.60E+03	3.20E+03
Pu-238	2.0550E-02	628.442	1,256.884	0.00E+00	1.29E+01	2.58E+01
Pu-239	4.2838E-04	628.442	1,256.884	0.00E+00	2.69E-01	5.38E-01
Pu-240	2.4401E-04	628.442	1,256.884	0.00E+00	1.53E-01	3.07E-01
Pu-241	6.8764E-02	628.442	1,256.884	0.00E+00	4.32E+01	8.64E+01
Pu-242	3.6329E-07	628.442	1,256.884	0.00E+00	2.28E-04	4.57E-04
Ra-226	3.8045E-11	628.442	1,256.884	0.00E+00	2.39E-08	4.78E-08
Ra-228	2.9902E-15	628.442	1,256.884	0.00E+00	1.88E-12	3.76E-12
Ru-106	1.9055E-01	628.442	1,256.884	0.00E+00	1.20E+02	2.39E+02
Se-79	1.2936E-05	628.442	1,256.884	0.00E+00	8.13E-03	1.63E-02
Sn-126	1.1574E-05	628.442	1,256.884	0.00E+00	7.27E-03	1.45E-02
Sr-90	2.7505E+00	628.442	1,256.884	0.00E+00	1.73E+03	3.46E+03
Tc-99	4.2239E-04	628.442	1,256.884	0.00E+00	2.65E-01	5.31E-01
Th-229	1.8848E-12	628.442	1,256.884	0.00E+00	1.18E-09	2.37E-09
Th-230	1.7042E-08	628.442	1,256.884	0.00E+00	1.07E-05	2.14E-05
Th-232	7.8132E-15	628.442	1,256.884	0.00E+00	4.91E-12	9.82E-12
Tl-208	4.4063E-08	628.442	1,256.884	0.00E+00	2.77E-05	5.54E-05
U-232	1.3151E-07	628.442	1,256.884	0.00E+00	8.26E-05	1.65E-04
U-233	1.9564E-09	628.442	1,256.884	0.00E+00	1.23E-06	2.46E-06
U-234	1.8371E-04	628.442	1,256.884	0.00E+00	1.15E-01	2.31E-01
U-235	-2.7235E-06	628.442	0.000	2.39E-03	6.78E-04	2.39E-03
U-236	1.5493E-05	628.442	1,256.884	0.00E+00	9.74E-03	1.95E-02
U-238	-4.2851E-09	628.442	0.000	1.49E-03	1.48E-03	1.49E-03
Y-90	2.7505E+00	628.442	1,256.884	0.00E+00	1.73E+03	3.46E+03
Other Radionuclides					3.23E+03	6.46E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.425E+14
0.0250	5.224E+13
0.0375	4.821E+13
0.0575	4.740E+13
0.0850	3.022E+13
0.1250	2.617E+13
0.2250	2.561E+13
0.3750	1.240E+13
0.5750	1.703E+14
0.8500	2.385E+13
1.2500	4.437E+12
1.7500	1.861E+11
2.2500	3.903E+11
2.7500	2.245E+09
3.5000	2.491E+08
5.0000	7.477E+02
7.0000	8.338E+01
11.0000	9.399E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.19E+01	6.37E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20.00000038	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		628.442
Bounding:		1,256.884

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.36	
Bounding:	0.72	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-C (PERU)	**[1]Fuel decay start date:**	2010
SNF ID #:	503	**Estimates as of:**	2010
Fuel Units & Descr:	6 - ASSEMBLY	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=6.00kg ; EOL=5.67kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.25

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	312.516	625.033	0.00E+00	4.55E-08	9.09E-08
Am-241	1.1190E-03	312.516	625.033	0.00E+00	3.50E-01	6.99E-01
Am-242m	4.5425E-07	312.516	625.033	0.00E+00	1.42E-04	2.84E-04
Am-243	1.4921E-06	312.516	625.033	0.00E+00	4.66E-04	9.33E-04
C-14	5.7244E-09	312.516	625.033	0.00E+00	1.79E-06	3.58E-06
Cl-36	1.3124E-32	312.516	625.033	0.00E+00	4.10E-30	8.20E-30
Cm-243	2.3676E-07	312.516	625.033	0.00E+00	7.40E-05	1.48E-04
Cm-244	5.2042E-05	312.516	625.033	0.00E+00	1.63E-02	3.25E-02
Co-60	3.8208E-05	312.516	625.033	0.00E+00	1.19E-02	2.39E-02
Cs-134	4.8693E-01	312.516	625.033	0.00E+00	1.52E+02	3.04E+02
Cs-135	3.4477E-06	312.516	625.033	0.00E+00	1.08E-03	2.15E-03
Cs-137	2.8731E+00	312.516	625.033	0.00E+00	8.98E+02	1.80E+03
Eu-154	8.2053E-02	312.516	625.033	0.00E+00	2.56E+01	5.13E+01
Eu-155	3.9134E-02	312.516	625.033	0.00E+00	1.22E+01	2.45E+01
Fe-55	6.7429E-03	312.516	625.033	0.00E+00	2.11E+00	4.21E+00
H-3	1.0599E-02	312.516	625.033	0.00E+00	3.31E+00	6.62E+00
I-129	7.5300E-07	312.516	625.033	0.00E+00	2.35E-04	4.71E-04
Kr-85	2.8595E-01	312.516	625.033	0.00E+00	8.94E+01	1.79E+02
Np-237	9.5479E-06	312.516	625.033	0.00E+00	2.98E-03	5.97E-03
Pa-231	8.9297E-10	312.516	625.033	0.00E+00	2.79E-07	5.58E-07
Pb-210	3.7609E-12	312.516	625.033	0.00E+00	1.18E-09	2.35E-09
Pm-147	2.5452E+00	312.516	625.033	0.00E+00	7.95E+02	1.59E+03
Pu-238	2.0550E-02	312.516	625.033	0.00E+00	6.42E+00	1.28E+01
Pu-239	4.2838E-04	312.516	625.033	0.00E+00	1.34E-01	2.68E-01
Pu-240	2.4401E-04	312.516	625.033	0.00E+00	7.63E-02	1.53E-01
Pu-241	6.8764E-02	312.516	625.033	0.00E+00	2.15E+01	4.30E+01
Pu-242	3.6329E-07	312.516	625.033	0.00E+00	1.14E-04	2.27E-04
Ra-226	3.8045E-11	312.516	625.033	0.00E+00	1.19E-08	2.38E-08
Ra-228	2.9902E-15	312.516	625.033	0.00E+00	9.34E-13	1.87E-12
Ru-106	1.9055E-01	312.516	625.033	0.00E+00	5.96E+01	1.19E+02
Se-79	1.2936E-05	312.516	625.033	0.00E+00	4.04E-03	8.09E-03
Sn-126	1.1574E-05	312.516	625.033	0.00E+00	3.62E-03	7.23E-03
Sr-90	2.7505E+00	312.516	625.033	0.00E+00	8.60E+02	1.72E+03
Tc-99	4.2239E-04	312.516	625.033	0.00E+00	1.32E-01	2.64E-01
Th-229	1.8848E-12	312.516	625.033	0.00E+00	5.89E-10	1.18E-09
Th-230	1.7042E-08	312.516	625.033	0.00E+00	5.33E-06	1.07E-05
Th-232	7.8132E-15	312.516	625.033	0.00E+00	2.44E-12	4.88E-12
Tl-208	4.4063E-08	312.516	625.033	0.00E+00	1.38E-05	2.75E-05
U-232	1.3151E-07	312.516	625.033	0.00E+00	4.11E-05	8.22E-05
U-233	1.9564E-09	312.516	625.033	0.00E+00	6.11E-07	1.22E-06
U-234	1.8371E-04	312.516	625.033	0.00E+00	5.74E-02	1.15E-01
U-235	-2.7235E-06	312.516	0.000	2.59E-03	1.74E-03	2.59E-03
U-236	1.5493E-05	312.516	625.033	0.00E+00	4.84E-03	9.68E-03
U-238	-4.2851E-09	312.516	0.000	1.61E-03	1.61E-03	1.61E-03
Y-90	2.7505E+00	312.516	625.033	0.00E+00	8.60E+02	1.72E+03
Other Radionuclides					1.61E+03	3.21E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.206E+14
0.0250	2.598E+13
0.0375	2.397E+13
0.0575	2.357E+13
0.0850	1.503E+13
0.1250	1.301E+13
0.2250	1.274E+13
0.3750	6.165E+12
0.5750	8.468E+13
0.8500	1.186E+13
1.2500	2.206E+12
1.7500	9.253E+10
2.2500	1.941E+11
2.7500	1.116E+09
3.5000	1.239E+08
5.0000	3.739E+02
7.0000	4.170E+01
11.0000	4.701E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.58E+01	3.17E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3O8	U
BOL Enrichment %:	20	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		312.516
Bounding:		625.033

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.17	
Bounding:	0.33	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (PORTUGAL)
SNF ID #: 540
Fuel Units & Descr: 9 - ASSEMBLY
Heavy Metal Mass: BOL=4.05kg ; EOL=3.91kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.38

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	1.4545E-10	130.405	260.809	0.00E+00	1.90E-08	3.79E-08
Am-241	1.1190E-03	130.405	260.809	0.00E+00	1.46E-01	2.92E-01
Am-242m	4.5425E-07	130.405	260.809	0.00E+00	5.92E-05	1.18E-04
Am-243	1.4921E-06	130.405	260.809	0.00E+00	1.95E-04	3.89E-04
C-14	5.7244E-09	130.405	260.809	0.00E+00	7.46E-07	1.49E-06
Cl-36	1.3124E-32	130.405	260.809	0.00E+00	1.71E-30	3.42E-30
Cm-243	2.3676E-07	130.405	260.809	0.00E+00	3.09E-05	6.18E-05
Cm-244	5.2042E-05	130.405	260.809	0.00E+00	6.79E-03	1.36E-02
Co-60	3.8208E-05	130.405	260.809	0.00E+00	4.98E-03	9.97E-03
Cs-134	4.8693E-01	130.405	260.809	0.00E+00	6.35E+01	1.27E+02
Cs-135	3.4477E-06	130.405	260.809	0.00E+00	4.50E-04	8.99E-04
Cs-137	2.8731E+00	130.405	260.809	0.00E+00	3.75E+02	7.49E+02
Eu-154	8.2053E-02	130.405	260.809	0.00E+00	1.07E+01	2.14E+01
Eu-155	3.9134E-02	130.405	260.809	0.00E+00	5.10E+00	1.02E+01
Fe-55	6.7429E-03	130.405	260.809	0.00E+00	8.79E-01	1.76E+00
H-3	1.0599E-02	130.405	260.809	0.00E+00	1.38E+00	2.76E+00
I-129	7.5300E-07	130.405	260.809	0.00E+00	9.82E-05	1.96E-04
Kr-85	2.8595E-01	130.405	260.809	0.00E+00	3.73E+01	7.46E+01
Np-237	9.5479E-06	130.405	260.809	0.00E+00	1.25E-03	2.49E-03
Pa-231	8.9297E-10	130.405	260.809	0.00E+00	1.16E-07	2.33E-07
Pb-210	3.7609E-12	130.405	260.809	0.00E+00	4.90E-10	9.81E-10
Pm-147	2.5452E+00	130.405	260.809	0.00E+00	3.32E+02	6.64E+02
Pu-238	2.0550E-02	130.405	260.809	0.00E+00	2.68E+00	5.36E+00
Pu-239	4.2838E-04	130.405	260.809	0.00E+00	5.59E-02	1.12E-01
Pu-240	2.4401E-04	130.405	260.809	0.00E+00	3.18E-02	6.36E-02
Pu-241	6.8764E-02	130.405	260.809	0.00E+00	8.97E+00	1.79E+01
Pu-242	3.6329E-07	130.405	260.809	0.00E+00	4.74E-05	9.47E-05
Ra-226	3.8045E-11	130.405	260.809	0.00E+00	4.96E-09	9.92E-09
Ra-228	2.9902E-15	130.405	260.809	0.00E+00	3.90E-13	7.80E-13
Ru-106	1.9055E-01	130.405	260.809	0.00E+00	2.48E+01	4.97E+01
Se-79	1.2936E-05	130.405	260.809	0.00E+00	1.69E-03	3.37E-03
Sn-126	1.1574E-05	130.405	260.809	0.00E+00	1.51E-03	3.02E-03
Sr-90	2.7505E+00	130.405	260.809	0.00E+00	3.59E+02	7.17E+02
Tc-99	4.2239E-04	130.405	260.809	0.00E+00	5.51E-02	1.10E-01
Th-229	1.8848E-12	130.405	260.809	0.00E+00	2.46E-10	4.92E-10
Th-230	1.7042E-08	130.405	260.809	0.00E+00	2.22E-06	4.44E-06
Th-232	7.8132E-15	130.405	260.809	0.00E+00	1.02E-12	2.04E-12
Tl-208	4.4063E-08	130.405	260.809	0.00E+00	5.75E-06	1.15E-05
U-232	1.3151E-07	130.405	260.809	0.00E+00	1.71E-05	3.43E-05
U-233	1.9564E-09	130.405	260.809	0.00E+00	2.55E-07	5.10E-07
U-234	1.8371E-04	130.405	260.809	0.00E+00	2.40E-02	4.79E-02
U-235	-2.7235E-06	130.405	0.000	1.75E-03	1.40E-03	1.75E-03
U-236	1.5493E-05	130.405	260.809	0.00E+00	2.02E-03	4.04E-03
U-238	-4.2851E-09	130.405	0.000	1.09E-03	1.09E-03	1.09E-03
Y-90	2.7505E+00	130.405	260.809	0.00E+00	3.59E+02	7.17E+02
Other Radionuclides					6.71E+02	1.34E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	5.032E+13
0.0250	1.084E+13
0.0375	1.000E+13
0.0575	9.836E+12
0.0850	6.270E+12
0.1250	5.430E+12
0.2250	5.315E+12
0.3750	2.573E+12
0.5750	3.534E+13
0.8500	4.948E+12
1.2500	9.207E+11
1.7500	3.861E+10
2.2500	8.099E+10
2.7500	4.659E+08
3.5000	5.169E+07
5.0000	1.570E+02
7.0000	1.751E+01
11.0000	1.974E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.61E+00	**1.32E+01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20.00000132	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		130.405
Bounding:		260.809

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.10	
Bounding:	0.20	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (PORTUGAL)	**[1]Fuel decay start date:**	2010		Estimated Canister usage:
SNF ID #: 631	**Estimates as of:**	2010		**18"x10'**
Fuel Units & Descr: 9 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)		0.38
Heavy Metal Mass: BOL=1.42kg ; EOL=.89kg	**[2]Template Burnup(MWd):**	367.2		
ROD Storage Site: SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689		
	Template Decay Time:	5 years		

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	1.4545E-10	501.163	1,002.325	0.00E+00	7.29E-08	1.46E-07
Am-241	1.1190E-03	501.163	1,002.325	0.00E+00	5.61E-01	1.12E+00
Am-242m	4.5425E-07	501.163	1,002.325	0.00E+00	2.28E-04	4.55E-04
Am-243	1.4921E-06	501.163	1,002.325	0.00E+00	7.48E-04	1.50E-03
C-14	5.7244E-09	501.163	1,002.325	0.00E+00	2.87E-06	5.74E-06
Cl-36	1.3124E-32	501.163	1,002.325	0.00E+00	6.58E-30	1.32E-29
Cm-243	2.3676E-07	501.163	1,002.325	0.00E+00	1.19E-04	2.37E-04
Cm-244	5.2042E-05	501.163	1,002.325	0.00E+00	2.61E-02	5.22E-02
Co-60	3.8208E-05	501.163	1,002.325	0.00E+00	1.91E-02	3.83E-02
Cs-134	4.8693E-01	501.163	1,002.325	0.00E+00	2.44E+02	4.88E+02
Cs-135	3.4477E-06	501.163	1,002.325	0.00E+00	1.73E-03	3.46E-03
Cs-137	2.8731E+00	501.163	1,002.325	0.00E+00	1.44E+03	2.88E+03
Eu-154	8.2053E-02	501.163	1,002.325	0.00E+00	4.11E+01	8.22E+01
Eu-155	3.9134E-02	501.163	1,002.325	0.00E+00	1.96E+01	3.92E+01
Fe-55	6.7429E-03	501.163	1,002.325	0.00E+00	3.38E+00	6.76E+00
H-3	1.0599E-02	501.163	1,002.325	0.00E+00	5.31E+00	1.06E+01
I-129	7.5300E-07	501.163	1,002.325	0.00E+00	3.77E-04	7.55E-04
Kr-85	2.8595E-01	501.163	1,002.325	0.00E+00	1.43E+02	2.87E+02
Np-237	9.5479E-06	501.163	1,002.325	0.00E+00	4.79E-03	9.57E-03
Pa-231	8.9297E-10	501.163	1,002.325	0.00E+00	4.48E-07	8.95E-07
Pb-210	3.7609E-12	501.163	1,002.325	0.00E+00	1.88E-09	3.77E-09
Pm-147	2.5452E+00	501.163	1,002.325	0.00E+00	1.28E+03	2.55E+03
Pu-238	2.0550E-02	501.163	1,002.325	0.00E+00	1.03E+01	2.06E+01
Pu-239	4.2838E-04	501.163	1,002.325	0.00E+00	2.15E-01	4.29E-01
Pu-240	2.4401E-04	501.163	1,002.325	0.00E+00	1.22E-01	2.45E-01
Pu-241	6.8764E-02	501.163	1,002.325	0.00E+00	3.45E+01	6.89E+01
Pu-242	3.6329E-07	501.163	1,002.325	0.00E+00	1.82E-04	3.64E-04
Ra-226	3.8045E-11	501.163	1,002.325	0.00E+00	1.91E-08	3.81E-08
Ra-228	2.9902E-15	501.163	1,002.325	0.00E+00	1.50E-12	3.00E-12
Ru-106	1.9055E-01	501.163	1,002.325	0.00E+00	9.55E+01	1.91E+02
Se-79	1.2936E-05	501.163	1,002.325	0.00E+00	6.48E-03	1.30E-02
Sn-126	1.1574E-05	501.163	1,002.325	0.00E+00	5.80E-03	1.16E-02
Sr-90	2.7505E+00	501.163	1,002.325	0.00E+00	1.38E+03	2.76E+03
Tc-99	4.2239E-04	501.163	1,002.325	0.00E+00	2.12E-01	4.23E-01
Th-229	1.8848E-12	501.163	1,002.325	0.00E+00	9.45E-10	1.89E-09
Th-230	1.7042E-08	501.163	1,002.325	0.00E+00	8.54E-06	1.71E-05
Th-232	7.8132E-15	501.163	1,002.325	0.00E+00	3.92E-12	7.83E-12
Tl-208	4.4063E-08	501.163	1,002.325	0.00E+00	2.21E-05	4.42E-05
U-232	1.3151E-07	501.163	1,002.325	0.00E+00	6.59E-05	1.32E-04
U-233	1.9564E-09	501.163	1,002.325	0.00E+00	9.80E-07	1.96E-06
U-234	1.8371E-04	501.163	1,002.325	0.00E+00	9.21E-02	1.84E-01
U-235	-2.7235E-06	501.163	0.000	2.86E-03	1.49E-03	2.86E-03
U-236	1.5493E-05	501.163	1,002.325	0.00E+00	7.76E-03	1.55E-02
U-238	-4.2851E-09	501.163	0.000	3.35E-05	3.13E-05	3.35E-05
Y-90	2.7505E+00	501.163	1,002.325	0.00E+00	1.38E+03	2.76E+03
Other Radionuclides					2.58E+03	5.16E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.934E+14
0.0250	4.166E+13
0.0375	3.844E+13
0.0575	3.780E+13
0.0850	2.410E+13
0.1250	2.087E+13
0.2250	2.042E+13
0.3750	9.887E+12
0.5750	1.358E+14
0.8500	1.902E+13
1.2500	3.538E+12
1.7500	1.484E+11
2.2500	3.112E+11
2.7500	1.790E+09
3.5000	1.986E+08
5.0000	5.937E+02
7.0000	6.619E+01
11.0000	7.461E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.54E+01	**5.08E+01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.00000971	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		501.163	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,002.325	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.12	
Bounding:	2.24	

Estimated EOL HM/Given EOL HM: 1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (SWEDEN)
SNF ID #: 523
Fuel Units & Descr: 480 - ASSEMBLY
Heavy Metal Mass: BOL=960.00kg ; EOL=789.89kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
20.00

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	161,099.364	322,198.728	0.00E+00	2.34E-05	4.69E-05
Am-241	1.1190E-03	161,099.364	322,198.728	0.00E+00	1.80E+02	3.61E+02
Am-242m	4.5425E-07	161,099.364	322,198.728	0.00E+00	7.32E-02	1.46E-01
Am-243	1.4921E-06	161,099.364	322,198.728	0.00E+00	2.40E-01	4.81E-01
C-14	5.7244E-09	161,099.364	322,198.728	0.00E+00	9.22E-04	1.84E-03
Cl-36	1.3124E-32	161,099.364	322,198.728	0.00E+00	2.11E-27	4.23E-27
Cm-243	2.3676E-07	161,099.364	322,198.728	0.00E+00	3.81E-02	7.63E-02
Cm-244	5.2042E-05	161,099.364	322,198.728	0.00E+00	8.38E+00	1.68E+01
Co-60	3.8208E-05	161,099.364	322,198.728	0.00E+00	6.16E+00	1.23E+01
Cs-134	4.8693E-01	161,099.364	322,198.728	0.00E+00	7.84E+04	1.57E+05
Cs-135	3.4477E-06	161,099.364	322,198.728	0.00E+00	5.55E-01	1.11E+00
Cs-137	2.8731E+00	161,099.364	322,198.728	0.00E+00	4.63E+05	9.26E+05
Eu-154	8.2053E-02	161,099.364	322,198.728	0.00E+00	1.32E+04	2.64E+04
Eu-155	3.9134E-02	161,099.364	322,198.728	0.00E+00	6.30E+03	1.26E+04
Fe-55	6.7429E-03	161,099.364	322,198.728	0.00E+00	1.09E+03	2.17E+03
H-3	1.0599E-02	161,099.364	322,198.728	0.00E+00	1.71E+03	3.42E+03
I-129	7.5300E-07	161,099.364	322,198.728	0.00E+00	1.21E-01	2.43E-01
Kr-85	2.8595E-01	161,099.364	322,198.728	0.00E+00	4.61E+04	9.21E+04
Np-237	9.5479E-06	161,099.364	322,198.728	0.00E+00	1.54E+00	3.08E+00
Pa-231	8.9297E-10	161,099.364	322,198.728	0.00E+00	1.44E-04	2.88E-04
Pb-210	3.7609E-12	161,099.364	322,198.728	0.00E+00	6.06E-07	1.21E-06
Pm-147	2.5452E+00	161,099.364	322,198.728	0.00E+00	4.10E+05	8.20E+05
Pu-238	2.0550E-02	161,099.364	322,198.728	0.00E+00	3.31E+03	6.62E+03
Pu-239	4.2838E-04	161,099.364	322,198.728	0.00E+00	6.90E+01	1.38E+02
Pu-240	2.4401E-04	161,099.364	322,198.728	0.00E+00	3.93E+01	7.86E+01
Pu-241	6.8764E-02	161,099.364	322,198.728	0.00E+00	1.11E+04	2.22E+04
Pu-242	3.6329E-07	161,099.364	322,198.728	0.00E+00	5.85E-02	1.17E-01
Ra-226	3.8045E-11	161,099.364	322,198.728	0.00E+00	6.13E-06	1.23E-05
Ra-228	2.9902E-15	161,099.364	322,198.728	0.00E+00	4.82E-10	9.63E-10
Ru-106	1.9055E-01	161,099.364	322,198.728	0.00E+00	3.07E+04	6.14E+04
Se-79	1.2936E-05	161,099.364	322,198.728	0.00E+00	2.08E+00	4.17E+00
Sn-126	1.1574E-05	161,099.364	322,198.728	0.00E+00	1.86E+00	3.73E+00
Sr-90	2.7505E+00	161,099.364	322,198.728	0.00E+00	4.43E+05	8.86E+05
Tc-99	4.2239E-04	161,099.364	322,198.728	0.00E+00	6.80E+01	1.36E+02
Th-229	1.8848E-12	161,099.364	322,198.728	0.00E+00	3.04E-07	6.07E-07
Th-230	1.7042E-08	161,099.364	322,198.728	0.00E+00	2.75E-03	5.49E-03
Th-232	7.8132E-15	161,099.364	322,198.728	0.00E+00	1.26E-09	2.52E-09
Tl-208	4.4063E-08	161,099.364	322,198.728	0.00E+00	7.10E-03	1.42E-02
U-232	1.3151E-07	161,099.364	322,198.728	0.00E+00	2.12E-02	4.24E-02
U-233	1.9564E-09	161,099.364	322,198.728	0.00E+00	3.15E-04	6.30E-04
U-234	1.8371E-04	161,099.364	322,198.728	0.00E+00	2.96E+01	5.92E+01
U-235	-2.7235E-06	161,099.364	0.000	4.15E-01	0.00E+00	4.15E-01
U-236	1.5493E-05	161,099.364	322,198.728	0.00E+00	2.50E+00	4.99E+00
U-238	-4.2851E-09	161,099.364	0.000	2.58E-01	2.57E-01	2.58E-01
Y-90	2.7505E+00	161,099.364	322,198.728	0.00E+00	4.43E+05	8.86E+05
Other Radionuclides					8.29E+05	1.66E+06

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.216E+16
0.0250	1.339E+16
0.0375	1.236E+16
0.0575	1.215E+16
0.0850	7.746E+15
0.1250	6.708E+15
0.2250	6.566E+15
0.3750	3.178E+15
0.5750	4.365E+16
0.8500	6.113E+15
1.2500	1.137E+15
1.7500	4.770E+13
2.2500	1.001E+14
2.7500	5.755E+11
3.5000	6.385E+10
5.0000	1.914E+05
7.0000	2.134E+04
11.0000	2.406E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.17E+03	**1.63E+04**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]	From SFD	Estimated
Nominal:		161,099.364
Bounding:		322,198.728

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.53	
Bounding:	1.07	

Estimated EOL HM/Given EOL HM
1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C (TURKEY)
SNF ID #: 643
Fuel Units & Descr: 8 - MTR TYPE
Heavy Metal Mass: BOL=1.78kg ; EOL=.95kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'
0.33

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	784.132	1,568.264	0.00E+00	1.14E-07	2.28E-07
Am-241	1.1190E-03	784.132	1,568.264	0.00E+00	8.77E-01	1.75E+00
Am-242m	4.5425E-07	784.132	1,568.264	0.00E+00	3.56E-04	7.12E-04
Am-243	1.4921E-06	784.132	1,568.264	0.00E+00	1.17E-03	2.34E-03
C-14	5.7244E-09	784.132	1,568.264	0.00E+00	4.49E-06	8.98E-06
Cl-36	1.3124E-32	784.132	1,568.264	0.00E+00	1.03E-29	2.06E-29
Cm-243	2.3676E-07	784.132	1,568.264	0.00E+00	1.86E-04	3.71E-04
Cm-244	5.2042E-05	784.132	1,568.264	0.00E+00	4.08E-02	8.16E-02
Co-60	3.8208E-05	784.132	1,568.264	0.00E+00	3.00E-02	5.99E-02
Cs-134	4.8693E-01	784.132	1,568.264	0.00E+00	3.82E+02	7.64E+02
Cs-135	3.4477E-06	784.132	1,568.264	0.00E+00	2.70E-03	5.41E-03
Cs-137	2.8731E+00	784.132	1,568.264	0.00E+00	2.25E+03	4.51E+03
Eu-154	8.2053E-02	784.132	1,568.264	0.00E+00	6.43E+01	1.29E+02
Eu-155	3.9134E-02	784.132	1,568.264	0.00E+00	3.07E+01	6.14E+01
Fe-55	6.7429E-03	784.132	1,568.264	0.00E+00	5.29E+00	1.06E+01
H-3	1.0599E-02	784.132	1,568.264	0.00E+00	8.31E+00	1.66E+01
I-129	7.5300E-07	784.132	1,568.264	0.00E+00	5.90E-04	1.18E-03
Kr-85	2.8595E-01	784.132	1,568.264	0.00E+00	2.24E+02	4.48E+02
Np-237	9.5479E-06	784.132	1,568.264	0.00E+00	7.49E-03	1.50E-02
Pa-231	8.9297E-10	784.132	1,568.264	0.00E+00	7.00E-07	1.40E-06
Pb-210	3.7609E-12	784.132	1,568.264	0.00E+00	2.95E-09	5.90E-09
Pm-147	2.5452E+00	784.132	1,568.264	0.00E+00	2.00E+03	3.99E+03
Pu-238	2.0550E-02	784.132	1,568.264	0.00E+00	1.61E+01	3.22E+01
Pu-239	4.2838E-04	784.132	1,568.264	0.00E+00	3.36E-01	6.72E-01
Pu-240	2.4401E-04	784.132	1,568.264	0.00E+00	1.91E-01	3.83E-01
Pu-241	6.8764E-02	784.132	1,568.264	0.00E+00	5.39E+01	1.08E+02
Pu-242	3.6329E-07	784.132	1,568.264	0.00E+00	2.85E-04	5.70E-04
Ra-226	3.8045E-11	784.132	1,568.264	0.00E+00	2.98E-08	5.97E-08
Ra-228	2.9902E-15	784.132	1,568.264	0.00E+00	2.34E-12	4.69E-12
Ru-106	1.9055E-01	784.132	1,568.264	0.00E+00	1.49E+02	2.99E+02
Se-79	1.2936E-05	784.132	1,568.264	0.00E+00	1.01E-02	2.03E-02
Sn-126	1.1574E-05	784.132	1,568.264	0.00E+00	9.08E-03	1.82E-02
Sr-90	2.7505E+00	784.132	1,568.264	0.00E+00	2.16E+03	4.31E+03
Tc-99	4.2239E-04	784.132	1,568.264	0.00E+00	3.31E-01	6.62E-01
Th-229	1.8848E-12	784.132	1,568.264	0.00E+00	1.48E-09	2.96E-09
Th-230	1.7042E-08	784.132	1,568.264	0.00E+00	1.34E-05	2.67E-05
Th-232	7.8132E-15	784.132	1,568.264	0.00E+00	6.13E-12	1.23E-11
Tl-208	4.4063E-08	784.132	1,568.264	0.00E+00	3.46E-05	6.91E-05
U-232	1.3151E-07	784.132	1,568.264	0.00E+00	1.03E-04	2.06E-04
U-233	1.9564E-09	784.132	1,568.264	0.00E+00	1.53E-06	3.07E-06
U-234	1.8371E-04	784.132	1,568.264	0.00E+00	1.44E-01	2.88E-01
U-235	-2.7235E-06	784.132	0.000	3.58E-03	1.44E-03	3.58E-03
U-236	1.5493E-05	784.132	1,568.264	0.00E+00	1.21E-02	2.43E-02
U-238	-4.2851E-09	784.132	0.000	4.19E-05	3.85E-05	4.19E-05
Y-90	2.7505E+00	784.132	1,568.264	0.00E+00	2.16E+03	4.31E+03
Other Radionuclides					4.03E+03	8.07E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	3.026E+14
0.0250	6.518E+13
0.0375	6.015E+13
0.0575	5.914E+13
0.0850	3.770E+13
0.1250	3.265E+13
0.2250	3.196E+13
0.3750	1.547E+13
0.5750	2.125E+14
0.8500	2.975E+13
1.2500	5.536E+12
1.7500	2.322E+11
2.2500	4.870E+11
2.7500	2.801E+09
3.5000	3.108E+08
5.0000	9.288E+02
7.0000	1.036E+02
11.0000	1.167E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.98E+01	7.95E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.00002122	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		784.132	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,568.264	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.40	
Bounding:	2.80	

Estimated EOL HM/Given EOL HM: 1.05

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-C1 (SWITZERLAND)	**[1]Fuel decay start date:**	2010
SNF ID #:	656	**Estimates as of:**	2010
Fuel Units & Descr:	7 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=1.28kg ; EOL=.52kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.29

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	721.250	1,211.806	0.00E+00	1.05E-07	1.76E-07
Am-241	1.1190E-03	721.250	1,211.806	0.00E+00	8.07E-01	1.36E+00
Am-242m	4.5425E-07	721.250	1,211.806	0.00E+00	3.28E-04	5.50E-04
Am-243	1.4921E-06	721.250	1,211.806	0.00E+00	1.08E-03	1.81E-03
C-14	5.7244E-09	721.250	1,211.806	0.00E+00	4.13E-06	6.94E-06
Cl-36	1.3124E-32	721.250	1,211.806	0.00E+00	9.47E-30	1.59E-29
Cm-243	2.3676E-07	721.250	1,211.806	0.00E+00	1.71E-04	2.87E-04
Cm-244	5.2042E-05	721.250	1,211.806	0.00E+00	3.75E-02	6.31E-02
Co-60	3.8208E-05	721.250	1,211.806	0.00E+00	2.76E-02	4.63E-02
Cs-134	4.8693E-01	721.250	1,211.806	0.00E+00	3.51E+02	5.90E+02
Cs-135	3.4477E-06	721.250	1,211.806	0.00E+00	2.49E-03	4.18E-03
Cs-137	2.8731E+00	721.250	1,211.806	0.00E+00	2.07E+03	3.48E+03
Eu-154	8.2053E-02	721.250	1,211.806	0.00E+00	5.92E+01	9.94E+01
Eu-155	3.9134E-02	721.250	1,211.806	0.00E+00	2.82E+01	4.74E+01
Fe-55	6.7429E-03	721.250	1,211.806	0.00E+00	4.86E+00	8.17E+00
H-3	1.0599E-02	721.250	1,211.806	0.00E+00	7.64E+00	1.28E+01
I-129	7.5300E-07	721.250	1,211.806	0.00E+00	5.43E-04	9.12E-04
Kr-85	2.8595E-01	721.250	1,211.806	0.00E+00	2.06E+02	3.47E+02
Np-237	9.5479E-06	721.250	1,211.806	0.00E+00	6.89E-03	1.16E-02
Pa-231	8.9297E-10	721.250	1,211.806	0.00E+00	6.44E-07	1.08E-06
Pb-210	3.7609E-12	721.250	1,211.806	0.00E+00	2.71E-09	4.56E-09
Pm-147	2.5452E+00	721.250	1,211.806	0.00E+00	1.84E+03	3.08E+03
Pu-238	2.0550E-02	721.250	1,211.806	0.00E+00	1.48E+01	2.49E+01
Pu-239	4.2838E-04	721.250	1,211.806	0.00E+00	3.09E-01	5.19E-01
Pu-240	2.4401E-04	721.250	1,211.806	0.00E+00	1.76E-01	2.96E-01
Pu-241	6.8764E-02	721.250	1,211.806	0.00E+00	4.96E+01	8.33E+01
Pu-242	3.6329E-07	721.250	1,211.806	0.00E+00	2.62E-04	4.40E-04
Ra-226	3.8045E-11	721.250	1,211.806	0.00E+00	2.74E-08	4.61E-08
Ra-228	2.9902E-15	721.250	1,211.806	0.00E+00	2.16E-12	3.62E-12
Ru-106	1.9055E-01	721.250	1,211.806	0.00E+00	1.37E+02	2.31E+02
Se-79	1.2936E-05	721.250	1,211.806	0.00E+00	9.33E-03	1.57E-02
Sn-126	1.1574E-05	721.250	1,211.806	0.00E+00	8.35E-03	1.40E-02
Sr-90	2.7505E+00	721.250	1,211.806	0.00E+00	1.98E+03	3.33E+03
Tc-99	4.2239E-04	721.250	1,211.806	0.00E+00	3.05E-01	5.12E-01
Th-229	1.8848E-12	721.250	1,211.806	0.00E+00	1.36E-09	2.28E-09
Th-230	1.7042E-08	721.250	1,211.806	0.00E+00	1.23E-05	2.07E-05
Th-232	7.8132E-15	721.250	1,211.806	0.00E+00	5.64E-12	9.47E-12
Tl-208	4.4063E-08	721.250	1,211.806	0.00E+00	3.18E-05	5.34E-05
U-232	1.3151E-07	721.250	1,211.806	0.00E+00	9.49E-05	1.59E-04
U-233	1.9564E-09	721.250	1,211.806	0.00E+00	1.41E-06	2.37E-06
U-234	1.8371E-04	721.250	1,211.806	0.00E+00	1.33E-01	2.23E-01
U-235	-2.7235E-06	721.250	0.000	2.57E-03	6.07E-04	2.57E-03
U-236	1.5493E-05	721.250	1,211.806	0.00E+00	1.12E-02	1.88E-02
U-238	-4.2851E-09	721.250	0.000	3.01E-05	2.70E-05	3.01E-05
Y-90	2.7505E+00	721.250	1,211.806	0.00E+00	1.98E+03	3.33E+03
Other Radionuclides					3.71E+03	6.23E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.338E+14
0.0250	5.037E+13
0.0375	4.648E+13
0.0575	4.570E+13
0.0850	2.913E+13
0.1250	2.523E+13
0.2250	2.469E+13
0.3750	1.195E+13
0.5750	1.642E+14
0.8500	2.299E+13
1.2500	4.278E+12
1.7500	1.794E+11
2.2500	3.763E+11
2.7500	2.165E+09
3.5000	2.401E+08
5.0000	7.177E+02
7.0000	8.002E+01
11.0000	9.019E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.66E+01	**6.14E+01**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.9999987	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		721.250	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,211.806	Bounding burnup calculated assuming all BOL heavy metal burned.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.79	
Bounding:	3.01	

Estimated EOL HM/Given EOL HM

1.09

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-C2 (SWITZERLAND)
SNF ID #: 657
Fuel Units & Descr: 11 - MTR TYPE
Heavy Metal Mass: BOL=2.46kg ; EOL=1.00kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.46

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	1.4545E-10	1,387.573	2,330.331	0.00E+00	2.02E-07	3.39E-07
Am-241	1.1190E-03	1,387.573	2,330.331	0.00E+00	1.55E+00	2.61E+00
Am-242m	4.5425E-07	1,387.573	2,330.331	0.00E+00	6.30E-04	1.06E-03
Am-243	1.4921E-06	1,387.573	2,330.331	0.00E+00	2.07E-03	3.48E-03
C-14	5.7244E-09	1,387.573	2,330.331	0.00E+00	7.94E-06	1.33E-05
Cl-36	1.3124E-32	1,387.573	2,330.331	0.00E+00	1.82E-29	3.06E-29
Cm-243	2.3676E-07	1,387.573	2,330.331	0.00E+00	3.29E-04	5.52E-04
Cm-244	5.2042E-05	1,387.573	2,330.331	0.00E+00	7.22E-02	1.21E-01
Co-60	3.8208E-05	1,387.573	2,330.331	0.00E+00	5.30E-02	8.90E-02
Cs-134	4.8693E-01	1,387.573	2,330.331	0.00E+00	6.76E+02	1.13E+03
Cs-135	3.4477E-06	1,387.573	2,330.331	0.00E+00	4.78E-03	8.03E-03
Cs-137	2.8731E+00	1,387.573	2,330.331	0.00E+00	3.99E+03	6.70E+03
Eu-154	8.2053E-02	1,387.573	2,330.331	0.00E+00	1.14E+02	1.91E+02
Eu-155	3.9134E-02	1,387.573	2,330.331	0.00E+00	5.43E+01	9.12E+01
Fe-55	6.7429E-03	1,387.573	2,330.331	0.00E+00	9.36E+00	1.57E+01
H-3	1.0599E-02	1,387.573	2,330.331	0.00E+00	1.47E+01	2.47E+01
I-129	7.5300E-07	1,387.573	2,330.331	0.00E+00	1.04E-03	1.75E-03
Kr-85	2.8595E-01	1,387.573	2,330.331	0.00E+00	3.97E+02	6.66E+02
Np-237	9.5479E-06	1,387.573	2,330.331	0.00E+00	1.32E-02	2.22E-02
Pa-231	8.9297E-10	1,387.573	2,330.331	0.00E+00	1.24E-06	2.08E-06
Pb-210	3.7609E-12	1,387.573	2,330.331	0.00E+00	5.22E-09	8.76E-09
Pm-147	2.5452E+00	1,387.573	2,330.331	0.00E+00	3.53E+03	5.93E+03
Pu-238	2.0550E-02	1,387.573	2,330.331	0.00E+00	2.85E+01	4.79E+01
Pu-239	4.2838E-04	1,387.573	2,330.331	0.00E+00	5.94E-01	9.98E-01
Pu-240	2.4401E-04	1,387.573	2,330.331	0.00E+00	3.39E-01	5.69E-01
Pu-241	6.8764E-02	1,387.573	2,330.331	0.00E+00	9.54E+01	1.60E+02
Pu-242	3.6329E-07	1,387.573	2,330.331	0.00E+00	5.04E-04	8.47E-04
Ra-226	3.8045E-11	1,387.573	2,330.331	0.00E+00	5.28E-08	8.87E-08
Ra-228	2.9902E-15	1,387.573	2,330.331	0.00E+00	4.15E-12	6.97E-12
Ru-106	1.9055E-01	1,387.573	2,330.331	0.00E+00	2.64E+02	4.44E+02
Se-79	1.2936E-05	1,387.573	2,330.331	0.00E+00	1.79E-02	3.01E-02
Sn-126	1.1574E-05	1,387.573	2,330.331	0.00E+00	1.61E-02	2.70E-02
Sr-90	2.7505E+00	1,387.573	2,330.331	0.00E+00	3.82E+03	6.41E+03
Tc-99	4.2239E-04	1,387.573	2,330.331	0.00E+00	5.86E-01	9.84E-01
Th-229	1.8848E-12	1,387.573	2,330.331	0.00E+00	2.62E-09	4.39E-09
Th-230	1.7042E-08	1,387.573	2,330.331	0.00E+00	2.36E-05	3.97E-05
Th-232	7.8132E-15	1,387.573	2,330.331	0.00E+00	1.08E-11	1.82E-11
Tl-208	4.4063E-08	1,387.573	2,330.331	0.00E+00	6.11E-05	1.03E-04
U-232	1.3151E-07	1,387.573	2,330.331	0.00E+00	1.82E-04	3.06E-04
U-233	1.9564E-09	1,387.573	2,330.331	0.00E+00	2.71E-06	4.56E-06
U-234	1.8371E-04	1,387.573	2,330.331	0.00E+00	2.55E-01	4.28E-01
U-235	-2.7235E-06	1,387.573	0.000	4.95E-03	1.17E-03	4.95E-03
U-236	1.5493E-05	1,387.573	2,330.331	0.00E+00	2.15E-02	3.61E-02
U-238	-4.2851E-09	1,387.573	0.000	5.79E-05	5.19E-05	5.79E-05
Y-90	2.7505E+00	1,387.573	2,330.331	0.00E+00	3.82E+03	6.41E+03
Other Radionuclides					7.14E+03	1.20E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	4.496E+14
0.0250	9.686E+13
0.0375	8.938E+13
0.0575	8.789E+13
0.0850	5.603E+13
0.1250	4.852E+13
0.2250	4.749E+13
0.3750	2.299E+13
0.5750	3.157E+14
0.8500	4.421E+13
1.2500	8.226E+12
1.7500	3.450E+11
2.2500	7.236E+11
2.7500	4.163E+09
3.5000	4.618E+08
5.0000	1.380E+03
7.0000	1.539E+02
11.0000	1.734E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
7.04E+01	**1.18E+02**
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.00001006	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		1,387.573
Bounding:		2,330.331

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup calculated assuming all BOL heavy metal burned.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.79	
Bounding:	3.01	

Estimated EOL HM/Given EOL HM
1.09

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-C2 (TURKEY)	**Fuel decay start date:**[1]	2010
SNF ID #:	527	**Estimates as of:**	2010
Fuel Units & Descr:	9 - ASSEMBLY	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=13.95kg ; EOL=12.28kg	**Template Burnup(MWd):**[2]	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.38

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	1,585.311	3,170.621	0.00E+00	2.31E-07	4.61E-07
Am-241	1.1190E-03	1,585.311	3,170.621	0.00E+00	1.77E+00	3.55E+00
Am-242m	4.5425E-07	1,585.311	3,170.621	0.00E+00	7.20E-04	1.44E-03
Am-243	1.4921E-06	1,585.311	3,170.621	0.00E+00	2.37E-03	4.73E-03
C-14	5.7244E-09	1,585.311	3,170.621	0.00E+00	9.07E-06	1.81E-05
Cl-36	1.3124E-32	1,585.311	3,170.621	0.00E+00	2.08E-29	4.16E-29
Cm-243	2.3676E-07	1,585.311	3,170.621	0.00E+00	3.75E-04	7.51E-04
Cm-244	5.2042E-05	1,585.311	3,170.621	0.00E+00	8.25E-02	1.65E-01
Co-60	3.8208E-05	1,585.311	3,170.621	0.00E+00	6.06E-02	1.21E-01
Cs-134	4.8693E-01	1,585.311	3,170.621	0.00E+00	7.72E+02	1.54E+03
Cs-135	3.4477E-06	1,585.311	3,170.621	0.00E+00	5.47E-03	1.09E-02
Cs-137	2.8731E+00	1,585.311	3,170.621	0.00E+00	4.55E+03	9.11E+03
Eu-154	8.2053E-02	1,585.311	3,170.621	0.00E+00	1.30E+02	2.60E+02
Eu-155	3.9134E-02	1,585.311	3,170.621	0.00E+00	6.20E+01	1.24E+02
Fe-55	6.7429E-03	1,585.311	3,170.621	0.00E+00	1.07E+01	2.14E+01
H-3	1.0599E-02	1,585.311	3,170.621	0.00E+00	1.68E+01	3.36E+01
I-129	7.5300E-07	1,585.311	3,170.621	0.00E+00	1.19E-03	2.39E-03
Kr-85	2.8595E-01	1,585.311	3,170.621	0.00E+00	4.53E+02	9.07E+02
Np-237	9.5479E-06	1,585.311	3,170.621	0.00E+00	1.51E-02	3.03E-02
Pa-231	8.9297E-10	1,585.311	3,170.621	0.00E+00	1.42E-06	2.83E-06
Pb-210	3.7609E-12	1,585.311	3,170.621	0.00E+00	5.96E-09	1.19E-08
Pm-147	2.5452E+00	1,585.311	3,170.621	0.00E+00	4.03E+03	8.07E+03
Pu-238	2.0550E-02	1,585.311	3,170.621	0.00E+00	3.26E+01	6.52E+01
Pu-239	4.2838E-04	1,585.311	3,170.621	0.00E+00	6.79E-01	1.36E+00
Pu-240	2.4401E-04	1,585.311	3,170.621	0.00E+00	3.87E-01	7.74E-01
Pu-241	6.8764E-02	1,585.311	3,170.621	0.00E+00	1.09E+02	2.18E+02
Pu-242	3.6329E-07	1,585.311	3,170.621	0.00E+00	5.76E-04	1.15E-03
Ra-226	3.8045E-11	1,585.311	3,170.621	0.00E+00	6.03E-08	1.21E-07
Ra-228	2.9902E-15	1,585.311	3,170.621	0.00E+00	4.74E-12	9.48E-12
Ru-106	1.9055E-01	1,585.311	3,170.621	0.00E+00	3.02E+02	6.04E+02
Se-79	1.2936E-05	1,585.311	3,170.621	0.00E+00	2.05E-02	4.10E-02
Sn-126	1.1574E-05	1,585.311	3,170.621	0.00E+00	1.83E-02	3.67E-02
Sr-90	2.7505E+00	1,585.311	3,170.621	0.00E+00	4.36E+03	8.72E+03
Tc-99	4.2239E-04	1,585.311	3,170.621	0.00E+00	6.70E-01	1.34E+00
Th-229	1.8848E-12	1,585.311	3,170.621	0.00E+00	2.99E-09	5.98E-09
Th-230	1.7042E-08	1,585.311	3,170.621	0.00E+00	2.70E-05	5.40E-05
Th-232	7.8132E-15	1,585.311	3,170.621	0.00E+00	1.24E-11	2.48E-11
Tl-208	4.4063E-08	1,585.311	3,170.621	0.00E+00	6.99E-05	1.40E-04
U-232	1.3151E-07	1,585.311	3,170.621	0.00E+00	2.08E-04	4.17E-04
U-233	1.9564E-09	1,585.311	3,170.621	0.00E+00	3.10E-06	6.20E-06
U-234	1.8371E-04	1,585.311	3,170.621	0.00E+00	2.91E-01	5.82E-01
U-235	-2.7235E-06	1,585.311	0.000	6.03E-03	1.71E-03	6.03E-03
U-236	1.5493E-05	1,585.311	3,170.621	0.00E+00	2.46E-02	4.91E-02
U-238	-4.2851E-09	1,585.311	0.000	3.75E-03	3.74E-03	3.75E-03
Y-90	2.7505E+00	1,585.311	3,170.621	0.00E+00	4.36E+03	8.72E+03
Other Radionuclides					8.15E+03	1.63E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.117E+14
0.0250	1.318E+14
0.0375	1.216E+14
0.0575	1.196E+14
0.0850	7.623E+13
0.1250	6.601E+13
0.2250	6.461E+13
0.3750	3.127E+13
0.5750	4.296E+14
0.8500	6.015E+13
1.2500	1.119E+13
1.7500	4.694E+11
2.2500	9.846E+11
2.7500	5.664E+09
3.5000	6.283E+08
5.0000	1.886E+03
7.0000	2.103E+02
11.0000	2.371E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.04E+01	1.61E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20.00000077	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		1,585.311
Bounding:		3,170.621

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.36	
Bounding:	0.72	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-O (PORTUGAL)
SNF ID #: 541
Fuel Units & Descr: 3 - ASSEMBLY
Heavy Metal Mass: BOL=1.35kg ; EOL=1.35kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.13

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	25.570	127.848	0.00E+00	3.72E-09	1.86E-08
Am-241	1.1190E-03	25.570	127.848	0.00E+00	2.86E-02	1.43E-01
Am-242m	4.5425E-07	25.570	127.848	0.00E+00	1.16E-05	5.81E-05
Am-243	1.4921E-06	25.570	127.848	0.00E+00	3.82E-05	1.91E-04
C-14	5.7244E-09	25.570	127.848	0.00E+00	1.46E-07	7.32E-07
Cl-36	1.3124E-32	25.570	127.848	0.00E+00	3.36E-31	1.68E-30
Cm-243	2.3676E-07	25.570	127.848	0.00E+00	6.05E-06	3.03E-05
Cm-244	5.2042E-05	25.570	127.848	0.00E+00	1.33E-03	6.65E-03
Co-60	3.8208E-05	25.570	127.848	0.00E+00	9.77E-04	4.88E-03
Cs-134	4.8693E-01	25.570	127.848	0.00E+00	1.25E+01	6.23E+01
Cs-135	3.4477E-06	25.570	127.848	0.00E+00	8.82E-05	4.41E-04
Cs-137	2.8731E+00	25.570	127.848	0.00E+00	7.35E+01	3.67E+02
Eu-154	8.2053E-02	25.570	127.848	0.00E+00	2.10E+00	1.05E+01
Eu-155	3.9134E-02	25.570	127.848	0.00E+00	1.00E+00	5.00E+00
Fe-55	6.7429E-03	25.570	127.848	0.00E+00	1.72E-01	8.62E-01
H-3	1.0599E-02	25.570	127.848	0.00E+00	2.71E-01	1.36E+00
I-129	7.5300E-07	25.570	127.848	0.00E+00	1.93E-05	9.63E-05
Kr-85	2.8595E-01	25.570	127.848	0.00E+00	7.31E+00	3.66E+01
Np-237	9.5479E-06	25.570	127.848	0.00E+00	2.44E-04	1.22E-03
Pa-231	8.9297E-10	25.570	127.848	0.00E+00	2.28E-08	1.14E-07
Pb-210	3.7609E-12	25.570	127.848	0.00E+00	9.62E-11	4.81E-10
Pm-147	2.5452E+00	25.570	127.848	0.00E+00	6.51E+01	3.25E+02
Pu-238	2.0550E-02	25.570	127.848	0.00E+00	5.25E-01	2.63E+00
Pu-239	4.2838E-04	25.570	127.848	0.00E+00	1.10E-02	5.48E-02
Pu-240	2.4401E-04	25.570	127.848	0.00E+00	6.24E-03	3.12E-02
Pu-241	6.8764E-02	25.570	127.848	0.00E+00	1.76E+00	8.79E+00
Pu-242	3.6329E-07	25.570	127.848	0.00E+00	9.29E-06	4.64E-05
Ra-226	3.8045E-11	25.570	127.848	0.00E+00	9.73E-10	4.86E-09
Ra-228	2.9902E-15	25.570	127.848	0.00E+00	7.65E-14	3.82E-13
Ru-106	1.9055E-01	25.570	127.848	0.00E+00	4.87E+00	2.44E+01
Se-79	1.2936E-05	25.570	127.848	0.00E+00	3.31E-04	1.65E-03
Sn-126	1.1574E-05	25.570	127.848	0.00E+00	2.96E-04	1.48E-03
Sr-90	2.7505E+00	25.570	127.848	0.00E+00	7.03E+01	3.52E+02
Tc-99	4.2239E-04	25.570	127.848	0.00E+00	1.08E-02	5.40E-02
Th-229	1.8848E-12	25.570	127.848	0.00E+00	4.82E-11	2.41E-10
Th-230	1.7042E-08	25.570	127.848	0.00E+00	4.36E-07	2.18E-06
Th-232	7.8132E-15	25.570	127.848	0.00E+00	2.00E-13	9.99E-13
Tl-208	4.4063E-08	25.570	127.848	0.00E+00	1.13E-06	5.63E-06
U-232	1.3151E-07	25.570	127.848	0.00E+00	3.36E-06	1.68E-05
U-233	1.9564E-09	25.570	127.848	0.00E+00	5.00E-08	2.50E-07
U-234	1.8371E-04	25.570	127.848	0.00E+00	4.70E-03	2.35E-02
U-235	-2.7235E-06	25.570	0.000	5.83E-04	5.14E-04	5.83E-04
U-236	1.5493E-05	25.570	127.848	0.00E+00	3.96E-04	1.98E-03
U-238	-4.2851E-09	25.570	0.000	3.63E-04	3.63E-04	3.63E-04
Y-90	2.7505E+00	25.570	127.848	0.00E+00	7.03E+01	3.52E+02
Other Radionuclides					1.32E+02	6.58E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.467E+13
0.0250	5.314E+12
0.0375	4.904E+12
0.0575	4.822E+12
0.0850	3.074E+12
0.1250	2.662E+12
0.2250	2.605E+12
0.3750	1.261E+12
0.5750	1.732E+13
0.8500	2.426E+12
1.2500	4.513E+11
1.7500	1.893E+10
2.2500	3.970E+10
2.7500	2.284E+08
3.5000	2.534E+07
5.0000	7.655E+01
7.0000	8.538E+00
11.0000	9.625E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.30E+00	6.48E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20.00000132	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		25.570
Bounding:	127.848	51.139

Basis for burnup used in estimate:
Nominal burnup assumed to be 2% of BOL heavy metal mass.
Bounding burnup taken directly from SFD (converted to MWd).

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.06	
Bounding:	0.30	0.40

Estimated EOL HM/Given EOL HM
0.98

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-O (TURKEY)	**[1]Fuel decay start date:**	2010
SNF ID #:	642	**Estimates as of:**	2010
Fuel Units & Descr:	2 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=.37kg ; EOL=.20kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.08

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	160.993	321.987	0.00E+00	2.34E-08	4.68E-08
Am-241	1.1190E-03	160.993	321.987	0.00E+00	1.80E-01	3.60E-01
Am-242m	4.5425E-07	160.993	321.987	0.00E+00	7.31E-05	1.46E-04
Am-243	1.4921E-06	160.993	321.987	0.00E+00	2.40E-04	4.80E-04
C-14	5.7244E-09	160.993	321.987	0.00E+00	9.22E-07	1.84E-06
Cl-36	1.3124E-32	160.993	321.987	0.00E+00	2.11E-30	4.23E-30
Cm-243	2.3676E-07	160.993	321.987	0.00E+00	3.81E-05	7.62E-05
Cm-244	5.2042E-05	160.993	321.987	0.00E+00	8.38E-03	1.68E-02
Co-60	3.8208E-05	160.993	321.987	0.00E+00	6.15E-03	1.23E-02
Cs-134	4.8693E-01	160.993	321.987	0.00E+00	7.84E+01	1.57E+02
Cs-135	3.4477E-06	160.993	321.987	0.00E+00	5.55E-04	1.11E-03
Cs-137	2.8731E+00	160.993	321.987	0.00E+00	4.63E+02	9.25E+02
Eu-154	8.2053E-02	160.993	321.987	0.00E+00	1.32E+01	2.64E+01
Eu-155	3.9134E-02	160.993	321.987	0.00E+00	6.30E+00	1.26E+01
Fe-55	6.7429E-03	160.993	321.987	0.00E+00	1.09E+00	2.17E+00
H-3	1.0599E-02	160.993	321.987	0.00E+00	1.71E+00	3.41E+00
I-129	7.5300E-07	160.993	321.987	0.00E+00	1.21E-04	2.42E-04
Kr-85	2.8595E-01	160.993	321.987	0.00E+00	4.60E+01	9.21E+01
Np-237	9.5479E-06	160.993	321.987	0.00E+00	1.54E-03	3.07E-03
Pa-231	8.9297E-10	160.993	321.987	0.00E+00	1.44E-07	2.88E-07
Pb-210	3.7609E-12	160.993	321.987	0.00E+00	6.05E-10	1.21E-09
Pm-147	2.5452E+00	160.993	321.987	0.00E+00	4.10E+02	8.20E+02
Pu-238	2.0550E-02	160.993	321.987	0.00E+00	3.31E+00	6.62E+00
Pu-239	4.2838E-04	160.993	321.987	0.00E+00	6.90E-02	1.38E-01
Pu-240	2.4401E-04	160.993	321.987	0.00E+00	3.93E-02	7.86E-02
Pu-241	6.8764E-02	160.993	321.987	0.00E+00	1.11E+01	2.21E+01
Pu-242	3.6329E-07	160.993	321.987	0.00E+00	5.85E-05	1.17E-04
Ra-226	3.8045E-11	160.993	321.987	0.00E+00	6.12E-09	1.22E-08
Ra-228	2.9902E-15	160.993	321.987	0.00E+00	4.81E-13	9.63E-13
Ru-106	1.9055E-01	160.993	321.987	0.00E+00	3.07E+01	6.14E+01
Se-79	1.2936E-05	160.993	321.987	0.00E+00	2.08E-03	4.17E-03
Sn-126	1.1574E-05	160.993	321.987	0.00E+00	1.86E-03	3.73E-03
Sr-90	2.7505E+00	160.993	321.987	0.00E+00	4.43E+02	8.86E+02
Tc-99	4.2239E-04	160.993	321.987	0.00E+00	6.80E-02	1.36E-01
Th-229	1.8848E-12	160.993	321.987	0.00E+00	3.03E-10	6.07E-10
Th-230	1.7042E-08	160.993	321.987	0.00E+00	2.74E-06	5.49E-06
Th-232	7.8132E-15	160.993	321.987	0.00E+00	1.26E-12	2.52E-12
Tl-208	4.4063E-08	160.993	321.987	0.00E+00	7.09E-06	1.42E-05
U-232	1.3151E-07	160.993	321.987	0.00E+00	2.12E-05	4.23E-05
U-233	1.9564E-09	160.993	321.987	0.00E+00	3.15E-07	6.30E-07
U-234	1.8371E-04	160.993	321.987	0.00E+00	2.96E-02	5.92E-02
U-235	-2.7235E-06	160.993	0.000	7.35E-04	2.96E-04	7.35E-04
U-236	1.5493E-05	160.993	321.987	0.00E+00	2.49E-03	4.99E-03
U-238	-4.2851E-09	160.993	0.000	8.60E-06	7.91E-06	8.60E-06
Y-90	2.7505E+00	160.993	321.987	0.00E+00	4.43E+02	8.86E+02
Other Radionuclides					8.28E+02	1.66E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.212E+13
0.0250	1.338E+13
0.0375	1.235E+13
0.0575	1.214E+13
0.0850	7.741E+12
0.1250	6.704E+12
0.2250	6.561E+12
0.3750	3.176E+12
0.5750	4.363E+13
0.8500	6.109E+12
1.2500	1.137E+12
1.7500	4.767E+10
2.2500	9.999E+10
2.7500	5.752E+08
3.5000	6.381E+07
5.0000	1.907E+02
7.0000	2.126E+01
11.0000	2.397E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.16E+00	1.63E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.9999987	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		160.993	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		321.987	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.40	
Bounding:	2.80	

Estimated EOL HM/Given EOL HM

1.05

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (CANADA)
SNF ID #: 513
Fuel Units & Descr: 35 - ASSEMBLY
Heavy Metal Mass: BOL=50.75kg ; EOL=45.68kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
1.46

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	4,806.123	9,612.247	0.00E+00	6.99E-07	1.40E-06
Am-241	1.1190E-03	4,806.123	9,612.247	0.00E+00	5.38E+00	1.08E+01
Am-242m	4.5425E-07	4,806.123	9,612.247	0.00E+00	2.18E-03	4.37E-03
Am-243	1.4921E-06	4,806.123	9,612.247	0.00E+00	7.17E-03	1.43E-02
C-14	5.7244E-09	4,806.123	9,612.247	0.00E+00	2.75E-05	5.50E-05
Cl-36	1.3124E-32	4,806.123	9,612.247	0.00E+00	6.31E-29	1.26E-28
Cm-243	2.3676E-07	4,806.123	9,612.247	0.00E+00	1.14E-03	2.28E-03
Cm-244	5.2042E-05	4,806.123	9,612.247	0.00E+00	2.50E-01	5.00E-01
Co-60	3.8208E-05	4,806.123	9,612.247	0.00E+00	1.84E-01	3.67E-01
Cs-134	4.8693E-01	4,806.123	9,612.247	0.00E+00	2.34E+03	4.68E+03
Cs-135	3.4477E-06	4,806.123	9,612.247	0.00E+00	1.66E-02	3.31E-02
Cs-137	2.8731E+00	4,806.123	9,612.247	0.00E+00	1.38E+04	2.76E+04
Eu-154	8.2053E-02	4,806.123	9,612.247	0.00E+00	3.94E+02	7.89E+02
Eu-155	3.9134E-02	4,806.123	9,612.247	0.00E+00	1.88E+02	3.76E+02
Fe-55	6.7429E-03	4,806.123	9,612.247	0.00E+00	3.24E+01	6.48E+01
H-3	1.0599E-02	4,806.123	9,612.247	0.00E+00	5.09E+01	1.02E+02
I-129	7.5300E-07	4,806.123	9,612.247	0.00E+00	3.62E-03	7.24E-03
Kr-85	2.8595E-01	4,806.123	9,612.247	0.00E+00	1.37E+03	2.75E+03
Np-237	9.5479E-06	4,806.123	9,612.247	0.00E+00	4.59E-02	9.18E-02
Pa-231	8.9297E-10	4,806.123	9,612.247	0.00E+00	4.29E-06	8.58E-06
Pb-210	3.7609E-12	4,806.123	9,612.247	0.00E+00	1.81E-08	3.62E-08
Pm-147	2.5452E+00	4,806.123	9,612.247	0.00E+00	1.22E+04	2.45E+04
Pu-238	2.0550E-02	4,806.123	9,612.247	0.00E+00	9.88E+01	1.98E+02
Pu-239	4.2838E-04	4,806.123	9,612.247	0.00E+00	2.06E+00	4.12E+00
Pu-240	2.4401E-04	4,806.123	9,612.247	0.00E+00	1.17E+00	2.35E+00
Pu-241	6.8764E-02	4,806.123	9,612.247	0.00E+00	3.30E+02	6.61E+02
Pu-242	3.6329E-07	4,806.123	9,612.247	0.00E+00	1.75E-03	3.49E-03
Ra-226	3.8045E-11	4,806.123	9,612.247	0.00E+00	1.83E-07	3.66E-07
Ra-228	2.9902E-15	4,806.123	9,612.247	0.00E+00	1.44E-11	2.87E-11
Ru-106	1.9055E-01	4,806.123	9,612.247	0.00E+00	9.16E+02	1.83E+03
Se-79	1.2936E-05	4,806.123	9,612.247	0.00E+00	6.22E-02	1.24E-01
Sn-126	1.1574E-05	4,806.123	9,612.247	0.00E+00	5.56E-02	1.11E-01
Sr-90	2.7505E+00	4,806.123	9,612.247	0.00E+00	1.32E+04	2.64E+04
Tc-99	4.2239E-04	4,806.123	9,612.247	0.00E+00	2.03E+00	4.06E+00
Th-229	1.8848E-12	4,806.123	9,612.247	0.00E+00	9.06E-09	1.81E-08
Th-230	1.7042E-08	4,806.123	9,612.247	0.00E+00	8.19E-05	1.64E-04
Th-232	7.8132E-15	4,806.123	9,612.247	0.00E+00	3.76E-11	7.51E-11
Tl-208	4.4063E-08	4,806.123	9,612.247	0.00E+00	2.12E-04	4.24E-04
U-232	1.3151E-07	4,806.123	9,612.247	0.00E+00	6.32E-04	1.26E-03
U-233	1.9564E-09	4,806.123	9,612.247	0.00E+00	9.40E-06	1.88E-05
U-234	1.8371E-04	4,806.123	9,612.247	0.00E+00	8.83E-01	1.77E+00
U-235	-2.7235E-06	4,806.123	0.000	2.19E-02	8.84E-03	2.19E-02
U-236	1.5493E-05	4,806.123	9,612.247	0.00E+00	7.45E-02	1.49E-01
U-238	-4.2851E-09	4,806.123	0.000	1.36E-02	1.36E-02	1.36E-02
Y-90	2.7505E+00	4,806.123	9,612.247	0.00E+00	1.32E+04	2.64E+04
Other Radionuclides					2.47E+04	4.94E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.855E+15
0.0250	3.995E+14
0.0375	3.687E+14
0.0575	3.625E+14
0.0850	2.311E+14
0.1250	2.001E+14
0.2250	1.959E+14
0.3750	9.481E+13
0.5750	1.302E+15
0.8500	1.824E+14
1.2500	3.393E+13
1.7500	1.423E+12
2.2500	2.985E+12
2.7500	1.717E+10
3.5000	1.905E+09
5.0000	5.724E+03
7.0000	6.383E+02
11.0000	7.195E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.44E+02	4.87E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		4,806.123
Bounding:		9,612.247

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.30	
Bounding:	0.60	

Estimated EOL HM/Given EOL HM
1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (CANADA)
SNF ID #: 720
Fuel Units & Descr: 21 - MTR TYPE
Heavy Metal Mass: BOL=4.43kg ; EOL=2.86kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.88

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	1,481.612	2,963.224	0.00E+00	2.16E-07	4.31E-07
Am-241	1.1190E-03	1,481.612	2,963.224	0.00E+00	1.66E+00	3.32E+00
Am-242m	4.5425E-07	1,481.612	2,963.224	0.00E+00	6.73E-04	1.35E-03
Am-243	1.4921E-06	1,481.612	2,963.224	0.00E+00	2.21E-03	4.42E-03
C-14	5.7244E-09	1,481.612	2,963.224	0.00E+00	8.48E-06	1.70E-05
Cl-36	1.3124E-32	1,481.612	2,963.224	0.00E+00	1.94E-29	3.89E-29
Cm-243	2.3676E-07	1,481.612	2,963.224	0.00E+00	3.51E-04	7.02E-04
Cm-244	5.2042E-05	1,481.612	2,963.224	0.00E+00	7.71E-02	1.54E-01
Co-60	3.8208E-05	1,481.612	2,963.224	0.00E+00	5.66E-02	1.13E-01
Cs-134	4.8693E-01	1,481.612	2,963.224	0.00E+00	7.21E+02	1.44E+03
Cs-135	3.4477E-06	1,481.612	2,963.224	0.00E+00	5.11E-03	1.02E-02
Cs-137	2.8731E+00	1,481.612	2,963.224	0.00E+00	4.26E+03	8.51E+03
Eu-154	8.2053E-02	1,481.612	2,963.224	0.00E+00	1.22E+02	2.43E+02
Eu-155	3.9134E-02	1,481.612	2,963.224	0.00E+00	5.80E+01	1.16E+02
Fe-55	6.7429E-03	1,481.612	2,963.224	0.00E+00	9.99E+00	2.00E+01
H-3	1.0599E-02	1,481.612	2,963.224	0.00E+00	1.57E+01	3.14E+01
I-129	7.5300E-07	1,481.612	2,963.224	0.00E+00	1.12E-03	2.23E-03
Kr-85	2.8595E-01	1,481.612	2,963.224	0.00E+00	4.24E+02	8.47E+02
Np-237	9.5479E-06	1,481.612	2,963.224	0.00E+00	1.41E-02	2.83E-02
Pa-231	8.9297E-10	1,481.612	2,963.224	0.00E+00	1.32E-06	2.65E-06
Pb-210	3.7609E-12	1,481.612	2,963.224	0.00E+00	5.57E-09	1.11E-08
Pm-147	2.5452E+00	1,481.612	2,963.224	0.00E+00	3.77E+03	7.54E+03
Pu-238	2.0550E-02	1,481.612	2,963.224	0.00E+00	3.04E+01	6.09E+01
Pu-239	4.2838E-04	1,481.612	2,963.224	0.00E+00	6.35E-01	1.27E+00
Pu-240	2.4401E-04	1,481.612	2,963.224	0.00E+00	3.62E-01	7.23E-01
Pu-241	6.8764E-02	1,481.612	2,963.224	0.00E+00	1.02E+02	2.04E+02
Pu-242	3.6329E-07	1,481.612	2,963.224	0.00E+00	5.38E-04	1.08E-03
Ra-226	3.8045E-11	1,481.612	2,963.224	0.00E+00	5.64E-08	1.13E-07
Ra-228	2.9902E-15	1,481.612	2,963.224	0.00E+00	4.43E-12	8.86E-12
Ru-106	1.9055E-01	1,481.612	2,963.224	0.00E+00	2.82E+02	5.65E+02
Se-79	1.2936E-05	1,481.612	2,963.224	0.00E+00	1.92E-02	3.83E-02
Sn-126	1.1574E-05	1,481.612	2,963.224	0.00E+00	1.71E-02	3.43E-02
Sr-90	2.7505E+00	1,481.612	2,963.224	0.00E+00	4.08E+03	8.15E+03
Tc-99	4.2239E-04	1,481.612	2,963.224	0.00E+00	6.26E-01	1.25E+00
Th-229	1.8848E-12	1,481.612	2,963.224	0.00E+00	2.79E-09	5.59E-09
Th-230	1.7042E-08	1,481.612	2,963.224	0.00E+00	2.53E-05	5.05E-05
Th-232	7.8132E-15	1,481.612	2,963.224	0.00E+00	1.16E-11	2.32E-11
Tl-208	4.4063E-08	1,481.612	2,963.224	0.00E+00	6.53E-05	1.31E-04
U-232	1.3151E-07	1,481.612	2,963.224	0.00E+00	1.95E-04	3.90E-04
U-233	1.9564E-09	1,481.612	2,963.224	0.00E+00	2.90E-06	5.80E-06
U-234	1.8371E-04	1,481.612	2,963.224	0.00E+00	2.72E-01	5.44E-01
U-235	-2.7235E-06	1,481.612	0.000	8.90E-03	4.86E-03	8.90E-03
U-236	1.5493E-05	1,481.612	2,963.224	0.00E+00	2.30E-02	4.59E-02
U-238	-4.2851E-09	1,481.612	0.000	1.04E-04	9.78E-05	1.04E-04
Y-90	2.7505E+00	1,481.612	2,963.224	0.00E+00	4.08E+03	8.15E+03
Other Radionuclides					7.62E+03	1.52E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	5.717E+14
0.0250	1.232E+14
0.0375	1.137E+14
0.0575	1.118E+14
0.0850	7.124E+13
0.1250	6.170E+13
0.2250	6.038E+13
0.3750	2.923E+13
0.5750	4.015E+14
0.8500	5.622E+13
1.2500	1.046E+13
1.7500	4.387E+11
2.2500	9.202E+11
2.7500	5.293E+09
3.5000	5.872E+08
5.0000	1.755E+03
7.0000	1.957E+02
11.0000	2.206E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
7.51E+01	1.50E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99999478	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,481.612	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		2,963.224	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.06	
Bounding:	2.13	

Estimated EOL HM/Given EOL HM
1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (GERMANY)	[1]Fuel decay start date:	2010
SNF ID #:	1068	Estimates as of:	2010
Fuel Units & Descr:	28 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=12.88kg ; EOL=9.17kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage: 18"x10'

1.17

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	3,513.442	7,026.884	0.00E+00	5.11E-07	1.02E-06
Am-241	1.1190E-03	3,513.442	7,026.884	0.00E+00	3.93E+00	7.86E+00
Am-242m	4.5425E-07	3,513.442	7,026.884	0.00E+00	1.60E-03	3.19E-03
Am-243	1.4921E-06	3,513.442	7,026.884	0.00E+00	5.24E-03	1.05E-02
C-14	5.7244E-09	3,513.442	7,026.884	0.00E+00	2.01E-05	4.02E-05
Cl-36	1.3124E-32	3,513.442	7,026.884	0.00E+00	4.61E-29	9.22E-29
Cm-243	2.3676E-07	3,513.442	7,026.884	0.00E+00	8.32E-04	1.66E-03
Cm-244	5.2042E-05	3,513.442	7,026.884	0.00E+00	1.83E-01	3.66E-01
Co-60	3.8208E-05	3,513.442	7,026.884	0.00E+00	1.34E-01	2.68E-01
Cs-134	4.8693E-01	3,513.442	7,026.884	0.00E+00	1.71E+03	3.42E+03
Cs-135	3.4477E-06	3,513.442	7,026.884	0.00E+00	1.21E-02	2.42E-02
Cs-137	2.8731E+00	3,513.442	7,026.884	0.00E+00	1.01E+04	2.02E+04
Eu-154	8.2053E-02	3,513.442	7,026.884	0.00E+00	2.88E+02	5.77E+02
Eu-155	3.9134E-02	3,513.442	7,026.884	0.00E+00	1.37E+02	2.75E+02
Fe-55	6.7429E-03	3,513.442	7,026.884	0.00E+00	2.37E+01	4.74E+01
H-3	1.0599E-02	3,513.442	7,026.884	0.00E+00	3.72E+01	7.45E+01
I-129	7.5300E-07	3,513.442	7,026.884	0.00E+00	2.65E-03	5.29E-03
Kr-85	2.8595E-01	3,513.442	7,026.884	0.00E+00	1.00E+03	2.01E+03
Np-237	9.5479E-06	3,513.442	7,026.884	0.00E+00	3.35E-02	6.71E-02
Pa-231	8.9297E-10	3,513.442	7,026.884	0.00E+00	3.14E-06	6.27E-06
Pb-210	3.7609E-12	3,513.442	7,026.884	0.00E+00	1.32E-08	2.64E-08
Pm-147	2.5452E+00	3,513.442	7,026.884	0.00E+00	8.94E+03	1.79E+04
Pu-238	2.0550E-02	3,513.442	7,026.884	0.00E+00	7.22E+01	1.44E+02
Pu-239	4.2838E-04	3,513.442	7,026.884	0.00E+00	1.51E+00	3.01E+00
Pu-240	2.4401E-04	3,513.442	7,026.884	0.00E+00	8.57E-01	1.71E+00
Pu-241	6.8764E-02	3,513.442	7,026.884	0.00E+00	2.42E+02	4.83E+02
Pu-242	3.6329E-07	3,513.442	7,026.884	0.00E+00	1.28E-03	2.55E-03
Ra-226	3.8045E-11	3,513.442	7,026.884	0.00E+00	1.34E-07	2.67E-07
Ra-228	2.9902E-15	3,513.442	7,026.884	0.00E+00	1.05E-11	2.10E-11
Ru-106	1.9055E-01	3,513.442	7,026.884	0.00E+00	6.69E+02	1.34E+03
Se-79	1.2936E-05	3,513.442	7,026.884	0.00E+00	4.54E-02	9.09E-02
Sn-126	1.1574E-05	3,513.442	7,026.884	0.00E+00	4.07E-02	8.13E-02
Sr-90	2.7505E+00	3,513.442	7,026.884	0.00E+00	9.66E+03	1.93E+04
Tc-99	4.2239E-04	3,513.442	7,026.884	0.00E+00	1.48E+00	2.97E+00
Th-229	1.8848E-12	3,513.442	7,026.884	0.00E+00	6.62E-09	1.32E-08
Th-230	1.7042E-08	3,513.442	7,026.884	0.00E+00	5.99E-05	1.20E-04
Th-232	7.8132E-15	3,513.442	7,026.884	0.00E+00	2.75E-11	5.49E-11
Tl-208	4.4063E-08	3,513.442	7,026.884	0.00E+00	1.55E-04	3.10E-04
U-232	1.3151E-07	3,513.442	7,026.884	0.00E+00	4.62E-04	9.24E-04
U-233	1.9564E-09	3,513.442	7,026.884	0.00E+00	6.87E-06	1.37E-05
U-234	1.8371E-04	3,513.442	7,026.884	0.00E+00	6.45E-01	1.29E+00
U-235	-2.7235E-06	3,513.442	0.000	1.25E-02	2.98E-03	1.25E-02
U-236	1.5493E-05	3,513.442	7,026.884	0.00E+00	5.44E-02	1.09E-01
U-238	-4.2851E-09	3,513.442	0.000	2.38E-03	2.36E-03	2.38E-03
Y-90	2.7505E+00	3,513.442	7,026.884	0.00E+00	9.66E+03	1.93E+04
Other Radionuclides					1.81E+04	3.61E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.356E+15
0.0250	2.921E+14
0.0375	2.695E+14
0.0575	2.650E+14
0.0850	1.689E+14
0.1250	1.463E+14
0.2250	1.432E+14
0.3750	6.931E+13
0.5750	9.521E+14
0.8500	1.333E+14
1.2500	2.481E+13
1.7500	1.040E+12
2.2500	2.182E+12
2.7500	1.255E+10
3.5000	1.393E+09
5.0000	4.167E+03
7.0000	4.646E+02
11.0000	5.237E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.78E+02	3.56E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	45.06986957	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		3,513.442
Bounding:		7,026.884

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.87	
Bounding:	1.73	

Estimated EOL HM/Given EOL HM: 1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (GERMANY)
SNF ID #: 519
Fuel Units & Descr: 97 - ASSEMBLY
Heavy Metal Mass: BOL=155.20kg ; EOL=131.80kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: TRIGA-Al (LW/U-Zrx, Alum., 10 to 20%, U)
[2]Template Burnup(MWd): 6.65
Template BOL Heavy Metal Mass (MT): 0.00018
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
4.04

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.0632E-10	22,332.297	44,664.593	0.00E+00	1.80E-05	3.60E-05
Am-241	2.2586E-03	22,332.297	44,664.593	0.00E+00	5.04E+01	1.01E+02
Am-242m	1.9925E-06	22,332.297	44,664.593	0.00E+00	4.45E-02	8.90E-02
Am-243	2.3323E-07	22,332.297	44,664.593	0.00E+00	5.21E-03	1.04E-02
C-14	4.3308E-05	22,332.297	44,664.593	0.00E+00	9.67E-01	1.93E+00
Cl-36	4.3023E-08	22,332.297	44,664.593	0.00E+00	9.61E-04	1.92E-03
Cm-243	2.7429E-07	22,332.297	44,664.593	0.00E+00	6.13E-03	1.23E-02
Cm-244	3.1504E-06	22,332.297	44,664.593	0.00E+00	7.04E-02	1.41E-01
Co-60	3.1008E-02	22,332.297	44,664.593	0.00E+00	6.92E+02	1.38E+03
Cs-134	1.0367E-01	22,332.297	44,664.593	0.00E+00	2.32E+03	4.63E+03
Cs-135	3.1549E-05	22,332.297	44,664.593	0.00E+00	7.05E-01	1.41E+00
Cs-137	2.7564E+00	22,332.297	44,664.593	0.00E+00	6.16E+04	1.23E+05
Eu-154	1.3490E+00	22,332.297	44,664.593	0.00E+00	3.01E+04	6.03E+04
Eu-155	4.3880E-01	22,332.297	44,664.593	0.00E+00	9.80E+03	1.96E+04
Fe-55	8.6782E-03	22,332.297	44,664.593	0.00E+00	1.94E+02	3.88E+02
H-3	1.0805E-02	22,332.297	44,664.593	0.00E+00	2.41E+02	4.83E+02
I-129	7.3805E-07	22,332.297	44,664.593	0.00E+00	1.65E-02	3.30E-02
Kr-85	2.5218E-01	22,332.297	44,664.593	0.00E+00	5.63E+03	1.13E+04
Np-237	1.4463E-06	22,332.297	44,664.593	0.00E+00	3.23E-02	6.46E-02
Pa-231	3.5970E-09	22,332.297	44,664.593	0.00E+00	8.03E-05	1.61E-04
Pb-210	8.2511E-15	22,332.297	44,664.593	0.00E+00	1.84E-10	3.69E-10
Pm-147	2.0767E+00	22,332.297	44,664.593	0.00E+00	4.64E+04	9.28E+04
Pu-238	1.3514E-03	22,332.297	44,664.593	0.00E+00	3.02E+01	6.04E+01
Pu-239	5.6947E-03	22,332.297	44,664.593	0.00E+00	1.27E+02	2.54E+02
Pu-240	2.2647E-03	22,332.297	44,664.593	0.00E+00	5.06E+01	1.01E+02
Pu-241	1.2574E-01	22,332.297	44,664.593	0.00E+00	2.81E+03	5.62E+03
Pu-242	3.0602E-07	22,332.297	44,664.593	0.00E+00	6.83E-03	1.37E-02
Ra-226	5.7353E-14	22,332.297	44,664.593	0.00E+00	1.28E-09	2.56E-09
Ra-228	1.8150E-10	22,332.297	44,664.593	0.00E+00	4.05E-06	8.11E-06
Ru-106	9.3744E-02	22,332.297	44,664.593	0.00E+00	2.09E+03	4.19E+03
Se-79	1.2938E-05	22,332.297	44,664.593	0.00E+00	2.89E-01	5.78E-01
Sn-126	1.2239E-05	22,332.297	44,664.593	0.00E+00	2.73E-01	5.47E-01
Sr-90	2.6000E+00	22,332.297	44,664.593	0.00E+00	5.81E+04	1.16E+05
Tc-99	4.4120E-04	22,332.297	44,664.593	0.00E+00	9.85E+00	1.97E+01
Th-229	1.4749E-10	22,332.297	44,664.593	0.00E+00	3.29E-06	6.59E-06
Th-230	1.9549E-11	22,332.297	44,664.593	0.00E+00	4.37E-07	8.73E-07
Th-232	2.3744E-10	22,332.297	44,664.593	0.00E+00	5.30E-06	1.06E-05
Tl-208	1.9459E-08	22,332.297	44,664.593	0.00E+00	4.35E-04	8.69E-04
U-232	5.6015E-08	22,332.297	44,664.593	0.00E+00	1.25E-03	2.50E-03
U-233	1.3132E-07	22,332.297	44,664.593	0.00E+00	2.93E-03	5.87E-03
U-234	1.7323E-07	22,332.297	44,664.593	0.00E+00	3.87E-03	7.74E-03
U-235	-2.6159E-06	22,332.297	0.000	6.71E-02	8.66E-03	6.71E-02
U-236	1.2717E-05	22,332.297	44,664.593	0.00E+00	2.84E-01	5.68E-01
U-238	-3.8857E-08	22,332.297	0.000	4.17E-02	4.09E-02	4.17E-02
Y-90	2.6015E+00	22,332.297	44,664.593	0.00E+00	5.81E+04	1.16E+05
Other Radionuclides					8.49E+04	1.70E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.557E+15
0.0250	1.641E+15
0.0375	2.044E+15
0.0575	1.567E+15
0.0850	1.097E+15
0.1250	1.640E+15
0.2250	9.156E+14
0.3750	4.075E+14
0.5750	5.166E+15
0.8500	1.272E+15
1.2500	1.318E+15
1.7500	3.773E+13
2.2500	4.586E+12
2.7500	3.724E+10
3.5000	4.355E+09
5.0000	2.557E+04
7.0000	2.894E+03
11.0000	3.296E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.12E+03	2.24E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LW AND U ZIRC HYDRIDE	LW AND U ZIRC HYDRIDE
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	19.99999963	10 to 20

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		22,332.297
Bounding:		44,664.593

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	3.89	
Bounding:	7.79	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (GERMANY)	[1]Fuel decay start date:	2010
SNF ID #:	588	Estimates as of:	2010
Fuel Units & Descr:	2 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=.40kg ; EOL=.27kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.08

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	124.060	248.119	0.00E+00	1.80E-08	3.61E-08
Am-241	1.1190E-03	124.060	248.119	0.00E+00	1.39E-01	2.78E-01
Am-242m	4.5425E-07	124.060	248.119	0.00E+00	5.64E-05	1.13E-04
Am-243	1.4921E-06	124.060	248.119	0.00E+00	1.85E-04	3.70E-04
C-14	5.7244E-09	124.060	248.119	0.00E+00	7.10E-07	1.42E-06
Cl-36	1.3124E-32	124.060	248.119	0.00E+00	1.63E-30	3.26E-30
Cm-243	2.3676E-07	124.060	248.119	0.00E+00	2.94E-05	5.87E-05
Cm-244	5.2042E-05	124.060	248.119	0.00E+00	6.46E-03	1.29E-02
Co-60	3.8208E-05	124.060	248.119	0.00E+00	4.74E-03	9.48E-03
Cs-134	4.8693E-01	124.060	248.119	0.00E+00	6.04E+01	1.21E+02
Cs-135	3.4477E-06	124.060	248.119	0.00E+00	4.28E-04	8.55E-04
Cs-137	2.8731E+00	124.060	248.119	0.00E+00	3.56E+02	7.13E+02
Eu-154	8.2053E-02	124.060	248.119	0.00E+00	1.02E+01	2.04E+01
Eu-155	3.9134E-02	124.060	248.119	0.00E+00	4.85E+00	9.71E+00
Fe-55	6.7429E-03	124.060	248.119	0.00E+00	8.37E-01	1.67E+00
H-3	1.0599E-02	124.060	248.119	0.00E+00	1.31E+00	2.63E+00
I-129	7.5300E-07	124.060	248.119	0.00E+00	9.34E-05	1.87E-04
Kr-85	2.8595E-01	124.060	248.119	0.00E+00	3.55E+01	7.09E+01
Np-237	9.5479E-06	124.060	248.119	0.00E+00	1.18E-03	2.37E-03
Pa-231	8.9297E-10	124.060	248.119	0.00E+00	1.11E-07	2.22E-07
Pb-210	3.7609E-12	124.060	248.119	0.00E+00	4.67E-10	9.33E-10
Pm-147	2.5452E+00	124.060	248.119	0.00E+00	3.16E+02	6.32E+02
Pu-238	2.0550E-02	124.060	248.119	0.00E+00	2.55E+00	5.10E+00
Pu-239	4.2838E-04	124.060	248.119	0.00E+00	5.31E-02	1.06E-01
Pu-240	2.4401E-04	124.060	248.119	0.00E+00	3.03E-02	6.05E-02
Pu-241	6.8764E-02	124.060	248.119	0.00E+00	8.53E+00	1.71E+01
Pu-242	3.6329E-07	124.060	248.119	0.00E+00	4.51E-05	9.01E-05
Ra-226	3.8045E-11	124.060	248.119	0.00E+00	4.72E-09	9.44E-09
Ra-228	2.9902E-15	124.060	248.119	0.00E+00	3.71E-13	7.42E-13
Ru-106	1.9055E-01	124.060	248.119	0.00E+00	2.36E+01	4.73E+01
Se-79	1.2936E-05	124.060	248.119	0.00E+00	1.60E-03	3.21E-03
Sn-126	1.1574E-05	124.060	248.119	0.00E+00	1.44E-03	2.87E-03
Sr-90	2.7505E+00	124.060	248.119	0.00E+00	3.41E+02	6.82E+02
Tc-99	4.2239E-04	124.060	248.119	0.00E+00	5.24E-02	1.05E-01
Th-229	1.8848E-12	124.060	248.119	0.00E+00	2.34E-10	4.68E-10
Th-230	1.7042E-08	124.060	248.119	0.00E+00	2.11E-06	4.23E-06
Th-232	7.8132E-15	124.060	248.119	0.00E+00	9.69E-13	1.94E-12
Tl-208	4.4063E-08	124.060	248.119	0.00E+00	5.47E-06	1.09E-05
U-232	1.3151E-07	124.060	248.119	0.00E+00	1.63E-05	3.26E-05
U-233	1.9564E-09	124.060	248.119	0.00E+00	2.43E-07	4.85E-07
U-234	1.8371E-04	124.060	248.119	0.00E+00	2.28E-02	4.56E-02
U-235	-2.7235E-06	124.060	0.000	7.87E-04	4.49E-04	7.87E-04
U-236	1.5493E-05	124.060	248.119	0.00E+00	1.92E-03	3.84E-03
U-238	-4.2851E-09	124.060	0.000	1.36E-05	1.31E-05	1.36E-05
Y-90	2.7505E+00	124.060	248.119	0.00E+00	3.41E+02	6.82E+02
Other Radionuclides					6.38E+02	1.28E+03

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	4.787E+13
0.0250	1.031E+13
0.0375	9.517E+12
0.0575	9.357E+12
0.0850	5.965E+12
0.1250	5.166E+12
0.2250	5.056E+12
0.3750	2.447E+12
0.5750	3.362E+13
0.8500	4.707E+12
1.2500	8.759E+11
1.7500	3.673E+10
2.2500	7.705E+10
2.7500	4.432E+08
3.5000	4.917E+07
5.0000	1.470E+02
7.0000	1.639E+01
11.0000	1.847E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
6.29E+00	1.26E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	90.00000989	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		124.060	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		248.119	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.97	
Bounding:	1.95	

Estimated EOL HM/Given EOL HM: 1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (GERMANY)
SNF ID #: 1067
Fuel Units & Descr: 7 - ASSEMBLY
Heavy Metal Mass: BOL=14.70kg ; EOL=12.94kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:

18"x10'
0.29

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	1,670.542	3,341.084	0.00E+00	2.43E-07	4.86E-07
Am-241	1.1190E-03	1,670.542	3,341.084	0.00E+00	1.87E+00	3.74E+00
Am-242m	4.5425E-07	1,670.542	3,341.084	0.00E+00	7.59E-04	1.52E-03
Am-243	1.4921E-06	1,670.542	3,341.084	0.00E+00	2.49E-03	4.99E-03
C-14	5.7244E-09	1,670.542	3,341.084	0.00E+00	9.56E-06	1.91E-05
Cl-36	1.3124E-32	1,670.542	3,341.084	0.00E+00	2.19E-29	4.38E-29
Cm-243	2.3676E-07	1,670.542	3,341.084	0.00E+00	3.96E-04	7.91E-04
Cm-244	5.2042E-05	1,670.542	3,341.084	0.00E+00	8.69E-02	1.74E-01
Co-60	3.8208E-05	1,670.542	3,341.084	0.00E+00	6.38E-02	1.28E-01
Cs-134	4.8693E-01	1,670.542	3,341.084	0.00E+00	8.13E+02	1.63E+03
Cs-135	3.4477E-06	1,670.542	3,341.084	0.00E+00	5.76E-03	1.15E-02
Cs-137	2.8731E+00	1,670.542	3,341.084	0.00E+00	4.80E+03	9.60E+03
Eu-154	8.2053E-02	1,670.542	3,341.084	0.00E+00	1.37E+02	2.74E+02
Eu-155	3.9134E-02	1,670.542	3,341.084	0.00E+00	6.54E+01	1.31E+02
Fe-55	6.7429E-03	1,670.542	3,341.084	0.00E+00	1.13E+01	2.25E+01
H-3	1.0599E-02	1,670.542	3,341.084	0.00E+00	1.77E+01	3.54E+01
I-129	7.5300E-07	1,670.542	3,341.084	0.00E+00	1.26E-03	2.52E-03
Kr-85	2.8595E-01	1,670.542	3,341.084	0.00E+00	4.78E+02	9.55E+02
Np-237	9.5479E-06	1,670.542	3,341.084	0.00E+00	1.60E-02	3.19E-02
Pa-231	8.9297E-10	1,670.542	3,341.084	0.00E+00	1.49E-06	2.98E-06
Pb-210	3.7609E-12	1,670.542	3,341.084	0.00E+00	6.28E-09	1.26E-08
Pm-147	2.5452E+00	1,670.542	3,341.084	0.00E+00	4.25E+03	8.50E+03
Pu-238	2.0550E-02	1,670.542	3,341.084	0.00E+00	3.43E+01	6.87E+01
Pu-239	4.2838E-04	1,670.542	3,341.084	0.00E+00	7.16E-01	1.43E+00
Pu-240	2.4401E-04	1,670.542	3,341.084	0.00E+00	4.08E-01	8.15E-01
Pu-241	6.8764E-02	1,670.542	3,341.084	0.00E+00	1.15E+02	2.30E+02
Pu-242	3.6329E-07	1,670.542	3,341.084	0.00E+00	6.07E-04	1.21E-03
Ra-226	3.8045E-11	1,670.542	3,341.084	0.00E+00	6.36E-08	1.27E-07
Ra-228	2.9902E-15	1,670.542	3,341.084	0.00E+00	5.00E-12	9.99E-12
Ru-106	1.9055E-01	1,670.542	3,341.084	0.00E+00	3.18E+02	6.37E+02
Se-79	1.2936E-05	1,670.542	3,341.084	0.00E+00	2.16E-02	4.32E-02
Sn-126	1.1574E-05	1,670.542	3,341.084	0.00E+00	1.93E-02	3.87E-02
Sr-90	2.7505E+00	1,670.542	3,341.084	0.00E+00	4.59E+03	9.19E+03
Tc-99	4.2239E-04	1,670.542	3,341.084	0.00E+00	7.06E-01	1.41E+00
Th-229	1.8848E-12	1,670.542	3,341.084	0.00E+00	3.15E-09	6.30E-09
Th-230	1.7042E-08	1,670.542	3,341.084	0.00E+00	2.85E-05	5.69E-05
Th-232	7.8132E-15	1,670.542	3,341.084	0.00E+00	1.31E-11	2.61E-11
Tl-208	4.4063E-08	1,670.542	3,341.084	0.00E+00	7.36E-05	1.47E-04
U-232	1.3151E-07	1,670.542	3,341.084	0.00E+00	2.20E-04	4.39E-04
U-233	1.9564E-09	1,670.542	3,341.084	0.00E+00	3.27E-06	6.54E-06
U-234	1.8371E-04	1,670.542	3,341.084	0.00E+00	3.07E-01	6.14E-01
U-235	-2.7235E-06	1,670.542	0.000	6.35E-03	1.80E-03	6.35E-03
U-236	1.5493E-05	1,670.542	3,341.084	0.00E+00	2.59E-02	5.18E-02
U-238	-4.2851E-09	1,670.542	0.000	3.95E-03	3.95E-03	3.95E-03
Y-90	2.7505E+00	1,670.542	3,341.084	0.00E+00	4.59E+03	9.19E+03
Other Radionuclides					8.59E+03	1.72E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.446E+14
0.0250	1.389E+14
0.0375	1.281E+14
0.0575	1.260E+14
0.0850	8.033E+13
0.1250	6.956E+13
0.2250	6.808E+13
0.3750	3.296E+13
0.5750	4.527E+14
0.8500	6.339E+13
1.2500	1.179E+13
1.7500	4.946E+11
2.2500	1.037E+12
2.7500	5.968E+09
3.5000	6.621E+08
5.0000	1.988E+03
7.0000	2.216E+02
11.0000	2.498E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.47E+01	1.69E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3Si2	U
BOL Enrichment %:	20.00000028	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		1,670.542
Bounding:		3,341.084

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.36	
Bounding:	0.72	

Estimated EOL HM/Given EOL HM

1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (GERMANY)	Fuel decay start date:[1]	2010
SNF ID #:	582	Estimates as of:	2010
Fuel Units & Descr:	1 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=.18kg ; EOL=.13kg	Template Burnup(MWd):[2]	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage: 18"x10'

0.04

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	48.109	96.217	0.00E+00	7.00E-09	1.40E-08
Am-241	1.1190E-03	48.109	96.217	0.00E+00	5.38E-02	1.08E-01
Am-242m	4.5425E-07	48.109	96.217	0.00E+00	2.19E-05	4.37E-05
Am-243	1.4921E-06	48.109	96.217	0.00E+00	7.18E-05	1.44E-04
C-14	5.7244E-09	48.109	96.217	0.00E+00	2.75E-07	5.51E-07
Cl-36	1.3124E-32	48.109	96.217	0.00E+00	6.31E-31	1.26E-30
Cm-243	2.3676E-07	48.109	96.217	0.00E+00	1.14E-05	2.28E-05
Cm-244	5.2042E-05	48.109	96.217	0.00E+00	2.50E-03	5.01E-03
Co-60	3.8208E-05	48.109	96.217	0.00E+00	1.84E-03	3.68E-03
Cs-134	4.8693E-01	48.109	96.217	0.00E+00	2.34E+01	4.69E+01
Cs-135	3.4477E-06	48.109	96.217	0.00E+00	1.66E-04	3.32E-04
Cs-137	2.8731E+00	48.109	96.217	0.00E+00	1.38E+02	2.76E+02
Eu-154	8.2053E-02	48.109	96.217	0.00E+00	3.95E+00	7.89E+00
Eu-155	3.9134E-02	48.109	96.217	0.00E+00	1.88E+00	3.77E+00
Fe-55	6.7429E-03	48.109	96.217	0.00E+00	3.24E-01	6.49E-01
H-3	1.0599E-02	48.109	96.217	0.00E+00	5.10E-01	1.02E+00
I-129	7.5300E-07	48.109	96.217	0.00E+00	3.62E-05	7.25E-05
Kr-85	2.8595E-01	48.109	96.217	0.00E+00	1.38E+01	2.75E+01
Np-237	9.5479E-06	48.109	96.217	0.00E+00	4.59E-04	9.19E-04
Pa-231	8.9297E-10	48.109	96.217	0.00E+00	4.30E-08	8.59E-08
Pb-210	3.7609E-12	48.109	96.217	0.00E+00	1.81E-10	3.62E-10
Pm-147	2.5452E+00	48.109	96.217	0.00E+00	1.22E+02	2.45E+02
Pu-238	2.0550E-02	48.109	96.217	0.00E+00	9.89E-01	1.98E+00
Pu-239	4.2838E-04	48.109	96.217	0.00E+00	2.06E-02	4.12E-02
Pu-240	2.4401E-04	48.109	96.217	0.00E+00	1.17E-02	2.35E-02
Pu-241	6.8764E-02	48.109	96.217	0.00E+00	3.31E+00	6.62E+00
Pu-242	3.6329E-07	48.109	96.217	0.00E+00	1.75E-05	3.50E-05
Ra-226	3.8045E-11	48.109	96.217	0.00E+00	1.83E-09	3.66E-09
Ra-228	2.9902E-15	48.109	96.217	0.00E+00	1.44E-13	2.88E-13
Ru-106	1.9055E-01	48.109	96.217	0.00E+00	9.17E+00	1.83E+01
Se-79	1.2936E-05	48.109	96.217	0.00E+00	6.22E-04	1.24E-03
Sn-126	1.1574E-05	48.109	96.217	0.00E+00	5.57E-04	1.11E-03
Sr-90	2.7505E+00	48.109	96.217	0.00E+00	1.32E+02	2.65E+02
Tc-99	4.2239E-04	48.109	96.217	0.00E+00	2.03E-02	4.06E-02
Th-229	1.8848E-12	48.109	96.217	0.00E+00	9.07E-11	1.81E-10
Th-230	1.7042E-08	48.109	96.217	0.00E+00	8.20E-07	1.64E-06
Th-232	7.8132E-15	48.109	96.217	0.00E+00	3.76E-13	7.52E-13
Tl-208	4.4063E-08	48.109	96.217	0.00E+00	2.12E-06	4.24E-06
U-232	1.3151E-07	48.109	96.217	0.00E+00	6.33E-06	1.27E-05
U-233	1.9564E-09	48.109	96.217	0.00E+00	9.41E-08	1.88E-07
U-234	1.8371E-04	48.109	96.217	0.00E+00	8.84E-03	1.77E-02
U-235	-2.7235E-06	48.109	0.000	3.54E-04	2.23E-04	3.54E-04
U-236	1.5493E-05	48.109	96.217	0.00E+00	7.45E-04	1.49E-03
U-238	-4.2851E-09	48.109	0.000	4.15E-06	3.94E-06	4.15E-06
Y-90	2.7505E+00	48.109	96.217	0.00E+00	1.32E+02	2.65E+02
Other Radionuclides					2.47E+02	4.95E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.856E+13
0.0250	3.999E+12
0.0375	3.690E+12
0.0575	3.629E+12
0.0850	2.313E+12
0.1250	2.003E+12
0.2250	1.961E+12
0.3750	9.491E+11
0.5750	1.304E+13
0.8500	1.825E+12
1.2500	3.397E+11
1.7500	1.424E+10
2.2500	2.988E+10
2.7500	1.719E+08
3.5000	1.907E+07
5.0000	5.699E+01
7.0000	6.354E+00
11.0000	7.162E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.44E+00	4.88E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99999263	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		48.109	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		96.217	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.87	
Bounding:	1.73	

Estimated EOL HM/Given EOL HM: 1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (GERMANY)	**[1]Fuel decay start date:**	2010
SNF ID #:	585	**Estimates as of:**	2010
Fuel Units & Descr:	50 - MTR TYPE	**Template:**	TRIGA-Al (LW/U-Zrx, Alum., 10 to 20%, U)
Heavy Metal Mass:	BOL=9.68kg ; EOL=4.64kg	**[2]Template Burnup(MWd):**	6.65
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00018
		Template Decay Time:	5 years

Estimated Canister usage: 18"x10'

2.08

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	8.0632E-10	4,810.774	9,234.967	0.00E+00	3.88E-06	7.45E-06
Am-241	2.2586E-03	4,810.774	9,234.967	0.00E+00	1.09E+01	2.09E+01
Am-242m	1.9925E-06	4,810.774	9,234.967	0.00E+00	9.59E-03	1.84E-02
Am-243	2.3323E-07	4,810.774	9,234.967	0.00E+00	1.12E-03	2.15E-03
C-14	4.3308E-05	4,810.774	9,234.967	0.00E+00	2.08E-01	4.00E-01
Cl-36	4.3023E-08	4,810.774	9,234.967	0.00E+00	2.07E-04	3.97E-04
Cm-243	2.7429E-07	4,810.774	9,234.967	0.00E+00	1.32E-03	2.53E-03
Cm-244	3.1504E-06	4,810.774	9,234.967	0.00E+00	1.52E-02	2.91E-02
Co-60	3.1008E-02	4,810.774	9,234.967	0.00E+00	1.49E+02	2.86E+02
Cs-134	1.0367E-01	4,810.774	9,234.967	0.00E+00	4.99E+02	9.57E+02
Cs-135	3.1549E-05	4,810.774	9,234.967	0.00E+00	1.52E-01	2.91E-01
Cs-137	2.7564E+00	4,810.774	9,234.967	0.00E+00	1.33E+04	2.55E+04
Eu-154	1.3490E+00	4,810.774	9,234.967	0.00E+00	6.49E+03	1.25E+04
Eu-155	4.3880E-01	4,810.774	9,234.967	0.00E+00	2.11E+03	4.05E+03
Fe-55	8.6782E-03	4,810.774	9,234.967	0.00E+00	4.17E+01	8.01E+01
H-3	1.0805E-02	4,810.774	9,234.967	0.00E+00	5.20E+01	9.98E+01
I-129	7.3805E-07	4,810.774	9,234.967	0.00E+00	3.55E-03	6.82E-03
Kr-85	2.5218E-01	4,810.774	9,234.967	0.00E+00	1.21E+03	2.33E+03
Np-237	1.4463E-06	4,810.774	9,234.967	0.00E+00	6.96E-03	1.34E-02
Pa-231	3.5970E-09	4,810.774	9,234.967	0.00E+00	1.73E-05	3.32E-05
Pb-210	8.2511E-15	4,810.774	9,234.967	0.00E+00	3.97E-11	7.62E-11
Pm-147	2.0767E+00	4,810.774	9,234.967	0.00E+00	9.99E+03	1.92E+04
Pu-238	1.3514E-03	4,810.774	9,234.967	0.00E+00	6.50E+00	1.25E+01
Pu-239	5.6947E-03	4,810.774	9,234.967	0.00E+00	2.74E+01	5.26E+01
Pu-240	2.2647E-03	4,810.774	9,234.967	0.00E+00	1.09E+01	2.09E+01
Pu-241	1.2574E-01	4,810.774	9,234.967	0.00E+00	6.05E+02	1.16E+03
Pu-242	3.0602E-07	4,810.774	9,234.967	0.00E+00	1.47E-03	2.83E-03
Ra-226	5.7353E-14	4,810.774	9,234.967	0.00E+00	2.76E-10	5.30E-10
Ra-228	1.8150E-10	4,810.774	9,234.967	0.00E+00	8.73E-07	1.68E-06
Ru-106	9.3744E-02	4,810.774	9,234.967	0.00E+00	4.51E+02	8.66E+02
Se-79	1.2938E-05	4,810.774	9,234.967	0.00E+00	6.22E-02	1.19E-01
Sn-126	1.2239E-05	4,810.774	9,234.967	0.00E+00	5.89E-02	1.13E-01
Sr-90	2.6000E+00	4,810.774	9,234.967	0.00E+00	1.25E+04	2.40E+04
Tc-99	4.4120E-04	4,810.774	9,234.967	0.00E+00	2.12E+00	4.07E+00
Th-229	1.4749E-10	4,810.774	9,234.967	0.00E+00	7.10E-07	1.36E-06
Th-230	1.9549E-11	4,810.774	9,234.967	0.00E+00	9.40E-08	1.81E-07
Th-232	2.3744E-10	4,810.774	9,234.967	0.00E+00	1.14E-06	2.19E-06
Tl-208	1.9459E-08	4,810.774	9,234.967	0.00E+00	9.36E-05	1.80E-04
U-232	5.6015E-08	4,810.774	9,234.967	0.00E+00	2.69E-04	5.17E-04
U-233	1.3132E-07	4,810.774	9,234.967	0.00E+00	6.32E-04	1.21E-03
U-234	1.7323E-07	4,810.774	9,234.967	0.00E+00	8.33E-04	1.60E-03
U-235	-2.6159E-06	4,810.774	0.000	1.94E-02	6.86E-03	1.94E-02
U-236	1.2717E-05	4,810.774	9,234.967	0.00E+00	6.12E-02	1.17E-01
U-238	-3.8857E-08	4,810.774	0.000	2.28E-04	4.07E-05	2.28E-04
Y-90	2.6015E+00	4,810.774	9,234.967	0.00E+00	1.25E+04	2.40E+04
Other Radionuclides					1.83E+04	3.51E+04

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	1.563E+15
0.0250	3.392E+14
0.0375	4.226E+14
0.0575	3.240E+14
0.0850	2.267E+14
0.1250	3.392E+14
0.2250	1.893E+14
0.3750	8.425E+13
0.5750	1.068E+15
0.8500	2.629E+14
1.2500	2.726E+14
1.7500	7.800E+12
2.2500	9.482E+11
2.7500	7.701E+09
3.5000	9.004E+08
5.0000	5.268E+03
7.0000	5.961E+02
11.0000	6.790E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.42E+02	4.64E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	LW AND U ZIRC HYDRIDE	LW AND U ZIRC HYDRIDE
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.9999938	10 to 20

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]	From SFD	Estimated
Nominal:		4,810.774
Bounding:		9,234.967

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup calculated assuming all BOL heavy metal burned.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	13.46	
Bounding:	25.84	

Estimated EOL HM/Given EOL HM

1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (GERMANY)	[1]Fuel decay start date:	2010
SNF ID #:	584	Estimates as of:	2010
Fuel Units & Descr:	44 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=8.14kg ; EOL=5.94kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage: 18"x10'

1.83

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	2,075.109	4,150.218	0.00E+00	3.02E-07	6.04E-07
Am-241	1.1190E-03	2,075.109	4,150.218	0.00E+00	2.32E+00	4.64E+00
Am-242m	4.5425E-07	2,075.109	4,150.218	0.00E+00	9.43E-04	1.89E-03
Am-243	1.4921E-06	2,075.109	4,150.218	0.00E+00	3.10E-03	6.19E-03
C-14	5.7244E-09	2,075.109	4,150.218	0.00E+00	1.19E-05	2.38E-05
Cl-36	1.3124E-32	2,075.109	4,150.218	0.00E+00	2.72E-29	5.45E-29
Cm-243	2.3676E-07	2,075.109	4,150.218	0.00E+00	4.91E-04	9.83E-04
Cm-244	5.2042E-05	2,075.109	4,150.218	0.00E+00	1.08E-01	2.16E-01
Co-60	3.8208E-05	2,075.109	4,150.218	0.00E+00	7.93E-02	1.59E-01
Cs-134	4.8693E-01	2,075.109	4,150.218	0.00E+00	1.01E+03	2.02E+03
Cs-135	3.4477E-06	2,075.109	4,150.218	0.00E+00	7.15E-03	1.43E-02
Cs-137	2.8731E+00	2,075.109	4,150.218	0.00E+00	5.96E+03	1.19E+04
Eu-154	8.2053E-02	2,075.109	4,150.218	0.00E+00	1.70E+02	3.41E+02
Eu-155	3.9134E-02	2,075.109	4,150.218	0.00E+00	8.12E+01	1.62E+02
Fe-55	6.7429E-03	2,075.109	4,150.218	0.00E+00	1.40E+01	2.80E+01
H-3	1.0599E-02	2,075.109	4,150.218	0.00E+00	2.20E+01	4.40E+01
I-129	7.5300E-07	2,075.109	4,150.218	0.00E+00	1.56E-03	3.13E-03
Kr-85	2.8595E-01	2,075.109	4,150.218	0.00E+00	5.93E+02	1.19E+03
Np-237	9.5479E-06	2,075.109	4,150.218	0.00E+00	1.98E-02	3.96E-02
Pa-231	8.9297E-10	2,075.109	4,150.218	0.00E+00	1.85E-06	3.71E-06
Pb-210	3.7609E-12	2,075.109	4,150.218	0.00E+00	7.80E-09	1.56E-08
Pm-147	2.5452E+00	2,075.109	4,150.218	0.00E+00	5.28E+03	1.06E+04
Pu-238	2.0550E-02	2,075.109	4,150.218	0.00E+00	4.26E+01	8.53E+01
Pu-239	4.2838E-04	2,075.109	4,150.218	0.00E+00	8.89E-01	1.78E+00
Pu-240	2.4401E-04	2,075.109	4,150.218	0.00E+00	5.06E-01	1.01E+00
Pu-241	6.8764E-02	2,075.109	4,150.218	0.00E+00	1.43E+02	2.85E+02
Pu-242	3.6329E-07	2,075.109	4,150.218	0.00E+00	7.54E-04	1.51E-03
Ra-226	3.8045E-11	2,075.109	4,150.218	0.00E+00	7.89E-08	1.58E-07
Ra-228	2.9902E-15	2,075.109	4,150.218	0.00E+00	6.20E-12	1.24E-11
Ru-106	1.9055E-01	2,075.109	4,150.218	0.00E+00	3.95E+02	7.91E+02
Se-79	1.2936E-05	2,075.109	4,150.218	0.00E+00	2.68E-02	5.37E-02
Sn-126	1.1574E-05	2,075.109	4,150.218	0.00E+00	2.40E-02	4.80E-02
Sr-90	2.7505E+00	2,075.109	4,150.218	0.00E+00	5.71E+03	1.14E+04
Tc-99	4.2239E-04	2,075.109	4,150.218	0.00E+00	8.76E-01	1.75E+00
Th-229	1.8848E-12	2,075.109	4,150.218	0.00E+00	3.91E-09	7.82E-09
Th-230	1.7042E-08	2,075.109	4,150.218	0.00E+00	3.54E-05	7.07E-05
Th-232	7.8132E-15	2,075.109	4,150.218	0.00E+00	1.62E-11	3.24E-11
Tl-208	4.4063E-08	2,075.109	4,150.218	0.00E+00	9.14E-05	1.83E-04
U-232	1.3151E-07	2,075.109	4,150.218	0.00E+00	2.73E-04	5.46E-04
U-233	1.9564E-09	2,075.109	4,150.218	0.00E+00	4.06E-06	8.12E-06
U-234	1.8371E-04	2,075.109	4,150.218	0.00E+00	3.81E-01	7.62E-01
U-235	-2.7235E-06	2,075.109	0.000	1.64E-02	1.07E-02	1.64E-02
U-236	1.5493E-05	2,075.109	4,150.218	0.00E+00	3.21E-02	6.43E-02
U-238	-4.2851E-09	2,075.109	0.000	1.91E-04	1.83E-04	1.91E-04
Y-90	2.7505E+00	2,075.109	4,150.218	0.00E+00	5.71E+03	1.14E+04
Other Radionuclides					1.07E+04	2.13E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	8.007E+14
0.0250	1.725E+14
0.0375	1.592E+14
0.0575	1.565E+14
0.0850	9.978E+13
0.1250	8.641E+13
0.2250	8.457E+13
0.3750	4.094E+13
0.5750	5.623E+14
0.8500	7.874E+13
1.2500	1.465E+13
1.7500	6.144E+11
2.2500	1.289E+12
2.7500	7.414E+09
3.5000	8.225E+08
5.0000	2.458E+03
7.0000	2.741E+02
11.0000	3.089E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.05E+02	2.10E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.00001838	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		2,075.109
Bounding:		4,150.218

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.

Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.81	
Bounding:	1.62	

Estimated EOL HM/Given EOL HM

1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (GREECE)	**¹Fuel decay start date:**	2010
SNF ID #:	532	**Estimates as of:**	2010
Fuel Units & Descr:	67 - ASSEMBLY	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=74.37kg ; EOL=67.68kg	**²Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
2.79

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)²	Bounding Fuel Burnup (MWd)²	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	6,332.340	12,664.680	0.00E+00	9.21E-07	1.84E-06
Am-241	1.1190E-03	6,332.340	12,664.680	0.00E+00	7.09E+00	1.42E+01
Am-242m	4.5425E-07	6,332.340	12,664.680	0.00E+00	2.88E-03	5.75E-03
Am-243	1.4921E-06	6,332.340	12,664.680	0.00E+00	9.45E-03	1.89E-02
C-14	5.7244E-09	6,332.340	12,664.680	0.00E+00	3.62E-05	7.25E-05
Cl-36	1.3124E-32	6,332.340	12,664.680	0.00E+00	8.31E-29	1.66E-28
Cm-243	2.3676E-07	6,332.340	12,664.680	0.00E+00	1.50E-03	3.00E-03
Cm-244	5.2042E-05	6,332.340	12,664.680	0.00E+00	3.30E-01	6.59E-01
Co-60	3.8208E-05	6,332.340	12,664.680	0.00E+00	2.42E-01	4.84E-01
Cs-134	4.8693E-01	6,332.340	12,664.680	0.00E+00	3.08E+03	6.17E+03
Cs-135	3.4477E-06	6,332.340	12,664.680	0.00E+00	2.18E-02	4.37E-02
Cs-137	2.8731E+00	6,332.340	12,664.680	0.00E+00	1.82E+04	3.64E+04
Eu-154	8.2053E-02	6,332.340	12,664.680	0.00E+00	5.20E+02	1.04E+03
Eu-155	3.9134E-02	6,332.340	12,664.680	0.00E+00	2.48E+02	4.96E+02
Fe-55	6.7429E-03	6,332.340	12,664.680	0.00E+00	4.27E+01	8.54E+01
H-3	1.0599E-02	6,332.340	12,664.680	0.00E+00	6.71E+01	1.34E+02
I-129	7.5300E-07	6,332.340	12,664.680	0.00E+00	4.77E-03	9.54E-03
Kr-85	2.8595E-01	6,332.340	12,664.680	0.00E+00	1.81E+03	3.62E+03
Np-237	9.5479E-06	6,332.340	12,664.680	0.00E+00	6.05E-02	1.21E-01
Pa-231	8.9297E-10	6,332.340	12,664.680	0.00E+00	5.65E-06	1.13E-05
Pb-210	3.7609E-12	6,332.340	12,664.680	0.00E+00	2.38E-08	4.76E-08
Pm-147	2.5452E+00	6,332.340	12,664.680	0.00E+00	1.61E+04	3.22E+04
Pu-238	2.0550E-02	6,332.340	12,664.680	0.00E+00	1.30E+02	2.60E+02
Pu-239	4.2838E-04	6,332.340	12,664.680	0.00E+00	2.71E+00	5.43E+00
Pu-240	2.4401E-04	6,332.340	12,664.680	0.00E+00	1.55E+00	3.09E+00
Pu-241	6.8764E-02	6,332.340	12,664.680	0.00E+00	4.35E+02	8.71E+02
Pu-242	3.6329E-07	6,332.340	12,664.680	0.00E+00	2.30E-03	4.60E-03
Ra-226	3.8045E-11	6,332.340	12,664.680	0.00E+00	2.41E-07	4.82E-07
Ra-228	2.9902E-15	6,332.340	12,664.680	0.00E+00	1.89E-11	3.79E-11
Ru-106	1.9055E-01	6,332.340	12,664.680	0.00E+00	1.21E+03	2.41E+03
Se-79	1.2936E-05	6,332.340	12,664.680	0.00E+00	8.19E-02	1.64E-01
Sn-126	1.1574E-05	6,332.340	12,664.680	0.00E+00	7.33E-02	1.47E-01
Sr-90	2.7505E+00	6,332.340	12,664.680	0.00E+00	1.74E+04	3.48E+04
Tc-99	4.2239E-04	6,332.340	12,664.680	0.00E+00	2.67E+00	5.35E+00
Th-229	1.8848E-12	6,332.340	12,664.680	0.00E+00	1.19E-08	2.39E-08
Th-230	1.7042E-08	6,332.340	12,664.680	0.00E+00	1.08E-04	2.16E-04
Th-232	7.8132E-15	6,332.340	12,664.680	0.00E+00	4.95E-11	9.90E-11
Tl-208	4.4063E-08	6,332.340	12,664.680	0.00E+00	2.79E-04	5.58E-04
U-232	1.3151E-07	6,332.340	12,664.680	0.00E+00	8.33E-04	1.67E-03
U-233	1.9564E-09	6,332.340	12,664.680	0.00E+00	1.24E-05	2.48E-05
U-234	1.8371E-04	6,332.340	12,664.680	0.00E+00	1.16E+00	2.33E+00
U-235	-2.7235E-06	6,332.340	0.000	3.21E-02	1.49E-02	3.21E-02
U-236	1.5493E-05	6,332.340	12,664.680	0.00E+00	9.81E-02	1.96E-01
U-238	-4.2851E-09	6,332.340	0.000	2.00E-02	2.00E-02	2.00E-02
Y-90	2.7505E+00	6,332.340	12,664.680	0.00E+00	1.74E+04	3.48E+04
Other Radionuclides					3.26E+04	6.51E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.443E+15
0.0250	5.264E+14
0.0375	4.858E+14
0.0575	4.776E+14
0.0850	3.045E+14
0.1250	2.637E+14
0.2250	2.581E+14
0.3750	1.249E+14
0.5750	1.716E+15
0.8500	2.403E+14
1.2500	4.471E+13
1.7500	1.875E+12
2.2500	3.933E+12
2.7500	2.262E+10
3.5000	2.510E+09
5.0000	7.546E+03
7.0000	8.415E+02
11.0000	9.486E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.21E+02	6.42E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)²

	From SFD	Estimated
Nominal:		6,332.340
Bounding:		12,664.680

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.27	
Bounding:	0.54	

Estimated EOL HM/Given EOL HM

1.01

¹Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

²Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (INDONESIA)	**[1]Fuel decay start date:**	2010		Estimated Canister usage:
SNF ID #:	502	**Estimates as of:**	2010		18"x10'
Fuel Units & Descr:	142 - ASSEMBLY	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)		5.92
Heavy Metal Mass:	BOL=177.50kg ; EOL=159.75kg	**[2]Template Burnup(MWd):**	367.2		
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689		
		Template Decay Time:	5 years		

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	16,809.594	33,619.189	0.00E+00	2.44E-06	4.89E-06
Am-241	1.1190E-03	16,809.594	33,619.189	0.00E+00	1.88E+01	3.76E+01
Am-242m	4.5425E-07	16,809.594	33,619.189	0.00E+00	7.64E-03	1.53E-02
Am-243	1.4921E-06	16,809.594	33,619.189	0.00E+00	2.51E-02	5.02E-02
C-14	5.7244E-09	16,809.594	33,619.189	0.00E+00	9.62E-05	1.92E-04
Cl-36	1.3124E-32	16,809.594	33,619.189	0.00E+00	2.21E-28	4.41E-28
Cm-243	2.3676E-07	16,809.594	33,619.189	0.00E+00	3.98E-03	7.96E-03
Cm-244	5.2042E-05	16,809.594	33,619.189	0.00E+00	8.75E-01	1.75E+00
Co-60	3.8208E-05	16,809.594	33,619.189	0.00E+00	6.42E-01	1.28E+00
Cs-134	4.8693E-01	16,809.594	33,619.189	0.00E+00	8.19E+03	1.64E+04
Cs-135	3.4477E-06	16,809.594	33,619.189	0.00E+00	5.80E-02	1.16E-01
Cs-137	2.8731E+00	16,809.594	33,619.189	0.00E+00	4.83E+04	9.66E+04
Eu-154	8.2053E-02	16,809.594	33,619.189	0.00E+00	1.38E+03	2.76E+03
Eu-155	3.9134E-02	16,809.594	33,619.189	0.00E+00	6.58E+02	1.32E+03
Fe-55	6.7429E-03	16,809.594	33,619.189	0.00E+00	1.13E+02	2.27E+02
H-3	1.0599E-02	16,809.594	33,619.189	0.00E+00	1.78E+02	3.56E+02
I-129	7.5300E-07	16,809.594	33,619.189	0.00E+00	1.27E-02	2.53E-02
Kr-85	2.8595E-01	16,809.594	33,619.189	0.00E+00	4.81E+03	9.61E+03
Np-237	9.5479E-06	16,809.594	33,619.189	0.00E+00	1.60E-01	3.21E-01
Pa-231	8.9297E-10	16,809.594	33,619.189	0.00E+00	1.50E-05	3.00E-05
Pb-210	3.7609E-12	16,809.594	33,619.189	0.00E+00	6.32E-08	1.26E-07
Pm-147	2.5452E+00	16,809.594	33,619.189	0.00E+00	4.28E+04	8.56E+04
Pu-238	2.0550E-02	16,809.594	33,619.189	0.00E+00	3.45E+02	6.91E+02
Pu-239	4.2838E-04	16,809.594	33,619.189	0.00E+00	7.20E+00	1.44E+01
Pu-240	2.4401E-04	16,809.594	33,619.189	0.00E+00	4.10E+00	8.20E+00
Pu-241	6.8764E-02	16,809.594	33,619.189	0.00E+00	1.16E+03	2.31E+03
Pu-242	3.6329E-07	16,809.594	33,619.189	0.00E+00	6.11E-03	1.22E-02
Ra-226	3.8045E-11	16,809.594	33,619.189	0.00E+00	6.40E-07	1.28E-06
Ra-228	2.9902E-15	16,809.594	33,619.189	0.00E+00	5.03E-11	1.01E-10
Ru-106	1.9055E-01	16,809.594	33,619.189	0.00E+00	3.20E+03	6.41E+03
Se-79	1.2936E-05	16,809.594	33,619.189	0.00E+00	2.17E-01	4.35E-01
Sn-126	1.1574E-05	16,809.594	33,619.189	0.00E+00	1.95E-01	3.89E-01
Sr-90	2.7505E+00	16,809.594	33,619.189	0.00E+00	4.62E+04	9.25E+04
Tc-99	4.2239E-04	16,809.594	33,619.189	0.00E+00	7.10E+00	1.42E+01
Th-229	1.8848E-12	16,809.594	33,619.189	0.00E+00	3.17E-08	6.34E-08
Th-230	1.7042E-08	16,809.594	33,619.189	0.00E+00	2.86E-04	5.73E-04
Th-232	7.8132E-15	16,809.594	33,619.189	0.00E+00	1.31E-10	2.63E-10
Tl-208	4.4063E-08	16,809.594	33,619.189	0.00E+00	7.41E-04	1.48E-03
U-232	1.3151E-07	16,809.594	33,619.189	0.00E+00	2.21E-03	4.42E-03
U-233	1.9564E-09	16,809.594	33,619.189	0.00E+00	3.29E-05	6.58E-05
U-234	1.8371E-04	16,809.594	33,619.189	0.00E+00	3.09E+00	6.18E+00
U-235	-2.7235E-06	16,809.594	0.000	7.67E-02	3.09E-02	7.67E-02
U-236	1.5493E-05	16,809.594	33,619.189	0.00E+00	2.60E-01	5.21E-01
U-238	-4.2851E-09	16,809.594	0.000	4.77E-02	4.77E-02	4.77E-02
Y-90	2.7505E+00	16,809.594	33,619.189	0.00E+00	4.62E+04	9.25E+04
Other Radionuclides					8.65E+04	1.73E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.486E+15
0.0250	1.397E+15
0.0375	1.289E+15
0.0575	1.268E+15
0.0850	8.083E+14
0.1250	7.000E+14
0.2250	6.851E+14
0.3750	3.316E+14
0.5750	4.555E+15
0.8500	6.378E+14
1.2500	1.187E+14
1.7500	4.977E+12
2.2500	1.044E+13
2.7500	6.005E+10
3.5000	6.662E+09
5.0000	2.002E+04
7.0000	2.232E+03
11.0000	2.516E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.52E+02	1.70E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3O8	U
BOL Enrichment %:	20	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		16,809.594	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		33,619.189	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.30	
Bounding:	0.60	

Estimated EOL HM/Given EOL HM: 1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (JAPAN)	**[1]Fuel decay start date:**	2010
SNF ID #:	508	**Estimates as of:**	2010
Fuel Units & Descr:	149 - ASSEMBLY	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=205.62kg ; EOL=193.28kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'

6.21

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	11,683.575	23,367.149	0.00E+00	1.70E-06	3.40E-06
Am-241	1.1190E-03	11,683.575	23,367.149	0.00E+00	1.31E+01	2.61E+01
Am-242m	4.5425E-07	11,683.575	23,367.149	0.00E+00	5.31E-03	1.06E-02
Am-243	1.4921E-06	11,683.575	23,367.149	0.00E+00	1.74E-02	3.49E-02
C-14	5.7244E-09	11,683.575	23,367.149	0.00E+00	6.69E-05	1.34E-04
Cl-36	1.3124E-32	11,683.575	23,367.149	0.00E+00	1.53E-28	3.07E-28
Cm-243	2.3676E-07	11,683.575	23,367.149	0.00E+00	2.77E-03	5.53E-03
Cm-244	5.2042E-05	11,683.575	23,367.149	0.00E+00	6.08E-01	1.22E+00
Co-60	3.8208E-05	11,683.575	23,367.149	0.00E+00	4.46E-01	8.93E-01
Cs-134	4.8693E-01	11,683.575	23,367.149	0.00E+00	5.69E+03	1.14E+04
Cs-135	3.4477E-06	11,683.575	23,367.149	0.00E+00	4.03E-02	8.06E-02
Cs-137	2.8731E+00	11,683.575	23,367.149	0.00E+00	3.36E+04	6.71E+04
Eu-154	8.2053E-02	11,683.575	23,367.149	0.00E+00	9.59E+02	1.92E+03
Eu-155	3.9134E-02	11,683.575	23,367.149	0.00E+00	4.57E+02	9.14E+02
Fe-55	6.7429E-03	11,683.575	23,367.149	0.00E+00	7.88E+01	1.58E+02
H-3	1.0599E-02	11,683.575	23,367.149	0.00E+00	1.24E+02	2.48E+02
I-129	7.5300E-07	11,683.575	23,367.149	0.00E+00	8.80E-03	1.76E-02
Kr-85	2.8595E-01	11,683.575	23,367.149	0.00E+00	3.34E+03	6.68E+03
Np-237	9.5479E-06	11,683.575	23,367.149	0.00E+00	1.12E-01	2.23E-01
Pa-231	8.9297E-10	11,683.575	23,367.149	0.00E+00	1.04E-05	2.09E-05
Pb-210	3.7609E-12	11,683.575	23,367.149	0.00E+00	4.39E-08	8.79E-08
Pm-147	2.5452E+00	11,683.575	23,367.149	0.00E+00	2.97E+04	5.95E+04
Pu-238	2.0550E-02	11,683.575	23,367.149	0.00E+00	2.40E+02	4.80E+02
Pu-239	4.2838E-04	11,683.575	23,367.149	0.00E+00	5.00E+00	1.00E+01
Pu-240	2.4401E-04	11,683.575	23,367.149	0.00E+00	2.85E+00	5.70E+00
Pu-241	6.8764E-02	11,683.575	23,367.149	0.00E+00	8.03E+02	1.61E+03
Pu-242	3.6329E-07	11,683.575	23,367.149	0.00E+00	4.24E-03	8.49E-03
Ra-226	3.8045E-11	11,683.575	23,367.149	0.00E+00	4.44E-07	8.89E-07
Ra-228	2.9902E-15	11,683.575	23,367.149	0.00E+00	3.49E-11	6.99E-11
Ru-106	1.9055E-01	11,683.575	23,367.149	0.00E+00	2.23E+03	4.45E+03
Se-79	1.2936E-05	11,683.575	23,367.149	0.00E+00	1.51E-01	3.02E-01
Sn-126	1.1574E-05	11,683.575	23,367.149	0.00E+00	1.35E-01	2.70E-01
Sr-90	2.7505E+00	11,683.575	23,367.149	0.00E+00	3.21E+04	6.43E+04
Tc-99	4.2239E-04	11,683.575	23,367.149	0.00E+00	4.93E+00	9.87E+00
Th-229	1.8848E-12	11,683.575	23,367.149	0.00E+00	2.20E-08	4.40E-08
Th-230	1.7042E-08	11,683.575	23,367.149	0.00E+00	1.99E-04	3.98E-04
Th-232	7.8132E-15	11,683.575	23,367.149	0.00E+00	9.13E-11	1.83E-10
Tl-208	4.4063E-08	11,683.575	23,367.149	0.00E+00	5.15E-04	1.03E-03
U-232	1.3151E-07	11,683.575	23,367.149	0.00E+00	1.54E-03	3.07E-03
U-233	1.9564E-09	11,683.575	23,367.149	0.00E+00	2.29E-05	4.57E-05
U-234	1.8371E-04	11,683.575	23,367.149	0.00E+00	2.15E+00	4.29E+00
U-235	-2.7235E-06	11,683.575	0.000	8.89E-02	5.70E-02	8.89E-02
U-236	1.5493E-05	11,683.575	23,367.149	0.00E+00	1.81E-01	3.62E-01
U-238	-4.2851E-09	11,683.575	0.000	5.53E-02	5.52E-02	5.53E-02
Y-90	2.7505E+00	11,683.575	23,367.149	0.00E+00	3.21E+04	6.43E+04
Other Radionuclides					6.01E+04	1.20E+05

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	4.508E+15
0.0250	9.712E+14
0.0375	8.963E+14
0.0575	8.813E+14
0.0850	5.618E+14
0.1250	4.865E+14
0.2250	4.762E+14
0.3750	2.305E+14
0.5750	3.166E+15
0.8500	4.433E+14
1.2500	8.249E+13
1.7500	3.459E+12
2.2500	7.256E+12
2.7500	4.174E+10
3.5000	4.631E+09
5.0000	1.397E+04
7.0000	1.558E+03
11.0000	1.756E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.92E+02	1.18E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	19.99999957	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		11,683.575
Bounding:		23,367.149

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.18	
Bounding:	0.36	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (JAPAN)	[1]**Fuel decay start date:**	2010	Estimated Canister usage:
SNF ID #:	553	**Estimates as of:**	2010	**18"x10'**
Fuel Units & Descr:	476 - ASSEMBLY	**Template:**	HFBR (Heavy Water, Alum., 10 to 20%, U)	19.83
Heavy Metal Mass:	BOL=714.00kg ; EOL=632.46kg	[2]**Template Burnup(MWd):**	15	
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00034251	
		Template Decay Time:	5 years	

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.7533E-10	77,499.759	154,999.518	0.00E+00	1.36E-05	2.72E-05
Am-241	1.2780E-02	77,499.759	154,999.518	0.00E+00	9.90E+02	1.98E+03
Am-242m	9.5467E-06	77,499.759	154,999.518	0.00E+00	7.40E-01	1.48E+00
Am-243	6.4100E-06	77,499.759	154,999.518	0.00E+00	4.97E-01	9.94E-01
C-14	2.9673E-08	77,499.759	154,999.518	0.00E+00	2.30E-03	4.60E-03
Cl-36	5.9513E-35	77,499.759	154,999.518	0.00E+00	4.61E-30	9.22E-30
Cm-243	3.1807E-06	77,499.759	154,999.518	0.00E+00	2.47E-01	4.93E-01
Cm-244	1.9540E-04	77,499.759	154,999.518	0.00E+00	1.51E+01	3.03E+01
Co-60	1.1753E-04	77,499.759	154,999.518	0.00E+00	9.11E+00	1.82E+01
Cs-134	3.3060E-01	77,499.759	154,999.518	0.00E+00	2.56E+04	5.12E+04
Cs-135	4.8607E-06	77,499.759	154,999.518	0.00E+00	3.77E-01	7.53E-01
Cs-137	2.8607E+00	77,499.759	154,999.518	0.00E+00	2.22E+05	4.43E+05
Eu-154	6.9933E-02	77,499.759	154,999.518	0.00E+00	5.42E+03	1.08E+04
Eu-155	3.3253E-02	77,499.759	154,999.518	0.00E+00	2.58E+03	5.15E+03
Fe-55	7.7267E-02	77,499.759	154,999.518	0.00E+00	5.99E+03	1.20E+04
H-3	1.0827E-02	77,499.759	154,999.518	0.00E+00	8.39E+02	1.68E+03
I-129	7.1600E-07	77,499.759	154,999.518	0.00E+00	5.55E-02	1.11E-01
Kr-85	2.7007E-01	77,499.759	154,999.518	0.00E+00	2.09E+04	4.19E+04
Np-237	3.6327E-06	77,499.759	154,999.518	0.00E+00	2.82E-01	5.63E-01
Pa-231	1.1267E-09	77,499.759	154,999.518	0.00E+00	8.73E-05	1.75E-04
Pb-210	1.9773E-15	77,499.759	154,999.518	0.00E+00	1.53E-10	3.06E-10
Pm-147	2.4367E+00	77,499.759	154,999.518	0.00E+00	1.89E+05	3.78E+05
Pu-238	6.2213E-03	77,499.759	154,999.518	0.00E+00	4.82E+02	9.64E+02
Pu-239	1.0320E-02	77,499.759	154,999.518	0.00E+00	8.00E+02	1.60E+03
Pu-240	5.4260E-03	77,499.759	154,999.518	0.00E+00	4.21E+02	8.41E+02
Pu-241	7.7333E-01	77,499.759	154,999.518	0.00E+00	5.99E+04	1.20E+05
Pu-242	3.0713E-06	77,499.759	154,999.518	0.00E+00	2.38E-01	4.76E-01
Ra-226	2.2027E-14	77,499.759	154,999.518	0.00E+00	1.71E-09	3.41E-09
Ra-228	2.6333E-15	77,499.759	154,999.518	0.00E+00	2.04E-10	4.08E-10
Ru-106	2.5580E-01	77,499.759	154,999.518	0.00E+00	1.98E+04	3.96E+04
Se-79	1.2540E-05	77,499.759	154,999.518	0.00E+00	9.72E-01	1.94E+00
Sn-126	1.1393E-05	77,499.759	154,999.518	0.00E+00	8.83E-01	1.77E+00
Sr-90	2.6293E+00	77,499.759	154,999.518	0.00E+00	2.04E+05	4.08E+05
Tc-99	4.3540E-04	77,499.759	154,999.518	0.00E+00	3.37E+01	6.75E+01
Th-229	1.3653E-13	77,499.759	154,999.518	0.00E+00	1.06E-08	2.12E-08
Th-230	1.2607E-11	77,499.759	154,999.518	0.00E+00	9.77E-07	1.95E-06
Th-232	6.7400E-15	77,499.759	154,999.518	0.00E+00	5.22E-10	1.04E-09
Tl-208	7.4667E-09	77,499.759	154,999.518	0.00E+00	5.79E-04	1.16E-03
U-232	2.1927E-08	77,499.759	154,999.518	0.00E+00	1.70E-03	3.40E-03
U-233	1.9920E-10	77,499.759	154,999.518	0.00E+00	1.54E-05	3.09E-05
U-234	2.2487E-07	77,499.759	154,999.518	0.00E+00	1.74E-02	3.49E-02
U-235	-2.5341E-06	77,499.759	0.000	3.09E-01	1.12E-01	3.09E-01
U-236	1.3000E-05	77,499.759	154,999.518	0.00E+00	1.01E+00	2.01E+00
U-238	-1.4207E-08	77,499.759	0.000	1.92E-01	1.91E-01	1.92E-01
Y-90	2.6300E+00	77,499.759	154,999.518	0.00E+00	2.04E+05	4.08E+05
Other Radionuclides					3.66E+05	7.32E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.812E+16
0.0250	6.060E+15
0.0375	5.522E+15
0.0575	5.513E+15
0.0850	3.472E+15
0.1250	2.899E+15
0.2250	2.961E+15
0.3750	1.436E+15
0.5750	1.982E+16
0.8500	2.102E+15
1.2500	4.647E+14
1.7500	2.212E+13
2.2500	3.847E+13
2.7500	3.480E+11
3.5000	4.124E+10
5.0000	4.035E+05
7.0000	4.596E+04
11.0000	5.250E+03

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.67E+03	7.34E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20	10 to 20

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		77,499.759	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		154,999.518	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	2.48	
Bounding:	4.96	

Estimated EOL HM/Given EOL HM: 1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (JAPAN)	**[1]Fuel decay start date:**	2010
SNF ID #:	506	**Estimates as of:**	2010
Fuel Units & Descr:	70 - ASSEMBLY	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=73.50kg ; EOL=70.41kg	**[2]Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
2.92

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	2,923.448	5,846.896	0.00E+00	4.25E-07	8.50E-07
Am-241	1.1190E-03	2,923.448	5,846.896	0.00E+00	3.27E+00	6.54E+00
Am-242m	4.5425E-07	2,923.448	5,846.896	0.00E+00	1.33E-03	2.66E-03
Am-243	1.4921E-06	2,923.448	5,846.896	0.00E+00	4.36E-03	8.72E-03
C-14	5.7244E-09	2,923.448	5,846.896	0.00E+00	1.67E-05	3.35E-05
Cl-36	1.3124E-32	2,923.448	5,846.896	0.00E+00	3.84E-29	7.67E-29
Cm-243	2.3676E-07	2,923.448	5,846.896	0.00E+00	6.92E-04	1.38E-03
Cm-244	5.2042E-05	2,923.448	5,846.896	0.00E+00	1.52E-01	3.04E-01
Co-60	3.8208E-05	2,923.448	5,846.896	0.00E+00	1.12E-01	2.23E-01
Cs-134	4.8693E-01	2,923.448	5,846.896	0.00E+00	1.42E+03	2.85E+03
Cs-135	3.4477E-06	2,923.448	5,846.896	0.00E+00	1.01E-02	2.02E-02
Cs-137	2.8731E+00	2,923.448	5,846.896	0.00E+00	8.40E+03	1.68E+04
Eu-154	8.2053E-02	2,923.448	5,846.896	0.00E+00	2.40E+02	4.80E+02
Eu-155	3.9134E-02	2,923.448	5,846.896	0.00E+00	1.14E+02	2.29E+02
Fe-55	6.7429E-03	2,923.448	5,846.896	0.00E+00	1.97E+01	3.94E+01
H-3	1.0599E-02	2,923.448	5,846.896	0.00E+00	3.10E+01	6.20E+01
I-129	7.5300E-07	2,923.448	5,846.896	0.00E+00	2.20E-03	4.40E-03
Kr-85	2.8595E-01	2,923.448	5,846.896	0.00E+00	8.36E+02	1.67E+03
Np-237	9.5479E-06	2,923.448	5,846.896	0.00E+00	2.79E-02	5.58E-02
Pa-231	8.9297E-10	2,923.448	5,846.896	0.00E+00	2.61E-06	5.22E-06
Pb-210	3.7609E-12	2,923.448	5,846.896	0.00E+00	1.10E-08	2.20E-08
Pm-147	2.5452E+00	2,923.448	5,846.896	0.00E+00	7.44E+03	1.49E+04
Pu-238	2.0550E-02	2,923.448	5,846.896	0.00E+00	6.01E+01	1.20E+02
Pu-239	4.2838E-04	2,923.448	5,846.896	0.00E+00	1.25E+00	2.50E+00
Pu-240	2.4401E-04	2,923.448	5,846.896	0.00E+00	7.13E-01	1.43E+00
Pu-241	6.8764E-02	2,923.448	5,846.896	0.00E+00	2.01E+02	4.02E+02
Pu-242	3.6329E-07	2,923.448	5,846.896	0.00E+00	1.06E-03	2.12E-03
Ra-226	3.8045E-11	2,923.448	5,846.896	0.00E+00	1.11E-07	2.22E-07
Ra-228	2.9902E-15	2,923.448	5,846.896	0.00E+00	8.74E-12	1.75E-11
Ru-106	1.9055E-01	2,923.448	5,846.896	0.00E+00	5.57E+02	1.11E+03
Se-79	1.2936E-05	2,923.448	5,846.896	0.00E+00	3.78E-02	7.56E-02
Sn-126	1.1574E-05	2,923.448	5,846.896	0.00E+00	3.38E-02	6.77E-02
Sr-90	2.7505E+00	2,923.448	5,846.896	0.00E+00	8.04E+03	1.61E+04
Tc-99	4.2239E-04	2,923.448	5,846.896	0.00E+00	1.23E+00	2.47E+00
Th-229	1.8848E-12	2,923.448	5,846.896	0.00E+00	5.51E-09	1.10E-08
Th-230	1.7042E-08	2,923.448	5,846.896	0.00E+00	4.98E-05	9.96E-05
Th-232	7.8132E-15	2,923.448	5,846.896	0.00E+00	2.28E-11	4.57E-11
Tl-208	4.4063E-08	2,923.448	5,846.896	0.00E+00	1.29E-04	2.58E-04
U-232	1.3151E-07	2,923.448	5,846.896	0.00E+00	3.84E-04	7.69E-04
U-233	1.9564E-09	2,923.448	5,846.896	0.00E+00	5.72E-06	1.14E-05
U-234	1.8371E-04	2,923.448	5,846.896	0.00E+00	5.37E-01	1.07E+00
U-235	-2.7235E-06	2,923.448	0.000	3.18E-02	2.38E-02	3.18E-02
U-236	1.5493E-05	2,923.448	5,846.896	0.00E+00	4.53E-02	9.06E-02
U-238	-4.2851E-09	2,923.448	0.000	1.98E-02	1.98E-02	1.98E-02
Y-90	2.7505E+00	2,923.448	5,846.896	0.00E+00	8.04E+03	1.61E+04
Other Radionuclides					1.50E+04	3.01E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.128E+15
0.0250	2.430E+14
0.0375	2.243E+14
0.0575	2.205E+14
0.0850	1.406E+14
0.1250	1.217E+14
0.2250	1.191E+14
0.3750	5.767E+13
0.5750	7.922E+14
0.8500	1.109E+14
1.2500	2.064E+13
1.7500	8.656E+11
2.2500	1.816E+12
2.7500	1.044E+10
3.5000	1.159E+09
5.0000	3.508E+03
7.0000	3.913E+02
11.0000	4.412E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.48E+02	2.96E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20.00000028	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		2,923.448
Bounding:		5,846.896

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.13	
Bounding:	0.25	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (JAPAN)
SNF ID #: 602
Fuel Units & Descr: 40 - MTR TYPE
Heavy Metal Mass: BOL=7.74kg ; EOL=6.01kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
1.67

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	**Ci/MWd From Template**	**Nominal Fuel Burnup (MWd)[2]**	**Bounding Fuel Burnup (MWd)[2]**	**Initial Activity (Ci)**	**Nominal Fuel Inventories(Ci)**	**Bounding Fuel Inventories(Ci)**
Ac-227	1.4545E-10	1,636.450	3,272.900	0.00E+00	2.38E-07	4.76E-07
Am-241	1.1190E-03	1,636.450	3,272.900	0.00E+00	1.83E+00	3.66E+00
Am-242m	4.5425E-07	1,636.450	3,272.900	0.00E+00	7.43E-04	1.49E-03
Am-243	1.4921E-06	1,636.450	3,272.900	0.00E+00	2.44E-03	4.88E-03
C-14	5.7244E-09	1,636.450	3,272.900	0.00E+00	9.37E-06	1.87E-05
Cl-36	1.3124E-32	1,636.450	3,272.900	0.00E+00	2.15E-29	4.30E-29
Cm-243	2.3676E-07	1,636.450	3,272.900	0.00E+00	3.87E-04	7.75E-04
Cm-244	5.2042E-05	1,636.450	3,272.900	0.00E+00	8.52E-02	1.70E-01
Co-60	3.8208E-05	1,636.450	3,272.900	0.00E+00	6.25E-02	1.25E-01
Cs-134	4.8693E-01	1,636.450	3,272.900	0.00E+00	7.97E+02	1.59E+03
Cs-135	3.4477E-06	1,636.450	3,272.900	0.00E+00	5.64E-03	1.13E-02
Cs-137	2.8731E+00	1,636.450	3,272.900	0.00E+00	4.70E+03	9.40E+03
Eu-154	8.2053E-02	1,636.450	3,272.900	0.00E+00	1.34E+02	2.69E+02
Eu-155	3.9134E-02	1,636.450	3,272.900	0.00E+00	6.40E+01	1.28E+02
Fe-55	6.7429E-03	1,636.450	3,272.900	0.00E+00	1.10E+01	2.21E+01
H-3	1.0599E-02	1,636.450	3,272.900	0.00E+00	1.73E+01	3.47E+01
I-129	7.5300E-07	1,636.450	3,272.900	0.00E+00	1.23E-03	2.46E-03
Kr-85	2.8595E-01	1,636.450	3,272.900	0.00E+00	4.68E+02	9.36E+02
Np-237	9.5479E-06	1,636.450	3,272.900	0.00E+00	1.56E-02	3.12E-02
Pa-231	8.9297E-10	1,636.450	3,272.900	0.00E+00	1.46E-06	2.92E-06
Pb-210	3.7609E-12	1,636.450	3,272.900	0.00E+00	6.15E-09	1.23E-08
Pm-147	2.5452E+00	1,636.450	3,272.900	0.00E+00	4.17E+03	8.33E+03
Pu-238	2.0550E-02	1,636.450	3,272.900	0.00E+00	3.36E+01	6.73E+01
Pu-239	4.2838E-04	1,636.450	3,272.900	0.00E+00	7.01E-01	1.40E+00
Pu-240	2.4401E-04	1,636.450	3,272.900	0.00E+00	3.99E-01	7.99E-01
Pu-241	6.8764E-02	1,636.450	3,272.900	0.00E+00	1.13E+02	2.25E+02
Pu-242	3.6329E-07	1,636.450	3,272.900	0.00E+00	5.95E-04	1.19E-03
Ra-226	3.8045E-11	1,636.450	3,272.900	0.00E+00	6.23E-08	1.25E-07
Ra-228	2.9902E-15	1,636.450	3,272.900	0.00E+00	4.89E-12	9.79E-12
Ru-106	1.9055E-01	1,636.450	3,272.900	0.00E+00	3.12E+02	6.24E+02
Se-79	1.2936E-05	1,636.450	3,272.900	0.00E+00	2.12E-02	4.23E-02
Sn-126	1.1574E-05	1,636.450	3,272.900	0.00E+00	1.89E-02	3.79E-02
Sr-90	2.7505E+00	1,636.450	3,272.900	0.00E+00	4.50E+03	9.00E+03
Tc-99	4.2239E-04	1,636.450	3,272.900	0.00E+00	6.91E-01	1.38E+00
Th-229	1.8848E-12	1,636.450	3,272.900	0.00E+00	3.08E-09	6.17E-09
Th-230	1.7042E-08	1,636.450	3,272.900	0.00E+00	2.79E-05	5.58E-05
Th-232	7.8132E-15	1,636.450	3,272.900	0.00E+00	1.28E-11	2.56E-11
Tl-208	4.4063E-08	1,636.450	3,272.900	0.00E+00	7.21E-05	1.44E-04
U-232	1.3151E-07	1,636.450	3,272.900	0.00E+00	2.15E-04	4.30E-04
U-233	1.9564E-09	1,636.450	3,272.900	0.00E+00	3.20E-06	6.40E-06
U-234	1.8371E-04	1,636.450	3,272.900	0.00E+00	3.01E-01	6.01E-01
U-235	-2.7235E-06	1,636.450	0.000	1.56E-02	1.11E-02	1.56E-02
U-236	1.5493E-05	1,636.450	3,272.900	0.00E+00	2.54E-02	5.07E-02
U-238	-4.2851E-09	1,636.450	0.000	1.82E-04	1.75E-04	1.82E-04
Y-90	2.7505E+00	1,636.450	3,272.900	0.00E+00	4.50E+03	9.00E+03
Other Radionuclides					8.42E+03	1.68E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	6.314E+14
0.0250	1.360E+14
0.0375	1.255E+14
0.0575	1.234E+14
0.0850	7.869E+13
0.1250	6.814E+13
0.2250	6.669E+13
0.3750	3.228E+13
0.5750	4.434E+14
0.8500	6.209E+13
1.2500	1.155E+13
1.7500	4.845E+11
2.2500	1.016E+12
2.7500	5.846E+09
3.5000	6.486E+08
5.0000	1.939E+03
7.0000	2.162E+02
11.0000	2.436E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
8.30E+01	1.66E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99999931	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		1,636.450	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		3,272.900	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.67	
Bounding:	1.34	

Estimated EOL HM/Given EOL HM
1.02

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (NETHERLANDS)
SNF ID #: 510
Fuel Units & Descr: 43 - ASSEMBLY
Heavy Metal Mass: BOL=64.50kg ; EOL=56.76kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'
1.79

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	7,329.929	14,659.858	0.00E+00	1.07E-06	2.13E-06
Am-241	1.1190E-03	7,329.929	14,659.858	0.00E+00	8.20E+00	1.64E+01
Am-242m	4.5425E-07	7,329.929	14,659.858	0.00E+00	3.33E-03	6.66E-03
Am-243	1.4921E-06	7,329.929	14,659.858	0.00E+00	1.09E-02	2.19E-02
C-14	5.7244E-09	7,329.929	14,659.858	0.00E+00	4.20E-05	8.39E-05
Cl-36	1.3124E-32	7,329.929	14,659.858	0.00E+00	9.62E-29	1.92E-28
Cm-243	2.3676E-07	7,329.929	14,659.858	0.00E+00	1.74E-03	3.47E-03
Cm-244	5.2042E-05	7,329.929	14,659.858	0.00E+00	3.81E-01	7.63E-01
Co-60	3.8208E-05	7,329.929	14,659.858	0.00E+00	2.80E-01	5.60E-01
Cs-134	4.8693E-01	7,329.929	14,659.858	0.00E+00	3.57E+03	7.14E+03
Cs-135	3.4477E-06	7,329.929	14,659.858	0.00E+00	2.53E-02	5.05E-02
Cs-137	2.8731E+00	7,329.929	14,659.858	0.00E+00	2.11E+04	4.21E+04
Eu-154	8.2053E-02	7,329.929	14,659.858	0.00E+00	6.01E+02	1.20E+03
Eu-155	3.9134E-02	7,329.929	14,659.858	0.00E+00	2.87E+02	5.74E+02
Fe-55	6.7429E-03	7,329.929	14,659.858	0.00E+00	4.94E+01	9.89E+01
H-3	1.0599E-02	7,329.929	14,659.858	0.00E+00	7.77E+01	1.55E+02
I-129	7.5300E-07	7,329.929	14,659.858	0.00E+00	5.52E-03	1.10E-02
Kr-85	2.8595E-01	7,329.929	14,659.858	0.00E+00	2.10E+03	4.19E+03
Np-237	9.5479E-06	7,329.929	14,659.858	0.00E+00	7.00E-02	1.40E-01
Pa-231	8.9297E-10	7,329.929	14,659.858	0.00E+00	6.55E-06	1.31E-05
Pb-210	3.7609E-12	7,329.929	14,659.858	0.00E+00	2.76E-08	5.51E-08
Pm-147	2.5452E+00	7,329.929	14,659.858	0.00E+00	1.87E+04	3.73E+04
Pu-238	2.0550E-02	7,329.929	14,659.858	0.00E+00	1.51E+02	3.01E+02
Pu-239	4.2838E-04	7,329.929	14,659.858	0.00E+00	3.14E+00	6.28E+00
Pu-240	2.4401E-04	7,329.929	14,659.858	0.00E+00	1.79E+00	3.58E+00
Pu-241	6.8764E-02	7,329.929	14,659.858	0.00E+00	5.04E+02	1.01E+03
Pu-242	3.6329E-07	7,329.929	14,659.858	0.00E+00	2.66E-03	5.33E-03
Ra-226	3.8045E-11	7,329.929	14,659.858	0.00E+00	2.79E-07	5.58E-07
Ra-228	2.9902E-15	7,329.929	14,659.858	0.00E+00	2.19E-11	4.38E-11
Ru-106	1.9055E-01	7,329.929	14,659.858	0.00E+00	1.40E+03	2.79E+03
Se-79	1.2936E-05	7,329.929	14,659.858	0.00E+00	9.48E-02	1.90E-01
Sn-126	1.1574E-05	7,329.929	14,659.858	0.00E+00	8.48E-02	1.70E-01
Sr-90	2.7505E+00	7,329.929	14,659.858	0.00E+00	2.02E+04	4.03E+04
Tc-99	4.2239E-04	7,329.929	14,659.858	0.00E+00	3.10E+00	6.19E+00
Th-229	1.8848E-12	7,329.929	14,659.858	0.00E+00	1.38E-08	2.76E-08
Th-230	1.7042E-08	7,329.929	14,659.858	0.00E+00	1.25E-04	2.50E-04
Th-232	7.8132E-15	7,329.929	14,659.858	0.00E+00	5.73E-11	1.15E-10
Tl-208	4.4063E-08	7,329.929	14,659.858	0.00E+00	3.23E-04	6.46E-04
U-232	1.3151E-07	7,329.929	14,659.858	0.00E+00	9.64E-04	1.93E-03
U-233	1.9564E-09	7,329.929	14,659.858	0.00E+00	1.43E-05	2.87E-05
U-234	1.8371E-04	7,329.929	14,659.858	0.00E+00	1.35E+00	2.69E+00
U-235	-2.7235E-06	7,329.929	0.000	2.79E-02	7.91E-03	2.79E-02
U-236	1.5493E-05	7,329.929	14,659.858	0.00E+00	1.14E-01	2.27E-01
U-238	-4.2851E-09	7,329.929	0.000	1.73E-02	1.73E-02	1.73E-02
Y-90	2.7505E+00	7,329.929	14,659.858	0.00E+00	2.02E+04	4.03E+04
Other Radionuclides					3.77E+04	7.54E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.828E+15
0.0250	6.093E+14
0.0375	5.623E+14
0.0575	5.529E+14
0.0850	3.525E+14
0.1250	3.052E+14
0.2250	2.987E+14
0.3750	1.446E+14
0.5750	1.986E+15
0.8500	2.781E+14
1.2500	5.175E+13
1.7500	2.170E+12
2.2500	4.552E+12
2.7500	2.619E+10
3.5000	2.905E+09
5.0000	8.721E+03
7.0000	9.725E+02
11.0000	1.096E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.72E+02	7.43E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20.00000079	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]	From SFD	Estimated
Nominal:		7,329.929
Bounding:		14,659.858

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.36	
Bounding:	0.72	

Estimated EOL HM/Given EOL HM
1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

				Estimated Canister usage:
Fuel Name:	FRR MTR-S (NETHERLANDS)	[1]Fuel decay start date:	2010	18"x10'
SNF ID #:	607	Estimates as of:	2010	0.79
Fuel Units & Descr:	19 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)	
Heavy Metal Mass:	BOL=2.04kg ; EOL=1.09kg	[2]Template Burnup(MWd):	367.2	
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689	
		Template Decay Time:	5 years	

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	899.668	1,799.337	0.00E+00	1.31E-07	2.62E-07
Am-241	1.1190E-03	899.668	1,799.337	0.00E+00	1.01E+00	2.01E+00
Am-242m	4.5425E-07	899.668	1,799.337	0.00E+00	4.09E-04	8.17E-04
Am-243	1.4921E-06	899.668	1,799.337	0.00E+00	1.34E-03	2.68E-03
C-14	5.7244E-09	899.668	1,799.337	0.00E+00	5.15E-06	1.03E-05
Cl-36	1.3124E-32	899.668	1,799.337	0.00E+00	1.18E-29	2.36E-29
Cm-243	2.3676E-07	899.668	1,799.337	0.00E+00	2.13E-04	4.26E-04
Cm-244	5.2042E-05	899.668	1,799.337	0.00E+00	4.68E-02	9.36E-02
Co-60	3.8208E-05	899.668	1,799.337	0.00E+00	3.44E-02	6.87E-02
Cs-134	4.8693E-01	899.668	1,799.337	0.00E+00	4.38E+02	8.76E+02
Cs-135	3.4477E-06	899.668	1,799.337	0.00E+00	3.10E-03	6.20E-03
Cs-137	2.8731E+00	899.668	1,799.337	0.00E+00	2.58E+03	5.17E+03
Eu-154	8.2053E-02	899.668	1,799.337	0.00E+00	7.38E+01	1.48E+02
Eu-155	3.9134E-02	899.668	1,799.337	0.00E+00	3.52E+01	7.04E+01
Fe-55	6.7429E-03	899.668	1,799.337	0.00E+00	6.07E+00	1.21E+01
H-3	1.0599E-02	899.668	1,799.337	0.00E+00	9.54E+00	1.91E+01
I-129	7.5300E-07	899.668	1,799.337	0.00E+00	6.77E-04	1.35E-03
Kr-85	2.8595E-01	899.668	1,799.337	0.00E+00	2.57E+02	5.15E+02
Np-237	9.5479E-06	899.668	1,799.337	0.00E+00	8.59E-03	1.72E-02
Pa-231	8.9297E-10	899.668	1,799.337	0.00E+00	8.03E-07	1.61E-06
Pb-210	3.7609E-12	899.668	1,799.337	0.00E+00	3.38E-09	6.77E-09
Pm-147	2.5452E+00	899.668	1,799.337	0.00E+00	2.29E+03	4.58E+03
Pu-238	2.0550E-02	899.668	1,799.337	0.00E+00	1.85E+01	3.70E+01
Pu-239	4.2838E-04	899.668	1,799.337	0.00E+00	3.85E-01	7.71E-01
Pu-240	2.4401E-04	899.668	1,799.337	0.00E+00	2.20E-01	4.39E-01
Pu-241	6.8764E-02	899.668	1,799.337	0.00E+00	6.19E+01	1.24E+02
Pu-242	3.6329E-07	899.668	1,799.337	0.00E+00	3.27E-04	6.54E-04
Ra-226	3.8045E-11	899.668	1,799.337	0.00E+00	3.42E-08	6.85E-08
Ra-228	2.9902E-15	899.668	1,799.337	0.00E+00	2.69E-12	5.38E-12
Ru-106	1.9055E-01	899.668	1,799.337	0.00E+00	1.71E+02	3.43E+02
Se-79	1.2936E-05	899.668	1,799.337	0.00E+00	1.16E-02	2.33E-02
Sn-126	1.1574E-05	899.668	1,799.337	0.00E+00	1.04E-02	2.08E-02
Sr-90	2.7505E+00	899.668	1,799.337	0.00E+00	2.47E+03	4.95E+03
Tc-99	4.2239E-04	899.668	1,799.337	0.00E+00	3.80E-01	7.60E-01
Th-229	1.8848E-12	899.668	1,799.337	0.00E+00	1.70E-09	3.39E-09
Th-230	1.7042E-08	899.668	1,799.337	0.00E+00	1.53E-05	3.07E-05
Th-232	7.8132E-15	899.668	1,799.337	0.00E+00	7.03E-12	1.41E-11
Tl-208	4.4063E-08	899.668	1,799.337	0.00E+00	3.96E-05	7.93E-05
U-232	1.3151E-07	899.668	1,799.337	0.00E+00	1.18E-04	2.37E-04
U-233	1.9564E-09	899.668	1,799.337	0.00E+00	1.76E-06	3.52E-06
U-234	1.8371E-04	899.668	1,799.337	0.00E+00	1.65E-01	3.31E-01
U-235	-2.7235E-06	899.668	0.000	4.10E-03	1.65E-03	4.10E-03
U-236	1.5493E-05	899.668	1,799.337	0.00E+00	1.39E-02	2.79E-02
U-238	-4.2851E-09	899.668	0.000	4.81E-05	4.42E-05	4.81E-05
Y-90	2.7505E+00	899.668	1,799.337	0.00E+00	2.47E+03	4.95E+03
Other Radionuclides					4.63E+03	9.25E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.471E+14
0.0250	7.479E+13
0.0375	6.901E+13
0.0575	6.786E+13
0.0850	4.326E+13
0.1250	3.746E+13
0.2250	3.667E+13
0.3750	1.775E+13
0.5750	2.438E+14
0.8500	3.414E+13
1.2500	6.352E+12
1.7500	2.664E+11
2.2500	5.587E+11
2.7500	3.214E+09
3.5000	3.566E+08
5.0000	1.066E+03
7.0000	1.188E+02
11.0000	1.339E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
4.56E+01	9.12E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99998697	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		899.668	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		1,799.337	Bounding burnup assumed to be twice nominal burnup.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.40	
Bounding:	2.80	

Estimated EOL HM/Given EOL HM: 1.05

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (NETHERLANDS)
SNF ID #: 608
Fuel Units & Descr: 61 - MTR TYPE
Heavy Metal Mass: BOL=12.46kg ; EOL=6.67kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]**Template Burnup(MWd):** 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'
2.54

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	5,487.977	10,975.954	0.00E+00	7.98E-07	1.60E-06
Am-241	1.1190E-03	5,487.977	10,975.954	0.00E+00	6.14E+00	1.23E+01
Am-242m	4.5425E-07	5,487.977	10,975.954	0.00E+00	2.49E-03	4.99E-03
Am-243	1.4921E-06	5,487.977	10,975.954	0.00E+00	8.19E-03	1.64E-02
C-14	5.7244E-09	5,487.977	10,975.954	0.00E+00	3.14E-05	6.28E-05
Cl-36	1.3124E-32	5,487.977	10,975.954	0.00E+00	7.20E-29	1.44E-28
Cm-243	2.3676E-07	5,487.977	10,975.954	0.00E+00	1.30E-03	2.60E-03
Cm-244	5.2042E-05	5,487.977	10,975.954	0.00E+00	2.86E-01	5.71E-01
Co-60	3.8208E-05	5,487.977	10,975.954	0.00E+00	2.10E-01	4.19E-01
Cs-134	4.8693E-01	5,487.977	10,975.954	0.00E+00	2.67E+03	5.34E+03
Cs-135	3.4477E-06	5,487.977	10,975.954	0.00E+00	1.89E-02	3.78E-02
Cs-137	2.8731E+00	5,487.977	10,975.954	0.00E+00	1.58E+04	3.15E+04
Eu-154	8.2053E-02	5,487.977	10,975.954	0.00E+00	4.50E+02	9.01E+02
Eu-155	3.9134E-02	5,487.977	10,975.954	0.00E+00	2.15E+02	4.30E+02
Fe-55	6.7429E-03	5,487.977	10,975.954	0.00E+00	3.70E+01	7.40E+01
H-3	1.0599E-02	5,487.977	10,975.954	0.00E+00	5.82E+01	1.16E+02
I-129	7.5300E-07	5,487.977	10,975.954	0.00E+00	4.13E-03	8.26E-03
Kr-85	2.8595E-01	5,487.977	10,975.954	0.00E+00	1.57E+03	3.14E+03
Np-237	9.5479E-06	5,487.977	10,975.954	0.00E+00	5.24E-02	1.05E-01
Pa-231	8.9297E-10	5,487.977	10,975.954	0.00E+00	4.90E-06	9.80E-06
Pb-210	3.7609E-12	5,487.977	10,975.954	0.00E+00	2.06E-08	4.13E-08
Pm-147	2.5452E+00	5,487.977	10,975.954	0.00E+00	1.40E+04	2.79E+04
Pu-238	2.0550E-02	5,487.977	10,975.954	0.00E+00	1.13E+02	2.26E+02
Pu-239	4.2838E-04	5,487.977	10,975.954	0.00E+00	2.35E+00	4.70E+00
Pu-240	2.4401E-04	5,487.977	10,975.954	0.00E+00	1.34E+00	2.68E+00
Pu-241	6.8764E-02	5,487.977	10,975.954	0.00E+00	3.77E+02	7.55E+02
Pu-242	3.6329E-07	5,487.977	10,975.954	0.00E+00	1.99E-03	3.99E-03
Ra-226	3.8045E-11	5,487.977	10,975.954	0.00E+00	2.09E-07	4.18E-07
Ra-228	2.9902E-15	5,487.977	10,975.954	0.00E+00	1.64E-11	3.28E-11
Ru-106	1.9055E-01	5,487.977	10,975.954	0.00E+00	1.05E+03	2.09E+03
Se-79	1.2936E-05	5,487.977	10,975.954	0.00E+00	7.10E-02	1.42E-01
Sn-126	1.1574E-05	5,487.977	10,975.954	0.00E+00	6.35E-02	1.27E-01
Sr-90	2.7505E+00	5,487.977	10,975.954	0.00E+00	1.51E+04	3.02E+04
Tc-99	4.2239E-04	5,487.977	10,975.954	0.00E+00	2.32E+00	4.64E+00
Th-229	1.8848E-12	5,487.977	10,975.954	0.00E+00	1.03E-08	2.07E-08
Th-230	1.7042E-08	5,487.977	10,975.954	0.00E+00	9.35E-05	1.87E-04
Th-232	7.8132E-15	5,487.977	10,975.954	0.00E+00	4.29E-11	8.58E-11
Tl-208	4.4063E-08	5,487.977	10,975.954	0.00E+00	2.42E-04	4.84E-04
U-232	1.3151E-07	5,487.977	10,975.954	0.00E+00	7.22E-04	1.44E-03
U-233	1.9564E-09	5,487.977	10,975.954	0.00E+00	1.07E-05	2.15E-05
U-234	1.8371E-04	5,487.977	10,975.954	0.00E+00	1.01E+00	2.02E+00
U-235	-2.7235E-06	5,487.977	0.000	2.50E-02	1.01E-02	2.50E-02
U-236	1.5493E-05	5,487.977	10,975.954	0.00E+00	8.50E-02	1.70E-01
U-238	-4.2851E-09	5,487.977	0.000	2.93E-04	2.70E-04	2.93E-04
Y-90	2.7505E+00	5,487.977	10,975.954	0.00E+00	1.51E+04	3.02E+04
Other Radionuclides					2.82E+04	5.65E+04

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	2.118E+15
0.0250	4.562E+14
0.0375	4.210E+14
0.0575	4.139E+14
0.0850	2.639E+14
0.1250	2.285E+14
0.2250	2.237E+14
0.3750	1.083E+14
0.5750	1.487E+15
0.8500	2.082E+14
1.2500	3.875E+13
1.7500	1.625E+12
2.2500	3.408E+12
2.7500	1.961E+10
3.5000	2.175E+09
5.0000	6.501E+03
7.0000	7.248E+02
11.0000	8.169E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.78E+02	5.57E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99998578	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		5,487.977
Bounding:		10,975.954

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.40	
Bounding:	2.80	

Estimated EOL HM/Given EOL HM
1.05

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (PERU)	**[1]Fuel decay start date:**	2010		Estimated Canister usage:
SNF ID #: 504	**Estimates as of:**	2010		18"x10'
Fuel Units & Descr: 23 - ASSEMBLY	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)		0.96
Heavy Metal Mass: BOL=32.20kg ; EOL=28.98kg	**[2]Template Burnup(MWd):**	367.2		
ROD Storage Site: SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689		
	Template Decay Time:	5 years		

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	3,049.400	6,098.801	0.00E+00	4.44E-07	8.87E-07
Am-241	1.1190E-03	3,049.400	6,098.801	0.00E+00	3.41E+00	6.82E+00
Am-242m	4.5425E-07	3,049.400	6,098.801	0.00E+00	1.39E-03	2.77E-03
Am-243	1.4921E-06	3,049.400	6,098.801	0.00E+00	4.55E-03	9.10E-03
C-14	5.7244E-09	3,049.400	6,098.801	0.00E+00	1.75E-05	3.49E-05
Cl-36	1.3124E-32	3,049.400	6,098.801	0.00E+00	4.00E-29	8.00E-29
Cm-243	2.3676E-07	3,049.400	6,098.801	0.00E+00	7.22E-04	1.44E-03
Cm-244	5.2042E-05	3,049.400	6,098.801	0.00E+00	1.59E-01	3.17E-01
Co-60	3.8208E-05	3,049.400	6,098.801	0.00E+00	1.17E-01	2.33E-01
Cs-134	4.8693E-01	3,049.400	6,098.801	0.00E+00	1.48E+03	2.97E+03
Cs-135	3.4477E-06	3,049.400	6,098.801	0.00E+00	1.05E-02	2.10E-02
Cs-137	2.8731E+00	3,049.400	6,098.801	0.00E+00	8.76E+03	1.75E+04
Eu-154	8.2053E-02	3,049.400	6,098.801	0.00E+00	2.50E+02	5.00E+02
Eu-155	3.9134E-02	3,049.400	6,098.801	0.00E+00	1.19E+02	2.39E+02
Fe-55	6.7429E-03	3,049.400	6,098.801	0.00E+00	2.06E+01	4.11E+01
H-3	1.0599E-02	3,049.400	6,098.801	0.00E+00	3.23E+01	6.46E+01
I-129	7.5300E-07	3,049.400	6,098.801	0.00E+00	2.30E-03	4.59E-03
Kr-85	2.8595E-01	3,049.400	6,098.801	0.00E+00	8.72E+02	1.74E+03
Np-237	9.5479E-06	3,049.400	6,098.801	0.00E+00	2.91E-02	5.82E-02
Pa-231	8.9297E-10	3,049.400	6,098.801	0.00E+00	2.72E-06	5.45E-06
Pb-210	3.7609E-12	3,049.400	6,098.801	0.00E+00	1.15E-08	2.29E-08
Pm-147	2.5452E+00	3,049.400	6,098.801	0.00E+00	7.76E+03	1.55E+04
Pu-238	2.0550E-02	3,049.400	6,098.801	0.00E+00	6.27E+01	1.25E+02
Pu-239	4.2838E-04	3,049.400	6,098.801	0.00E+00	1.31E+00	2.61E+00
Pu-240	2.4401E-04	3,049.400	6,098.801	0.00E+00	7.44E-01	1.49E+00
Pu-241	6.8764E-02	3,049.400	6,098.801	0.00E+00	2.10E+02	4.19E+02
Pu-242	3.6329E-07	3,049.400	6,098.801	0.00E+00	1.11E-03	2.22E-03
Ra-226	3.8045E-11	3,049.400	6,098.801	0.00E+00	1.16E-07	2.32E-07
Ra-228	2.9902E-15	3,049.400	6,098.801	0.00E+00	9.12E-12	1.82E-11
Ru-106	1.9055E-01	3,049.400	6,098.801	0.00E+00	5.81E+02	1.16E+03
Se-79	1.2936E-05	3,049.400	6,098.801	0.00E+00	3.94E-02	7.89E-02
Sn-126	1.1574E-05	3,049.400	6,098.801	0.00E+00	3.53E-02	7.06E-02
Sr-90	2.7505E+00	3,049.400	6,098.801	0.00E+00	8.39E+03	1.68E+04
Tc-99	4.2239E-04	3,049.400	6,098.801	0.00E+00	1.29E+00	2.58E+00
Th-229	1.8848E-12	3,049.400	6,098.801	0.00E+00	5.75E-09	1.15E-08
Th-230	1.7042E-08	3,049.400	6,098.801	0.00E+00	5.20E-05	1.04E-04
Th-232	7.8132E-15	3,049.400	6,098.801	0.00E+00	2.38E-11	4.77E-11
Tl-208	4.4063E-08	3,049.400	6,098.801	0.00E+00	1.34E-04	2.69E-04
U-232	1.3151E-07	3,049.400	6,098.801	0.00E+00	4.01E-04	8.02E-04
U-233	1.9564E-09	3,049.400	6,098.801	0.00E+00	5.97E-06	1.19E-05
U-234	1.8371E-04	3,049.400	6,098.801	0.00E+00	5.60E-01	1.12E+00
U-235	-2.7235E-06	3,049.400	0.000	1.14E-02	3.13E-03	1.14E-02
U-236	1.5493E-05	3,049.400	6,098.801	0.00E+00	4.72E-02	9.45E-02
U-238	-4.2851E-09	3,049.400	0.000	9.04E-03	9.03E-03	9.04E-03
Y-90	2.7505E+00	3,049.400	6,098.801	0.00E+00	8.39E+03	1.68E+04
Other Radionuclides					1.57E+04	3.14E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.177E+15
0.0250	2.535E+14
0.0375	2.339E+14
0.0575	2.300E+14
0.0850	1.466E+14
0.1250	1.270E+14
0.2250	1.243E+14
0.3750	6.016E+13
0.5750	8.263E+14
0.8500	1.157E+14
1.2500	2.153E+13
1.7500	9.029E+11
2.2500	1.894E+12
2.7500	1.089E+10
3.5000	1.209E+09
5.0000	3.632E+03
7.0000	4.051E+02
11.0000	4.566E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.55E+02	3.09E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3O8	U
BOL Enrichment %:	16.42857201	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		3,049.400
Bounding:		6,098.801

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.30	
Bounding:	0.60	

Estimated EOL HM/Given EOL HM: 1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (PORTUGAL)	[1]Fuel decay start date:	2010
SNF ID #:	632	Estimates as of:	2010
Fuel Units & Descr:	22 - MTR TYPE	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=6.25kg ; EOL=3.92kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.92

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	2,200.116	4,400.231	0.00E+00	3.20E-07	6.40E-07
Am-241	1.1190E-03	2,200.116	4,400.231	0.00E+00	2.46E+00	4.92E+00
Am-242m	4.5425E-07	2,200.116	4,400.231	0.00E+00	9.99E-04	2.00E-03
Am-243	1.4921E-06	2,200.116	4,400.231	0.00E+00	3.28E-03	6.57E-03
C-14	5.7244E-09	2,200.116	4,400.231	0.00E+00	1.26E-05	2.52E-05
Cl-36	1.3124E-32	2,200.116	4,400.231	0.00E+00	2.89E-29	5.77E-29
Cm-243	2.3676E-07	2,200.116	4,400.231	0.00E+00	5.21E-04	1.04E-03
Cm-244	5.2042E-05	2,200.116	4,400.231	0.00E+00	1.14E-01	2.29E-01
Co-60	3.8208E-05	2,200.116	4,400.231	0.00E+00	8.41E-02	1.68E-01
Cs-134	4.8693E-01	2,200.116	4,400.231	0.00E+00	1.07E+03	2.14E+03
Cs-135	3.4477E-06	2,200.116	4,400.231	0.00E+00	7.59E-03	1.52E-02
Cs-137	2.8731E+00	2,200.116	4,400.231	0.00E+00	6.32E+03	1.26E+04
Eu-154	8.2053E-02	2,200.116	4,400.231	0.00E+00	1.81E+02	3.61E+02
Eu-155	3.9134E-02	2,200.116	4,400.231	0.00E+00	8.61E+01	1.72E+02
Fe-55	6.7429E-03	2,200.116	4,400.231	0.00E+00	1.48E+01	2.97E+01
H-3	1.0599E-02	2,200.116	4,400.231	0.00E+00	2.33E+01	4.66E+01
I-129	7.5300E-07	2,200.116	4,400.231	0.00E+00	1.66E-03	3.31E-03
Kr-85	2.8595E-01	2,200.116	4,400.231	0.00E+00	6.29E+02	1.26E+03
Np-237	9.5479E-06	2,200.116	4,400.231	0.00E+00	2.10E-02	4.20E-02
Pa-231	8.9297E-10	2,200.116	4,400.231	0.00E+00	1.96E-06	3.93E-06
Pb-210	3.7609E-12	2,200.116	4,400.231	0.00E+00	8.27E-09	1.65E-08
Pm-147	2.5452E+00	2,200.116	4,400.231	0.00E+00	5.60E+03	1.12E+04
Pu-238	2.0550E-02	2,200.116	4,400.231	0.00E+00	4.52E+01	9.04E+01
Pu-239	4.2838E-04	2,200.116	4,400.231	0.00E+00	9.42E-01	1.88E+00
Pu-240	2.4401E-04	2,200.116	4,400.231	0.00E+00	5.37E-01	1.07E+00
Pu-241	6.8764E-02	2,200.116	4,400.231	0.00E+00	1.51E+02	3.03E+02
Pu-242	3.6329E-07	2,200.116	4,400.231	0.00E+00	7.99E-04	1.60E-03
Ra-226	3.8045E-11	2,200.116	4,400.231	0.00E+00	8.37E-08	1.67E-07
Ra-228	2.9902E-15	2,200.116	4,400.231	0.00E+00	6.58E-12	1.32E-11
Ru-106	1.9055E-01	2,200.116	4,400.231	0.00E+00	4.19E+02	8.38E+02
Se-79	1.2936E-05	2,200.116	4,400.231	0.00E+00	2.85E-02	5.69E-02
Sn-126	1.1574E-05	2,200.116	4,400.231	0.00E+00	2.55E-02	5.09E-02
Sr-90	2.7505E+00	2,200.116	4,400.231	0.00E+00	6.05E+03	1.21E+04
Tc-99	4.2239E-04	2,200.116	4,400.231	0.00E+00	9.29E-01	1.86E+00
Th-229	1.8848E-12	2,200.116	4,400.231	0.00E+00	4.15E-09	8.29E-09
Th-230	1.7042E-08	2,200.116	4,400.231	0.00E+00	3.75E-05	7.50E-05
Th-232	7.8132E-15	2,200.116	4,400.231	0.00E+00	1.72E-11	3.44E-11
Tl-208	4.4063E-08	2,200.116	4,400.231	0.00E+00	9.69E-05	1.94E-04
U-232	1.3151E-07	2,200.116	4,400.231	0.00E+00	2.89E-04	5.79E-04
U-233	1.9564E-09	2,200.116	4,400.231	0.00E+00	4.30E-06	8.61E-06
U-234	1.8371E-04	2,200.116	4,400.231	0.00E+00	4.04E-01	8.08E-01
U-235	-2.7235E-06	2,200.116	0.000	1.26E-02	6.56E-03	1.26E-02
U-236	1.5493E-05	2,200.116	4,400.231	0.00E+00	3.41E-02	6.82E-02
U-238	-4.2851E-09	2,200.116	0.000	1.47E-04	1.38E-04	1.47E-04
Y-90	2.7505E+00	2,200.116	4,400.231	0.00E+00	6.05E+03	1.21E+04
Other Radionuclides					1.13E+04	2.26E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	8.489E+14
0.0250	1.829E+14
0.0375	1.688E+14
0.0575	1.659E+14
0.0850	1.058E+14
0.1250	9.161E+13
0.2250	8.966E+13
0.3750	4.340E+13
0.5750	5.962E+14
0.8500	8.348E+13
1.2500	1.553E+13
1.7500	6.514E+11
2.2500	1.366E+12
2.7500	7.860E+09
3.5000	8.720E+08
5.0000	2.606E+03
7.0000	2.906E+02
11.0000	3.275E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.12E+02	2.23E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99999055	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		2,200.116	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		4,400.231	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.12	
Bounding:	2.24	

Estimated EOL HM/Given EOL HM: 1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (PORTUGAL)	[1]Fuel decay start date:	2010	Estimated Canister usage:
SNF ID #:	542	Estimates as of:	2010	18"x10'
Fuel Units & Desc.:	6 - ASSEMBLY	Template:	ATR (Light Water, Alum., 60 to 100%, U)	0.25
Heavy Metal Mass:	BOL=5.40kg ; EOL=5.15kg	[2]Template Burnup(MWd):	367.2	
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689	
		Template Decay Time:	5 years	

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	235.239	470.479	0.00E+00	3.42E-08	6.84E-08
Am-241	1.1190E-03	235.239	470.479	0.00E+00	2.63E-01	5.26E-01
Am-242m	4.5425E-07	235.239	470.479	0.00E+00	1.07E-04	2.14E-04
Am-243	1.4921E-06	235.239	470.479	0.00E+00	3.51E-04	7.02E-04
C-14	5.7244E-09	235.239	470.479	0.00E+00	1.35E-06	2.69E-06
Cl-36	1.3124E-32	235.239	470.479	0.00E+00	3.09E-30	6.17E-30
Cm-243	2.3676E-07	235.239	470.479	0.00E+00	5.57E-05	1.11E-04
Cm-244	5.2042E-05	235.239	470.479	0.00E+00	1.22E-02	2.45E-02
Co-60	3.8208E-05	235.239	470.479	0.00E+00	8.99E-03	1.80E-02
Cs-134	4.8693E-01	235.239	470.479	0.00E+00	1.15E+02	2.29E+02
Cs-135	3.4477E-06	235.239	470.479	0.00E+00	8.11E-04	1.62E-03
Cs-137	2.8731E+00	235.239	470.479	0.00E+00	6.76E+02	1.35E+03
Eu-154	8.2053E-02	235.239	470.479	0.00E+00	1.93E+01	3.86E+01
Eu-155	3.9134E-02	235.239	470.479	0.00E+00	9.21E+00	1.84E+01
Fe-55	6.7429E-03	235.239	470.479	0.00E+00	1.59E+00	3.17E+00
H-3	1.0599E-02	235.239	470.479	0.00E+00	2.49E+00	4.99E+00
I-129	7.5300E-07	235.239	470.479	0.00E+00	1.77E-04	3.54E-04
Kr-85	2.8595E-01	235.239	470.479	0.00E+00	6.73E+01	1.35E+02
Np-237	9.5479E-06	235.239	470.479	0.00E+00	2.25E-03	4.49E-03
Pa-231	8.9297E-10	235.239	470.479	0.00E+00	2.10E-07	4.20E-07
Pb-210	3.7609E-12	235.239	470.479	0.00E+00	8.85E-10	1.77E-09
Pm-147	2.5452E+00	235.239	470.479	0.00E+00	5.99E+02	1.20E+03
Pu-238	2.0550E-02	235.239	470.479	0.00E+00	4.83E+00	9.67E+00
Pu-239	4.2838E-04	235.239	470.479	0.00E+00	1.01E-01	2.02E-01
Pu-240	2.4401E-04	235.239	470.479	0.00E+00	5.74E-02	1.15E-01
Pu-241	6.8764E-02	235.239	470.479	0.00E+00	1.62E+01	3.24E+01
Pu-242	3.6329E-07	235.239	470.479	0.00E+00	8.55E-05	1.71E-04
Ra-226	3.8045E-11	235.239	470.479	0.00E+00	8.95E-09	1.79E-08
Ra-228	2.9902E-15	235.239	470.479	0.00E+00	7.03E-13	1.41E-12
Ru-106	1.9055E-01	235.239	470.479	0.00E+00	4.48E+01	8.96E+01
Se-79	1.2936E-05	235.239	470.479	0.00E+00	3.04E-03	6.09E-03
Sn-126	1.1574E-05	235.239	470.479	0.00E+00	2.72E-03	5.45E-03
Sr-90	2.7505E+00	235.239	470.479	0.00E+00	6.47E+02	1.29E+03
Tc-99	4.2239E-04	235.239	470.479	0.00E+00	9.94E-02	1.99E-01
Th-229	1.8848E-12	235.239	470.479	0.00E+00	4.43E-10	8.87E-10
Th-230	1.7042E-08	235.239	470.479	0.00E+00	4.01E-06	8.02E-06
Th-232	7.8132E-15	235.239	470.479	0.00E+00	1.84E-12	3.68E-12
Tl-208	4.4063E-08	235.239	470.479	0.00E+00	1.04E-05	2.07E-05
U-232	1.3151E-07	235.239	470.479	0.00E+00	3.09E-05	6.19E-05
U-233	1.9564E-09	235.239	470.479	0.00E+00	4.60E-07	9.20E-07
U-234	1.8371E-04	235.239	470.479	0.00E+00	4.32E-02	8.64E-02
U-235	-2.7235E-06	235.239	0.000	2.33E-03	1.69E-03	2.33E-03
U-236	1.5493E-05	235.239	470.479	0.00E+00	3.64E-03	7.29E-03
U-238	-4.2851E-09	235.239	0.000	1.45E-03	1.45E-03	1.45E-03
Y-90	2.7505E+00	235.239	470.479	0.00E+00	6.47E+02	1.29E+03
Other Radionuclides					1.21E+03	2.42E+03

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	9.077E+13
0.0250	1.955E+13
0.0375	1.805E+13
0.0575	1.774E+13
0.0850	1.131E+13
0.1250	9.796E+12
0.2250	9.587E+12
0.3750	4.641E+12
0.5750	6.374E+13
0.8500	8.926E+12
1.2500	1.661E+12
1.7500	6.965E+10
2.2500	1.461E+11
2.7500	8.404E+08
3.5000	9.324E+07
5.0000	2.820E+02
7.0000	3.145E+01
11.0000	3.546E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.19E+01	2.39E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	20.00000132	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		235.239	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		470.479	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.14	
Bounding:	0.28	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR MTR-S (SWITZERLAND)	[1]**Fuel decay start date:**	2010
SNF ID #:	658	**Estimates as of:**	2010
Fuel Units & Descr:	55 - MTR TYPE	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=16.68kg ; EOL=5.97kg	[2]**Template Burnup(MWd):**	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
2.29

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	10,135.949	15,792.496	0.00E+00	1.47E-06	2.30E-06
Am-241	1.1190E-03	10,135.949	15,792.496	0.00E+00	1.13E+01	1.77E+01
Am-242m	4.5425E-07	10,135.949	15,792.496	0.00E+00	4.60E-03	7.17E-03
Am-243	1.4921E-06	10,135.949	15,792.496	0.00E+00	1.51E-02	2.36E-02
C-14	5.7244E-09	10,135.949	15,792.496	0.00E+00	5.80E-05	9.04E-05
Cl-36	1.3124E-32	10,135.949	15,792.496	0.00E+00	1.33E-28	2.07E-28
Cm-243	2.3676E-07	10,135.949	15,792.496	0.00E+00	2.40E-03	3.74E-03
Cm-244	5.2042E-05	10,135.949	15,792.496	0.00E+00	5.27E-01	8.22E-01
Co-60	3.8208E-05	10,135.949	15,792.496	0.00E+00	3.87E-01	6.03E-01
Cs-134	4.8693E-01	10,135.949	15,792.496	0.00E+00	4.94E+03	7.69E+03
Cs-135	3.4477E-06	10,135.949	15,792.496	0.00E+00	3.49E-02	5.44E-02
Cs-137	2.8731E+00	10,135.949	15,792.496	0.00E+00	2.91E+04	4.54E+04
Eu-154	8.2053E-02	10,135.949	15,792.496	0.00E+00	8.32E+02	1.30E+03
Eu-155	3.9134E-02	10,135.949	15,792.496	0.00E+00	3.97E+02	6.18E+02
Fe-55	6.7429E-03	10,135.949	15,792.496	0.00E+00	6.83E+01	1.06E+02
H-3	1.0599E-02	10,135.949	15,792.496	0.00E+00	1.07E+02	1.67E+02
I-129	7.5300E-07	10,135.949	15,792.496	0.00E+00	7.63E-03	1.19E-02
Kr-85	2.8595E-01	10,135.949	15,792.496	0.00E+00	2.90E+03	4.52E+03
Np-237	9.5479E-06	10,135.949	15,792.496	0.00E+00	9.68E-02	1.51E-01
Pa-231	8.9297E-10	10,135.949	15,792.496	0.00E+00	9.05E-06	1.41E-05
Pb-210	3.7609E-12	10,135.949	15,792.496	0.00E+00	3.81E-08	5.94E-08
Pm-147	2.5452E+00	10,135.949	15,792.496	0.00E+00	2.58E+04	4.02E+04
Pu-238	2.0550E-02	10,135.949	15,792.496	0.00E+00	2.08E+02	3.25E+02
Pu-239	4.2838E-04	10,135.949	15,792.496	0.00E+00	4.34E+00	6.77E+00
Pu-240	2.4401E-04	10,135.949	15,792.496	0.00E+00	2.47E+00	3.85E+00
Pu-241	6.8764E-02	10,135.949	15,792.496	0.00E+00	6.97E+02	1.09E+03
Pu-242	3.6329E-07	10,135.949	15,792.496	0.00E+00	3.68E-03	5.74E-03
Ra-226	3.8045E-11	10,135.949	15,792.496	0.00E+00	3.86E-07	6.01E-07
Ra-228	2.9902E-15	10,135.949	15,792.496	0.00E+00	3.03E-11	4.72E-11
Ru-106	1.9055E-01	10,135.949	15,792.496	0.00E+00	1.93E+03	3.01E+03
Se-79	1.2936E-05	10,135.949	15,792.496	0.00E+00	1.31E-01	2.04E-01
Sn-126	1.1574E-05	10,135.949	15,792.496	0.00E+00	1.17E-01	1.83E-01
Sr-90	2.7505E+00	10,135.949	15,792.496	0.00E+00	2.79E+04	4.34E+04
Tc-99	4.2239E-04	10,135.949	15,792.496	0.00E+00	4.28E+00	6.67E+00
Th-229	1.8848E-12	10,135.949	15,792.496	0.00E+00	1.91E-08	2.98E-08
Th-230	1.7042E-08	10,135.949	15,792.496	0.00E+00	1.73E-04	2.69E-04
Th-232	7.8132E-15	10,135.949	15,792.496	0.00E+00	7.92E-11	1.23E-10
Tl-208	4.4063E-08	10,135.949	15,792.496	0.00E+00	4.47E-04	6.96E-04
U-232	1.3151E-07	10,135.949	15,792.496	0.00E+00	1.33E-03	2.08E-03
U-233	1.9564E-09	10,135.949	15,792.496	0.00E+00	1.98E-05	3.09E-05
U-234	1.8371E-04	10,135.949	15,792.496	0.00E+00	1.86E+00	2.90E+00
U-235	-2.7235E-06	10,135.949	0.000	3.35E-02	5.91E-03	3.35E-02
U-236	1.5493E-05	10,135.949	15,792.496	0.00E+00	1.57E-01	2.45E-01
U-238	-4.2851E-09	10,135.949	0.000	3.92E-04	3.49E-04	3.92E-04
Y-90	2.7505E+00	10,135.949	15,792.496	0.00E+00	2.79E+04	4.34E+04
Other Radionuclides					5.21E+04	8.12E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.047E+15
0.0250	6.564E+14
0.0375	6.057E+14
0.0575	5.956E+14
0.0850	3.797E+14
0.1250	3.288E+14
0.2250	3.218E+14
0.3750	1.558E+14
0.5750	2.140E+15
0.8500	2.996E+14
1.2500	5.575E+13
1.7500	2.338E+12
2.2500	4.904E+12
2.7500	2.821E+10
3.5000	3.130E+09
5.0000	9.353E+03
7.0000	1.043E+03
11.0000	1.175E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
5.14E+02	8.01E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.00000816	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		10,135.949	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		15,792.496	Bounding burnup calculated assuming all BOL heavy metal burned.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.93	
Bounding:	3.01	

Estimated EOL HM/Given EOL HM

1.10

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (TURKEY)
SNF ID #: 644
Fuel Units & Descr: 18 - MTR TYPE
Heavy Metal Mass: BOL=5.42kg ; EOL=2.90kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'
0.75

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	2,386.489	4,772.977	0.00E+00	3.47E-07	6.94E-07
Am-241	1.1190E-03	2,386.489	4,772.977	0.00E+00	2.67E+00	5.34E+00
Am-242m	4.5425E-07	2,386.489	4,772.977	0.00E+00	1.08E-03	2.17E-03
Am-243	1.4921E-06	2,386.489	4,772.977	0.00E+00	3.56E-03	7.12E-03
C-14	5.7244E-09	2,386.489	4,772.977	0.00E+00	1.37E-05	2.73E-05
Cl-36	1.3124E-32	2,386.489	4,772.977	0.00E+00	3.13E-29	6.26E-29
Cm-243	2.3676E-07	2,386.489	4,772.977	0.00E+00	5.65E-04	1.13E-03
Cm-244	5.2042E-05	2,386.489	4,772.977	0.00E+00	1.24E-01	2.48E-01
Co-60	3.8208E-05	2,386.489	4,772.977	0.00E+00	9.12E-02	1.82E-01
Cs-134	4.8693E-01	2,386.489	4,772.977	0.00E+00	1.16E+03	2.32E+03
Cs-135	3.4477E-06	2,386.489	4,772.977	0.00E+00	8.23E-03	1.65E-02
Cs-137	2.8731E+00	2,386.489	4,772.977	0.00E+00	6.86E+03	1.37E+04
Eu-154	8.2053E-02	2,386.489	4,772.977	0.00E+00	1.96E+02	3.92E+02
Eu-155	3.9134E-02	2,386.489	4,772.977	0.00E+00	9.34E+01	1.87E+02
Fe-55	6.7429E-03	2,386.489	4,772.977	0.00E+00	1.61E+01	3.22E+01
H-3	1.0599E-02	2,386.489	4,772.977	0.00E+00	2.53E+01	5.06E+01
I-129	7.5300E-07	2,386.489	4,772.977	0.00E+00	1.80E-03	3.59E-03
Kr-85	2.8595E-01	2,386.489	4,772.977	0.00E+00	6.82E+02	1.36E+03
Np-237	9.5479E-06	2,386.489	4,772.977	0.00E+00	2.28E-02	4.56E-02
Pa-231	8.9297E-10	2,386.489	4,772.977	0.00E+00	2.13E-06	4.26E-06
Pb-210	3.7609E-12	2,386.489	4,772.977	0.00E+00	8.98E-09	1.80E-08
Pm-147	2.5452E+00	2,386.489	4,772.977	0.00E+00	6.07E+03	1.21E+04
Pu-238	2.0550E-02	2,386.489	4,772.977	0.00E+00	4.90E+01	9.81E+01
Pu-239	4.2838E-04	2,386.489	4,772.977	0.00E+00	1.02E+00	2.04E+00
Pu-240	2.4401E-04	2,386.489	4,772.977	0.00E+00	5.82E-01	1.16E+00
Pu-241	6.8764E-02	2,386.489	4,772.977	0.00E+00	1.64E+02	3.28E+02
Pu-242	3.6329E-07	2,386.489	4,772.977	0.00E+00	8.67E-04	1.73E-03
Ra-226	3.8045E-11	2,386.489	4,772.977	0.00E+00	9.08E-08	1.82E-07
Ra-228	2.9902E-15	2,386.489	4,772.977	0.00E+00	7.14E-12	1.43E-11
Ru-106	1.9055E-01	2,386.489	4,772.977	0.00E+00	4.55E+02	9.09E+02
Se-79	1.2936E-05	2,386.489	4,772.977	0.00E+00	3.09E-02	6.17E-02
Sn-126	1.1574E-05	2,386.489	4,772.977	0.00E+00	2.76E-02	5.52E-02
Sr-90	2.7505E+00	2,386.489	4,772.977	0.00E+00	6.56E+03	1.31E+04
Tc-99	4.2239E-04	2,386.489	4,772.977	0.00E+00	1.01E+00	2.02E+00
Th-229	1.8848E-12	2,386.489	4,772.977	0.00E+00	4.50E-09	9.00E-09
Th-230	1.7042E-08	2,386.489	4,772.977	0.00E+00	4.07E-05	8.13E-05
Th-232	7.8132E-15	2,386.489	4,772.977	0.00E+00	1.86E-11	3.73E-11
Tl-208	4.4063E-08	2,386.489	4,772.977	0.00E+00	1.05E-04	2.10E-04
U-232	1.3151E-07	2,386.489	4,772.977	0.00E+00	3.14E-04	6.28E-04
U-233	1.9564E-09	2,386.489	4,772.977	0.00E+00	4.67E-06	9.34E-06
U-234	1.8371E-04	2,386.489	4,772.977	0.00E+00	4.38E-01	8.77E-01
U-235	-2.7235E-06	2,386.489	0.000	1.09E-02	4.39E-03	1.09E-02
U-236	1.5493E-05	2,386.489	4,772.977	0.00E+00	3.70E-02	7.39E-02
U-238	-4.2851E-09	2,386.489	0.000	1.28E-04	1.17E-04	1.28E-04
Y-90	2.7505E+00	2,386.489	4,772.977	0.00E+00	6.56E+03	1.31E+04
Other Radionuclides					1.23E+04	2.45E+04

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	9.209E+14
0.0250	1.984E+14
0.0375	1.831E+14
0.0575	1.800E+14
0.0850	1.148E+14
0.1250	9.937E+13
0.2250	9.726E+13
0.3750	4.708E+13
0.5750	6.467E+14
0.8500	9.055E+13
1.2500	1.685E+13
1.7500	7.066E+11
2.2500	1.482E+12
2.7500	8.526E+09
3.5000	9.459E+08
5.0000	2.827E+03
7.0000	3.152E+02
11.0000	3.552E+01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.21E+02	2.42E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99998782	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		2,386.489
Bounding:		4,772.977

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.40	
Bounding:	2.80	

Estimated EOL HM/Given EOL HM: 1.05

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR MTR-S (TURKEY)
SNF ID #: 528
Fuel Units & Descr: 32 - ASSEMBLY
Heavy Metal Mass: BOL=67.20kg ; EOL=59.14kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
1.33

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	7,636.763	15,273.525	0.00E+00	1.11E-06	2.22E-06
Am-241	1.1190E-03	7,636.763	15,273.525	0.00E+00	8.55E+00	1.71E+01
Am-242m	4.5425E-07	7,636.763	15,273.525	0.00E+00	3.47E-03	6.94E-03
Am-243	1.4921E-06	7,636.763	15,273.525	0.00E+00	1.14E-02	2.28E-02
C-14	5.7244E-09	7,636.763	15,273.525	0.00E+00	4.37E-05	8.74E-05
Cl-36	1.3124E-32	7,636.763	15,273.525	0.00E+00	1.00E-28	2.00E-28
Cm-243	2.3676E-07	7,636.763	15,273.525	0.00E+00	1.81E-03	3.62E-03
Cm-244	5.2042E-05	7,636.763	15,273.525	0.00E+00	3.97E-01	7.95E-01
Co-60	3.8208E-05	7,636.763	15,273.525	0.00E+00	2.92E-01	5.84E-01
Cs-134	4.8693E-01	7,636.763	15,273.525	0.00E+00	3.72E+03	7.44E+03
Cs-135	3.4477E-06	7,636.763	15,273.525	0.00E+00	2.63E-02	5.27E-02
Cs-137	2.8731E+00	7,636.763	15,273.525	0.00E+00	2.19E+04	4.39E+04
Eu-154	8.2053E-02	7,636.763	15,273.525	0.00E+00	6.27E+02	1.25E+03
Eu-155	3.9134E-02	7,636.763	15,273.525	0.00E+00	2.99E+02	5.98E+02
Fe-55	6.7429E-03	7,636.763	15,273.525	0.00E+00	5.15E+01	1.03E+02
H-3	1.0599E-02	7,636.763	15,273.525	0.00E+00	8.09E+01	1.62E+02
I-129	7.5300E-07	7,636.763	15,273.525	0.00E+00	5.75E-03	1.15E-02
Kr-85	2.8595E-01	7,636.763	15,273.525	0.00E+00	2.18E+03	4.37E+03
Np-237	9.5479E-06	7,636.763	15,273.525	0.00E+00	7.29E-02	1.46E-01
Pa-231	8.9297E-10	7,636.763	15,273.525	0.00E+00	6.82E-06	1.36E-05
Pb-210	3.7609E-12	7,636.763	15,273.525	0.00E+00	2.87E-08	5.74E-08
Pm-147	2.5452E+00	7,636.763	15,273.525	0.00E+00	1.94E+04	3.89E+04
Pu-238	2.0550E-02	7,636.763	15,273.525	0.00E+00	1.57E+02	3.14E+02
Pu-239	4.2838E-04	7,636.763	15,273.525	0.00E+00	3.27E+00	6.54E+00
Pu-240	2.4401E-04	7,636.763	15,273.525	0.00E+00	1.86E+00	3.73E+00
Pu-241	6.8764E-02	7,636.763	15,273.525	0.00E+00	5.25E+02	1.05E+03
Pu-242	3.6329E-07	7,636.763	15,273.525	0.00E+00	2.77E-03	5.55E-03
Ra-226	3.8045E-11	7,636.763	15,273.525	0.00E+00	2.91E-07	5.81E-07
Ra-228	2.9902E-15	7,636.763	15,273.525	0.00E+00	2.28E-11	4.57E-11
Ru-106	1.9055E-01	7,636.763	15,273.525	0.00E+00	1.46E+03	2.91E+03
Se-79	1.2936E-05	7,636.763	15,273.525	0.00E+00	9.88E-02	1.98E-01
Sn-126	1.1574E-05	7,636.763	15,273.525	0.00E+00	8.84E-02	1.77E-01
Sr-90	2.7505E+00	7,636.763	15,273.525	0.00E+00	2.10E+04	4.20E+04
Tc-99	4.2239E-04	7,636.763	15,273.525	0.00E+00	3.23E+00	6.45E+00
Th-229	1.8848E-12	7,636.763	15,273.525	0.00E+00	1.44E-08	2.88E-08
Th-230	1.7042E-08	7,636.763	15,273.525	0.00E+00	1.30E-04	2.60E-04
Th-232	7.8132E-15	7,636.763	15,273.525	0.00E+00	5.97E-11	1.19E-10
Tl-208	4.4063E-08	7,636.763	15,273.525	0.00E+00	3.37E-04	6.73E-04
U-232	1.3151E-07	7,636.763	15,273.525	0.00E+00	1.00E-03	2.01E-03
U-233	1.9564E-09	7,636.763	15,273.525	0.00E+00	1.49E-05	2.99E-05
U-234	1.8371E-04	7,636.763	15,273.525	0.00E+00	1.40E+00	2.81E+00
U-235	-2.7235E-06	7,636.763	0.000	2.90E-02	8.24E-03	2.90E-02
U-236	1.5493E-05	7,636.763	15,273.525	0.00E+00	1.18E-01	2.37E-01
U-238	-4.2851E-09	7,636.763	0.000	1.81E-02	1.80E-02	1.81E-02
Y-90	2.7505E+00	7,636.763	15,273.525	0.00E+00	2.10E+04	4.20E+04
Other Radionuclides					3.93E+04	7.86E+04

Gamma Sources

Photon Energy Group Avg. MeV	Total Photons/sec (bounding)
0.0150	2.947E+15
0.0250	6.348E+14
0.0375	5.858E+14
0.0575	5.760E+14
0.0850	3.672E+14
0.1250	3.180E+14
0.2250	3.112E+14
0.3750	1.507E+14
0.5750	2.069E+15
0.8500	2.898E+14
1.2500	5.392E+13
1.7500	2.261E+12
2.2500	4.743E+12
2.7500	2.728E+10
3.5000	3.027E+09
5.0000	9.086E+03
7.0000	1.013E+03
11.0000	1.142E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.87E+02	7.74E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20.00000028	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches on all parameters except enrichment.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		7,636.763
Bounding:		15,273.525

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.36	
Bounding:	0.72	

Estimated EOL HM/Given EOL HM
1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR PIN CLUSTER (CANADA)	**Fuel decay start date:**[1]	2010
SNF ID #:	661	**Estimates as of:**	2010
Fuel Units & Descr:	225 - MULTI-PIN CLUSTER	**Template:**	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=118.60kg ; EOL=34.63kg	**Template Burnup(MWd):**[2]	367.2
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x15'
18.75

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	79,521.220	112,314.133	0.00E+00	1.16E-05	1.63E-05
Am-241	1.1190E-03	79,521.220	112,314.133	0.00E+00	8.90E+01	1.26E+02
Am-242m	4.5425E-07	79,521.220	112,314.133	0.00E+00	3.61E-02	5.10E-02
Am-243	1.4921E-06	79,521.220	112,314.133	0.00E+00	1.19E-01	1.68E-01
C-14	5.7244E-09	79,521.220	112,314.133	0.00E+00	4.55E-04	6.43E-04
Cl-36	1.3124E-32	79,521.220	112,314.133	0.00E+00	1.04E-27	1.47E-27
Cm-243	2.3676E-07	79,521.220	112,314.133	0.00E+00	1.88E-02	2.66E-02
Cm-244	5.2042E-05	79,521.220	112,314.133	0.00E+00	4.14E+00	5.85E+00
Co-60	3.8208E-05	79,521.220	112,314.133	0.00E+00	3.04E+00	4.29E+00
Cs-134	4.8693E-01	79,521.220	112,314.133	0.00E+00	3.87E+04	5.47E+04
Cs-135	3.4477E-06	79,521.220	112,314.133	0.00E+00	2.74E-01	3.87E-01
Cs-137	2.8731E+00	79,521.220	112,314.133	0.00E+00	2.28E+05	3.23E+05
Eu-154	8.2053E-02	79,521.220	112,314.133	0.00E+00	6.52E+03	9.22E+03
Eu-155	3.9134E-02	79,521.220	112,314.133	0.00E+00	3.11E+03	4.40E+03
Fe-55	6.7429E-03	79,521.220	112,314.133	0.00E+00	5.36E+02	7.57E+02
H-3	1.0599E-02	79,521.220	112,314.133	0.00E+00	8.43E+02	1.19E+03
I-129	7.5300E-07	79,521.220	112,314.133	0.00E+00	5.99E-02	8.46E-02
Kr-85	2.8595E-01	79,521.220	112,314.133	0.00E+00	2.27E+04	3.21E+04
Np-237	9.5479E-06	79,521.220	112,314.133	0.00E+00	7.59E-01	1.07E+00
Pa-231	8.9297E-10	79,521.220	112,314.133	0.00E+00	7.10E-05	1.00E-04
Pb-210	3.7609E-12	79,521.220	112,314.133	0.00E+00	2.99E-07	4.22E-07
Pm-147	2.5452E+00	79,521.220	112,314.133	0.00E+00	2.02E+05	2.86E+05
Pu-238	2.0550E-02	79,521.220	112,314.133	0.00E+00	1.63E+03	2.31E+03
Pu-239	4.2838E-04	79,521.220	112,314.133	0.00E+00	3.41E+01	4.81E+01
Pu-240	2.4401E-04	79,521.220	112,314.133	0.00E+00	1.94E+01	2.74E+01
Pu-241	6.8764E-02	79,521.220	112,314.133	0.00E+00	5.47E+03	7.72E+03
Pu-242	3.6329E-07	79,521.220	112,314.133	0.00E+00	2.89E-02	4.08E-02
Ra-226	3.8045E-11	79,521.220	112,314.133	0.00E+00	3.03E-06	4.27E-06
Ra-228	2.9902E-15	79,521.220	112,314.133	0.00E+00	2.38E-10	3.36E-10
Ru-106	1.9055E-01	79,521.220	112,314.133	0.00E+00	1.52E+04	2.14E+04
Se-79	1.2936E-05	79,521.220	112,314.133	0.00E+00	1.03E+00	1.45E+00
Sn-126	1.1574E-05	79,521.220	112,314.133	0.00E+00	9.20E-01	1.30E+00
Sr-90	2.7505E+00	79,521.220	112,314.133	0.00E+00	2.19E+05	3.09E+05
Tc-99	4.2239E-04	79,521.220	112,314.133	0.00E+00	3.36E+01	4.74E+01
Th-229	1.8848E-12	79,521.220	112,314.133	0.00E+00	1.50E-07	2.12E-07
Th-230	1.7042E-08	79,521.220	112,314.133	0.00E+00	1.36E-03	1.91E-03
Th-232	7.8132E-15	79,521.220	112,314.133	0.00E+00	6.21E-10	8.78E-10
Tl-208	4.4063E-08	79,521.220	112,314.133	0.00E+00	3.50E-03	4.95E-03
U-232	1.3151E-07	79,521.220	112,314.133	0.00E+00	1.05E-02	1.48E-02
U-233	1.9564E-09	79,521.220	112,314.133	0.00E+00	1.56E-04	2.20E-04
U-234	1.8371E-04	79,521.220	112,314.133	0.00E+00	1.46E+01	2.06E+01
U-235	-2.7235E-06	79,521.220	0.000	2.39E-01	2.22E-02	2.39E-01
U-236	1.5493E-05	79,521.220	112,314.133	0.00E+00	1.23E+00	1.74E+00
U-238	-4.2851E-09	79,521.220	0.000	2.73E-03	2.39E-03	2.73E-03
Y-90	2.7505E+00	79,521.220	112,314.133	0.00E+00	2.19E+05	3.09E+05
Other Radionuclides					4.09E+05	5.78E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.167E+16
0.0250	4.668E+15
0.0375	4.308E+15
0.0575	4.236E+15
0.0850	2.700E+15
0.1250	2.338E+15
0.2250	2.289E+15
0.3750	1.108E+15
0.5750	1.522E+16
0.8500	2.131E+15
1.2500	3.965E+14
1.7500	1.663E+13
2.2500	3.488E+13
2.7500	2.006E+11
3.5000	2.226E+10
5.0000	6.652E+04
7.0000	7.417E+03
11.0000	8.359E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
4.03E+03	5.69E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.14999856	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		79,521.220	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		112,314.133	Bounding burnup calculated assuming all BOL heavy metal burned.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	2.13	
Bounding:	3.01	

Estimated EOL HM/Given EOL HM

1.14

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR PIN CLUSTER (CANADA)	[1]Fuel decay start date:	2010
SNF ID #:	660	Estimates as of:	2010
Fuel Units & Descr:	1527 - MULTI-PIN CLUSTER	Template:	HFBR (Heavy Water, Alum., 10 to 20%, U)
Heavy Metal Mass:	BOL=3796.27kg ; EOL=3226.40kg	[2]Template Burnup(MWd):	15
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00034251
		Template Decay Time:	5 years

Estimated Canister usage:

18"x15'
127.25

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.7533E-10	541,647.528	1,083,295.056	0.00E+00	9.50E-05	1.90E-04
Am-241	1.2780E-02	541,647.528	1,083,295.056	0.00E+00	6.92E+03	1.38E+04
Am-242m	9.5467E-06	541,647.528	1,083,295.056	0.00E+00	5.17E+00	1.03E+01
Am-243	6.4100E-06	541,647.528	1,083,295.056	0.00E+00	3.47E+00	6.94E+00
C-14	2.9673E-08	541,647.528	1,083,295.056	0.00E+00	1.61E-02	3.21E-02
Cl-36	5.9513E-35	541,647.528	1,083,295.056	0.00E+00	3.22E-29	6.45E-29
Cm-243	3.1807E-06	541,647.528	1,083,295.056	0.00E+00	1.72E+00	3.45E+00
Cm-244	1.9540E-04	541,647.528	1,083,295.056	0.00E+00	1.06E+02	2.12E+02
Co-60	1.1753E-04	541,647.528	1,083,295.056	0.00E+00	6.37E+01	1.27E+02
Cs-134	3.3060E-01	541,647.528	1,083,295.056	0.00E+00	1.79E+05	3.58E+05
Cs-135	4.8607E-06	541,647.528	1,083,295.056	0.00E+00	2.63E+00	5.27E+00
Cs-137	2.8607E+00	541,647.528	1,083,295.056	0.00E+00	1.55E+06	3.10E+06
Eu-154	6.9933E-02	541,647.528	1,083,295.056	0.00E+00	3.79E+04	7.58E+04
Eu-155	3.3253E-02	541,647.528	1,083,295.056	0.00E+00	1.80E+04	3.60E+04
Fe-55	7.7267E-02	541,647.528	1,083,295.056	0.00E+00	4.19E+04	8.37E+04
H-3	1.0827E-02	541,647.528	1,083,295.056	0.00E+00	5.86E+03	1.17E+04
I-129	7.1600E-07	541,647.528	1,083,295.056	0.00E+00	3.88E-01	7.76E-01
Kr-85	2.7007E-01	541,647.528	1,083,295.056	0.00E+00	1.46E+05	2.93E+05
Np-237	3.6327E-06	541,647.528	1,083,295.056	0.00E+00	1.97E+00	3.94E+00
Pa-231	1.1267E-09	541,647.528	1,083,295.056	0.00E+00	6.10E-04	1.22E-03
Pb-210	1.9773E-15	541,647.528	1,083,295.056	0.00E+00	1.07E-09	2.14E-09
Pm-147	2.4367E+00	541,647.528	1,083,295.056	0.00E+00	1.32E+06	2.64E+06
Pu-238	6.2213E-03	541,647.528	1,083,295.056	0.00E+00	3.37E+03	6.74E+03
Pu-239	1.0320E-02	541,647.528	1,083,295.056	0.00E+00	5.59E+03	1.12E+04
Pu-240	5.4260E-03	541,647.528	1,083,295.056	0.00E+00	2.94E+03	5.88E+03
Pu-241	7.7333E-01	541,647.528	1,083,295.056	0.00E+00	4.19E+05	8.38E+05
Pu-242	3.0713E-06	541,647.528	1,083,295.056	0.00E+00	1.66E+00	3.33E+00
Ra-226	2.2027E-14	541,647.528	1,083,295.056	0.00E+00	1.19E-08	2.39E-08
Ra-228	2.6333E-15	541,647.528	1,083,295.056	0.00E+00	1.43E-09	2.85E-09
Ru-106	2.5580E-01	541,647.528	1,083,295.056	0.00E+00	1.39E+05	2.77E+05
Se-79	1.2540E-05	541,647.528	1,083,295.056	0.00E+00	6.79E+00	1.36E+01
Sn-126	1.1393E-05	541,647.528	1,083,295.056	0.00E+00	6.17E+00	1.23E+01
Sr-90	2.6293E+00	541,647.528	1,083,295.056	0.00E+00	1.42E+06	2.85E+06
Tc-99	4.3540E-04	541,647.528	1,083,295.056	0.00E+00	2.36E+02	4.72E+02
Th-229	1.3653E-13	541,647.528	1,083,295.056	0.00E+00	7.40E-08	1.48E-07
Th-230	1.2607E-11	541,647.528	1,083,295.056	0.00E+00	6.83E-06	1.37E-05
Th-232	6.7400E-15	541,647.528	1,083,295.056	0.00E+00	3.65E-09	7.30E-09
Tl-208	7.4667E-09	541,647.528	1,083,295.056	0.00E+00	4.04E-03	8.09E-03
U-232	2.1927E-08	541,647.528	1,083,295.056	0.00E+00	1.19E-02	2.38E-02
U-233	1.9920E-10	541,647.528	1,083,295.056	0.00E+00	1.08E-04	2.16E-04
U-234	2.2487E-07	541,647.528	1,083,295.056	0.00E+00	1.22E-01	2.44E-01
U-235	-2.5341E-06	541,647.528	0.000	1.62E+00	2.48E-01	1.62E+00
U-236	1.3000E-05	541,647.528	1,083,295.056	0.00E+00	7.04E+00	1.41E+01
U-238	-1.4207E-08	541,647.528	0.000	1.02E+00	1.02E+00	1.02E+00
Y-90	2.6300E+00	541,647.528	1,083,295.056	0.00E+00	1.42E+06	2.85E+06
Other Radionuclides					2.56E+06	5.12E+06

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.966E+17
0.0250	4.235E+16
0.0375	3.859E+16
0.0575	3.853E+16
0.0850	2.426E+16
0.1250	2.026E+16
0.2250	2.069E+16
0.3750	1.003E+16
0.5750	1.385E+17
0.8500	1.469E+16
1.2500	3.248E+15
1.7500	1.546E+14
2.2500	2.689E+14
2.7500	2.432E+12
3.5000	2.882E+11
5.0000	2.819E+06
7.0000	3.212E+05
11.0000	3.668E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.56E+04	5.13E+04
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3Si2	U
BOL Enrichment %:	19.75000043	10 to 20

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		541,647.528
Bounding:		1,083,295.056

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.

Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	3.26	
Bounding:	6.52	

Estimated EOL HM/Given EOL HM

1.04

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR PIN CLUSTER (CANADA)	**[1]Fuel decay start date:**	2010		Estimated Canister usage:
SNF ID #:	662	**Estimates as of:**	2010		18"x15'
Fuel Units & Descr:	741 - MULTI-PIN CLUSTER	**Template:**	HFBR (Heavy Water, Alum., 40 to 100%, U)		61.75
Heavy Metal Mass:	BOL=395.69kg ; EOL=97.59kg	**[2]Template Burnup(MWd):**	164.6		
ROD Storage Site:	SRS	**Template BOL Heavy Metal Mass (MT):**	0.000377		
		Template Decay Time:	5 years		

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6950E-11	274,584.760	364,474.925	0.00E+00	1.84E-05	2.44E-05
Am-241	4.4557E-03	274,584.760	364,474.925	0.00E+00	1.22E+03	1.62E+03
Am-242m	1.4666E-06	274,584.760	364,474.925	0.00E+00	4.03E-01	5.35E-01
Am-243	3.7151E-05	274,584.760	364,474.925	0.00E+00	1.02E+01	1.35E+01
C-14	2.6513E-08	274,584.760	364,474.925	0.00E+00	7.28E-03	9.66E-03
Cl-36	4.4441E-31	274,584.760	364,474.925	0.00E+00	1.22E-25	1.62E-25
Cm-243	8.2139E-06	274,584.760	364,474.925	0.00E+00	2.26E+00	2.99E+00
Cm-244	8.2625E-03	274,584.760	364,474.925	0.00E+00	2.27E+03	3.01E+03
Co-60	3.4951E-04	274,584.760	364,474.925	0.00E+00	9.60E+01	1.27E+02
Cs-134	1.6409E+00	274,584.760	364,474.925	0.00E+00	4.51E+05	5.98E+05
Cs-135	4.2564E-06	274,584.760	364,474.925	0.00E+00	1.17E+00	1.55E+00
Cs-137	2.8791E+00	274,584.760	364,474.925	0.00E+00	7.91E+05	1.05E+06
Eu-154	1.7388E-01	274,584.760	364,474.925	0.00E+00	4.77E+04	6.34E+04
Eu-155	1.1616E-01	274,584.760	364,474.925	0.00E+00	3.19E+04	4.23E+04
Fe-55	7.3755E-02	274,584.760	364,474.925	0.00E+00	2.03E+04	2.69E+04
H-3	1.0729E-02	274,584.760	364,474.925	0.00E+00	2.95E+03	3.91E+03
I-129	6.6403E-07	274,584.760	364,474.925	0.00E+00	1.82E-01	2.42E-01
Kr-85	2.8487E-01	274,584.760	364,474.925	0.00E+00	7.82E+04	1.04E+05
Np-237	3.1507E-05	274,584.760	364,474.925	0.00E+00	8.65E+00	1.15E+01
Pa-231	4.1938E-10	274,584.760	364,474.925	0.00E+00	1.15E-04	1.53E-04
Pb-210	8.4083E-13	274,584.760	364,474.925	0.00E+00	2.31E-07	3.06E-07
Pm-147	1.2807E+00	274,584.760	364,474.925	0.00E+00	3.52E+05	4.67E+05
Pu-238	1.7290E-01	274,584.760	364,474.925	0.00E+00	4.75E+04	6.30E+04
Pu-239	6.9563E-04	274,584.760	364,474.925	0.00E+00	1.91E+02	2.54E+02
Pu-240	3.6865E-04	274,584.760	364,474.925	0.00E+00	1.01E+02	1.34E+02
Pu-241	2.7643E-01	274,584.760	364,474.925	0.00E+00	7.59E+04	1.01E+05
Pu-242	3.0911E-06	274,584.760	364,474.925	0.00E+00	8.49E-01	1.13E+00
Ra-226	8.6330E-12	274,584.760	364,474.925	0.00E+00	2.37E-06	3.15E-06
Ra-228	3.1817E-15	274,584.760	364,474.925	0.00E+00	8.74E-10	1.16E-09
Ru-106	2.1981E-01	274,584.760	364,474.925	0.00E+00	6.04E+04	8.01E+04
Se-79	1.2339E-05	274,584.760	364,474.925	0.00E+00	3.39E+00	4.50E+00
Sn-126	1.0194E-05	274,584.760	364,474.925	0.00E+00	2.80E+00	3.72E+00
Sr-90	2.7242E+00	274,584.760	364,474.925	0.00E+00	7.48E+05	9.93E+05
Tc-99	3.8056E-04	274,584.760	364,474.925	0.00E+00	1.04E+02	1.39E+02
Th-229	1.0413E-12	274,584.760	364,474.925	0.00E+00	2.86E-07	3.80E-07
Th-230	3.9648E-09	274,584.760	364,474.925	0.00E+00	1.09E-03	1.45E-03
Th-232	8.3536E-15	274,584.760	364,474.925	0.00E+00	2.29E-09	3.04E-09
Tl-208	4.3888E-08	274,584.760	364,474.925	0.00E+00	1.21E-02	1.60E-02
U-232	1.3645E-07	274,584.760	364,474.925	0.00E+00	3.75E-02	4.97E-02
U-233	1.7023E-09	274,584.760	364,474.925	0.00E+00	4.67E-04	6.20E-04
U-234	4.5389E-05	274,584.760	364,474.925	0.00E+00	1.25E+01	1.65E+01
U-235	-2.8661E-06	274,584.760	0.000	7.95E-01	8.24E-03	7.95E-01
U-236	1.6701E-05	274,584.760	364,474.925	0.00E+00	4.59E+00	6.09E+00
U-238	-9.4194E-09	274,584.760	0.000	9.31E-03	6.72E-03	9.31E-03
Y-90	2.7248E+00	274,584.760	364,474.925	0.00E+00	7.48E+05	9.93E+05
Other Radionuclides					1.46E+06	1.94E+06

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	7.241E+16
0.0250	1.543E+16
0.0375	1.489E+16
0.0575	1.421E+16
0.0850	9.306E+15
0.1250	8.490E+15
0.2250	7.666E+15
0.3750	3.631E+15
0.5750	6.948E+16
0.8500	2.124E+16
1.2500	2.901E+15
1.7500	7.628E+13
2.2500	1.207E+14
2.7500	7.421E+11
3.5000	8.336E+10
5.0000	1.896E+07
7.0000	2.181E+06
11.0000	2.501E+05

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.90E+04	2.52E+04
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	92.99999565	40 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		274,584.760	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		364,474.925	Bounding burnup calculated assuming all BOL heavy metal burned.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.59	
Bounding:	2.11	

Estimated EOL HM/Given EOL HM: 1.07

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR PIN CLUSTER (CANADA)	[1]Fuel decay start date:	2010	Estimated Canister usage:
SNF ID #:	663	Estimates as of:	2010	18"x15'
Fuel Units & Descr:	131 - MULTI-PIN CLUSTER	Template:	HFBR (Heavy Water, Alum., 40 to 100%, U)	10.92
Heavy Metal Mass:	BOL=76.65kg ; EOL=32.38kg	[2]Template Burnup(MWd):	164.6	
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.000377	
		Template Decay Time:	5 years	

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	6.6950E-11	40,772.532	70,600.795	0.00E+00	2.73E-06	4.73E-06
Am-241	4.4557E-03	40,772.532	70,600.795	0.00E+00	1.82E+02	3.15E+02
Am-242m	1.4666E-06	40,772.532	70,600.795	0.00E+00	5.98E-02	1.04E-01
Am-243	3.7151E-05	40,772.532	70,600.795	0.00E+00	1.51E+00	2.62E+00
C-14	2.6513E-08	40,772.532	70,600.795	0.00E+00	1.08E-03	1.87E-03
Cl-36	4.4441E-31	40,772.532	70,600.795	0.00E+00	1.81E-26	3.14E-26
Cm-243	8.2139E-06	40,772.532	70,600.795	0.00E+00	3.35E-01	5.80E-01
Cm-244	8.2625E-03	40,772.532	70,600.795	0.00E+00	3.37E+02	5.83E+02
Co-60	3.4951E-04	40,772.532	70,600.795	0.00E+00	1.43E+01	2.47E+01
Cs-134	1.6409E+00	40,772.532	70,600.795	0.00E+00	6.69E+04	1.16E+05
Cs-135	4.2564E-06	40,772.532	70,600.795	0.00E+00	1.74E-01	3.01E-01
Cs-137	2.8791E+00	40,772.532	70,600.795	0.00E+00	1.17E+05	2.03E+05
Eu-154	1.7388E-01	40,772.532	70,600.795	0.00E+00	7.09E+03	1.23E+04
Eu-155	1.1616E-01	40,772.532	70,600.795	0.00E+00	4.74E+03	8.20E+03
Fe-55	7.3755E-02	40,772.532	70,600.795	0.00E+00	3.01E+03	5.21E+03
H-3	1.0729E-02	40,772.532	70,600.795	0.00E+00	4.37E+02	7.57E+02
I-129	6.6403E-07	40,772.532	70,600.795	0.00E+00	2.71E-02	4.69E-02
Kr-85	2.8487E-01	40,772.532	70,600.795	0.00E+00	1.16E+04	2.01E+04
Np-237	3.1507E-05	40,772.532	70,600.795	0.00E+00	1.28E+00	2.22E+00
Pa-231	4.1938E-10	40,772.532	70,600.795	0.00E+00	1.71E-05	2.96E-05
Pb-210	8.4083E-13	40,772.532	70,600.795	0.00E+00	3.43E-08	5.94E-08
Pm-147	1.2807E+00	40,772.532	70,600.795	0.00E+00	5.22E+04	9.04E+04
Pu-238	1.7290E-01	40,772.532	70,600.795	0.00E+00	7.05E+03	1.22E+04
Pu-239	6.9563E-04	40,772.532	70,600.795	0.00E+00	2.84E+01	4.91E+01
Pu-240	3.6865E-04	40,772.532	70,600.795	0.00E+00	1.50E+01	2.60E+01
Pu-241	2.7643E-01	40,772.532	70,600.795	0.00E+00	1.13E+04	1.95E+04
Pu-242	3.0911E-06	40,772.532	70,600.795	0.00E+00	1.26E-01	2.18E-01
Ra-226	8.6330E-12	40,772.532	70,600.795	0.00E+00	3.52E-07	6.10E-07
Ra-228	3.1817E-15	40,772.532	70,600.795	0.00E+00	1.30E-10	2.25E-10
Ru-106	2.1981E-01	40,772.532	70,600.795	0.00E+00	8.96E+03	1.55E+04
Se-79	1.2339E-05	40,772.532	70,600.795	0.00E+00	5.03E-01	8.71E-01
Sn-126	1.0194E-05	40,772.532	70,600.795	0.00E+00	4.16E-01	7.20E-01
Sr-90	2.7242E+00	40,772.532	70,600.795	0.00E+00	1.11E+05	1.92E+05
Tc-99	3.8056E-04	40,772.532	70,600.795	0.00E+00	1.55E+01	2.69E+01
Th-229	1.0413E-12	40,772.532	70,600.795	0.00E+00	4.25E-08	7.35E-08
Th-230	3.9648E-09	40,772.532	70,600.795	0.00E+00	1.62E-04	2.80E-04
Th-232	8.3536E-15	40,772.532	70,600.795	0.00E+00	3.41E-10	5.90E-10
Tl-208	4.3888E-08	40,772.532	70,600.795	0.00E+00	1.79E-03	3.10E-03
U-232	1.3645E-07	40,772.532	70,600.795	0.00E+00	5.56E-03	9.63E-03
U-233	1.7023E-09	40,772.532	70,600.795	0.00E+00	6.94E-05	1.20E-04
U-234	4.5389E-05	40,772.532	70,600.795	0.00E+00	1.85E+00	3.20E+00
U-235	-2.8661E-06	40,772.532	0.000	1.54E-01	3.74E-02	1.54E-01
U-236	1.6701E-05	40,772.532	70,600.795	0.00E+00	6.81E-01	1.18E+00
U-238	-9.4194E-09	40,772.532	0.000	1.76E-03	1.38E-03	1.76E-03
Y-90	2.7248E+00	40,772.532	70,600.795	0.00E+00	1.11E+05	1.92E+05
Other Radionuclides					2.17E+05	3.76E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.403E+16
0.0250	2.988E+15
0.0375	2.885E+15
0.0575	2.752E+15
0.0850	1.803E+15
0.1250	1.645E+15
0.2250	1.485E+15
0.3750	7.033E+14
0.5750	1.346E+16
0.8500	4.115E+15
1.2500	5.619E+14
1.7500	1.478E+13
2.2500	2.337E+13
2.7500	1.438E+11
3.5000	1.615E+10
5.0000	3.673E+06
7.0000	4.224E+05
11.0000	4.845E+04

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.82E+03	4.88E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	HEAVY WATER	HEAVY WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.15000501	40 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		40,772.532	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		70,600.795	Bounding burnup calculated assuming all BOL heavy metal burned.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	1.22	
Bounding:	2.11	

Estimated EOL HM/Given EOL HM: 1.03

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR PIN CLUSTER (SO. KOREA)
SNF ID #: 659
Fuel Units & Descr: 158 - MULTI-PIN CLUSTER
Heavy Metal Mass: BOL=343.65kg ; EOL=298.29kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x15'
13.17

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	42,958.501	85,917.002	0.00E+00	6.25E-06	1.25E-05
Am-241	1.1190E-03	42,958.501	85,917.002	0.00E+00	4.81E+01	9.61E+01
Am-242m	4.5425E-07	42,958.501	85,917.002	0.00E+00	1.95E-02	3.90E-02
Am-243	1.4921E-06	42,958.501	85,917.002	0.00E+00	6.41E-02	1.28E-01
C-14	5.7244E-09	42,958.501	85,917.002	0.00E+00	2.46E-04	4.92E-04
Cl-36	1.3124E-32	42,958.501	85,917.002	0.00E+00	5.64E-28	1.13E-27
Cm-243	2.3676E-07	42,958.501	85,917.002	0.00E+00	1.02E-02	2.03E-02
Cm-244	5.2042E-05	42,958.501	85,917.002	0.00E+00	2.24E+00	4.47E+00
Co-60	3.8208E-05	42,958.501	85,917.002	0.00E+00	1.64E+00	3.28E+00
Cs-134	4.8693E-01	42,958.501	85,917.002	0.00E+00	2.09E+04	4.18E+04
Cs-135	3.4477E-06	42,958.501	85,917.002	0.00E+00	1.48E-01	2.96E-01
Cs-137	2.8731E+00	42,958.501	85,917.002	0.00E+00	1.23E+05	2.47E+05
Eu-154	8.2053E-02	42,958.501	85,917.002	0.00E+00	3.52E+03	7.05E+03
Eu-155	3.9134E-02	42,958.501	85,917.002	0.00E+00	1.68E+03	3.36E+03
Fe-55	6.7429E-03	42,958.501	85,917.002	0.00E+00	2.90E+02	5.79E+02
H-3	1.0599E-02	42,958.501	85,917.002	0.00E+00	4.55E+02	9.11E+02
I-129	7.5300E-07	42,958.501	85,917.002	0.00E+00	3.23E-02	6.47E-02
Kr-85	2.8595E-01	42,958.501	85,917.002	0.00E+00	1.23E+04	2.46E+04
Np-237	9.5479E-06	42,958.501	85,917.002	0.00E+00	4.10E-01	8.20E-01
Pa-231	8.9297E-10	42,958.501	85,917.002	0.00E+00	3.84E-05	7.67E-05
Pb-210	3.7609E-12	42,958.501	85,917.002	0.00E+00	1.62E-07	3.23E-07
Pm-147	2.5452E+00	42,958.501	85,917.002	0.00E+00	1.09E+05	2.19E+05
Pu-238	2.0550E-02	42,958.501	85,917.002	0.00E+00	8.83E+02	1.77E+03
Pu-239	4.2838E-04	42,958.501	85,917.002	0.00E+00	1.84E+01	3.68E+01
Pu-240	2.4401E-04	42,958.501	85,917.002	0.00E+00	1.05E+01	2.10E+01
Pu-241	6.8764E-02	42,958.501	85,917.002	0.00E+00	2.95E+03	5.91E+03
Pu-242	3.6329E-07	42,958.501	85,917.002	0.00E+00	1.56E-02	3.12E-02
Ra-226	3.8045E-11	42,958.501	85,917.002	0.00E+00	1.63E-06	3.27E-06
Ra-228	2.9902E-15	42,958.501	85,917.002	0.00E+00	1.28E-10	2.57E-10
Ru-106	1.9055E-01	42,958.501	85,917.002	0.00E+00	8.19E+03	1.64E+04
Se-79	1.2936E-05	42,958.501	85,917.002	0.00E+00	5.56E-01	1.11E+00
Sn-126	1.1574E-05	42,958.501	85,917.002	0.00E+00	4.97E-01	9.94E-01
Sr-90	2.7505E+00	42,958.501	85,917.002	0.00E+00	1.18E+05	2.36E+05
Tc-99	4.2239E-04	42,958.501	85,917.002	0.00E+00	1.81E+01	3.63E+01
Th-229	1.8848E-12	42,958.501	85,917.002	0.00E+00	8.10E-08	1.62E-07
Th-230	1.7042E-08	42,958.501	85,917.002	0.00E+00	7.32E-04	1.46E-03
Th-232	7.8132E-15	42,958.501	85,917.002	0.00E+00	3.36E-10	6.71E-10
Tl-208	4.4063E-08	42,958.501	85,917.002	0.00E+00	1.89E-03	3.79E-03
U-232	1.3151E-07	42,958.501	85,917.002	0.00E+00	5.65E-03	1.13E-02
U-233	1.9564E-09	42,958.501	85,917.002	0.00E+00	8.40E-05	1.68E-04
U-234	1.8371E-04	42,958.501	85,917.002	0.00E+00	7.89E+00	1.58E+01
U-235	-2.7235E-06	42,958.501	0.000	1.49E-01	3.15E-02	1.49E-01
U-236	1.5493E-05	42,958.501	85,917.002	0.00E+00	6.66E-01	1.33E+00
U-238	-4.2851E-09	42,958.501	0.000	9.24E-02	9.22E-02	9.24E-02
Y-90	2.7505E+00	42,958.501	85,917.002	0.00E+00	1.18E+05	2.36E+05
Other Radionuclides					2.21E+05	4.42E+05

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.658E+16
0.0250	3.571E+15
0.0375	3.295E+15
0.0575	3.240E+15
0.0850	2.066E+15
0.1250	1.789E+15
0.2250	1.751E+15
0.3750	8.475E+14
0.5750	1.164E+16
0.8500	1.630E+15
1.2500	3.033E+14
1.7500	1.272E+13
2.2500	2.668E+13
2.7500	1.535E+11
3.5000	1.703E+10
5.0000	5.109E+04
7.0000	5.697E+03
11.0000	6.422E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
2.18E+03	4.36E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	20.00000055	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches on all parameters except enrichment

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		42,958.501
Bounding:		85,917.002

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.40	
Bounding:	0.79	

Estimated EOL HM/Given EOL HM: 1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR PIN CLUSTER (SO. KOREA)
SNF ID #: 293
Fuel Units & Descr: 48 - MULTI-PIN CLUSTER
Heavy Metal Mass: BOL=59.52kg ; EOL=52.14kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x15'
4.00

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	6,991.276	13,982.553	0.00E+00	1.02E-06	2.03E-06
Am-241	1.1190E-03	6,991.276	13,982.553	0.00E+00	7.82E+00	1.56E+01
Am-242m	4.5425E-07	6,991.276	13,982.553	0.00E+00	3.18E-03	6.35E-03
Am-243	1.4921E-06	6,991.276	13,982.553	0.00E+00	1.04E-02	2.09E-02
C-14	5.7244E-09	6,991.276	13,982.553	0.00E+00	4.00E-05	8.00E-05
Cl-36	1.3124E-32	6,991.276	13,982.553	0.00E+00	9.18E-29	1.84E-28
Cm-243	2.3676E-07	6,991.276	13,982.553	0.00E+00	1.66E-03	3.31E-03
Cm-244	5.2042E-05	6,991.276	13,982.553	0.00E+00	3.64E-01	7.28E-01
Co-60	3.8208E-05	6,991.276	13,982.553	0.00E+00	2.67E-01	5.34E-01
Cs-134	4.8693E-01	6,991.276	13,982.553	0.00E+00	3.40E+03	6.81E+03
Cs-135	3.4477E-06	6,991.276	13,982.553	0.00E+00	2.41E-02	4.82E-02
Cs-137	2.8731E+00	6,991.276	13,982.553	0.00E+00	2.01E+04	4.02E+04
Eu-154	8.2053E-02	6,991.276	13,982.553	0.00E+00	5.74E+02	1.15E+03
Eu-155	3.9134E-02	6,991.276	13,982.553	0.00E+00	2.74E+02	5.47E+02
Fe-55	6.7429E-03	6,991.276	13,982.553	0.00E+00	4.71E+01	9.43E+01
H-3	1.0599E-02	6,991.276	13,982.553	0.00E+00	7.41E+01	1.48E+02
I-129	7.5300E-07	6,991.276	13,982.553	0.00E+00	5.26E-03	1.05E-02
Kr-85	2.8595E-01	6,991.276	13,982.553	0.00E+00	2.00E+03	4.00E+03
Np-237	9.5479E-06	6,991.276	13,982.553	0.00E+00	6.68E-02	1.34E-01
Pa-231	8.9297E-10	6,991.276	13,982.553	0.00E+00	6.24E-06	1.25E-05
Pb-210	3.7609E-12	6,991.276	13,982.553	0.00E+00	2.63E-08	5.26E-08
Pm-147	2.5452E+00	6,991.276	13,982.553	0.00E+00	1.78E+04	3.56E+04
Pu-238	2.0550E-02	6,991.276	13,982.553	0.00E+00	1.44E+02	2.87E+02
Pu-239	4.2838E-04	6,991.276	13,982.553	0.00E+00	2.99E+00	5.99E+00
Pu-240	2.4401E-04	6,991.276	13,982.553	0.00E+00	1.71E+00	3.41E+00
Pu-241	6.8764E-02	6,991.276	13,982.553	0.00E+00	4.81E+02	9.61E+02
Pu-242	3.6329E-07	6,991.276	13,982.553	0.00E+00	2.54E-03	5.08E-03
Ra-226	3.8045E-11	6,991.276	13,982.553	0.00E+00	2.66E-07	5.32E-07
Ra-228	2.9902E-15	6,991.276	13,982.553	0.00E+00	2.09E-11	4.18E-11
Ru-106	1.9055E-01	6,991.276	13,982.553	0.00E+00	1.33E+03	2.66E+03
Se-79	1.2936E-05	6,991.276	13,982.553	0.00E+00	9.04E-02	1.81E-01
Sn-126	1.1574E-05	6,991.276	13,982.553	0.00E+00	8.09E-02	1.62E-01
Sr-90	2.7505E+00	6,991.276	13,982.553	0.00E+00	1.92E+04	3.85E+04
Tc-99	4.2239E-04	6,991.276	13,982.553	0.00E+00	2.95E+00	5.91E+00
Th-229	1.8848E-12	6,991.276	13,982.553	0.00E+00	1.32E-08	2.64E-08
Th-230	1.7042E-08	6,991.276	13,982.553	0.00E+00	1.19E-04	2.38E-04
Th-232	7.8132E-15	6,991.276	13,982.553	0.00E+00	5.46E-11	1.09E-10
Tl-208	4.4063E-08	6,991.276	13,982.553	0.00E+00	3.08E-04	6.16E-04
U-232	1.3151E-07	6,991.276	13,982.553	0.00E+00	9.19E-04	1.84E-03
U-233	1.9564E-09	6,991.276	13,982.553	0.00E+00	1.37E-05	2.74E-05
U-234	1.8371E-04	6,991.276	13,982.553	0.00E+00	1.28E+00	2.57E+00
U-235	-2.7235E-06	6,991.276	0.000	2.57E-02	6.68E-03	2.57E-02
U-236	1.5493E-05	6,991.276	13,982.553	0.00E+00	1.08E-01	2.17E-01
U-238	-4.2851E-09	6,991.276	0.000	1.60E-02	1.60E-02	1.60E-02
Y-90	2.7505E+00	6,991.276	13,982.553	0.00E+00	1.92E+04	3.85E+04
Other Radionuclides					3.60E+04	7.19E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.698E+15
0.0250	5.812E+14
0.0375	5.363E+14
0.0575	5.273E+14
0.0850	3.362E+14
0.1250	2.911E+14
0.2250	2.849E+14
0.3750	1.379E+14
0.5750	1.894E+15
0.8500	2.653E+14
1.2500	4.936E+13
1.7500	2.070E+12
2.2500	4.342E+12
2.7500	2.498E+10
3.5000	2.771E+09
5.0000	8.317E+03
7.0000	9.274E+02
11.0000	1.045E+02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
3.54E+02	7.09E+02
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U3SI2	U
BOL Enrichment %:	19.99999952	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches ATR Template on all but one parameter (enrichment) making ATR a reasonable match.

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		6,991.276
Bounding:		13,982.553

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.37	
Bounding:	0.75	

Estimated EOL HM/Given EOL HM
1.01

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR SLOWPOKE (CANADA)
SNF ID #: 666
Fuel Units & Desc.: 2 - 297 ROD ARRAY
Heavy Metal Mass: BOL=1.77kg ; EOL=1.74kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:

18"x10'
0.50

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	28.240	56.480	0.00E+00	4.11E-09	8.22E-09
Am-241	1.1190E-03	28.240	56.480	0.00E+00	3.16E-02	6.32E-02
Am-242m	4.5425E-07	28.240	56.480	0.00E+00	1.28E-05	2.57E-05
Am-243	1.4921E-06	28.240	56.480	0.00E+00	4.21E-05	8.43E-05
C-14	5.7244E-09	28.240	56.480	0.00E+00	1.62E-07	3.23E-07
Cl-36	1.3124E-32	28.240	56.480	0.00E+00	3.71E-31	7.41E-31
Cm-243	2.3676E-07	28.240	56.480	0.00E+00	6.69E-06	1.34E-05
Cm-244	5.2042E-05	28.240	56.480	0.00E+00	1.47E-03	2.94E-03
Co-60	3.8208E-05	28.240	56.480	0.00E+00	1.08E-03	2.16E-03
Cs-134	4.8693E-01	28.240	56.480	0.00E+00	1.38E+01	2.75E+01
Cs-135	3.4477E-06	28.240	56.480	0.00E+00	9.74E-05	1.95E-04
Cs-137	2.8731E+00	28.240	56.480	0.00E+00	8.11E+01	1.62E+02
Eu-154	8.2053E-02	28.240	56.480	0.00E+00	2.32E+00	4.63E+00
Eu-155	3.9134E-02	28.240	56.480	0.00E+00	1.11E+00	2.21E+00
Fe-55	6.7429E-03	28.240	56.480	0.00E+00	1.90E-01	3.81E-01
H-3	1.0599E-02	28.240	56.480	0.00E+00	2.99E-01	5.99E-01
I-129	7.5300E-07	28.240	56.480	0.00E+00	2.13E-05	4.25E-05
Kr-85	2.8595E-01	28.240	56.480	0.00E+00	8.08E+00	1.62E+01
Np-237	9.5479E-06	28.240	56.480	0.00E+00	2.70E-04	5.39E-04
Pa-231	8.9297E-10	28.240	56.480	0.00E+00	2.52E-08	5.04E-08
Pb-210	3.7609E-12	28.240	56.480	0.00E+00	1.06E-10	2.12E-10
Pm-147	2.5452E+00	28.240	56.480	0.00E+00	7.19E+01	1.44E+02
Pu-238	2.0550E-02	28.240	56.480	0.00E+00	5.80E-01	1.16E+00
Pu-239	4.2838E-04	28.240	56.480	0.00E+00	1.21E-02	2.42E-02
Pu-240	2.4401E-04	28.240	56.480	0.00E+00	6.89E-03	1.38E-02
Pu-241	6.8764E-02	28.240	56.480	0.00E+00	1.94E+00	3.88E+00
Pu-242	3.6329E-07	28.240	56.480	0.00E+00	1.03E-05	2.05E-05
Ra-226	3.8045E-11	28.240	56.480	0.00E+00	1.07E-09	2.15E-09
Ra-228	2.9902E-15	28.240	56.480	0.00E+00	8.44E-14	1.69E-13
Ru-106	1.9055E-01	28.240	56.480	0.00E+00	5.38E+00	1.08E+01
Se-79	1.2936E-05	28.240	56.480	0.00E+00	3.65E-04	7.31E-04
Sn-126	1.1574E-05	28.240	56.480	0.00E+00	3.27E-04	6.54E-04
Sr-90	2.7505E+00	28.240	56.480	0.00E+00	7.77E+01	1.55E+02
Tc-99	4.2239E-04	28.240	56.480	0.00E+00	1.19E-02	2.39E-02
Th-229	1.8848E-12	28.240	56.480	0.00E+00	5.32E-11	1.06E-10
Th-230	1.7042E-08	28.240	56.480	0.00E+00	4.81E-07	9.63E-07
Th-232	7.8132E-15	28.240	56.480	0.00E+00	2.21E-13	4.41E-13
Tl-208	4.4063E-08	28.240	56.480	0.00E+00	1.24E-06	2.49E-06
U-232	1.3151E-07	28.240	56.480	0.00E+00	3.71E-06	7.43E-06
U-233	1.9564E-09	28.240	56.480	0.00E+00	5.52E-08	1.10E-07
U-234	1.8371E-04	28.240	56.480	0.00E+00	5.19E-03	1.04E-02
U-235	-2.7235E-06	28.240	0.000	3.57E-03	3.49E-03	3.57E-03
U-236	1.5493E-05	28.240	56.480	0.00E+00	4.38E-04	8.75E-04
U-238	-4.2851E-09	28.240	0.000	4.10E-05	4.09E-05	4.10E-05
Y-90	2.7505E+00	28.240	56.480	0.00E+00	7.77E+01	1.55E+02
Other Radionuclides					1.45E+02	2.90E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.090E+13
0.0250	2.348E+12
0.0375	2.166E+12
0.0575	2.130E+12
0.0850	1.358E+12
0.1250	1.176E+12
0.2250	1.151E+12
0.3750	5.571E+11
0.5750	7.652E+12
0.8500	1.072E+12
1.2500	1.994E+11
1.7500	8.362E+09
2.2500	1.754E+10
2.7500	1.009E+08
3.5000	1.119E+07
5.0000	3.359E+01
7.0000	3.745E+00
11.0000	4.221E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.43E+00	2.86E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.11512415	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		28.240	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		56.480	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.05	
Bounding:	0.10	

Estimated EOL HM/Given EOL HM

1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR SLOWPOKE (CANADA)
SNF ID #: 665
Fuel Units & Descr: 2 - 297 ROD ARRAY
Heavy Metal Mass: BOL=1.77kg ; EOL=1.74kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage: 18"x10'
0.50

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	28.240	56.480	0.00E+00	4.11E-09	8.22E-09
Am-241	1.1190E-03	28.240	56.480	0.00E+00	3.16E-02	6.32E-02
Am-242m	4.5425E-07	28.240	56.480	0.00E+00	1.28E-05	2.57E-05
Am-243	1.4921E-06	28.240	56.480	0.00E+00	4.21E-05	8.43E-05
C-14	5.7244E-09	28.240	56.480	0.00E+00	1.62E-07	3.23E-07
Cl-36	1.3124E-32	28.240	56.480	0.00E+00	3.71E-31	7.41E-31
Cm-243	2.3676E-07	28.240	56.480	0.00E+00	6.69E-06	1.34E-05
Cm-244	5.2042E-05	28.240	56.480	0.00E+00	1.47E-03	2.94E-03
Co-60	3.8208E-05	28.240	56.480	0.00E+00	1.08E-03	2.16E-03
Cs-134	4.8693E-01	28.240	56.480	0.00E+00	1.38E+01	2.75E+01
Cs-135	3.4477E-06	28.240	56.480	0.00E+00	9.74E-05	1.95E-04
Cs-137	2.8731E+00	28.240	56.480	0.00E+00	8.11E+01	1.62E+02
Eu-154	8.2053E-02	28.240	56.480	0.00E+00	2.32E+00	4.63E+00
Eu-155	3.9134E-02	28.240	56.480	0.00E+00	1.11E+00	2.21E+00
Fe-55	6.7429E-03	28.240	56.480	0.00E+00	1.90E-01	3.81E-01
H-3	1.0599E-02	28.240	56.480	0.00E+00	2.99E-01	5.99E-01
I-129	7.5300E-07	28.240	56.480	0.00E+00	2.13E-05	4.25E-05
Kr-85	2.8595E-01	28.240	56.480	0.00E+00	8.08E+00	1.62E+01
Np-237	9.5479E-06	28.240	56.480	0.00E+00	2.70E-04	5.39E-04
Pa-231	8.9297E-10	28.240	56.480	0.00E+00	2.52E-08	5.04E-08
Pb-210	3.7609E-12	28.240	56.480	0.00E+00	1.06E-10	2.12E-10
Pm-147	2.5452E+00	28.240	56.480	0.00E+00	7.19E+01	1.44E+02
Pu-238	2.0550E-02	28.240	56.480	0.00E+00	5.80E-01	1.16E+00
Pu-239	4.2838E-04	28.240	56.480	0.00E+00	1.21E-02	2.42E-02
Pu-240	2.4401E-04	28.240	56.480	0.00E+00	6.89E-03	1.38E-02
Pu-241	6.8764E-02	28.240	56.480	0.00E+00	1.94E+00	3.88E+00
Pu-242	3.6329E-07	28.240	56.480	0.00E+00	1.03E-05	2.05E-05
Ra-226	3.8045E-11	28.240	56.480	0.00E+00	1.07E-09	2.15E-09
Ra-228	2.9902E-15	28.240	56.480	0.00E+00	8.44E-14	1.69E-13
Ru-106	1.9055E-01	28.240	56.480	0.00E+00	5.38E+00	1.08E+01
Se-79	1.2936E-05	28.240	56.480	0.00E+00	3.65E-04	7.31E-04
Sn-126	1.1574E-05	28.240	56.480	0.00E+00	3.27E-04	6.54E-04
Sr-90	2.7505E+00	28.240	56.480	0.00E+00	7.77E+01	1.55E+02
Tc-99	4.2239E-04	28.240	56.480	0.00E+00	1.19E-02	2.39E-02
Th-229	1.8848E-12	28.240	56.480	0.00E+00	5.32E-11	1.06E-10
Th-230	1.7042E-08	28.240	56.480	0.00E+00	4.81E-07	9.63E-07
Th-232	7.8132E-15	28.240	56.480	0.00E+00	2.21E-13	4.41E-13
Tl-208	4.4063E-08	28.240	56.480	0.00E+00	1.24E-06	2.49E-06
U-232	1.3151E-07	28.240	56.480	0.00E+00	3.71E-06	7.43E-06
U-233	1.9564E-09	28.240	56.480	0.00E+00	5.52E-08	1.10E-07
U-234	1.8371E-04	28.240	56.480	0.00E+00	5.19E-03	1.04E-02
U-235	-2.7235E-06	28.240	0.000	3.57E-03	3.49E-03	3.57E-03
U-236	1.5493E-05	28.240	56.480	0.00E+00	4.38E-04	8.75E-04
U-238	-4.2851E-09	28.240	0.000	4.10E-05	4.09E-05	4.10E-05
Y-90	2.7505E+00	28.240	56.480	0.00E+00	7.77E+01	1.55E+02
Other Radionuclides					1.45E+02	2.90E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.090E+13
0.0250	2.348E+12
0.0375	2.166E+12
0.0575	2.130E+12
0.0850	1.358E+12
0.1250	1.176E+12
0.2250	1.151E+12
0.3750	5.571E+11
0.5750	7.652E+12
0.8500	1.072E+12
1.2500	1.994E+11
1.7500	8.362E+09
2.2500	1.754E+10
2.7500	1.009E+08
3.5000	1.119E+07
5.0000	3.359E+01
7.0000	3.745E+00
11.0000	4.221E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.43E+00	2.86E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.11512415	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		28.240	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		56.480	Bounding burnup assumed to be twice nominal burnup.

Checks	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.05	
Bounding:	0.10	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template information

Fuel Name: FRR SLOWPOKE (CANADA)
SNF ID #: 669
Fuel Units & Descr: 2 - 297 ROD ARRAY
Heavy Metal Mass: BOL=1.77kg ; EOL=1.74kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.50

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	28.221	56.442	0.00E+00	4.10E-09	8.21E-09
Am-241	1.1190E-03	28.221	56.442	0.00E+00	3.16E-02	6.32E-02
Am-242m	4.5425E-07	28.221	56.442	0.00E+00	1.28E-05	2.56E-05
Am-243	1.4921E-06	28.221	56.442	0.00E+00	4.21E-05	8.42E-05
C-14	5.7244E-09	28.221	56.442	0.00E+00	1.62E-07	3.23E-07
Cl-36	1.3124E-32	28.221	56.442	0.00E+00	3.70E-31	7.41E-31
Cm-243	2.3676E-07	28.221	56.442	0.00E+00	6.68E-06	1.34E-05
Cm-244	5.2042E-05	28.221	56.442	0.00E+00	1.47E-03	2.94E-03
Co-60	3.8208E-05	28.221	56.442	0.00E+00	1.08E-03	2.16E-03
Cs-134	4.8693E-01	28.221	56.442	0.00E+00	1.37E+01	2.75E+01
Cs-135	3.4477E-06	28.221	56.442	0.00E+00	9.73E-05	1.95E-04
Cs-137	2.8731E+00	28.221	56.442	0.00E+00	8.11E+01	1.62E+02
Eu-154	8.2053E-02	28.221	56.442	0.00E+00	2.32E+00	4.63E+00
Eu-155	3.9134E-02	28.221	56.442	0.00E+00	1.10E+00	2.21E+00
Fe-55	6.7429E-03	28.221	56.442	0.00E+00	1.90E-01	3.81E-01
H-3	1.0599E-02	28.221	56.442	0.00E+00	2.99E-01	5.98E-01
I-129	7.5300E-07	28.221	56.442	0.00E+00	2.13E-05	4.25E-05
Kr-85	2.8595E-01	28.221	56.442	0.00E+00	8.07E+00	1.61E+01
Np-237	9.5479E-06	28.221	56.442	0.00E+00	2.69E-04	5.39E-04
Pa-231	8.9297E-10	28.221	56.442	0.00E+00	2.52E-08	5.04E-08
Pb-210	3.7609E-12	28.221	56.442	0.00E+00	1.06E-10	2.12E-10
Pm-147	2.5452E+00	28.221	56.442	0.00E+00	7.18E+01	1.44E+02
Pu-238	2.0550E-02	28.221	56.442	0.00E+00	5.80E-01	1.16E+00
Pu-239	4.2838E-04	28.221	56.442	0.00E+00	1.21E-02	2.42E-02
Pu-240	2.4401E-04	28.221	56.442	0.00E+00	6.89E-03	1.38E-02
Pu-241	6.8764E-02	28.221	56.442	0.00E+00	1.94E+00	3.88E+00
Pu-242	3.6329E-07	28.221	56.442	0.00E+00	1.03E-05	2.05E-05
Ra-226	3.8045E-11	28.221	56.442	0.00E+00	1.07E-09	2.15E-09
Ra-228	2.9902E-15	28.221	56.442	0.00E+00	8.44E-14	1.69E-13
Ru-106	1.9055E-01	28.221	56.442	0.00E+00	5.38E+00	1.08E+01
Se-79	1.2936E-05	28.221	56.442	0.00E+00	3.65E-04	7.30E-04
Sn-126	1.1574E-05	28.221	56.442	0.00E+00	3.27E-04	6.53E-04
Sr-90	2.7505E+00	28.221	56.442	0.00E+00	7.76E+01	1.55E+02
Tc-99	4.2239E-04	28.221	56.442	0.00E+00	1.19E-02	2.38E-02
Th-229	1.8848E-12	28.221	56.442	0.00E+00	5.32E-11	1.06E-10
Th-230	1.7042E-08	28.221	56.442	0.00E+00	4.81E-07	9.62E-07
Th-232	7.8132E-15	28.221	56.442	0.00E+00	2.20E-13	4.41E-13
Tl-208	4.4063E-08	28.221	56.442	0.00E+00	1.24E-06	2.49E-06
U-232	1.3151E-07	28.221	56.442	0.00E+00	3.71E-06	7.42E-06
U-233	1.9564E-09	28.221	56.442	0.00E+00	5.52E-08	1.10E-07
U-234	1.8371E-04	28.221	56.442	0.00E+00	5.18E-03	1.04E-02
U-235	-2.7235E-06	28.221	0.000	3.57E-03	3.49E-03	3.57E-03
U-236	1.5493E-05	28.221	56.442	0.00E+00	4.37E-04	8.74E-04
U-238	-4.2851E-09	28.221	0.000	4.10E-05	4.09E-05	4.10E-05
Y-90	2.7505E+00	28.221	56.442	0.00E+00	7.76E+01	1.55E+02
Other Radionuclides					1.45E+02	2.90E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.089E+13
0.0250	2.346E+12
0.0375	2.165E+12
0.0575	2.129E+12
0.0850	1.357E+12
0.1250	1.175E+12
0.2250	1.150E+12
0.3750	5.567E+11
0.5750	7.647E+12
0.8500	1.071E+12
1.2500	1.992E+11
1.7500	8.356E+09
2.2500	1.753E+10
2.7500	1.008E+08
3.5000	1.119E+07
5.0000	3.357E+01
7.0000	3.743E+00
11.0000	4.219E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.43E+00	2.86E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.11512415	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated	Basis for burnup used in estimate:
Nominal:		28.221	Nominal burnup calculated from the heavy metal mass destroyed.
Bounding:		56.442	Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.05	
Bounding:	0.10	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR SLOWPOKE (CANADA)
SNF ID #: 668
Fuel Units & Descr: 2 - 297 ROD ARRAY
Heavy Metal Mass: BOL=1.77kg ; EOL=1.74kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: ATR (Light Water, Alum., 60 to 100%, U)
[2]Template Burnup(MWd): 367.2
Template BOL Heavy Metal Mass (MT): 0.00116689
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
0.50

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	28.240	56.480	0.00E+00	4.11E-09	8.22E-09
Am-241	1.1190E-03	28.240	56.480	0.00E+00	3.16E-02	6.32E-02
Am-242m	4.5425E-07	28.240	56.480	0.00E+00	1.28E-05	2.57E-05
Am-243	1.4921E-06	28.240	56.480	0.00E+00	4.21E-05	8.43E-05
C-14	5.7244E-09	28.240	56.480	0.00E+00	1.62E-07	3.23E-07
Cl-36	1.3124E-32	28.240	56.480	0.00E+00	3.71E-31	7.41E-31
Cm-243	2.3676E-07	28.240	56.480	0.00E+00	6.69E-06	1.34E-05
Cm-244	5.2042E-05	28.240	56.480	0.00E+00	1.47E-03	2.94E-03
Co-60	3.8208E-05	28.240	56.480	0.00E+00	1.08E-03	2.16E-03
Cs-134	4.8693E-01	28.240	56.480	0.00E+00	1.38E+01	2.75E+01
Cs-135	3.4477E-06	28.240	56.480	0.00E+00	9.74E-05	1.95E-04
Cs-137	2.8731E+00	28.240	56.480	0.00E+00	8.11E+01	1.62E+02
Eu-154	8.2053E-02	28.240	56.480	0.00E+00	2.32E+00	4.63E+00
Eu-155	3.9134E-02	28.240	56.480	0.00E+00	1.11E+00	2.21E+00
Fe-55	6.7429E-03	28.240	56.480	0.00E+00	1.90E-01	3.81E-01
H-3	1.0599E-02	28.240	56.480	0.00E+00	2.99E-01	5.99E-01
I-129	7.5300E-07	28.240	56.480	0.00E+00	2.13E-05	4.25E-05
Kr-85	2.8595E-01	28.240	56.480	0.00E+00	8.08E+00	1.62E+01
Np-237	9.5479E-06	28.240	56.480	0.00E+00	2.70E-04	5.39E-04
Pa-231	8.9297E-10	28.240	56.480	0.00E+00	2.52E-08	5.04E-08
Pb-210	3.7609E-12	28.240	56.480	0.00E+00	1.06E-10	2.12E-10
Pm-147	2.5452E+00	28.240	56.480	0.00E+00	7.19E+01	1.44E+02
Pu-238	2.0550E-02	28.240	56.480	0.00E+00	5.80E-01	1.16E+00
Pu-239	4.2838E-04	28.240	56.480	0.00E+00	1.21E-02	2.42E-02
Pu-240	2.4401E-04	28.240	56.480	0.00E+00	6.89E-03	1.38E-02
Pu-241	6.8764E-02	28.240	56.480	0.00E+00	1.94E+00	3.88E+00
Pu-242	3.6329E-07	28.240	56.480	0.00E+00	1.03E-05	2.05E-05
Ra-226	3.8045E-11	28.240	56.480	0.00E+00	1.07E-09	2.15E-09
Ra-228	2.9902E-15	28.240	56.480	0.00E+00	8.44E-14	1.69E-13
Ru-106	1.9055E-01	28.240	56.480	0.00E+00	5.38E+00	1.08E+01
Se-79	1.2936E-05	28.240	56.480	0.00E+00	3.65E-04	7.31E-04
Sn-126	1.1574E-05	28.240	56.480	0.00E+00	3.27E-04	6.54E-04
Sr-90	2.7505E+00	28.240	56.480	0.00E+00	7.77E+01	1.55E+02
Tc-99	4.2239E-04	28.240	56.480	0.00E+00	1.19E-02	2.39E-02
Th-229	1.8848E-12	28.240	56.480	0.00E+00	5.32E-11	1.06E-10
Th-230	1.7042E-08	28.240	56.480	0.00E+00	4.81E-07	9.63E-07
Th-232	7.8132E-15	28.240	56.480	0.00E+00	2.21E-13	4.41E-13
Tl-208	4.4063E-08	28.240	56.480	0.00E+00	1.24E-06	2.49E-06
U-232	1.3151E-07	28.240	56.480	0.00E+00	3.71E-06	7.43E-06
U-233	1.9564E-09	28.240	56.480	0.00E+00	5.52E-08	1.10E-07
U-234	1.8371E-04	28.240	56.480	0.00E+00	5.19E-03	1.04E-02
U-235	-2.7235E-06	28.240	0.000	3.57E-03	3.49E-03	3.57E-03
U-236	1.5493E-05	28.240	56.480	0.00E+00	4.38E-04	8.75E-04
U-238	-4.2851E-09	28.240	0.000	4.10E-05	4.09E-05	4.10E-05
Y-90	2.7505E+00	28.240	56.480	0.00E+00	7.77E+01	1.55E+02
Other Radionuclides					1.45E+02	2.90E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.090E+13
0.0250	2.348E+12
0.0375	2.166E+12
0.0575	2.130E+12
0.0850	1.358E+12
0.1250	1.176E+12
0.2250	1.151E+12
0.3750	5.571E+11
0.5750	7.652E+12
0.8500	1.072E+12
1.2500	1.994E+11
1.7500	8.362E+09
2.2500	1.754E+10
2.7500	1.009E+08
3.5000	1.119E+07
5.0000	3.359E+01
7.0000	3.745E+00
11.0000	4.221E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.43E+00	2.86E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.11512415	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		28.240
Bounding:		56.480

Basis for burnup used in estimate:
Nominal burnup calculated from the heavy metal mass destroyed.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.05	
Bounding:	0.10	

Estimated EOL HM/Given EOL HM
1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name:	FRR SLOWPOKE (MONTREAL)	[1]Fuel decay start date:	2010
SNF ID #:	667	Estimates as of:	2010
Fuel Units & Desc.:	2 - 297 ROD ARRAY	Template:	ATR (Light Water, Alum., 60 to 100%, U)
Heavy Metal Mass:	BOL=1.77kg ; EOL=1.74kg	[2]Template Burnup(MWd):	367.2
ROD Storage Site:	SRS	Template BOL Heavy Metal Mass (MT):	0.00116689
		Template Decay Time:	5 years

Estimated Canister usage:

18"x10'
0.50

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.4545E-10	28.240	56.480	0.00E+00	4.11E-09	8.22E-09
Am-241	1.1190E-03	28.240	56.480	0.00E+00	3.16E-02	6.32E-02
Am-242m	4.5425E-07	28.240	56.480	0.00E+00	1.28E-05	2.57E-05
Am-243	1.4921E-06	28.240	56.480	0.00E+00	4.21E-05	8.43E-05
C-14	5.7244E-09	28.240	56.480	0.00E+00	1.62E-07	3.23E-07
Cl-36	1.3124E-32	28.240	56.480	0.00E+00	3.71E-31	7.41E-31
Cm-243	2.3676E-07	28.240	56.480	0.00E+00	6.69E-06	1.34E-05
Cm-244	5.2042E-05	28.240	56.480	0.00E+00	1.47E-03	2.94E-03
Co-60	3.8208E-05	28.240	56.480	0.00E+00	1.08E-03	2.16E-03
Cs-134	4.8693E-01	28.240	56.480	0.00E+00	1.38E+01	2.75E+01
Cs-135	3.4477E-06	28.240	56.480	0.00E+00	9.74E-05	1.95E-04
Cs-137	2.8731E+00	28.240	56.480	0.00E+00	8.11E+01	1.62E+02
Eu-154	8.2053E-02	28.240	56.480	0.00E+00	2.32E+00	4.63E+00
Eu-155	3.9134E-02	28.240	56.480	0.00E+00	1.11E+00	2.21E+00
Fe-55	6.7429E-03	28.240	56.480	0.00E+00	1.90E-01	3.81E-01
H-3	1.0599E-02	28.240	56.480	0.00E+00	2.99E-01	5.99E-01
I-129	7.5300E-07	28.240	56.480	0.00E+00	2.13E-05	4.25E-05
Kr-85	2.8595E-01	28.240	56.480	0.00E+00	8.08E+00	1.62E+01
Np-237	9.5479E-06	28.240	56.480	0.00E+00	2.70E-04	5.39E-04
Pa-231	8.9297E-10	28.240	56.480	0.00E+00	2.52E-08	5.04E-08
Pb-210	3.7609E-12	28.240	56.480	0.00E+00	1.06E-10	2.12E-10
Pm-147	2.5452E+00	28.240	56.480	0.00E+00	7.19E+01	1.44E+02
Pu-238	2.0550E-02	28.240	56.480	0.00E+00	5.80E-01	1.16E+00
Pu-239	4.2838E-04	28.240	56.480	0.00E+00	1.21E-02	2.42E-02
Pu-240	2.4401E-04	28.240	56.480	0.00E+00	6.89E-03	1.38E-02
Pu-241	6.8764E-02	28.240	56.480	0.00E+00	1.94E+00	3.88E+00
Pu-242	3.6329E-07	28.240	56.480	0.00E+00	1.03E-05	2.05E-05
Ra-226	3.8045E-11	28.240	56.480	0.00E+00	1.07E-09	2.15E-09
Ra-228	2.9902E-15	28.240	56.480	0.00E+00	8.44E-14	1.69E-13
Ru-106	1.9055E-01	28.240	56.480	0.00E+00	5.38E+00	1.08E+01
Se-79	1.2936E-05	28.240	56.480	0.00E+00	3.65E-04	7.31E-04
Sn-126	1.1574E-05	28.240	56.480	0.00E+00	3.27E-04	6.54E-04
Sr-90	2.7505E+00	28.240	56.480	0.00E+00	7.77E+01	1.55E+02
Tc-99	4.2239E-04	28.240	56.480	0.00E+00	1.19E-02	2.39E-02
Th-229	1.8848E-12	28.240	56.480	0.00E+00	5.32E-11	1.06E-10
Th-230	1.7042E-08	28.240	56.480	0.00E+00	4.81E-07	9.63E-07
Th-232	7.8132E-15	28.240	56.480	0.00E+00	2.21E-13	4.41E-13
Tl-208	4.4063E-08	28.240	56.480	0.00E+00	1.24E-06	2.49E-06
U-232	1.3151E-07	28.240	56.480	0.00E+00	3.71E-06	7.43E-06
U-233	1.9564E-09	28.240	56.480	0.00E+00	5.52E-08	1.10E-07
U-234	1.8371E-04	28.240	56.480	0.00E+00	5.19E-03	1.04E-02
U-235	-2.7235E-06	28.240	0.000	3.57E-03	3.49E-03	3.57E-03
U-236	1.5493E-05	28.240	56.480	0.00E+00	4.38E-04	8.75E-04
U-238	-4.2851E-09	28.240	0.000	4.10E-05	4.09E-05	4.10E-05
Y-90	2.7505E+00	28.240	56.480	0.00E+00	7.77E+01	1.55E+02
Other Radionuclides					1.45E+02	2.90E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	1.090E+13
0.0250	2.348E+12
0.0375	2.166E+12
0.0575	2.130E+12
0.0850	1.358E+12
0.1250	1.176E+12
0.2250	1.151E+12
0.3750	5.571E+11
0.5750	7.652E+12
0.8500	1.072E+12
1.2500	1.994E+11
1.7500	8.362E+09
2.2500	1.754E+10
2.7500	1.009E+08
3.5000	1.119E+07
5.0000	3.359E+01
7.0000	3.745E+00
11.0000	4.221E-01

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
1.43E+00	2.86E+00
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	ALUM	ALUM
BOL HM Constituents:	U-ALX	U
BOL Enrichment %:	93.11512415	60 to 100

Basis for Parameter Differences:

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		28.240
Bounding:		56.480

Basis for burnup used in estimate:

Nominal burnup calculated from the heavy metal mass destroyed.

Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.05	
Bounding:	0.10	

Estimated EOL HM/Given EOL HM: 1.00

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR TARGET (ARGENTINA)
SNF ID #: 297
Fuel Units & Descr: 48 - PARTICULATE
Heavy Metal Mass: BOL=3.97kg ; EOL=3.97kg
ROD Storage Site: SRS

[1]**Fuel decay start date:** 2010
Estimates as of: 2010
Template: Pathfinder (Light Water, SST, 60 to 100%, U)
[2]**Template Burnup(MWd):** 6.01
Template BOL Heavy Metal Mass (MT): 0.00012882
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
1.33

II. Estimates

	m	x_n	x_b	b	y_n	y_b
Radionuclide	Ci/MWd From Template	Nominal Fuel Burnup (MWd)[2]	Bounding Fuel Burnup (MWd)[2]	Initial Activity (Ci)	Nominal Fuel Inventories(Ci)	Bounding Fuel Inventories(Ci)
Ac-227	1.9667E-09	74.997	149.995	0.00E+00	1.47E-07	2.95E-07
Am-241	4.9468E-05	74.997	149.995	0.00E+00	3.71E-03	7.42E-03
Am-242m	9.7537E-09	74.997	149.995	0.00E+00	7.32E-07	1.46E-06
Am-243	9.8802E-10	74.997	149.995	0.00E+00	7.41E-08	1.48E-07
C-14	2.3095E-04	74.997	149.995	0.00E+00	1.73E-02	3.46E-02
Cl-36	1.2261E-06	74.997	149.995	0.00E+00	9.20E-05	1.84E-04
Cm-243	5.1581E-10	74.997	149.995	0.00E+00	3.87E-08	7.74E-08
Cm-244	7.3012E-09	74.997	149.995	0.00E+00	5.48E-07	1.10E-06
Co-60	3.6556E+00	74.997	149.995	0.00E+00	2.74E+02	5.48E+02
Cs-134	7.2063E-02	74.997	149.995	0.00E+00	5.40E+00	1.08E+01
Cs-135	3.0316E-05	74.997	149.995	0.00E+00	2.27E-03	4.55E-03
Cs-137	2.9002E+00	74.997	149.995	0.00E+00	2.18E+02	4.35E+02
Eu-154	7.5025E-03	74.997	149.995	0.00E+00	5.63E-01	1.13E+00
Eu-155	4.6123E-02	74.997	149.995	0.00E+00	3.46E+00	6.92E+00
Fe-55	3.6439E+00	74.997	149.995	0.00E+00	2.73E+02	5.47E+02
H-3	1.3524E-02	74.997	149.995	0.00E+00	1.01E+00	2.03E+00
I-129	7.3195E-07	74.997	149.995	0.00E+00	5.49E-05	1.10E-04
Kr-85	2.8686E-01	74.997	149.995	0.00E+00	2.15E+01	4.30E+01
Np-237	1.1478E-06	74.997	149.995	0.00E+00	8.61E-05	1.72E-04
Pa-231	1.0990E-08	74.997	149.995	0.00E+00	8.24E-07	1.65E-06
Pb-210	8.0782E-15	74.997	149.995	0.00E+00	6.06E-13	1.21E-12
Pm-147	3.2097E+00	74.997	149.995	0.00E+00	2.41E+02	4.81E+02
Pu-238	3.7404E-04	74.997	149.995	0.00E+00	2.81E-02	5.61E-02
Pu-239	6.6839E-04	74.997	149.995	0.00E+00	5.01E-02	1.00E-01
Pu-240	8.7121E-05	74.997	149.995	0.00E+00	6.53E-03	1.31E-02
Pu-241	3.0283E-03	74.997	149.995	0.00E+00	2.27E-01	4.54E-01
Pu-242	1.9717E-09	74.997	149.995	0.00E+00	1.48E-07	2.96E-07
Ra-226	7.3527E-14	74.997	149.995	0.00E+00	5.51E-12	1.10E-11
Ra-228	6.0965E-12	74.997	149.995	0.00E+00	4.57E-10	9.14E-10
Ru-106	1.6531E-01	74.997	149.995	0.00E+00	1.24E+01	2.48E+01
Se-79	1.3228E-05	74.997	149.995	0.00E+00	9.92E-04	1.98E-03
Sn-126	1.1494E-05	74.997	149.995	0.00E+00	8.62E-04	1.72E-03
Sr-90	2.7854E+00	74.997	149.995	0.00E+00	2.09E+02	4.18E+02
Tc-99	4.6656E-04	74.997	149.995	0.00E+00	3.50E-02	7.00E-02
Th-229	2.9368E-12	74.997	149.995	0.00E+00	2.20E-10	4.41E-10
Th-230	3.2662E-11	74.997	149.995	0.00E+00	2.45E-09	4.90E-09
Th-232	8.3045E-12	74.997	149.995	0.00E+00	6.23E-10	1.25E-09
Tl-208	2.6722E-08	74.997	149.995	0.00E+00	2.00E-06	4.01E-06
U-232	7.7720E-08	74.997	149.995	0.00E+00	5.83E-06	1.17E-05
U-233	2.9834E-09	74.997	149.995	0.00E+00	2.24E-07	4.47E-07
U-234	3.5275E-07	74.997	149.995	0.00E+00	2.65E-05	5.29E-05
U-235	-2.7761E-06	74.997	0.000	4.15E-03	3.94E-03	4.15E-03
U-236	1.6190E-05	74.997	149.995	0.00E+00	1.21E-03	2.43E-03
U-238	-2.8547E-09	74.997	0.000	6.89E-04	6.89E-04	6.89E-04
Y-90	2.7870E+00	74.997	149.995	0.00E+00	2.09E+02	4.18E+02
Other Radionuclides					3.95E+02	7.89E+02

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	2.950E+13
0.0250	6.291E+12
0.0375	5.614E+12
0.0575	5.644E+12
0.0850	3.577E+12
0.1250	2.854E+12
0.2250	2.962E+12
0.3750	1.438E+12
0.5750	1.743E+13
0.8500	8.438E+11
1.2500	4.075E+13
1.7500	1.439E+10
2.2500	4.117E+10
2.7500	2.335E+08
3.5000	2.579E+07
5.0000	5.410E+00
7.0000	6.050E-01
11.0000	6.841E-02

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
7.96E+00	1.59E+01
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	NONE	SST
BOL HM Constituents:	UO2	U
BOL Enrichment %:	48.34531901	60 to 100

Basis for Parameter Differences:

This Template was used for the following reasons:
This fuel matches Pathfinder Template except enrichment and cladding (but substituting Stainless Steel is a good conservative assumption).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		74.997
Bounding:		149.995

Basis for burnup used in estimate:

Nominal burnup assumed to be 2% of BOL heavy metal mass.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.40	
Bounding:	0.81	

Estimated EOL HM/Given EOL HM
0.98

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).

Fuel Radionuclide Inventory Worksheet

I. Fuel and Template Information

Fuel Name: FRR TARGET (CANADA)
SNF ID #: 671
Fuel Units & Descr: 5952 - PARTICULATE
Heavy Metal Mass: BOL=492.23kg ; EOL=492.23kg
ROD Storage Site: SRS

[1]Fuel decay start date: 2010
Estimates as of: 2010
Template: Pathfinder (Light Water, SST, 60 to 100%, U)
[2]Template Burnup(MWd): 6.01
Template BOL Heavy Metal Mass (MT): 0.00012882
Template Decay Time: 5 years

Estimated Canister usage:
18"x10'
165.33

II. Estimates

Radionuclide	m Ci/MWd From Template	x_n Nominal Fuel Burnup (MWd)[2]	x_b Bounding Fuel Burnup (MWd)[2]	b Initial Activity (Ci)	y_n Nominal Fuel Inventories(Ci)	y_b Bounding Fuel Inventories(Ci)
Ac-227	1.9667E-09	9,299.685	18,599.370	0.00E+00	1.83E-05	3.66E-05
Am-241	4.9468E-05	9,299.685	18,599.370	0.00E+00	4.60E-01	9.20E-01
Am-242m	9.7537E-09	9,299.685	18,599.370	0.00E+00	9.07E-05	1.81E-04
Am-243	9.8802E-10	9,299.685	18,599.370	0.00E+00	9.19E-06	1.84E-05
C-14	2.3095E-04	9,299.685	18,599.370	0.00E+00	2.15E+00	4.30E+00
Cl-36	1.2261E-06	9,299.685	18,599.370	0.00E+00	1.14E-02	2.28E-02
Cm-243	5.1581E-10	9,299.685	18,599.370	0.00E+00	4.80E-06	9.59E-06
Cm-244	7.3012E-09	9,299.685	18,599.370	0.00E+00	6.79E-05	1.36E-04
Co-60	3.6556E+00	9,299.685	18,599.370	0.00E+00	3.40E+04	6.80E+04
Cs-134	7.2063E-02	9,299.685	18,599.370	0.00E+00	6.70E+02	1.34E+03
Cs-135	3.0316E-05	9,299.685	18,599.370	0.00E+00	2.82E-01	5.64E-01
Cs-137	2.9002E+00	9,299.685	18,599.370	0.00E+00	2.70E+04	5.39E+04
Eu-154	7.5025E-03	9,299.685	18,599.370	0.00E+00	6.98E+01	1.40E+02
Eu-155	4.6123E-02	9,299.685	18,599.370	0.00E+00	4.29E+02	8.58E+02
Fe-55	3.6439E+00	9,299.685	18,599.370	0.00E+00	3.39E+04	6.78E+04
H-3	1.3524E-02	9,299.685	18,599.370	0.00E+00	1.26E+02	2.52E+02
I-129	7.3195E-07	9,299.685	18,599.370	0.00E+00	6.81E-03	1.36E-02
Kr-85	2.8686E-01	9,299.685	18,599.370	0.00E+00	2.67E+03	5.34E+03
Np-237	1.1478E-06	9,299.685	18,599.370	0.00E+00	1.07E-02	2.13E-02
Pa-231	1.0990E-08	9,299.685	18,599.370	0.00E+00	1.02E-04	2.04E-04
Pb-210	8.0782E-15	9,299.685	18,599.370	0.00E+00	7.51E-11	1.50E-10
Pm-147	3.2097E+00	9,299.685	18,599.370	0.00E+00	2.98E+04	5.97E+04
Pu-238	3.7404E-04	9,299.685	18,599.370	0.00E+00	3.48E+00	6.96E+00
Pu-239	6.6839E-04	9,299.685	18,599.370	0.00E+00	6.22E+00	1.24E+01
Pu-240	8.7121E-05	9,299.685	18,599.370	0.00E+00	8.10E-01	1.62E+00
Pu-241	3.0283E-03	9,299.685	18,599.370	0.00E+00	2.82E+01	5.63E+01
Pu-242	1.9717E-09	9,299.685	18,599.370	0.00E+00	1.83E-05	3.67E-05
Ra-226	7.3527E-14	9,299.685	18,599.370	0.00E+00	6.84E-10	1.37E-09
Ra-228	6.0965E-12	9,299.685	18,599.370	0.00E+00	5.67E-08	1.13E-07
Ru-106	1.6531E-01	9,299.685	18,599.370	0.00E+00	1.54E+03	3.07E+03
Se-79	1.3228E-05	9,299.685	18,599.370	0.00E+00	1.23E-01	2.46E-01
Sn-126	1.1494E-05	9,299.685	18,599.370	0.00E+00	1.07E-01	2.14E-01
Sr-90	2.7854E+00	9,299.685	18,599.370	0.00E+00	2.59E+04	5.18E+04
Tc-99	4.6656E-04	9,299.685	18,599.370	0.00E+00	4.34E+00	8.68E+00
Th-229	2.9368E-12	9,299.685	18,599.370	0.00E+00	2.73E-08	5.46E-08
Th-230	3.2662E-11	9,299.685	18,599.370	0.00E+00	3.04E-07	6.07E-07
Th-232	8.3045E-12	9,299.685	18,599.370	0.00E+00	7.72E-08	1.54E-07
Tl-208	2.6722E-08	9,299.685	18,599.370	0.00E+00	2.49E-04	4.97E-04
U-232	7.7720E-08	9,299.685	18,599.370	0.00E+00	7.23E-04	1.45E-03
U-233	2.9834E-09	9,299.685	18,599.370	0.00E+00	2.77E-05	5.55E-05
U-234	3.5275E-07	9,299.685	18,599.370	0.00E+00	3.28E-03	6.56E-03
U-235	-2.7761E-06	9,299.685	0.000	5.14E-01	4.88E-01	5.14E-01
U-236	1.6190E-05	9,299.685	18,599.370	0.00E+00	1.51E-01	3.01E-01
U-238	-2.8547E-09	9,299.685	0.000	8.55E-02	8.54E-02	8.55E-02
Y-90	2.7870E+00	9,299.685	18,599.370	0.00E+00	2.59E+04	5.18E+04
Other Radionuclides					4.89E+04	9.78E+04

Gamma Sources

Photon Energy Group	Total Photons/sec (bounding)
Avg. MeV	
0.0150	3.657E+15
0.0250	7.801E+14
0.0375	6.961E+14
0.0575	6.998E+14
0.0850	4.435E+14
0.1250	3.539E+14
0.2250	3.673E+14
0.3750	1.783E+14
0.5750	2.161E+15
0.8500	1.046E+14
1.2500	5.053E+15
1.7500	1.784E+12
2.2500	5.105E+12
2.7500	2.896E+10
3.5000	3.198E+09
5.0000	6.709E+02
7.0000	7.502E+01
11.0000	8.483E+00

Thermal Power

Nominal Heat Output (Watts)	Bounding Heat Output (Watts)
9.87E+02	1.97E+03
Total	Total

III. Template Selection Summary, Burnup Summary, and Checks

Template Selection Summary

	From SFD	Used
Reactor Moderator:	LIGHT WATER	LIGHT WATER
Fuel Cladding:	NONE	SST
BOL HM Constituents:	UO2	U
BOL Enrichment %:	48.34531901	60 to 100

Basis for Parameter Differences:
This Template was used for the following reasons:
This fuel matches Pathfinder Template except enrichment and cladding (but substituting Stainless Steel is a good conservative assumption).

Burnup Summary (MWd)[2]

	From SFD	Estimated
Nominal:		9,299.685
Bounding:		18,599.370

Basis for burnup used in estimate:
Nominal burnup assumed to be 2% of BOL heavy metal mass.
Bounding burnup assumed to be twice nominal burnup.

Checks

	Burnup Multiplier	Estimated Burnup/ Given Burnup
Nominal:	0.40	
Bounding:	0.81	

Estimated EOL HM/Given EOL HM
0.98

[1]Reactor shutdown, core removal, storage, shipping or other date confirming that irradiation ceased for fuel.

[2]Total burnup for all fuel associated with this worksheet must be divided by BOL heavy metal mass to get specific burnup values (MWd/MT).