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**Spent Fuel Disassembly Hardware
and Other Non-Fuel Bearing
Components: Characterization,
Disposal Cost Estimates, and
Proposed Repository Acceptance
Requirements**

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1.0 INTRODUCTION

The Nuclear Waste Policy Act of 1982 (NWPAct), assigns the responsibility for the development of repositories for the disposal of high-level nuclear waste and spent nuclear fuel to the U.S. Department of Energy. In order to determine the requirements for the repositories, and the remainder of the federal waste management system, it is necessary to adequately characterize all of the wastes that may require repository disposal. One category of wastes not necessarily classified as high-level waste, but that DOE has responsibility for, is referred to generally as non-fuel wastes. The DOE Office of Civilian Radioactive Waste Management (OCRWM), through the Richland Operations Office, commissioned the Pacific Northwest Laboratory (PNL) to identify and characterize the non-fuel waste that may require handling and disposal by the federal waste management system.

Recent passage of the Low-Level Waste Policy Act Amendments of 1985 (LLWPA) has added Federal Government responsibility for

"any other low-level radioactive waste with concentrations of radionuclides that exceed the limits established by the Commission for Class C radioactive waste as defined by section 61.55 of title 10, Code of Federal Regulations, as in effect on January 26, 1983."

10 CFR 61 is the regulation which covers the near-surface disposal of low-level radioactive waste. Within that regulation, there are several classifications of waste, Class A, B, and C, with Class C being the most restrictive category (see Appendix A for classifications). Waste in excess of the Class C limits according to 10 CFR 61 "is not generally acceptable for near-surface disposal." 10 CFR 61.55(a)(2)(iv) states that

"Waste that is not generally acceptable for near-surface disposal is waste for which waste form and disposal methods must be different, and in general more stringent, than those specified for Class C waste. In the absence of specific requirements in this part, proposals for disposal of this waste may be submitted to the Commission for approval, pursuant to Section 61.58 of this part."

Section 61.58 states that

"The Commission may, upon request or on its own initiative, authorize other provisions for the classification and characteristics of waste on a specific basis, if...it finds reasonable assurance of compliance with the performance objectives...."

Section 61.7(b)(5) states in part that

"...Waste with concentrations above these [Class C] limits is generally unacceptable for near-surface disposal. There may be some instances where waste with greater than Class C would be acceptable for near-surface disposal with special processing or design. These will be evaluated on a case-by-case basis...."

To date there have been few exceptions granted. The geologic repositories are one potential disposal possibility for these wastes. However, this is not, at present, required so other disposal options are at least a possibility.

The LLWPA provides a requirement, as follows, for a licensed facility but does not define what facility type is needed.

"All radioactive waste designated a Federal responsibility ... that results from activities licensed by the Nuclear Regulatory Commission under the Atomic Energy Act of 1954, as amended, shall be disposed of in a facility licensed by the Nuclear Regulatory Commission that the Commission determines is adequate to protect the public health and safety."

Many (but not all) of the non-fuel wastes that are described in this report will exceed Class C waste limits. Some, but not likely all, of these may ultimately be classed as high level waste. The ramifications of this will not be clear until the NRC promulgates regulations covering the greater-than Class C wastes. The NRC is presently considering promulgation of a new regulation defining high-level wastes that should clarify the situation for some of the greater-than Class C wastes. For the present there remains a region of uncertainty in the laws and regulations that govern disposal of wastes that contain too much radioactivity to qualify for near-surface disposal as 10 CFR 61 Class C wastes, yet are not "high-level wastes" in the sense in which that term is usually applied.

There are two categories of non-fuel waste evaluated in this report. The first is spent fuel assembly hardware, which is that portion of a fuel assembly remaining after the fuel pins have been removed during spent-fuel consolidation. This is referred to here as the spent-fuel disassembly (SFD) hardware. If fuel consolidation occurs, as assumed in the current OCRWM Mission Plan, then this hardware will become a separate waste stream which will require disposal. If fuel consolidation does not occur, this hardware will remain a part of the fuel assemblies and must still be characterized in order to properly account for it in the performance assessment of the repositories. Characterization

will be necessary for any radionuclides deposited in the repository as the performance criteria imposed on the repository is applied to the whole repository inventory, and not just the spent fuel inventory. Much of these SFD wastes will exceed the 10 CFR 61 Class C waste limits for contained radioactivity.

The second category of non-fuel waste considered here is the other non-fuel-bearing (NFB) components which the DOE has contracted to accept from the nuclear utilities under Appendix E of the standard utility contract (10 CFR 961). They are defined in the contract as follows:

"Non-fuel components including, but not limited to, control spiders, burnable poison rod assemblies, control rod elements, thimble plugs, fission chambers, and primary and secondary neutron sources, that are contained within the fuel assembly, or BWR channels that are an integral part of the fuel assembly, which do not require special handling, may be included as part of the spent nuclear fuel delivered for disposal pursuant to this contract."

It is apparent that there are a variety of components that fall under this category. The implications of the "special handling" reservation are not yet clear. Much of these wastes will also exceed the 10 CFR 61 Class C limits. There are additional components such as BWR cruciform blades and local power-range monitors which could not as easily be packaged for shipment with the fuel assemblies but which may exceed the 10 CFR 61 Class C limits and will thus be a Federal Government responsibility. They are not included in the final quantities estimated here. However, these items, on an annual basis, would add only a very small increment to the waste quantities.

Other non-fuel wastes, in addition to the two discussed above, that may require repository disposal are the transuranic (TRU) wastes. These are above-Class-C wastes as defined by 10 CFR 61. They contain more than 100 nanocuries of alpha emitting transuranic isotopes, with half-lives greater than five years, per gram of waste. This type of waste (customarily referred to as TRU waste) is generated in a variety of commercial activities. These include manufacture of well-logging devices, manufacture of smoke detectors, and other radioisotope applications. Research applications employing sealed sources and radioisotopes in small quantities are another source. Nuclear power plants also may generate small quantities of TRU waste from time to time. These

wastes are addressed in a companion report (Daling, et al. 1986). A final category of non-fuel wastes that may require repository disposal includes limited quantities of other waste that can be classed as above-Class C wastes.

This report describes and characterizes spent fuel disassembly hardware and non-fuel bearing components. Section 3 provides descriptive information of the wastes by reactor type. Section 4 goes on to provide detailed metallurgical data of the constituent metals that are used in the SFD hardware and NFB components. Also provided are decay heat and radionuclide characteristics of the waste. Section 5 discusses regulatory constraints for various disposal options, and an economic analysis of various options. Details of projected waste quantities, both cumulative and annual rates are also presented. In Section 6, a set of "strawman" acceptance requirements are offered.

2.0 SUMMARY

There are two categories of waste considered in this report. The first is the spent fuel disassembly (SFD) hardware. This consists of the hardware remaining after the fuel pins have been removed from the fuel assembly. This includes end fittings, spacer grids, water rods (BWR) or guide tubes (PWR) as appropriate, and assorted springs, fasteners, etc. The second category is other non-fuel-bearing (NFB) components the DOE has agreed to accept for disposal, such as control rods, fuel channels, etc., under Appendix E of the standard utility contract (10 CFR 961).

It is estimated that there will be approximately 150 kg of SFD and NFB waste per average metric ton of uranium (MTU) of spent uranium. PWR fuel accounts for approximately two-thirds of the average spent-fuel mass but only 50 kg of the SFD and NFB waste, with most of that being spent fuel disassembly hardware. BWR fuel accounts for one-third of the average spent-fuel mass and the remaining 100 kg of the waste. The relatively large contribution of waste hardware in BWR fuel, will be non-fuel-bearing components, primarily consisting of the fuel channels.

Using PNL's Spent Fuel Data Base and based on use of a 26-in OD x 13-ft long canister, annual waste quantities were projected through the year 2025. The number of canisters requiring disposal is a function of the waste treatment and the fuel type and design being accepted for disposal. The annual quantities vary with the amount of fuel being accepted as well as the type of fuel. For the treatment assumed here and during the early years, when fuel is being accepted at the rate of 400 MTU/year, the number of canisters generated is approximately 70 per year. This increases to over 800 canisters per year if two repositories are assumed to be accepting fuel at the combined rate of 6000 MTU/year. Most of this waste will be composed of various alloys of stainless steel, Inconel, and Zircaloy. Some of it, though, will include small amounts of neutron sources, absorber material, and other materials.

To assure that this waste will be acceptable for disposal in a repository, a "strawman" set of acceptance requirements was developed. The repository must establish waste acceptance requirements to ensure that the overall

performance of the geologic isolation system (which includes the waste form, engineered barriers, and geologic media) is adequate to protect the health and safety of the general public and waste handling personnel. The requirements developed in this study apply specifically to the waste form and the primary or innermost waste canister for acceptance at a repository. Depending on the repository media, an additional overpack (container) and possibly some backfill material may be required at the repository to provide resistance to long-term corrosion and/or lithostatic pressures. The proposed non-fuel-component waste acceptance requirements are summarized in Figure 2.1. These requirements, and suggested ways for waste producers to certify that their wastes meet these requirements, are described in detail in Section 6.0.

The major implications of the proposed requirements are:

- Finely-divided powders and particulates must be immobilized in cement or other suitable material.
- All waste containers must be fabricated of noncombustible materials to prevent the waste packages from adding fuel to a potential fire.
- All waste packages to be delivered to the repository must receive a radionuclide assay to estimate the radionuclide content, fissile material content, and TRU isotope content.
- All waste packages must have their surface dose rate and surface contamination levels measured.
- Waste containers must be capable of meeting the DOT Type A shipping container requirements both at the time of production and after 110 years in air storage.
- Waste containers must be color-coded to identify their surface dose rates.
- Waste form leach rates must be limited to one part in one thousand per year.

Figure 2.1. Summary of Proposed Non-Fuel Component Waste Acceptance Requirements for Repository Disposal

- Thermal output limitations cannot be determined at this time. These limitations are repository-media-specific and will be established after the final designs for waste packages are developed.
- Waste producers, as well as the repository operators, must implement a quality assurance plan that is consistent with the requirements of 10 CFR 50, Appendix B.

The primary regulations governing the disposal of radioactive waste are 10 CFR 60 (deep geologic burial) and 10 CFR 61 (near-surface burial). 10 CFR 60 addresses the deep geologic burial of spent nuclear fuel and high-level radioactive wastes only. 10 CFR 61 addresses the near-surface burial of "low-level" waste. It classifies low-level wastes as Class A, B, or C, with greater than Class C "not generally acceptable for near-surface disposal". Much of the waste under consideration in this report falls into the greater than Class C category. This is due to the activation of various isotopes within the constituent materials. Of major concern are the isotopes C-14, Ni-59, Ni-63, and Nb-94. In Inconel, Ni-59, Ni-63, and Nb-94 are the major concern. These are the result of the activation of nickel and niobium (a.k.a. columbium) which are major constituents of Inconel. In stainless steel and Zircaloy, C-14 and Nb-94 are the primary radionuclides of concern. These result from the activation of nitrogen and niobium, which are impurities found in these alloys.

Neither the C-14 nor the Nb-94 content of the non-fuel components are currently and routinely well characterized. Although the nitrogen impurity level is recognized as a concern for metallurgical reasons, and may at times be noted in material specifications, its concentration is not always available. For niobium the situation is worse. Few material certifications contain any information on the level of the niobium impurity in the metal. Those that do so generally only list it at less than an upper limit of 100 ppm. However, measured values range from as low as 5 ppm to as high as 300 ppm. Values of greater than 25 ppm being sufficient to produce enough Nb-94 by neutron activation during a nominal fuel assembly burnup to exceed the Class C limit. Because the niobium content is not usually defined, this results in a lack of recognition of even the existence of the niobium. We also found that the term columbium, still used in the metallurgical industries, is not always

recognized as niobium by nuclear engineers. As a consequence of these factors, niobium is not generally accounted for in activation calculations predicting the inventory of radionuclides in radioactive waste. To complicate matters, both the C-14 and Nb-94 isotopes are difficult to detect without sophisticated laboratory techniques. The net result is that they have been generally overlooked.

Disposal of waste which is greater than Class C is not specifically addressed in federal regulations. Under 10 CFR 61, greater than Class C waste will be considered for near-surface disposal but only on a case-by-case basis (the intent apparently being that it is not to be considered routinely eligible). 10 CFR 60 does not cover this category of waste at all; only high-level waste and spent fuel. The Nuclear Waste Policy Act of 1982 defines "high-level radioactive waste", in part, as "highly radioactive material that the [NRC] Commission, consistent with existing law, determines by rule requires permanent isolation". "Low-level radioactive waste" is defined, in part, as "radioactive material that ... the Commission, consistent with existing law, classifies as low-level radioactive". The Commission will have to make a determination as to how much and under what conditions greater than Class C waste will be eligible for near-surface disposal, if it requires permanent isolation in a geologic repository, or if some intermediate disposal alternative is acceptable. This is an area that warrants further attention and monitoring as it will impact the options available for these waste streams as well as the cost of those options.

Within Appendix E of 10 CFR 961 (the DOE/utilities contract), the term "special handling" is used to define a category of non-fuel components which "may be included as part of the spent nuclear fuel delivered for disposal pursuant to this contract". The term is not defined within the contract. A number of examples are given such as control rod elements, fission chambers, and BWR channels, but the phrase "not limited to" is also used. Thus there appears to be room for interpretation as to the meanings of "not limited to" and "special handling". It was assumed that all components that could be packaged for shipment with whole fuel assemblies, such as control rods and thimble plugs, would be accepted for disposal at the repository. This excluded a few components such as BWR cruciform blades and power range monitors from

the waste quantities evaluated here. These would amount to only a very small additional increment however.

The economic analysis indicates that there is a large incentive for volume reduction. It was found to reduce system life cycle cost estimates for disposal of the wastes from a range of \$1 to \$2 billion down to a range of \$200 to \$400 million. Both near-surface and deep geologic were considered as options for disposal. Other parameters included location of consolidation facilities, transportation mode, and package size. If volume reduction is assumed, in all cases it was less costly for the waste to be sent to a repository than to near-surface burial. This was in large part due to the surcharges imposed on the waste at the near-surface burial site. However, these may have potential for future reductions. Transport mode did not have significant effects on the cost when volume reduction is assumed. Finally, given volume reduction, it was shown to be cost advantageous to package these wastes in large canisters rather than 55-gallon drums for geologic repository disposal. (For repository disposal, the 55-gallon drums were repackaged [four each] into the longer canisters for placement in repository boreholes.) Further refinement of these cost comparisons are desirable as more data on the component costs becomes available.

3.0 DESCRIPTION OF SPENT FUEL DISASSEMBLY HARDWARE AND NON-FUEL ASSEMBLY COMPONENTS

There are a variety of wastes that will be disposed of by the federal waste management system under the Nuclear Waste Policy Act of 1982. The primary waste form is, of course, spent nuclear fuel. Currently, this is in the form of fuel assemblies. If the fuel pins are removed from the fuel assembly, as in consolidation, then the fuel pins and the structural portion of the fuel assembly must be considered as separate waste streams. The structural hardware consists of end fittings, grid spacers, water rods (BWR 8x8 only), control rod guide tubes (PWR only) and various nuts, washers, springs, etc. These are referred to as spent fuel disassembly (SFD) hardware. There will also be a number of non-fuel components, most of which are defined in Appendix E of 10 CFR 961. For clarity, these are referred to as non-fuel-bearing (NFB) components, and include fuel channels (BWR), control rods, fission chambers, neutron sources, thimble plugs, and other components noted in Section 1.

This section presents the results of an assessment to define and characterize spent fuel disassembly (SFD) hardware, and non-fuel-bearing (NFB) components which may require geologic disposal. The section is broken down into a description of the hardware and components originating in BWR and PWR reactors, and an estimate of the total quantities involved.

Table 3.1 and 3.2 list the variety of fuel types by rod configuration and vendor found in BWR and PWR reactors. Though there are quite a few different fuels to be considered, the problem of uniquely identifying all the hardware is more complex than Tables 3.1 and 3.2 indicate. Within fuel types, there are differences of design details and materials over time. One major recent change has been the replacement of Inconel grid spacers by ones manufactured of Zircaloy. This makes it impossible to uniquely identify a fuel design based solely on its rod configuration designation. Also, for many of the reactors non-fuel bearing components, there are differences of composition and design which vary from reactor to reactor.

Table 3.1. PWR Fuel Manufacturers and Fuel Assembly Array Descriptions

Westinghouse (WE)

13 x 13
14 x 14
15 x 15
16 x 16
17 x 17

Babcock and Wilcox (BW)

14 x 14 (all reprocessed)
15 x 15
17 x 17

Combustion Engineering

14 x 14
15 x 15
16 x 16

Exxon Nuclear Corporation (Exxon)

14 x 14 (WE design)
15 x 15 (WE design)
17 x 17 (WE design)
14 x 14 (CE design)
15 x 15 (CE design)

Table 3.2. BWR Fuel Manufacturers and Fuel Assembly Array Descriptions

General Electric Corporation (GE)

6 x 6
7 x 7
8 x 8
9 x 9
11 x 11

Exxon Nuclear Corporation (Exxon)

7 x 7 (GE design)
8 x 8 (GE design)
10 x 10 (AC design)
9 x 9 (GE design)
11 x 11 (GE design)

Allis-Chalmers (AC)

10 x 10

Many design details are considered proprietary by the various fuel vendors to varying degrees. Some consider only the mechanical design proprietary while others consider the material used for specific components as proprietary. This has made it impossible to present the same level of detail for all the fuel types. Inevitably there will be other fuel types over the course of time. Westinghouse is currently marketing replacement fuel for General Electric reactors. It is not unreasonable to expect that other fuel vendors will offer replacement products for their competitors. This will complicate the logistics of fuel consolidation and handling of spent fuel hardware.

Sufficient detail has been assembled here to grasp the complexity of the problem and provide an initial estimate of the quantity involved. From this data, an understanding of the systems impacts, and the magnitude of their effect can be obtained.

3.1 BOILING WATER REACTOR

General Electric (GE) has made five different fuel designs. Their current fuel is designated as the BWR/6. It is an 8x8 fuel array. Figure 3.1 is an isometric drawing of one with its fuel channels. GE designates a fuel assembly as a fuel bundle and the fuel channel surrounding it. Previous designs have included 6x6, 7x7, 9x9, and 11x11 arrays. Only the 8x8 fuel design is described here as representative of BWR fuel design. However, the other fuel designs have been accounted for in estimating the waste quantities.

A BWR/6 fuel bundle contains 62 or 63 fuel rods and 2 or 1 water rods in a square 8x8 array. It contains approximately 0.183 metric ton of initial heavy metal (MTIHM) per assembly. The hardware of a GE 8x8 fuel assembly contains an upper and lower end fitting. The lower end fitting is a nozzle which directs coolant to the fuel pins. The upper end fitting, in part, serves as the handling fixture. Both end fittings are made of castings of SS-304. The ends of the fuel pins are secured by these fittings. Along the length of the assembly, are seven (7) fuel rod spacers (grid spacers) which maintain uniform rod to rod spacing along the length of the assembly. There are coil springs at the top of the fuel pins and leaf springs as part of the fuel rod spacers which allow the fuel bundle to expand vertically. There are also one or two water rods which have the same diameter as a fuel pin but contain water instead of fuel. The water rods have "keys" which vertically locate the spacer grids. There are a total of 8.5-13.5 kg of disassembly hardware per fuel assembly.

Fuel channels have been noted in 10 CFR 961 as acceptable for inclusion in the non-fuel waste DOE will accept. The fuel channel is essentially a Zircaloy-4 box surrounding the fuel assembly and is attached to it. They vary in thickness from 80-120 mil and weigh 30-45 kg apiece with the newer design having the thicker walls. In general, one fuel channel has a lifetime of one fuel assembly. However, some have been reused. The newer, thicker,

Source: General Electric 1980

Figure 3.1. General Electric 8x8 BWR Fuel Assembly

channels are designed to last up to twice as long. This results in each assembly having an average of 22-45 kg of component waste associated with it due to the fuel channel alone.

There are also several components which are not explicitly noted in Appendix E of 10 CFR 961, but which DOE may have to accept for geologic disposal. For example, control blades (Figure 3.2) weigh slightly more than 100 kg. They are constructed of SS-304 with boron carbide absorber contained in stainless steel tubes. Their estimated lifetime ranges from 3-25 years. The SS-304 they are composed of has a maximum niobium impurity level of 0.01 w/o. Depending on how the control blade is positioned in the core, it may exceed the limits for shallow land burial (see Section 4). Additionally the upper end of the control blade has four (4) sets of pins and rollers. These are made of Haynes-25 and Stellite-3 respectively, both of which are high cobalt alloys (approximately 50% cobalt). The manufacturing specification for the Haynes-25 of one manufacturer requires that niobium content be less than 0.1 w/o (1000 ppm). However, the sensitivity of the material analysis only indicates if the niobium is present in concentrations greater than 0.05 w/o (500 ppm). When the analysis produces negative results, it is not known just how far below 500 ppm level the niobium concentration might be. The manufacturer is fairly certain though that the niobium concentration could reasonably be several hundred ppm. This would be more than sufficient to generally preclude shallow land burial (see Section 4). The situation is similar for Stellite-3.

Similar concerns relate to other components such as poison curtains and local power range monitors which are located in part within the core. If they are in the core long enough, they could also be activated sufficiently to preclude shallow land burial. However, these items are discarded infrequently and would not significantly increase the amount of non-fuel assembly components which may require geologic disposal.

It is estimated that on the average there will be 25-50 kg of NFB components, other than cruciforms, per assembly. The total estimate of spent fuel assembly hardware and non-fuel-bearing components is 34-64 kg per fuel assembly.

Source: General Electric 1980

Figure 3.2 BWR Control Rod

3.2 PRESSURIZED WATER REACTOR (PWR)

There are four vendors who have manufactured fuel for pressurized water reactors. They are Westinghouse, Babcock & Wilcox, Combustion Engineering, and Exxon. Each is discussed below separately.

3.2.1 Westinghouse

Westinghouse has made four different fuel designs, the most recent being the 17x17. Figure 3.3 shows an isometric drawing of a 17x17 fuel assembly and Figure 3.4 shows a side view with dimensions. Other designs include 14x14, 15x15, and 16x16 arrays, both standard (std) and optimized (low neutron absorption) fuel assemblies (ofa). Only the 17x17 fuel design is described here as representative of Westinghouse fuel but the other fuel designs are accounted for in the estimated quantities of waste.

The 17x17 design incorporates an array of 289 positions, of which 264 are occupied by fuel pins. It contains approximately 0.461 metric ton of initial heavy metal per assembly. The remaining 25 positions are occupied by 24 guide tubes and one instrument tube, in which a variety of other components are inserted. The positions are shown on Figure 3.5. The 17x17 includes upper and lower end fittings, both of which are made of cast SS-304. Together they weigh 12.5 kg. On the top fitting, there are several leaf springs which are made of Inconel. Along the length of the fuel assembly, there are ten (10) fuel rod spacers (grid spacers), which maintain rod-to-rod configuration along the length of the assembly. In the past, these have been made of Inconel-718 and that is what was used in the estimates presented herein. However, recent designs have replaced the middle eight (8) Inconel grid spacers with Zircaloy grid spacers. The 24 guide tubes and one instrument tube are externally larger than fuel pins but only replace one fuel pin each. They guide the travel of control rod cluster assemblies and other components. In total, there is 26-38 kg of spent fuel disassembly hardware per fuel assembly, depending on the specific fuel design.

A Westinghouse core has a number of NFB components located in the core region, which will have to be disposed of. These components include control rod cluster assemblies (Figure 3.6), absorber assemblies (Figures 3.7, 3.8,

and 3.9), thimble plug (Figure 3.10), and neutron sources (Figures 3.11 and 3.12). These components are primarily constructed of stainless steel with other constituents as required (absorber material, neutron sources, etc.). Each fuel assembly will have one or the other of these components located within the guide tubes.

Control rod clusters weigh 6-8 kg and have a nominal useful life of fifteen years. A core can have 50-60 of these assemblies, which are expected to be replaced once during the life of the plant. This averages out to about three per year. Burnable poison rod assemblies weigh about 4-6 kg a piece and it is estimated that on the order of ten per year are changed out. There are a few neutron source assemblies and fission chambers which come out intermittently. The remainder of the fuel assemblies have thimble plugs in them. They only weigh 3 kg and are replaced when damaged. It is estimated that there is 65-90 kg of NFB components per year per reactor. With slightly over 50 fuel assemblies discharged per year, this is about 1-2 kg of components per assembly. The total estimate of spent fuel disassembly hardware and NFB components range from 27 to 40 kg per assembly.

Source: Westinghouse (no date)
Figure 3.3. Westinghouse 17x17 PWR Fuel Assembly

NOTE:

ALL DIMENSIONS ARE IN INCHES

Source: Northeast Utilities 1972.
Figure 3.4. Westinghouse 17x17 Fuel Assembly

NOTE:
ALL DIMENSIONS ARE IN INCHES

Source: Northeast Utilities 1972.
Figure 3.5. Westinghouse Fuel Assembly Cross

NOTE:

ALL DIMENSIONS ARE IN INCHES

Source: Northeast Utilities 1972.

Figure 3.6. Westinghouse Full Length Cluster Control Assembly

Source: Radford, et. al. 1983.

Figure 3.7. Westinghouse Burnable Absorber Rod Assembly

Source: Northeast Utilities 1972.

Figure 3.8. Westinghouse Burnable Poison Rod Assembly

Source: Radford, et. al. 1983.
Figure 3.9. Westinghouse Burnable Absorber Rod

NOTE:
ALL DIMENSIONS ARE IN INCHES

Source: Northeast Utilities 1972.
Figure 3.10. Westinghouse Thimble Plug Assembly

Figure 3.11. Westinghouse Primary Source Assembly

NOTE
ALL DIMENSIONS ARE IN INCHES

Source: Northeast Utilities 1972.

Figure 3.12. Westinghouse Secondary Source Assembly

3.2.2 Babcock & Wilcox (B&W)

B&W fuel assemblies are similar to the Westinghouse design in that they have 24 control rod guide tubes and one instrument tube into which a variety of core components are located. However, their detailed design is markedly different from the Westinghouse design.

B&W has manufactured three different fuel designs: 14x14, 15x15, and 17x17. Currently there are two being used, the 15x15 and 17x17. Figures 3.13 and 3.14 show side-by-side comparisons of the two designs. (All of the 14x14 manufactured have been reprocessed at West Valley and will be disposed of as commercial high-level waste.) They have two end fittings with eight spacer grids between them. The end fittings are made of cast stainless steel while the spacer grids have been made from Inconel. However, current production fuel assemblies have the middle six grids manufactured from Zircaloy. Their location on a 15x15 design are illustrated on Figure 3.15. The total SFD hardware ranges from 31.5 to 45.5 kg per assembly.

B&W assemblies have 24 control rod guide tubes (Figure 3.16) into which either a burnable poison rod assembly (Figure 3.17), control rod assembly (Figure 3.18), orifice rod assembly (Figure 3.19), or an axial power shaping rod assembly (Figure 3.20) are located. The primary waste component will be the burnable poison rod assemblies, at 6-8 kg each. They occupy over one-half the fuel assemblies and are changed out with each assembly. Control rod assemblies occupy most of the remaining position are expected to be replaced only once during the reactor life. The remainder of the assemblies have either orifice or axial power rod assemblies in them. These assemblies range from 4-10 kg a piece. It is estimated that there will be about 6-8 kg of NFB components per fuel assembly. This results in a total estimate range from 38 to 54 kg per assembly of waste.

Source: Babcock & Wilcox
 Figure 3.13. Babcock & Wilcox Fuel Assemblies

MARK B-4
15 x 15

MARK C
17 x 17

Source: Babcock and Wilcox
Figure 3.14. Babcock & Wilcox Fuel Assemblies

Mark BZ Fuel Assembly

Source: Stein 1984

Figure 3.15. Babcock & Wilcox Mark BZ Fuel Assembly

Source: Consumers Power 1966

Figure 3.16. Babcock & Wilcox 15x15 Fuel Assembly

Source: Consumers Power 1966

Figure 3.17. Babcock & Wilcox Burnable Poison Rod Assembly

Source: Consumers Power 1966

Figure 3.18. Babcock & Wilcox Control Rod Assembly

Source: Consumers Power 1966

Figure 3.19. Babcock & Wilcox Orifice Rod Assembly

Source: Consumers Power 1966

Figure 3.20. Babcock & Wilcox Axial Power Shaping Rod Assembly

3.2.3 Combustion Engineering

Combustion Engineering (CE) fuel assemblies are similar to other PWR fuel assemblies in several aspects. They have two cast stainless steel end fittings and ten spacer grids made of Zircaloy and one of Inconel. They also have guide tubes, however, there are only five of them. Each tube is larger in diameter and takes up four fuel pin positions instead of one position like the smaller diameter Westinghouse and Babcock & Wilcox guide tubes. Figure 3.21 shows a 16x16 fuel assembly. Figure 3.22 shows an exploded views of an end fitting and Figure 3.23 shows another view of the 16x16. Figure 3.24 illustrates a 14x14 fuel assembly. The SFD hardware ranges from 30.5 to 45.5 kg per fuel assembly.

The major NFB component of note is the control rod. These are bundles of four or five rods which insert into the guide tubes. However, at least one plant, Palisades, had cruciform blades. There are also a number of instruments which are located in the central guide tube throughout the core. These are changed out infrequently and do not contribute significantly to the total waste. They do though contain some fission chambers and other similar detectors which may be of concern depending on the volume reduction process used. It is estimated that there will be 1-2 kg of NFB hardware per assembly. The total combined SFD hardware and NFB components waste ranges from 31 to 47 kg per assembly.

Source: Arkansas Power and Light 1975

Figure 3.21. Combustion Engineering 16x16 Fuel Assembly

Source: Anderson 1984

Figure 3.22. Combustion Engineering 16x16
Reconstitutable Upper End Fitting
3.30

- 16 x 16 FUEL ROD ARRAY
- FIVE LARGE GUIDE TUBES
- ALL WELDED STRUCTURAL CONSTRUCTION
- REDUCED GRID SPACING
- REMOVABLE UPPER END FITTING

Source: Anderson 1984

Figure 3.23. Combustion Engineering 16x16 Fuel Assembly Design Features

Source: Arkansas Power and Light 1975

Figure 3.24. Combustion Engineering 14x14 Fuel Assembly

3.2.4 Exxon

Exxon makes reloads for both BWR and PWR reactors. Their assemblies are nearly identical to the fuel they are replacing except for minor differences, whether they be Westinghouse, Babcock & Wilcox, Combustion Engineering or General Electric fuel assemblies as described in previous sections. The only fuel type of note is the Allis-Chalmers 10x10 that Exxon has made in the past for the LaCrosse plant. Details of this fuel type were not available. Allis-Chalmers (AC) itself does not make fuel anymore, and Exxon appears to be the only manufacturer providing reload fuel for the A-C reactor. Exxon does not make other core components.

3.3 WASTE QUANTITIES

It is clear from the preceding descriptions of the various fuel assembly designs that there could be considerable variability in spent fuel disassembly hardware and non-fuel-assembly component quantities that may require disposal. For this reason an attempt was made to define potential waste quantities associated with each assembly type.

Tables 3.3 and 3.4 are tabulations, prepared earlier by Green (1980), of fuel assembly dimensional data for a variety of fuel assembly types. It can be seen that there are many missing items in the data. Many of the parameters in this table are not necessary for estimating quantities of waste, but will be of considerable importance in determining how the spent fuel is to be handled and disassembled for consolidation. Even though this table provides a great deal of information that describes many of the various fuel assemblies of interest and materials of construction, it is incomplete for waste management purposes in that it does not provide sufficient information to develop quantitative estimates of fuel disassembly wastes. Using this table as a starting point other resources were utilized to develop a more complete description.

The ORNL Integrated Data Base Program (IDB) initiated a program in FY-1985 to survey the fuel vendors to obtain detailed descriptive information on the various fuel assembly types and models that have been produced. They provided us with copies of all relevant information that they had collected but this

still left some deficiencies in the data for our purposes. We supplemented this data with direct contacts with some of the fuel vendors. The resulting data are tabulated in Table 3.5.

Table 3.5 is a tabulation of material quantity and composition by fuel vendor and fuel type. Material and weight data are shown for four categories of assembly hardware, i.e., end fittings, guide tubes, spacer grids and miscellaneous components including such items as springs, fasteners, etc., and including components not specifically identified. As can be seen, there is considerable variation of quantities of materials within each fuel type, i.e., BWR and PWR fuel types. It was originally anticipated that there would be more uniformity within these fuel types. In part, some of this variation is probably due to uncertainty in some of the source data. However, much of it is also due to differences from reactor-to-reactor in their tailored fuel designs. There are also missing items in this table. This reflects the difficulty in obtaining this level of detail for all the various fuel designs and the constraints on assembling this data due to proprietary information concerns.

The data in Table 3.5 are summarized in Table 3.6. This table provides a breakdown of the spent fuel disassembly hardware weights by metal alloy for each fuel vendor in terms of a single mid-range value (not a weighted average) with a plus and minus range value to represent the potential variation in weight due to the range of fuel designs available. As noted in the previous table (Table 3.5), a complete component breakdown was not obtained for every fuel design. For this reason engineering judgment was used in some cases to assign an alloy type to some of the components to develop this summary.

Table 3.7 presents a summary compilation of estimated quantities of the non-fuel-bearing components which may require disposal. We were unable at this time to develop a more specific breakdown by fuel assembly type and material due to a lack of data. Make up of these materials was discussed in the preceding two sections where the various fuel assembly designs were discussed. Most of this material is metallic hardware composed of various alloys of stainless steel, Inconel, and Zircaloy. However, other components include such items as neutron sources, fission chambers, and absorber materials (B_4C ,

Ag-In-Cd, HfO_4). These latter items may require special handling. The largest quantities of these non-fuel-assembly components are associated with the flow channels that are used with the General Electric BWR fuel assemblies. In general, there is a large degree of uncertainty in these estimates of NFB components due to a lack of detailed design data describing the actual components, as well as the uncertainty in their useful life.

TABLE 3.3. Fuel Assembly Design Data

Fuel Element Array	15 x 15 Westing- house PWR-ZION Unit 1	17 x 17 Westing- house PWR-SLUURY Unit 2	14 x 14 Westing- house PWR-	16 x 16 Combustion Engineering PWR-ALUE Hills St.	15 x 15 Rabcock & Wilcox PWR	17 x 17 Rabcock & Wilcox PWR	7 x 7 General Electric PWR	8 x 8 General Electric PWR	14 x 14 Exxon Combustion Engineering PWR	15 x 15 Exxon Combustion Engineering PWR	15 x 15 Exxon Westing- house PWR	17 x 17 Exxon Westing- house PWR	7 x 7 Exxon General Electric PWR	8 x 8 Exxon General Electric PWR-2	8 x 8 Exxon General Electric PWR-3,4,5,6	14 x 14 Combustion Engineering PWR	15 x 15 Combustion Engineering PWR
<u>Fuel Designation</u>																	
<u>Bundle Components and Characteristics</u>																	
Assembly Weight (kg)	703	665	7,763	657	689	689	308	278	588	612	644	657	290	312	322	588	612
Lower Tie Plate (in) ²	8.424	8.424		8.11	8.536	8.536	5.263	5.47	8.11	8.25	8.42	8.42	5.44	5.44	5.44	8.11	8.25
Spacer Area (in) ²				7.98	8.536	8.536	5.258	5.28	8.10	8.20	8.43	8.42	5.24	5.24	5.24	7.98	8.14
Fuel Rod Pitch (in)	0.563	0.496	0.556	0.5063	0.568	0.501	0.738	0.640	0.58	0.58	0.563	0.496	0.738	0.642	0.641	0.580	0.55
Assembly length (in)	159.76 (+1.75 for Spring)	159.76 (+1.76 for Spring)		176.8	165.7	165.7	171.40	171.40	156.7	148.9	161.3	161.3	171.2	171.2	171.2- 178.5	146.3- 157.241	148.1
<u>Standard Fuel Cost</u>																	
Number	204	264	179	236	208	264	49	63	176	216	204	264	40(260)	52(460)	55	176	216
Length (in)	151.8- 152.35	151.6- 152.3	152.36	161.64					146.5	139.5	152.0	152.0	156.1	156.1	156.1	137	
Fuel Length (in)	122- 144	144- 164	120- 144	150	144	142	144- 146	146- 148	136.7	131.8	144.0	144.0	144.0	144.0	144.0- 150.0	128- 137	132
Outside Diameter (in)	0.422	0.374	0.422	0.382	0.430	0.379	0.563	0.493	0.440	0.415	0.424	0.380	0.570	0.501	0.484	0.440	
Wall Thickness (in)	0.024	0.0225	0.0243	0.025	0.0265	0.024	0.032- 0.037	0.034	0.031	0.028	0.030	0.025	0.035- 0.045	0.036	0.035	0.026	
Material	Zr-4	Zr-4	Zr-4	Zr-4	Zr-4	Zr-4	Zr-2	Zr-2	Zr-4	Zr-4	Zr-4	Zr-4	Zr-2	Zr-2	Zr-2	Zr-4	Zr-4
<u>Guide Tubes</u>																	
Number	20	23		5	16	24	8	8	4		20	24	8	8	8	5	
Upper O.D. (in)				0.530	0.530	0.430 10	0.563	0.493	1.115		0.544	0.480	0.570	0.501	0.484		
Wall Thickness (in)							0.032- 0.037	0.034	0.036		0.017	0.016	0.035	0.035	0.035		
Material	Zr-4			Zr-4	Zr-4	Zr-4	Zr-2	Zr-2	Zr-4		Zr-4	Zr-4	Zr-2	Zr-2	Zr-2		
<u>Instrument Tubes</u>																	
Number	1	1		1	1	1			1	1	1	1	9-1	1-4	1-4		
Outside Diameter (in)						0.390 10			1.115	0.417	0.544	4.380		0.501			
Wall Thickness (in)									0.036	0.027	0.017	0.016		0.036			
Material	Zr-4			Zr-4	Zr-4	Zr-4			Zr-4	Zr-4	Zr-4	Zr-4		Zr-2			
<u>Guide Bars</u>																	
Number	20	23		5			1	1		8			1	1	1		
Cross Section (in)										0.27 x 0.40							
Material	Zr-4									Zr-4			Zr-2	Zr-2	Zr-2		
<u>Tie Plate</u>																	
Material	304 SS	304 SS		SS	304 SS	304 SS	SS	304 SS	304 SS	304 SS	304 SS	304 SS	304 SS	304 SS	304 SS		
<u>Spacers</u>																	
Number	6 & 7	7 & 9	7	12	8	8	7	2	9	10	7	7	7	7	7	889	
Material	INCONEL 718	INCONEL 718	11 Zr-4	INCONEL	INCONEL	Zr	Zr-4	Zr-4	Zr-4	Zr-4	Zr-4	Zr-4	Zr-4	Zr-4	Zr-4	Zr-4	
Springs	INCONEL 718	INCONEL 718		1 INCONEL 625			INCONEL	INCONEL X	INCONEL	INCONEL	INCONEL	INCONEL	INCONEL	INCONEL	INCONEL	INCONEL 625	
<u>Plenum Springs</u>																	
Working Length (in)									8.60	6.48	6.80	6.70	10.6	10.6	10.6- 16.0		
Wire Diameter (in)									0.10	0.10	0.10	0.10	0.10	0.10	0.10		
Material					304SS(top) A286(bottom)	304SS(top) A286(bottom)		INCONEL	INCONEL	INCONEL	INCONEL	INCONEL	INCONEL	INCONEL	INCONEL	INCONEL	

TABLE 3.4. Fuel Assembly Design Data

DIMENSION	DESCRIPTION
A	Overall Length of Element Before Irradiation
B	Overall Length of Upper Tie Plate
C	Upper Tie Plate to Fuel Pin Pressure Boundary Before Irradiation
D	Upper Tie Plate to Spacer
E	Length of Spacer (typical)
F	Lower Tie Plate to Spacer
G	Overall Length of Lower Tie Plate
H	Upper Tie Plate to Fuel Before Irradiation
I	Lower Tie Plate to Fuel
J	Lower Tie Plate to Pressure Boundary
K	Lower Tie Plate Width

DIMENSION	DESCRIPTION
A	Overall Length of Element
B	Overall Length of Upper Tie Plate
C	Upper Tie Plate to Upper End of Fuel Pin After Irradiation
D	Upper Tie Plate to Spacer
E	Spacer Length (typical)
F	Lower Tie Plate to Spacer
G	Lower Tie Plate to Lower End of Fuel Pin After Irradiation
H	Overall Length of Lower Tie Plate
I	Upper End of Fuel Pin to Fuel
J	Lower End of Fuel Pin to Fuel
K	Thickness of Lower Tie Plate Grille Area
L	Wall Thickness, Lower End of Fuel Pin to Pressure Boundary
M	Wall Thickness, Upper End of Fuel Pin to Pressure Boundary
N	Lower Tie Plate Width

BWR Fuel Assembly Schematic Dimensions (Inches)												
Fuel Designation	Fuel Element Array	A	B	C	D	E	F	G	H	I	J	K
EXX0H (General Electric)	7x7	171.2	6.87	0.84	20.00	2.50 MAX	17.42	6.75	12.15	0.72	0.23	5.263
EXX0H (General Electric)	8x8 BWR-2	171.20	7.50	0.88	20.00	2.50 MAX	17.42	6.75	12.20	0.72	0.24	5.438
EXX0H (General Electric)	8x8 BWR-3 4,5A6	17.2 178.5	7.50	0.84	20.00	2.50 MAX	17.42	6.75	12.20 18.2	0.72	0.24	5.425
General Electric	7x7	17.4	7.5	0.84	19.94	1.625	18.225	6.76	12.315	0.625	0.23	5.263
General Electric	8x8	171.4	7.5	0.84	20.07	1.625	18.145	6.76	12.515	0.625	0.24	5.438
General Electric	8x8	176.16	7.5	0.8	20.63	1.625	18.745	6.76	13.275	0.625	0.24	5.425

		Area X		Area Y	
		Compression Spring			
		Wire Diameter	End Cap	End Cap	
Fuel Designation	Fuel Element	Material	O/A {In.}	O/A {In.}	O/A {In.}
EXX0H (General Electric)	7x7	Inconel	0.10	Zr-2	0.250
EXX0H (General Electric)	8x8 BWR-2	Inconel	0.10	Zr-2	0.250
EXX0H (General Electric)	8x8 BWR-3,4,5A6	Inconel	0.10	Zr-2	0.250

PWR Fuel Bundle Schematic Dimensions (Inches)															
Fuel Designation	Fuel Element Array	A	B	C	D	E	F	G	H	I	J	K	L	M	N
EXXON (Combustion Eng)	14x14	156.7	6.10	0.5	1.52	2.75 MAX	1.52	0.5	2.60	9.20	0.60				
EXXON (Westinghouse)	15x15	159.7	5.05	0.5	1.63	2.75 MAX	1.80	0.5	2.72	7.40	0.60				
EXXON (Combustion Eng)	15x15	148.9	3.39	1.0	1.40	2.75 MAX	1.40	0	4.86	7.06	0.59				
EXXON (Westinghouse)	17x17	159.7	3.67	0.5	1.60	2.75 MAX	1.80	0.5	2.74	7.40	0.50			0.425	
Combustion Engineering	16x16	178.3	11.05	0			0	0-	4.437	11.82			1/2	3/8	0.18
Combustion Engineering	14x14	157.24	0	0			0	0-					5/8	3/8	0.4
Combustion Engineering	15x15	148.1	0	0			0	0-							8.55
Westinghouse	14x14	158.8	0	0			0								
Westinghouse	15x15	158.76	0	0			0								8.426
Westinghouse	17x17	150.7 (+1.75 for spring)	3.670	0	1.790	2.142	1.793	0	2.738	6.950	0.688				8.426
Babcock and Wilcox	14x14	No Longer Manufactured--All Reprocessed													
Babcock and Wilcox	15x15	165.7	6 7/16	8	8	1.5/ 4.15	0	0	4 5/8	5 9/16					
	Mark B2 and Mark B3 & B4	165.7	6 7/16	0	0	1.5/ 4.15	0	0	4 1/4	5 11/32 7 11/32	4 11/32	5/8			8.54
Babcock and Wilcox	17x17	165.7	7 15/16	0	0	54/ 14.17	0	0	3 15/32	6 11/32	3 11/32	5/8			8.54

Table 3.5. Spent Fuel Disassembly Hardware Estimates (kg/assembly)

Fuel Vendor	West	West	West	West	West	West	West	West
Fuel Designation	14x14 std	14x14 ofa	15x15 std	15x15 ofa	16x16 std	17x17 std	17x17 ofa	17x17 long
End Fittings								
Material	SS-304	SS-304	SS-304	SS-304	SS-304	SS-304	SS-304	n/a ^(a)
Weight (kg)	11.3	11.3	12.5	12.5	11.4	12.5	12.5	n/a
Guide Tubes								
Material	Zirc-4	Zirc-4	Zirc-4	Zirc-4	Zirc-4	Zirc-4	Zirc-4	n/a
Weight (kg)	7.6	7.5	9.7	9.4	7.8	9.4	9.4	n/a
Spacer Grids								
Material	Inc-718	Inc-718	Inc-718	Inc-718	Inc-718	Inc-718	Inc-718	n/a
Weight (kg)	4.6	1.3	5.2	1.5	5.4	5.9	1.5	n/a
Material	--- ^(f)	Zirc-4	---	Zirc-4	---	---	Zirc-4	n/a
Weight (kg)	---	2.7	---	2.9	---	---	3.5	n/a
Misc. (Springs, etc.)								
Material	n/a	n/a	n/a	n/a	SS-304	n/a	n/a	n/a
Weight (kg)	8.6	3.3	8.1	11.4	8.6	7.3	9.7	n/a
TOTAL (kg)	32.1	26.1	35.5	37.7	33.2	35.1	36.6	

Table 3.5. (Cont'd.)

Fuel Vendor	C-E	C-E	C-E	C-E	C-E	C-E
Fuel Designation	14x14 ^(c)	14x14	15x15	16x16	16x16	16x16
End Fittings Material	SS-304	SS-304	SS-304	SS-304	SS-304	SS-304
Weight (kg)	12.3	14.1	9.5	14.9	16.8	18.1
Guide Tubes Material	Zirc-4	Zirc-4	Zirc-4	Zirc-4	Zirc-4	Zirc-4
Weight (kg)	11.6	9.3	21.2	10.3	11.3	11.3
Spacer Grids Material	Inc-718	Inc-718	Inc-718	Inc-718	Inc-718	Inc-718
Weight (kg)	n/a	1.2	n/a	1.2	1.2	1.5
Material	Zirc-4	Zirc-4	Zirc-4	Zirc-4	Zirc-4	Zirc-4
Weight (kg)	n/a	5.4	n/a	7.3	11.4	8.2
Misc. (Springs, etc.) Material	Inc X-750	Inc X-750	Inc X-750	Inc X-750	Inc X-750	Inc X-750
Weight (kg)	0.7	0.7	n/a	1.6	4.4	4.4
TOTAL (kg)		30.7		35.3	45.1	43.5

Table 3.5. (Cont'd.)

Fuel Vendor	B&W	B&W	GE	GE	GE	GE
Fuel Designation	15x15	17x17	6x6	7x7	8x8	9x9
End Fittings						
Material	SS-304	SS-304	n/a	SS-304	SS-304	n/a
Weight (kg)	15.2	16.3	n/a	6.3	6.8-8.8	n/a
Guide Tubes						
Material	Zirc-4	Zirc-4	---	---	Zirc-2 ^(b)	n/a
Weight (kg)	7.8	11.2	---	---	1.7-3.4	n/a
Spacer Grids						
Material	Inc ^(d)	Inc ^(d)	n/a	n/a	Inc X-750	n/a
Weight (kg)	9.1	10.0	n/a	n/a	0.4	n/a
Material	n/a	n/a	n/a	Zirc-4	Zirc-4	n/a
Weight (kg)	n/a	n/a	n/a	1.5	1.1	n/a
Misc. (Springs, etc.)						
Material	n/a	n/a	n/a	Inc X-750	Inc X-750	n/a
Weight (kg)	2.0	3.4	n/a	0.2	0.7-1.1	n/a
TOTAL (kg)	34.1	40.9		8.0	11.5-15.6	

Table 3.5. (Cont'd.)

Fuel Vendor	Exxon	Exxon	Exxon	Exxon	Exxon	Exxon	Exxon	Exxon
Fuel Designation	C-E 14x14	C-E 15x15	West 15x15	West 17x17	GE 7x7	GE 8x8	GE 9x9	AC ^(a) 10x10 ^(e)
End Fittings Material	SS-304L	SS-304L	SS-304L	SS-304	SS-304, CF-3	SS-304, CF-3	SS-304, CF-3	n/a
Weight (kg)	15.2	15.2	15.2	15.2	5.4	5.6	5.8	n/a
Guide Tubes Material	Zirc-4	Zirc-4	Zirc-4	Zirc-4	---	Zirc-4 ^(b)	---	n/a
Weight (kg)	7.9	11.9	12.1	13.2	---	1.7-3.4	---	n/a
Spacer Grids Material	Inc-718	Inc-718	Inc-718	Inc-718	n/a	n/a	n/a	n/a
Weight (kg)	0.2	0.2	0.3	0.2	n/a	n/a	n/a	n/a
Material	Zirc-4	Zirc-4	Zirc-4	Zirc-4	n/a	n/a	Zirc-4	n/a
Weight (kg)	0.9	0.9	1.1	0.9	1.6	1.6	1.5	n/a
Misc. (Springs, etc.) Material	---	---	---	---	Inc	Inc	Inc	n/a
Weight (kg)	---	---	---	---	0.2	0.2	0.2	n/a
TOTAL (kg)	24.3	28.3	28.8	29.5	7.2	9.2-10.9	7.6	

(a) n/a indicates no data available

(b) Water rods, 1-2 per assembly

(c) Ft. Calhoun, first generation fuel assemblies

(d) B&W current generation fuel assemblies utilize Zircaloy grids

(e) Allis-Chalmers

(f) --- indicated not applicable

Table 3.6. Summary of Estimated Quantity of Spent Fuel Disassembly Hardware^{(a) (c)}
(kg per fuel assembly)

<u>Fuel Vendor</u>	<u>SS-304</u>	<u>Inconel</u>	<u>Zircaloy</u>	<u>Other</u> ^(b)	<u>Total</u>
Babcock & Wilcox	18.0 $\pm$ 1.5	9.5 $\pm$ 0.5	9.5 $\pm$ 1.5	-0-	37.0 $\pm$ 3
Westinghouse	12.5 $\pm$ 1	1.5 $\pm$ 0.5	11.5 $\pm$ 1.0	7 $\pm$ 4.0	32.0 $\pm$ 6.0
Combustion Engineering	15.5 $\pm$ 1.5	3.5 $\pm$ 2.0	18.5 $\pm$ 4.0	---	38.0 $\pm$ 7.5
General Electric	7.5 $\pm$ 1.5	0.5 $\pm$ 0.5	2.5 $\pm$ 1.5	---	11.0 $\pm$ 2.5
Exxon - BWR	5.5 $\pm$ 0.5	<0.5	2.5 $\pm$ 1.0	---	8.0 $\pm$ 1.0
Exxon - PWR	15.5 $\pm$ 0.5	<0.5	11.5 $\pm$ 2.5	---	27.0 $\pm$ 2.5

(a) The weight values represent mid-range value with spread of all fuel assembly models for each vendor where data is available.

(b) Material composition unknown.

(c) PWR's contain approximately 0.46 MTIHM.
BWR's contain approximately 0.18 MTIHM.

Table 3.7. Estimated Quantity of Non-fuel-bearing Components^(a)
(kg per fuel assembly discharged)

<u>Reactor Vendor</u>	<u>Quantity</u>	<u>Primary Materials</u>
General Electric	25 - 50 Kg	Zircaloy
Westinghouse	1 - 2 Kg	SS / ZY
Babcock & Wilcox	6 - 8 Kg	SS / ZY
Combustion-Engineering	1 - 2 Kg	SS / ZY

(a) PWR's contain approximately 0.46 MTIHM.
BWR's contain approximately 0.18 MTIHM.

4.0 CHARACTERIZATION OF ACTIVATED COMPONENTS

This section describes the composition of the various alloys used in spent fuel assemblies and NFA components. It then describes the results of calculations carried out to characterize the radionuclide inventory, as a result of activation, of SFD hardware, NFB components and the principal alloys used. Also included are estimates of the decay heat resulting from these radionuclides.

The calculations were done using the ORIGEN2 computer code as described in ORNL/TM-6051. The code modeled the irradiation of SFD hardware and NFB components for typical lifetimes at full power. For PWR SFD hardware, calculations were made for 33,000 MWD/MTU burnup. For BWR SFD hardware, 28,000 MWD/MTU was assumed. Allowances were made to account for some parts of the assemblies residing within the active core, and other parts residing outside of it. The calculation results are summarized in this section, with more detailed results regarding decay heat, radionuclide inventories, and photon sources presented in the appendices.

4.1 METAL ALLOY COMPOSITIONS

The spent fuel disassembly hardware and the non-fuel-bearing components are primarily comprised of alloys of three materials. They are stainless steel, Zircaloy, and Inconel. In general the stainless steel is found outside the active core region whereas the Zircaloy and Inconel is used within the active core region. Recent design modifications have resulted in more Zircaloy in the core region than Inconel.

The composition for the various alloys used in this study is given in Table 4.1. Those values less than 1,000 ppm can be expected to have a wide variance. For example, cobalt, an element of concern because of the high energy gamma produced by its Co-60 activation product, has a value of 800 ppm (0.08 w/o) in stainless steel. This is a value which is found in many specifications for nuclear grade steel. It can be higher in a particular heat (one batch from a furnace) and still be deemed acceptable by the purchaser

Table 4.1. Assumed Elemental Compositions of LWR
Fuel-Assembly Structural Materials

Structural material composition, grams per tonne of metal ^(a)					
Element	Atomic Number	Zircaloy-2	Zircaloy-4	Inconel-718	Inconel X-750
H	1	13	13	0	0
B	5	0.33	0.33	0	0
C	6	120	120	400	400
N	7	80	80	1,300	1,300
O	8	950	950	0	0
Al	13	24	24	6,000	8,000
Si	14	0	0	2,000	3,000
P	15	0	0	0	0
S	16	35	35	70	70
Ti	22	20	20	8,000	24,900
V	23	20	20	0	0
Cr	24	1,000	1,250	190,000	150,000
Mn	25	20	20	2,000	70,000
Fe	26	1,500	2,250	180,000	67,800
Co	27	10	10	4,700	6,490
Ni	28	500	20	520,000	722,000
Cu	29	20	20	1,000	500
Zr ^(b)	40	980,000	980,000	0	0
Nb	41	120	120	55,500	9,000
Mo	42	0	0	30,000	0
Cd	48	0.25	0.25	0	0
Sn	50	16,000	16,000	0	0
Hf	72	78	78	0	0
W	74	20	20	0	0
U	92	0.2	0.2	0	0
Density, ₃ grams/cm	--	6.56	6.56	8.19	8.30

Table 4.1.(cont'd). Assumed Elemental Compositions of LWR Fuel-Assembly Structural Materials

Structural material composition, grams per tonne of metal						
Element	Atomic Number	Haynes-25	Stellite-3	Stainless Steel 302	Stainless Steel 304	Microbrazed 50
H	1	0	0	0	0	0
B	5	0	0	0	0	50
C	6	1,500	27,000	1,500	800	100
N	7	0	0	1,300	1,300	66
O	8	0	0	0	0	43
Al	13	0	0	0	0	100
Si	14	10,000	10,000	10,000	10,000	511
P	15	300	0	450	450	103,244
S	16	300	0	300	300	100
Ti	22	0	0	0	0	100
V	23	0	0	0	0	0
Cr	24	210,000	330,000	180,000	190,000	149,709
Mn	25	20,000	10,000	20,000	20,000	100
Fe	26	30,000 (d)	30,000 (e)	697,740	688,440	471
Co	27	457,900	423,000	800	800	381
Ni	28	110,000	30,000	89,200	89,200	744,438
Cu	29	0	0	0	0	0
Zr (b)	40	0 (c)	0 (c)	0	0	100
Nb	41	1,000 (c)	1,000 (c)	100	100	0
Mo	42	0	0	0	0	0
Cd	48	0	0	0	0	0
Sn	50	0	0	0	0	0
Hf	72	0	0	0	0	0
W	74	160,000	140,000	0	0	100
U	92	0	0	0	0	0
Density, 3 -- grams/cm				8.02	8.02	

- (a) All numbers rounded
 (b) Also known as Columbium (Cb)
 (c) Maximum limit
 (d) Can be as high as 528,900
 (e) Can be as high as 500,000

for a particular application. Nominal values will be in the 200-600 ppm range. In general, a measured value is available.

Niobium, also known as columbium, on the other hand, is not well identified. Purchase specifications for stainless steel and Zircaloy require niobium to be 100-120 ppm max. The material certifications generally will note that the level is less than one-half the specification limit. Nominal values though can run as low as the 20-30 ppm range, but this information is difficult to verify. One manufacturer of Haynes-25 only checks to determine that the niobium impurity is less than 500 ppm (with a manufacturing limit of 1000 ppm). This manufacturer believes, however, that the niobium is present, perhaps in the hundreds of ppm level. It has not been a concern to them with regard to material properties and therefore they do not go to the added expense and trouble of determining its actual level. This is true of many of the trace impurities listed in Table 4.1.

Manufacturing techniques, (i.e., type of furnace) can also impact the levels of certain trace elements. Nitrogen, which has typical concentrations of 300-400 ppm in SS-304, can be kept to less than 100 ppm if vacuum induction melting is used. Even greater variation can occur depending on the use of scrap metal as opposed to virgin metal.

The results presented herein are based on maximum limits for the trace elements. As will be shown later, the presence of niobium at concentration equivalent to the maximum allowable in components which will be in the active region of the core, results in concentrations of Nb-94 well in excess of 10 CFR 61 limits. At that concentration, the niobium (natural niobium is all Nb-93) can become sufficiently activated to exceed shallow land burial limits for Nb-94. It is apparent from our investigation that niobium is present in all of the fuel components, but the actual levels are not well defined.

4.2 RADIONUCLIDE CONTENT AND DECAY HEAT FOR BWR/PWR SFD HARDWARE AND NFA COMPONENTS

Appendix B gives the curie inventories and decay heat results from ORIGEN-2 calculations for the various BWR and PWR spent fuel disassembly hardware and non-fuel assembly components on a per metric ton of initial heavy metal basis.

The compositions and quantities of the waste were given in Section 3.0. Appendix B also presents the decay heat as a function of time after irradiation for a typical BWR and PWR assembly, their SFD hardware and a BWR cruciform. It must be kept in mind, that not all fuel vendors make similar components from the same materials and that weights presented here of components will vary from vendor to vendor. For the purposes of Appendix B, GE 8x8 and Westinghouse 17x17 were used as representative of BWR and PWR fuel, respectively, since they are the most commonly used. A summary of the radioactivity data for the 10 CFR 61 radionuclides of interest is presented in Table 4.2.

4.3 RADIONUCLIDE CONTENT AND DECAY HEAT FOR METAL ALLOYS

ORIGEN-2 was also used to calculate activation of components made of SS-304, Inconel-718, and Zircaloy-4.⁽¹⁾ These are the most common alloys used in core components, though not the only ones. Appendix C presents the activity inventory due to the activation of one cubic meter of each of the alloys in a BWR fuel assembly (28 GWD/MTU) and a PWR fuel assembly (33 GWD/MTU). The use of one cubic meter basis allows the results to be compared to Table 1 and 2 in 10 CFR 61 (Appendix A) directly. Appendix C presents the decay heat as a function of decay time after irradiation. The data from Appendix C is summarized in Table 4.3 for several of the key radionuclides.

(1) The ORIGEN2 calculations were done using methodology described in ORNL/TM-6051. Recent calculation indicate that the method described may significantly underestimate the reaction rates outside the fueled region. This is a region that has much of the waste and would have a significant impact on our results.

Table 4.2 Specific Activity of Selected Components
(Ci/m³)

	<u>m³/MTU</u>	<u>C-14</u>	<u>Ni-59</u>	<u>Nb-94</u>	<u>Ni-63</u>
Half-Life		5730 yrs	8x10 ⁴ yrs	2x10 ⁴ yrs	100 yrs
10 CFR 61 limit		80 Ci/m ³	220 Ci/m ³	0.2 Ci/m ³	7000 Ci/m ³
<u>PWR Assembly (33,000 MWD/MTU)</u>					
Whole Fuel Assembly	0.00651	92	780	200	100,000
Grids/Springs/Etc. (SS-304 and Inconel-718)	0.00312	190	1600	410	220,000
End Fitting (SS-304)	0.00339	2.3	4.2	0.02	580
<u>BWR Assembly (28,000 MWD/MTU)</u>					
Whole Fuel Assembly with Channel	0.04526	12	20	2.0	3,000
Grids/Springs/Etc. (Zircaloy-4 and Inconel X-750)	0.00209	33	330	17	51,000
End Fittings (SS-304)	0.00461	26	43	0.19	6,600
Channel (Zircaloy-4)	0.03856	10	0.06	1.4	9.1
<u>BWR Cruciform</u>					
Cruciform without Pins & Rollers (SS-304 & B ₄ C)	0.01330	42	70	0.30	11,000
Pins & Rollers (Stellite-3 and Haynes-25)	4.7x10 ⁻⁶	0.03	150		23,000

Specific activities rounded to two significant figures.
Full density metal.
Based on GE 8x8 and Westinghouse 17x17

Table 4.3 Specific Activity Irradiated Within Fueled
Region of Principal Core Alloys
(Ci/m³)

	<u>C-14</u>	<u>Ni-59</u>	<u>Nb-94</u>	<u>Ni-63</u>
Half-Life	5730 yrs	8x10 ⁴ yrs	2x10 ⁴ yrs	100 yrs
10 CFR 61 limit	80 Ci/m ³	220 Ci/m ³	0.2 Ci/m ³	7000 Ci/m ³

PWR Alloys

Inconel-718	210	2300	820	310,000
SS-304	210	380	1.4	52,000
Zircaloy-4	10	0.07	1.4	9.9

BWR Alloys

Inconel-718	200	2000	820	30,000
SS-304	200	330	1.4	51,000
Zircaloy-4	10	0.06	1.4	9.6

Full density.

5.0 DISPOSAL CONSIDERATIONS

This section discusses disposal considerations for the SFD hardware and NFB components. It includes three subsections which describe regulatory requirements, an economic analysis of disposal system alternatives and estimates of projected quantities of the wastes to be delivered to repositories for disposal. In this section the term package refers to the final waste package to be disposed of, whether it be a 55 gallon drum or the canister.

5.1 REGULATORY REQUIREMENTS

Both the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC) promulgate regulations that impact disposal requirements for radioactive wastes. The EPA defines dose limits to the public. The NRC in turn develops industry regulation to insure that those limits are not exceeded.

5.1.1 Environmental Protection Agency (EPA) Requirements

The EPA, under the Radiological Programs Office, promulgates regulations for the radiological protection of the general public. Title 40 of the Code of Federal Regulations, Part 190 (40 CFR 190), covers commercial nuclear fuel cycle operations after mining up to waste disposal. Regulation 40 CFR 191, covers disposal of spent nuclear fuel, high-level and transuranic waste. Regulation 40 CFR 193, proposed rule making, will cover low-level radioactive waste.

These regulations define allowable annual dose limits to the general public due to the nuclear fuel cycle. Regulation 40 CFR 191 also presents release limits to the environment for a number of isotopes. These regulations define performance criteria, which the NRC, in turn, meets via other regulations.

5.1.2 Nuclear Regulatory Commission (NRC) Requirements

The NRC has two regulations covering waste disposal. They are 10 CFR Part 60 and Part 61. 10 CFR 60 covers the deep geologic disposal of spent fuel and high-level radioactive waste. 10 CFR 61 covers the near-surface burial of low-level radioactive waste. There exists though, due to the

definitions of high-level and low-level wastes within these regulations, a class of waste which is not addressed in the regulations. Much of the waste under consideration in this report falls within this category.

10 CFR 60 is titled "Disposal Of High-Level Radioactive Waste In Geologic Repositories". Section 60.2(j) defines high-level radioactive (HLW) as

(1) "irradiated reactor fuel; (2) liquid wastes resulting from the operation of the first cycle solvent extraction system, or equivalent, and the concentrated wastes from subsequent extraction cycles, or equivalent, in a facility for reprocessing irradiated reactor fuel; and (3) solids into which such liquid wastes have been converted."

It also defines radioactive waste as

"HLW and any other radioactive materials other than HLW that are received for emplacement in a geologic repository."

What the other radioactive materials are is not defined any further. However, under the Nuclear Waste Policy Act of 1982 (Public Law 97-425), high-level radioactive waste is defined, in part, as "highly radioactive material that the Commission, consistent with existing law, determines by rule requires permanent isolation". To date, there has been no rulemaking but the NRC is developing such a rule.

10 CFR 61 is titled "Licensing Requirements For Land Disposal Of Radioactive Waste". It classifies radioactive wastes in three classes according to radionuclide inventory. They are classes A, B, and C, with C containing the highest inventory. [Section 61.55 provides the limits for each class and is presented in Appendix A.] "Waste with concentrations above these limits is generally unacceptable for near-surface disposal. There may be some instances where waste with concentrations greater than permitted for Class C would be acceptable for near-surface disposal with special waste forms or more secure burial requirements. These will be evaluated on a "case-by-case basis." However, it is apparent that this waste will not be considered for near-surface burial routinely.

Of particular interest are the limits given for C-14, Ni-59, and Nb-94, which are summarized in Table 5.1. Irradiating Zircaloy, stainless steel, and Inconel alloys in the reactor core region produces sufficient quantities of these isotopes to essentially preclude shallow land burial. The Ni-59 is

largely produced by the reaction $\text{Ni-58}(n,\gamma)\text{Ni-59}$. Nickel is a major constituent of stainless steel and Inconel and so initial inventories are well known. Therefore, estimates of the amount of Ni-59 due to activation are reasonably accurate. This is not the case for Zircaloy where nickel is a trace element. As can be seen from Table 4.3, the Ni-59 concentration in SS-304 is 1.5 (BWR) to 1.75 (PWR) times greater than specified in 10 CFR 61. This is based on 9% nickel in the SS-304. In Inconel-718 the nickel content is about 50%, and the Ni-59 concentration is 9 to 10 times greater than in the SS-304. These results indicate that nickel concentration in excess of 5 w/o will result in Ni-59 concentrations in excess of 10 CFR 61 limits for nominal burnup fuel.

Table 5.1. Activation Product Limits Specified in
10 CFR 61 for Class C Wastes

<u>10 CFR 61 Table 1</u> <u>Radionuclides</u>	<u>Limit</u> <u>(Ci/m³)</u>	<u>Half-Life</u> <u>(Years)</u>
C-14	80	5730
Ni-59	220	8×10^4
Nb-94	0.2	2×10^4
 <u>10 CFR 61 Table 2</u> <u>Radionuclides</u>	 <u>Limit</u> <u>(Ci/m³)</u>	 <u>Half-Life</u> <u>(Years)</u>
Ni-63	7000	100

Carbon-14 and Niobium-94 are both a result of the activation of trace impurities (except Nb in Inconel) whose nominal concentrations are not well known, although a maximum concentration is specified. Carbon-14 results from activating nitrogen via the reaction $\text{N-14}(n,p)\text{C-14}$. In Zircaloy-4, where the nitrogen is less than 0.008 w/o, the C-14 is only 12% of the limit specified in 10 CFR 61. However, in stainless steel and Inconel, where the maximum is 0.13 w/o, the C-14 is almost a factor of 3 above the 10 CFR 61 limit. Given that nominal values of nitrogen are 0.03-0.07 w/o, this results in a C-14 level right at the limit.

Niobium-94 is produced as a result of activating niobium via the reaction $\text{Nb-93}(n,\gamma)\text{Nb-94}$. It is present in Inconel-718 at 5 w/o. The activation results

in Nb-94 levels more than 4000 times greater than that specified in 10 CFR 61. In Zircaloy and stainless steel, assuming impurities of 0.012 w/o (120 ppm) and 0.01 w/o (100 ppm) respectively, the levels of Nb-94 are about a factor of 7 above the limit. This means that traces of niobium in excess of about 20 ppm will result in Nb-94 concentrations which exceed the Class C limit.

One must keep in mind that the limits in 10 CFR 61 are based on the sum of the fractions. This means that for all the isotopes, one takes the value of each one and divides it by its limit. The sum of all these fractions must be less than 1.0 to be considered acceptable for shallow-land burial. As an example, if Ni-59 was determined to be 110 Ci/m³, Nb-94 to be 0.08 Ci/m³ and C-14 to be 30 Ci/m³ then the waste would exceed the Class C limit.

$$(110/220) + (0.08/0.2) + (30/80) = 1.3$$

Table 5.2^(a) summarizes the ratio of specific activities to the maximum allowable activities for the radionuclides of interest from Table 1 of 10 CFR 61. Also included is Ni-63. This is the only nuclide from Table 2 of 10 CFR 61 which presently precludes shallow land burial. However, note that it is not additive to the nuclides in Table 1 (10 CFR 61).

5.2 ECONOMIC ANALYSIS

Costs estimates were developed for disposal of the non-fuel disassembly hardware and other non-fuel assembly components from 70,000 MTU of spent fuel (the current mission plan now has the first repository receiving 62,000 MTU of spent fuel, with the remainder defense waste). A range of cases were evaluated that included variations of the waste canister size, transport mode and shipping distances, and disposal by shallow land burial or geologic disposal and two treatment options. For the first treatment option we assumed the metallic wastes would be loosely packaged with random distribution of components (an inefficient use of space) in drums or canisters without volume reduction and for the second we assumed the wastes would be compacted to reduce volumes.

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- (a) Further analyses carried out subsequent to preparation of this report have indicated that the concentration of activation products in some non-fuel components outside of the active core region (e.g., end fittings) may be substantially higher than reported here.

Table 5.2. Ratio of Calculated Specific Activity to Maximum Allowable Specific Activity for Shallow Land Burial for Selected Components

	<u>m³/MTU</u>	<u>C-14</u>	<u>Ni-59</u>	<u>Nb-94</u>	<u>Ni-63</u>
Half-Life		5730 yrs	8x10 ⁴ yrs	2x10 ⁴ yrs	100 yrs
10 CFR 61 limit		80 Ci/m ³	220 Ci/m ³	0.2 Ci/m ³	7000 Ci/m ³
<u>PWR Fuel Assembly (33,000 MWD/MTU)</u>					
Total Fuel Assembly Hardware	0.00651	1.1	3.6	990	15
Grids/Springs/Etc. (SS-304 & Inconel-718)	0.00312	2.4	7.4	2100	32
End Fitting (SS-304)	0.00339	0.03	0.02	0.08	0.08
<u>BWR Assembly (28,000 MWD/MTU)</u>					
Total Fuel Assembly Hardware with Channel	0.04526	0.15	0.09	9.8	0.43
Grids/Springs/Etc. (Zircaloy-4 and Inconel X-750)	0.00209	0.41	1.5	86	7.3
End Fittings (SS-304)	0.00461	0.33	0.20	0.94	0.95
Channel (Zircaloy-4)	0.03856	0.12	<0.01	6.8	<0.01
<u>BWR Cruciform</u>					
Cruciform without Pins & Rollers (SS-304 & B ₄ C)	0.01330	0.53	0.32	1.5	1.5
Pins & Rollers (Stellite-3 and Haynes-25)	4.7x10 ⁻⁶	<0.01	0.69	>>1	3.3

All ratios rounded to two significant figures.
Full density.
Based on GE 8x8 and Westinghouse 17x17

An estimate of the volume of compacted and uncompact waste is presented in Table 5.3. The waste volume estimates used here correspond approximately to the high-range estimate that is developed in the more comprehensive volume estimates for the waste volume projections presented in the next section (Section 5.3). All of the costs are about 20% higher than would be the case if the mid-range volume estimates were used. These differences, however, would not affect the conclusions. The estimates in this section are based on GE 8x8 as representative of BWR fuel and Westinghouse 17x17 as representative of PWR fuel. For the uncompact case, it was assumed that the waste was cut in approximately 2 1/2 foot lengths and placed into 55-gallon drums. These sections have square cross-sections and do not fill out the cylindrical drum very efficiently. For the compacted case, a volume reduction to 13% of full density was assumed. Later data, reflected in other sections of this report, indicate a somewhat higher density can be achieved.

Table 5.3. Waste Volume Estimate

	<u>(kg/MTU)</u>	<u>Compacted (m³/MTU)</u>	<u>Uncompact (m³/MTU)</u>
PWR	75	0.056	0.90
BWR	310	0.32	1.7
Average (a)	150	0.14	1.2

(a) assume 1/3 BWR and 2/3 PWR

From the discussion of regulatory requirements, it would seem that the only feasible disposal alternative is a geologic repository. However, for the purposes of this study, it was assumed that shallow land burial could be made available if there existed sufficient incentive or if regulatory requirements were changed.

5.2.1 Alternatives Considered

In developing the alternatives to be evaluated several options were considered. The first was the type of waste container used. The use of 55-gallon drums or a canister (26 inches OD x 13 feet) that could hold the equivalent of four 55-gallon drums, were the options considered. These are

not necessarily optimum choices but are representative of the range of possible continuous options.

A second option was whether the waste (non-fuel components) would be compacted or not. Compaction via one of several volume reduction techniques can attain a waste volume reduction to thirteen percent of full theoretical density. (Later work, used in Section 5.3, indicate that higher values can be attained.) It was determined that an uncompacted PWR fuel assembly skeleton, cut into six sections could be placed into two 55-gallon drums. Likewise, a BWR, with an uncompacted fuel channel would require 1 1/2 55-gallon drums (almost one drum for the fuel channel alone and the remainder of the space for the end fittings, grid spacers, etc.)

Crushing and shredding both have the capability to provide significant volume reduction. Another possibility which was not considered here is melting, which could provide even greater volume reduction. Volume reduction technologies are the focus of current development programs. The options evaluated were based on currently available processes.

Finally, the location of the fuel consolidation was considered. It could be done at a repository, reactor site, or at some interim facility. This consideration has many other impacts such as the type of fuel consolidation equipment, cask requirements for the fuel transportation, etc., which are beyond the scope of this study. Necessarily, this aspect is greatly simplified and we considered herein only the waste disposal aspects and not any aspects related to fuel handling or fuel consolidation. The facility and/or the equipment necessary to perform waste compaction/packaging is not considered, with one exception. In the case where 55-gallon drums are sent to a repository from either a reactor site or an interim facility, they are assumed to be packaged four to a container at the repository. This cost is included, but not the initial packaging into the 55-gallon drum. This overpackaging is considered operationally necessary for the repository to emplace the wastes in emplacement bore holes.

To evaluate the two main alternatives (geologic versus shallow land disposal) considering these three suboptions, three scenarios were defined.

These are illustrated schematically in Figure 5.1. These illustrate that fuel consolidation, the point at which the non-fuel wastes are produced, might occur at the repository, at an interim facility such as an MRS or at the reactors. In each case we have assumed and considered that the compaction options for the non-fuel wastes would only be exercised at the same location as the spent fuel consolidation. It could of course be done at another location such as the disposal site but we did not evaluate this alternative. Likewise we have assumed that the non-fuel waste could be packaged in either, 55-gallon drums or in larger canisters at the location of the fuel consolidation.

In Scenario I, where the spent fuel consolidation takes place at the repository, we assumed that non-fuel wastes being sent to surface burial would have to be returned to the region of their origin rather than to the regional surface burial facility nearest the repository. This results in a 2500 mile return shipment assumption.

In the case of consolidation at the intermediate facility (Scenario II) we assumed 1200 miles from reactors to intermediate facility and 1500 miles from there to either the geologic repository or back to a regional disposal site.

In Scenario III, the waste will go 2500 miles to a repository or 300 miles to a regional burial site.

The matrix of eight cases for each disposal option is shown Table 5.4. Since there are two disposal options for each scenario, i.e., repository or surface burial disposal, a total of sixteen cases were evaluated for each scenario.

5.2.2 Transportation Costs

Transportation costs were developed for both truck and rail transport modes for each of the packaged waste alternatives. Cost estimates for both 100% rail/0% truck and 0% rail/100% truck shipping cases, and for two shipping distances, 1500 and 2500 one-way miles were calculated. (Estimates for 300 miles were obtained by extrapolation). In all, transportation costs were estimated for a total of twenty-four cases.

Scenario I Spent Fuel Consolidation at the Repository

Scenario II Spent Fuel Consolidation at an Intermediate Facility

Scenario III Spent Fuel Consolidation at Each Reactor

Figure 5.1. Three Scenarios for Disposal of Non-Fuel Wastes

Table 5.4. Matrix of Cases Evaluated for Each Disposal Option

<u>Compaction</u>	<u>Transport Mode</u>	<u>Package Type</u>
No	Rail	Drum
	Rail	Canister
	Truck	Drum
	Truck	Canister
Yes	Rail	Drum
	Rail	Canister
	Truck	Drum
	Truck	Canister

Additional information regarding the waste canisters is as follows. It is assumed that an empty 55-gallon drum weighs 31 kg and an empty canister weighs 560 kg. The net waste weights for the package without compaction were 27 kg of waste per drum and 108 kg of waste per canister. For the cases where the wastes are compacted, the net waste weight were 216 kg per drum and 864 kg per canister. The resulting loaded weights for both waste packages with compacted and uncompact waste are shown in Table 5.5. Also shown are the drum and canister production rates for both compacted and uncompact wastes.

Table 5.5. Waste Package Weights and Number of Packages^(a)

	<u>Weight, kg</u>	<u>Canisters Per 70,000 MTU</u>
Uncompacted Wastes		
55-gal drum	60	394,000
Canister	670	98,500
Treated Wastes		
55-gal drum	250	49,000
Canister	1,425	12,250

(a) These waste quantities correspond approximately to the high-range waste quantity estimates developed in the next section (Section 5.3).

For the transportation cost estimates we assumed that the Federal government will purchase shipping casks required for the shipments. The reference shipping casks used to determine the transportation costs were the High-Level Defense Waste (HLDW) truck and rail casks that are currently under development by GA Technologies Inc. (General Atomic Co., 1982). The cargo capacities of these casks for the waste packages shown in Table 5.6.

Table 5.6. HLDW-Cask Cargo-Capacities for the Assembly Waste Packages

	Number of Packages Per Cask	
	<u>Truck</u>	<u>Rail</u>
Uncompacted Wastes		
55-gal drum	3	24
Canister	1	8
Compacted Wastes		
55-gal drum	3	15
Canister	1	5

The rail cargo capacities for the compacted and uncompacted wastes are estimated to be different because the compacted wastes will have a higher dose rate and will thus require more shielding. The reference rail shipping cask is a convertible design that will use interchangeable liners or baskets to provide various levels of gamma shielding. It was assumed that the uncompacted wastes will require the equivalent of approximately six inches of steel shielding and the compacted wastes will require nine inches of steel shielding equivalent. The truck cask is not a convertible design so the cargo capacities for compacted and uncompacted waste are the same with the cask somewhat overdesigned for the uncompacted case.

The capital costs for the transportation casks are \$2.25-million for the rail cask and \$1.4-million for the truck cask (including railcar or semitrailer) mid-1984 dollars. We assumed that shipping casks have 15-year operational lifetimes. Since the repository is assumed to have a 26-year receiving period, these casks will have to be replaced once during the lifetime of the repository.

Further assumptions needed to calculate transportation costs are as follows. First, truck shipments are assumed to travel at an average speed of 35 mph and rail shipments travel at an average speed of 12 mph (Wilmot, et al. 1983). Turnaround times are assumed to be five days for rail shipments and three days for truck shipments. These turnaround times are the combined times for loading at the origin facility and unloading at the destination facility. It is further assumed that shipping casks are available 300 days per year.

The transportation costs are the sum of the capital costs and freight (i.e., shipping) charges. Since it was assumed that the government would purchase shipping casks to perform these shipments, the required number of casks must be calculated. The number of casks needed for each case was calculated on an annual basis by first calculating shipment durations for both 1500- and 2500-one-way-mile shipments. The results were 16 and 23 days per rail shipment and 7 and 9 days per truck shipment, respectively. These shipment durations were multiplied by the annual number of shipments for each case to determine the number of cask-days per year that are needed to perform the shipments.

These values were then divided by the 300 day per year cask availability factor to determine the number of casks per year that are needed. After the annual cask requirements were calculated, they were multiplied by a factor of two to determine the total number of shipping casks required over the 26-year repository receiving period. After the required number of shipping casks was determined, it was multiplied by the capital costs to calculate total life-cycle capital costs.

The final portion of the transportation costs is the freight shipping charges assessed by carrier companies for delivery of the cargo. Freight charges include distance and weight costs, detention or demurrage costs, and a surcharge for highway route controlled quantities of radioactive materials. The sum of these charges is shown in Table 5.7.

Table 5.7. Freight Charges for Assembly Waste Shipments

	Freight Charge Rate (\$/kg of waste)	
	<u>1500 miles</u>	<u>2500 miles</u>
Rail	2.3	3.3
Truck	1.5	2.1

The freight charge rates shown above were multiplied first by the cargo weights for each type of shipment and then by the annual number of shipments to determine annual freight charges. The annual freight charges were then multiplied by the 26-year repository receiving period to calculate a 70,000 MTU repository life-cycle freight charges for these assembly wastes.

The results of the transportation cost calculations are shown in Table 5.8. Compaction reduces total transportation costs substantially (three to eight-fold) even for the 300 mile shipment. Rail transport costs are substantially cheaper than truck for the uncompacted wastes but truck transport costs are generally a little cheaper for compacted wastes.

5.2.3 Disposal Costs

Disposal costs were estimated for non-fuel components of the fuel assemblies by shallow land burial as well as for a geologic repository. Shallow land burial was included to determine if there exists sufficient economic incentive to warrant its consideration even though the waste at present may exceed Class C limits. These disposal costs are intended to compare the relative magnitude of the costs for shallow land burial and geologic disposal.

For shallow land burial, published rate charges (4/84) for the Barnwell, South Carolina disposal site were used to determine cost estimates of disposal at the site. (Cost estimates at a federal facility may differ from a commercial site.) A computer code, BELOW, was used to calculate the cost, given the receipt rates and transport modes detailed earlier. At this time, Barnwell does not accept rail shipments. However, this was included as a parameter for comparison purposes. One of the important costs is a curie content

Table 5.8. Transportation Costs for 70,000 MTU of Fuel Assembly Wastes

<u>Compaction</u>	<u>Transport Mode</u>	<u>Container Type</u>	<u>Number of Containers</u>	<u>Transportation Costs in \$millions</u>		
				<u>2500 mi</u>	<u>1500 mi</u>	<u>300 mi</u>
No	Rail	55-gal. Drum	394,000	289	202	98
		Canister	98,500	387	270	130
	Truck	55-gal. Drum	394,000	473	368	242
		Canister	98,500	453	345	215
Yes	Rail	55-gal. Drum	49,000	93	68	38
		Canister	12,500	102	76	45
	Truck	55-gal. Drum	49,500	87	64	36
		Canister	12,500	85	66	43

surcharge. This surcharge is based on ten-year old wastes here. The curie surcharge rate per curie, which is as high as \$6 per curie for truck shipments of uncompacted waste, declines as the number of curies in a shipment increases even though the surcharge per shipment increases.

The cost estimates for shallow land burial disposal are presented in Table 5.9. These disposal cost are broken down into four categories in addition to the total. These include a high integrity container (HIC) cost for Class C wastes which is actually incurred at the treatment and packaging site. We have used HIC costs of \$300 for 55-gallon drums and \$5000 for the large canister compared to \$50 and \$2000 respectively for these size canisters going to geologic disposal. The other cost categories include (1) the basic burial charge combined with cask handling charges, weight surcharges when applicable and taxes, (2) the radiation surcharge, (3) the curie surcharge and (4) the total costs. The radiation and curie surcharges are clearly very significant cost components.

The estimates for disposal costs in a repository were calculated by adding these waste canister requirements to an existing RECON case for high-level waste disposal in a salt repository model, and determining the incremental costs. No capital costs were allocated to this additional waste; only the additional incremental operating costs of handling and disposal were included.

The cost estimates for repository disposal were broken down into four categories, which are applicable, either in part or in total, for the three scenarios. These include receiving, packaging, and emplacement plus the initial container cost. Repository disposal costs include (1) the cost of receiving the waste packages at the repository if the consolidation occurs at a facility other than the repository, (2) overpacking, that is, the cost of placing 55-gallon drums into a container, four drums per container and (3) emplacement in the repository. It was assumed that if drums were sent to a repository, they would be overpacked into a more efficient configuration for disposal since the facility would already be geared to handling, large, remote-handled, packages. Emplacement is the cost of emplacing those containers into boreholes in the repository.

Table 5.9. Shallow Land Burial Costs (\$millions) for 70,000 MTU of Fuel Assembly Hardware

<u>Compaction</u>	<u>Transport Mode</u>	<u>Package Type</u>	<u>Package Cost (millions\$)</u>	<u>Shallow Land Burial</u>			<u>Total</u>
				<u>Radiation Surcharge (millions\$)</u>	<u>Curie Surcharge (millions\$)</u>	<u>Fee, Taxes, and Other (millions\$)</u>	
No	Rail	Drum	118	289	163	81	651
		Canister	493	288	163	77	1021
	Truck	Drum	118	289	1049	161	1617
		Canister	493	288	784	138	1703
Yes	Rail	Drum	15	108	163	13	299
		Canister	61	108	163	15	347
	Truck	Drum	15	108	163	22	308
		Canister	61	108	163	22	354

The cost estimates for geologic disposal are presented in Table 5.10^(a). All three repository costs are incurred in Scenarios II and III. The receiving cost is not incurred in Scenario I where spent fuel consolidation is accomplished at the repository so the total disposal cost is reduced by that amount.

Comparing the costs for disposal in Tables 5.9 and 5.10 it is apparent that disposal costs for shallow land burial can exceed geologic disposal costs in some cases. Canister costs are considerably larger than drum costs, and their use does not appear to be cost effective in the case of shallow land burial but does appear to be cost effective for geologic disposal. Waste compaction reduces these disposal costs as much as eight-fold.

5.2.4 Disposal System Costs

The estimated disposal system costs, transportation plus disposal, are compared in Table 5.11 for the three scenarios described in Figure 5.1. These are essentially the total system costs except that they do not include the costs of the initial waste compaction and packaging but do include the container costs. Facilities for these two operations are assumed to be an integral component of the spent-fuel consolidation facilities and we have not attempted in this study to develop these costs.

The results compared in Table 5.11 show a significant incentive for waste consolidation. Even though the cost for the consolidation operation is not included it is clear that the magnitude of saving is so large that compaction facility costs should be easily absorbed for either shallow land or geologic disposal.

The larger package (canister) does not appear to be a cost effective option for the shallow land disposal but this is largely a result of the canister cost assumptions and deserves further study.

(a) These repository costs do not include the cost of a 300-1000 year container as is required by 10 CFR 60 for high-level waste or spent fuel. If such a long lived container is required for the non-fuel components, the total repository costs would be substantially increased.

Table 5.10. Geologic Disposal Costs (\$millions) for 70,000 MTU of Fuel Assembly Hardware

<u>Compaction</u>	<u>Transport Mode</u>	<u>Package Type</u>	<u>Package Cost (millions\$)</u>	<u>Repository Disposal</u>			<u>Total</u>
				<u>Receiving</u>	<u>Packaging^(a)</u>	<u>Emplacement</u>	
No	Rail	Drum	20	101	666	880	1667
		Canister	197	46	---	880	1123
	Truck	Drum	20	374	666	880	1940
		Canister	197	251	---	880	1328
Yes	Rail	Drum	2	16	85	110	213
		Canister	25	8	---	110	143
	Truck	Drum	2	47	85	110	244
		Canister	25	32	---	110	167

(a) with \$2000-overpack

Table 5.11. Total Cost Estimate for Three Scenarios

<u>Compaction</u>	<u>Transport Mode</u>	<u>Package Type</u>	<u>Scenario I</u>		<u>Scenario II</u>		<u>Scenario III</u>	
			<u>Repository</u>	<u>Shallow Land</u>	<u>Repository</u>	<u>Shallow Land</u>	<u>Repository</u>	<u>Shallow Land</u>
No	Rail	Drum	1566	940	1667	843	1667	749
		Canister	1077	1408	1393	1291	1510	1151
	Truck	Drum	1566	2090	2308	1985	2413	1859
		Canister	1077	2156	1673	2048	1781	1918
Yes	Rail	Drum	197	392	281	367	306	337
		Canister	135	449	219	423	245	392
	Truck	Drum	197	395	308	372	331	344
		Canister	135	439	233	420	252	397

System costs with truck transport is substantially more costly than rail with the large number of packages in the uncompacted waste cases. In the compacted waste cases the differences are relatively small although the truck transport is still generally the more costly option. However, the difference is not always decisive.

The Scenario I assumptions result in the lowest total costs for repository disposal and the highest total costs for shallow land disposal and a significant cost advantage for geologic disposal assuming waste compaction. This is because with spent fuel consolidation at the repository there are no waste receiving costs and because returning the wastes to the region of their origin for shallow land disposal requires the largest shipping distance and cost.

The Scenario II assumptions with spent fuel consolidation at an intermediate facility results in cost differences between geologic and land disposal that are intermediate between those for Scenario I and III. The shallow-land disposal costs are less than in Scenario I but a little larger than in Scenario III.

The Scenario III assumptions with spent fuel consolidation at each reactor result in the closest cost comparisons between geologic and shallow land disposal costs (i.e., assuming compaction of wastes). This is because the long (2500 mile) shipment to geologic disposal compared to the relatively short (300 mile) shipment to shallow land disposal tends to mitigate the larger differences between the basic disposal costs.

Although these results indicate a fairly clear cost advantage for geologic disposal, the possibility of more stringent packaging requirements for geologic disposal could reduce the advantage. It might also be possible to develop packaging concepts that would reduce shallow land disposal costs. Storing the waste for longer periods prior to disposal could reduce the curie surcharges substantially for shallow land disposal. Further cost analysis of these issues is warranted.

The principal cost conclusions can be summed up as follows:

1. There is a strong cost advantage for compaction of the fuel assembly components remaining after spent-fuel rod consolidation.
2. Waste packaging in a large canister on the order of 2-feet diameter x 13-feet long appears more cost effective than use of 55-gallon drums for geologic disposal but questionable for shallow land disposal.
3. Assuming waste compaction, geologic disposal appears to have a cost advantage compared to shallow land disposal even though some components might qualify for shallow land disposal.
4. Assuming compaction, the cost differences between rail transport compared to truck are generally small and the choice will depend on facility siting.

5.3 PROJECTED ANNUAL WASTE QUANTITIES

Based on the results of the analysis presented in Section 4.0 and the current limitations regarding materials that can be disposed of by shallow land burial as well as the apparent lack of an economic incentive for shallow land disposal as opposed to geologic repository disposal just discussed, it appears prudent at this time to assume that all of the SFD and NFB wastes will require geologic disposal.

The data on waste quantities developed in Section 3 were combined with the PNL Spent Fuel Data Base (Heeb, Libby, and Holter, 1985), to develop projected annual quantities of this waste type requiring geologic disposal. The spent fuel data base maintained at PNL contains a file for each operating reactor as well as those under construction with planned startup dates. In addition, generic reactor files are maintained to account for unspecified reactors required to make up the difference between nuclear power growth projections and the capacity to be available from operating and planned reactors. The file includes detailed information on spent fuel stored at each reactor and spent fuel projected yet to be discharged over the life of each plant. The file includes data describing each fuel discharge batch including the number of assemblies and the vendor (manufacturer) who supplied the fuel. The data base can be queried to develop information on spent fuel availability and characteristics under a variety of assumed scenarios.

5.3.1 Unit Waste Quantities for Disposal

To use the Spent Fuel Data Base to project quantities of non-fuel wastes, it was first necessary to correct the vendor specific data developed in Section 3 to unit quantities of waste ready for repository receipt. We had originally intended to develop projections based on specific waste quantity estimates for each fuel assembly model. Two problems prevented this: 1) we were unable in the time available to develop the necessary data for each fuel assembly model and 2) the Spent Fuel Data Base could only identify the fuel by fuel vendor rather than fuel model. (A more complete fuel assembly description has recently been added to the Spent Fuel Data Base but was not available in time to use for these analyses.)

Using the untreated waste quantities estimated in Section 3, we projected treated waste volumes by fuel vendor. For these projections it was assumed that the spent fuel disassembly hardware and non-fuel-assembly components were processed through some form of volume reduction. Two types of volume reduction were considered, that is, shredding or compaction. Either of these options will result in a density of approximately 15% of full density. (A 13% theoretical density by compaction was estimated in Section 4 and the MRS Architect-Engineer has estimated 17% of theoretical density by shredding.) Melting is another option, but it was not considered here because of its uncertain feasibility and cost. Its effect on the waste volume would be to reduce waste volumes by about another factor of six. One of the problems associated with melting would be the corresponding increase in the heat load associated with each waste package.

Because of the advantages inherent in handling fewer large canisters as compared to more small canisters or 55-gallon drums, a fairly large waste canister was assumed. It is 26-inches in outside diameter and approximately 13-feet long including a lifting pintle. This size canister could either be loaded directly with compacted or shredded waste or it could be loaded with four standard 55-gallon drums individually filled with waste. This flexibility might be desirable if spent-fuel disassembly is performed at more than one site, for example, at some reactors and at an MRS.

The canister is similar to the defense-waste RH-TRU canister except longer (Rockwell, 1984). The RH-TRU canister is only 10-feet long and holds three 55-gallon drums. Its length was limited to fit the defense HLW shipping cask employing a modified shielding insert that is required to accommodate the 26-inch diameter canister size.

Two waste loadings of the canister were considered. One loading consists of four standard 55-gallon drums being individually filled and placed inside the canister. The other loading is based on the canister being filled directly with compacted or shredded waste. A 50:50 mix of these two loadings was assumed. At 15% of full density for the waste (1.1 kg/liter), and 96% packaging efficiency, a drum will hold approximately 240 kg of waste. Four of these drums will hold 960 kg of waste. Using the same assumptions for density and packaging efficiency, a canister filled directly will hold slightly more than 1300 kg. Averaging the two canisters loadings results in approximately 1.1 MT of waste per canister.

The canister loading estimate was combined with the vendor specific waste quantity estimates from Table 3.6 and 3.7 to provide a vendor-specific estimate in terms of numbers of canisters requiring disposal. The results are presented in Table 5.12. Three estimates are shown, i.e., minimum, mid-range, and maximum. These are derived from the plus and minus range values presented in Table 3.6 and are used to develop the low-range, mid-range, and high-range waste quantity projections in Section 5.3.2.

An important aspect of the assumptions regarding canister size and loading is their impact on the potential heat output of the loaded canisters. One of the principal activation components in the spent fuel hardware components is cobalt-60. The heat generation effect is much more significant in PWR components than in BWR components as shown in Table 5.13. This is because there is a considerable amount of Inconel in the core region, which has a cobalt content of 0.5-0.6 w/o (see Table 4.1). BWR assemblies have predominantly Zircaloy in the core region which has a very low cobalt content.

Table 5.12. Canisters per Fuel Assembly

<u>Fuel Vendor</u>	<u>Spent Fuel Disassembly Hardware</u>			<u>Non-Fuel- Bearing Components</u>			<u>Total Estimated Waste</u>		
	<u>Min.</u>	<u>Mid</u>	<u>Max.</u>	<u>Min.</u>	<u>Mid</u>	<u>Max.</u>	<u>Min.</u>	<u>Mid</u>	<u>Max.</u>
General Electric	0.007	0.010	0.012	0.023	0.034	0.045	0.030	0.044	0.058
Westinghouse	0.024	0.029	0.035	0.001	0.001	0.002	0.025	0.031	0.036
Babcock & Wilcox	0.031	0.034	0.037	0.005	0.006	0.007	0.036	0.040	0.044
Combustion Engineering	0.027	0.034	0.041	0.001	0.001	0.002	0.028	0.036	0.043
Exxon - BWR	0.007	0.007	0.008	0.023	0.034	0.045	0.029	0.042	0.054
Exxon - PWR	0.022	0.025	0.027	0.002	0.003	0.004	0.024	0.028	0.031

Table 5.13. Heat Generation Rates in Spent Fuel Hardware Canisters Assuming 15% of Theoretical Density

<u>Years Since Discharge</u>	<u>Watts / Canisters</u> (a) (d)	
	<u>PWR Fuel</u> (b)	<u>BWR Fuel</u> (c)
5	834	85
10	417	38
15	222	19
20	125	9

(a) Based on 26-inch O.D. x 13-feet long canister.

(b) Based on average exposure of 33,000 MWD/MTU.

(c) Based on average exposure of 28,000 MWD/MTU.

(d) Primary contributor Co-60; half-life is 5.3 years.

The estimates in Table 5.13 are based on an average mix of components. Individual canisters could be substantially higher or lower if there is any segregation of components.

5.3.2 Annual Waste Generation Rates

The waste generation rates in terms of both annual and cumulative numbers of canisters for the low-range, mid-range and high-range estimates are presented respectively in Table 5.14, 5.15 and 5.16. These ranges correspond respectively to the minimum, mid-range, and maximum canisters per fuel assembly shown in Table 5.12. The projection starts in 1998, the year of the first repository startup, and continues through 2025, three years after the first repository is filled. The second repository startup is 2006.

Throughput rates are based on the 1984 EIA middle-case nuclear-power growth projection and the current Office of Civilian Radioactive Waste Management Mission Plan repository schedules. The annual and cumulative metric tons of uranium-equivalent are shown in columns 5 and 6, respectively. Quantities for each year are shown for both PWR and BWR fuel as well as the total. The order of priority for processing and disposal is strictly oldest fuel first. The minimum and maximum ages, i.e., years cooled since reactor discharge, are shown in columns 2 and 3. The age of the fuel and associated

Table 5.14. Canisters of Non-Fuel Waste for Repository Disposal, Low-Range Estimate

Year	Cooling Fuel		Metric Tons	Metric Tons		Canisters by Fuel Vendor						Canisters		Repository No. 1	
	MMY	MXV		Type	Annual	Cum.	BW	CE	EX	GE	WE	OT	Annual	Cum.	Annual
1998	25	28	PWR	173	173	9	0	0	0	5	0	14	14	14	14
			BWR	227	227	0	0	0	38	0	1	38	38	38	38
TOTALS				400	400							52	52	52	52
1999	25	26	PWR	213	386	2	2	0	0	11	0	16	30	16	30
			BWR	187	414	0	0	0	30	0	2	32	70	32	70
TOTALS				400	800							47	100	47	100
2000	25	26	PWR	226	613	2	13	0	0	2	0	16	46	16	46
			BWR	173	587	0	0	0	29	0	2	31	101	31	101
TOTALS				400	1200							47	147	47	147
2001	24	26	PWR	449	1061	8	1	0	0	18	1	29	74	29	74
			BWR	451	1038	0	0	0	72	0	0	72	173	72	173
TOTALS				900	2099							101	247	101	247
2002	24	25	PWR	1053	2115	21	14	2	2	31	1	71	145	71	145
			BWR	746	1785	0	0	7	107	0	12	126	299	126	299
TOTALS				1800	3899							197	444	197	444
2003	22	25	PWR	1760	3875	32	18	6	0	60	0	115	260	115	260
			BWR	1240	3024	0	0	5	195	0	1	201	501	201	501
TOTALS				3000	6899							316	760	316	760
2004	21	23	PWR	1911	5786	32	19	14	0	56	0	122	382	122	382
			BWR	1089	4113	0	0	8	172	0	0	180	680	180	680
TOTALS				3000	9899							302	1062	302	1062
2005	19	22	PWR	1948	7734	28	21	14	0	61	0	123	504	123	504
			BWR	1052	5165	0	0	8	172	0	0	180	860	180	860
TOTALS				3000	12899							303	1365	303	1365
2006	18	20	PWR	2380	10113	32	35	11	0	72	0	150	654	115	503
			BWR	1520	6685	0	0	7	246	0	0	253	1113	194	856
TOTALS				3900	16799							402	1767	310	1674
2007	17	19	PWR	3079	13192	31	30	18	0	110	0	189	844	118	527
			BWR	1721	8406	0	0	12	275	0	0	287	1399	179	875
TOTALS				4800	21599							476	2243	298	1972
2008	16	18	PWR	3081	16273	43	35	11	0	105	0	193	1037	121	648
			BWR	1719	10125	0	0	7	279	0	0	286	1686	179	1053
TOTALS				4800	26398							479	2723	300	2271
2009	15	17	PWR	3059	19333	36	34	12	0	109	0	190	1227	119	767
			BWR	1740	11866	0	0	8	281	0	0	289	1975	181	1234
TOTALS				4800	31198							479	3202	300	2571
2010	14	16	PWR	3175	22508	42	34	15	0	108	0	199	1426	124	891
			BWR	1625	13490	0	0	7	263	0	0	270	2245	169	1403
TOTALS				4800	35998							469	3671	293	2864

NOTES: MMY = minimum years cooled
 MXV = maximum years cooled
 BW = Babcock and Wilcox
 CE = Combustion Engineering

EX = Exxon
 GE = General Electric
 WE = Westinghouse
 OT = Others

Table 5.14. (Cont'd.)

Year	Cooling Fuel		Type	Metric Tons		Canisters by Fuel Vendor						Canisters		Repository No.	
	MNY	MXV		Annual	Cum.	BW	CE	EX	GE	WE	QT	Annual	Cum.	Annual	Cum.
2011	13	15	PWR	3394	25901	51	37	11	0	115	0	213	1639	118	911
			BWR	2006	15497	0	0	8	326	0	0	334	2579	186	1433
			TOTALS	5400	41398							547	4218	304	3168
2012	12	14	PWR	3798	29699	45	39	15	0	136	0	235	1874	118	937
			BWR	2202	17699	0	0	10	356	0	0	366	2945	183	1473
			TOTALS	6000	47398							602	4820	301	3469
2013	10	13	PWR	3815	33514	50	39	15	0	132	0	236	2111	118	1055
			BWR	2185	19884	0	0	13	351	0	0	364	3309	182	1655
			TOTALS	6000	53398							600	5420	300	3769
2014	10	11	PWR	3821	37335	50	38	10	0	139	0	237	2348	118	1174
			BWR	2178	22062	0	0	6	353	0	0	359	3668	179	1834
			TOTALS	6000	59397							596	6016	298	4067
2015	9	11	PWR	3645	40980	41	33	12	0	138	0	224	2572	112	1286
			BWR	2355	24417	0	0	18	372	0	0	390	4058	195	2029
			TOTALS	6000	65397							614	6630	307	4374
2016	8	10	PWR	3419	44399	35	32	13	0	129	0	209	2781	104	1390
			BWR	2581	26998	0	0	0	426	0	0	426	4484	213	2242
			TOTALS	6000	71397							635	7265	318	4692
2017	8	9	PWR	3625	48024	31	21	9	0	156	0	217	2998	108	1499
			BWR	2375	29873	0	0	0	391	0	0	391	4876	196	2438
			TOTALS	6000	77397							608	7873	304	4996
2018	7	9	PWR	3920	51944	42	35	14	0	149	0	241	3238	120	1619
			BWR	2080	31453	0	0	0	341	0	0	341	5216	170	2608
			TOTALS	6000	83397							581	8455	291	5286
2019	7	8	PWR	3510	55454	20	25	0	0	163	0	208	3446	104	1723
			BWR	2490	33943	0	0	0	402	0	0	402	5618	201	2809
			TOTALS	6000	89397							610	9065	305	5592
2020	6	8	PWR	3804	59257	20	20	0	0	183	0	224	3670	112	1835
			BWR	2196	36139	0	0	0	359	0	0	359	5978	180	2989
			TOTALS	6000	95396							583	9648	291	5883
2021	6	7	PWR	3774	63032	19	24	0	0	182	0	225	3895	113	1948
			BWR	2226	38865	0	0	0	364	0	0	364	6342	182	3171
			TOTALS	6000	101396							589	10237	295	6178
2022	6	7	PWR	2406	65438	9	9	0	0	124	0	142	4037	38	1083
			BWR	1694	40058	0	0	0	277	0	0	277	6619	74	1776
			TOTALS	4100	105496							419	10656	112	6290
2023	6	7	PWR	2004	67441	7	10	0	0	102	0	119	4156	0	0
			BWR	996	41054	0	0	0	164	0	0	164	6783	0	0
			TOTALS	3000	108496							283	10939	0	6290

Table 5.14. (Cont'd.)

Year	Cooling Fuel		Metric Tons Annual Cum.	Canisters by Fuel Vendor							Canisters		Repository No. 1		
	MNY	MXV		Type	BW	CE	EX	GE	HE	OT	Annual	Cum.	Annual	Cum.	
2024	7	7	PWR	1783	69225	5	6	0	0	94	0	104	4261	0	0
			BWR	1217	42271	0	0	0	200	0	0	200	6983	0	0
			TOTALS	3000	111496							305	11244	0	6290
2025	7	8	PWR	1791	71016	5	5	0	0	95	0	106	4366	0	0
			BWR	1208	41479	0	0	0	199	0	0	199	7182	0	0
			TOTALS	3000	114495							304	11548	0	6290

Table 5.15. Canisters of Non-Fuel Waste for Repository Disposal, Mid-Range Estimate

Year	Cooling Fuel		Type	Metric Tons		Canisters by Fuel Vendor						Canisters		Repository No.	
	MMY	MXV		Annual	Cum.	BW	CE	EX	GE	WE	OT	Annual	Cum.	Annual	Cum.
1998	25	28	PWR	173	173	10	0	0	0	7	0	16	16	16	16
			BWR	227	227	0	0	0	55	0	1	56	56	56	56
			TOTALS	400	400								73	73	73
1999	25	26	PWR	213	386	3	3	0	0	14	0	19	35	19	35
			BWR	187	414	0	0	0	44	0	3	46	103	46	103
			TOTALS	400	800								65	138	65
2000	25	26	PWR	226	613	2	16	0	0	2	0	20	56	20	56
			BWR	173	587	0	0	0	43	0	3	45	148	45	148
			TOTALS	400	1200								66	204	66
2001	24	26	PWR	449	1061	9	2	0	0	22	1	35	90	35	90
			BWR	451	1038	0	0	0	105	0	0	105	254	105	254
			TOTALS	900	2099								140	344	140
2002	24	25	PWR	1053	2115	24	18	2	2	39	1	85	175	85	175
			BWR	746	1785	0	0	10	158	0	18	185	439	185	439
			TOTALS	1800	3899								271	614	271
2003	22	25	PWR	1760	3875	35	23	7	0	74	0	138	314	138	314
			BWR	1240	3024	0	0	7	287	0	2	295	734	295	734
			TOTALS	3000	6899								433	1048	433
2004	21	23	PWR	1911	5786	36	25	17	0	70	0	147	461	147	461
			BWR	1089	4113	0	0	11	252	0	0	263	997	263	997
			TOTALS	3000	9899								410	1458	410
2005	19	22	PWR	1948	7734	31	26	16	0	75	0	149	610	149	610
			BWR	1052	5165	0	0	11	253	0	0	264	1261	264	1261
			TOTALS	3000	12899								412	1871	412
2006	18	20	PWR	2380	10113	35	45	13	0	90	0	183	792	140	609
			BWR	1520	6685	0	0	10	360	0	0	370	1631	285	1255
			TOTALS	3900	16799								553	2424	425
2007	17	19	PWR	3079	13192	35	39	21	0	136	0	231	1023	144	639
			BWR	1721	8406	0	0	17	403	0	0	420	2052	263	1282
			TOTALS	4800	21599								651	3075	407
2008	16	18	PWR	3081	16273	47	45	13	0	130	0	235	1258	147	786
			BWR	1719	10125	0	0	11	409	0	0	420	2471	262	1544
			TOTALS	4800	26398								655	3729	409
2009	15	17	PWR	3059	19333	40	43	14	0	135	0	232	1490	145	931
			BWR	1740	11866	0	0	12	413	0	0	424	2895	265	1810
			TOTALS	4800	31198								656	4385	410
2010	14	16	PWR	3175	22508	47	44	18	0	133	0	241	1731	151	1082
			BWR	1625	13490	0	0	11	386	0	0	397	3292	248	2057
			TOTALS	4800	35998								638	5023	399

NOTES: MMY = minimum years cooled
 MXV = maximum years cooled
 BW = Babcock and Wilcox
 CE = Combustion Engineering
 EX = Exxon
 GE = General Electric
 WE = Westinghouse
 OT = other

Table 5.15. (Cont'd.)

Year	Cooling Fuel		Metric Tons	Canisters by Fuel Vendor								Canisters		Repository No. 1	
	MNY	MXV		Type	Annual	Cum.	BW	GE	EX	GE	NE	QT	Annual	Cum.	Annual
2011	13	15	PWR	3394	25901	57	47	13	0	142	0	259	1990	144	1106
			BWR	2006	15497	0	0	11	479	0	0	490	3782	272	2101
			TOTALS	5400	41398							748	5772	416	4337
2012	12	14	PWR	3798	29699	50	50	18	0	169	0	287	2277	143	1138
			BWR	2202	17699	0	0	14	523	0	0	537	4318	268	2159
			TOTALS	6000	47398							824	6595	412	4748
2013	10	13	PWR	3815	33514	56	51	17	0	164	0	287	2564	144	1282
			BWR	2185	19884	0	0	18	515	0	0	533	4851	267	2426
			TOTALS	6000	53398							820	7416	410	5159
2014	10	11	PWR	3821	37335	56	48	12	0	172	0	288	2852	144	1426
			BWR	2178	22062	0	0	9	518	0	0	526	5378	263	2689
			TOTALS	6000	59397							814	8230	407	5566
2015	9	11	PWR	3645	40980	45	42	14	0	171	0	273	3125	137	1563
			BWR	2355	24417	0	0	27	545	0	0	572	5949	286	2975
			TOTALS	6000	65397							845	9075	422	5988
2016	8	10	PWR	3419	44399	39	41	16	0	160	0	255	3381	128	1690
			BWR	2581	26998	0	0	0	625	0	0	625	6575	313	3287
			TOTALS	6000	71397							880	9955	440	6428
2017	8	9	PWR	3625	48024	34	27	11	0	193	0	265	3646	133	1823
			BWR	2375	29373	0	0	0	574	0	0	574	7149	287	3574
			TOTALS	6000	77397							839	10795	420	6848
2018	7	9	PWR	3920	51944	47	46	16	0	185	0	293	3939	147	1970
			BWR	2080	31453	0	0	0	500	0	0	500	7648	250	3824
			TOTALS	6000	83397							793	11588	397	7245
2019	7	8	PWR	3510	55454	22	33	0	0	203	0	257	4196	128	2098
			BWR	2490	33943	0	0	0	590	0	0	590	8238	295	4119
			TOTALS	6000	89397							847	12434	423	7668
2020	6	8	PWR	3804	59257	22	26	0	0	227	0	276	4472	138	2236
			BWR	2196	36139	0	0	0	527	0	0	527	8765	263	4382
			TOTALS	6000	95396							802	13237	401	8069
2021	6	7	PWR	3774	63032	21	31	0	0	226	0	278	4750	139	2375
			BWR	2226	38365	0	0	0	534	0	0	534	9299	267	4650
			TOTALS	6000	101396							812	14049	406	8475
2022	6	7	PWR	2406	65438	10	11	0	0	154	0	175	4925	47	1321
			BWR	1694	40058	0	0	0	407	0	0	407	9706	109	2604
			TOTALS	4100	105496							582	14630	156	8631
2023	6	7	PWR	2004	67441	8	13	0	0	126	0	147	5072	0	0
			BWR	996	41054	0	0	0	240	0	0	240	9946	0	0
			TOTALS	3000	108496							388	15018	0	8631

Table 5.15. (Cont'd.)

Year	Cooling Fuel		Metric Tons	Canisters by Fuel Vendor								Canisters		Repository No. 1	
	MNY	MOY		Type	Annual	Cum.	BW	CE	EX	GE	WE	QT	Annual	Cum.	Annual
2024	7	7	PWR	1783	69225	6	7	0	0	116	0	129	5201	0	0
			BWR	1217	42271	0	0	0	294	0	0	294	10240	0	0
			TOTALS	3000	111496							423	15441	0	8631
2025	7	8	PWR	1791	71016	6	7	0	0	118	0	131	5332	0	0
			BWR	1208	43479	0	0	0	291	0	0	291	10531	0	0
			TOTALS	3000	114495							422	15863	0	8631

Table 5.16. Canisters of Non-Fuel Waste for Repository Disposal, High-Range Estimate

Year	Cooling		Fuel Type	Metric Tons		Canisters by Fuel Vendor						Canisters		Repository No. 1	
	MMY	MXV		Annual	Cum.	BW	CE	EX	GE	WE	OT	Annual	Cum.	Annual	Cum.
1998	25	28	PWR	173	173	11	0	0	0	8	0	18	18	18	18
			BWR	227	227	0	0	0	73	0	2	74	74	74	74
TOTALS				400	400							93	93	93	93
1999	25	26	PWR	213	386	3	3	0	0	16	0	22	40	22	40
			BWR	187	414	0	0	0	58	0	3	61	135	61	135
TOTALS				400	800							83	176	83	176
2000	25	26	PWR	226	613	2	19	0	0	3	0	24	64	24	64
			BWR	173	587	0	0	0	56	0	4	60	195	60	195
TOTALS				400	1200							84	260	84	260
2001	24	26	PWR	449	1061	10	2	0	0	26	1	40	104	40	104
			BWR	451	1038	0	0	0	139	0	0	139	334	139	334
TOTALS				900	2099							179	438	179	438
2002	24	25	PWR	1053	2115	26	21	2	2	45	1	98	202	98	202
			BWR	746	1785	0	0	13	208	0	23	244	578	244	578
TOTALS				1800	3899							342	780	342	780
2003	22	25	PWR	1760	3875	39	27	7	0	86	0	159	361	159	361
			BWR	1240	3024	0	0	9	378	0	2	389	967	389	967
TOTALS				3000	6899							548	1328	548	1328
2004	21	23	PWR	1911	5786	39	30	19	0	81	0	169	530	169	530
			BWR	1089	4113	0	0	15	332	0	0	347	1314	347	1314
TOTALS				3000	9899							515	1843	515	1843
2005	19	22	PWR	1948	7734	34	32	17	0	88	0	171	700	171	700
			BWR	1052	5165	0	0	15	333	0	0	347	1661	347	1661
TOTALS				3000	12899							518	2361	518	2361
2006	18	20	PWR	2380	10113	39	53	14	0	104	0	211	911	162	701
			BWR	1520	6685	0	0	13	475	0	0	488	2149	375	1653
TOTALS				3900	16799							698	3060	537	2899
2007	17	19	PWR	3079	13192	38	46	23	0	158	0	266	1177	166	736
			BWR	1721	8406	0	0	22	532	0	0	553	2702	346	1689
TOTALS				4800	21599							820	3879	512	3411
2008	16	18	PWR	3081	16273	52	54	14	0	151	0	271	1448	169	905
			BWR	1719	10125	0	0	14	539	0	0	553	3255	345	2034
TOTALS				4800	26398							824	4703	515	3925
2009	15	17	PWR	3059	19333	44	52	16	0	157	0	267	1715	167	1072
			BWR	1740	11866	0	0	15	544	0	0	559	3814	349	2384
TOTALS				4800	31198							826	5529	516	4442
2010	14	16	PWR	3175	22508	52	52	19	0	155	0	278	1993	174	1246
			BWR	1625	13490	0	0	14	509	0	0	522	4336	377	2710
TOTALS				4800	35998							800	6329	500	4942

NOTES: MMY = minimum years cooled
 MXV = maximum years cooled
 BW = Babcock and Wilcox
 CE = Combustion Engineering

EX = Exxon
 GE = General Electric
 WE = Westinghouse
 OT = Other

Table 5.16. (Cont'd.)

Year	Cooling Fuel			Metric Tons		Canisters by Fuel Vendor						Canisters		Repository No. 1	
	MNY	MXV	Type	Annual	Cum.	BW	CE	EX	GE	ME	QT	Annual	Cum.	Annual	Cum.
2011	13	15	PWR	3394	25901	62	57	14	0	165	0	298	2291	166	1273
			BWR	<u>2006</u>	<u>15497</u>	0	0	14	631	0	0	<u>645</u>	<u>4981</u>	<u>358</u>	<u>2767</u>
TOTALS				5400	41398							943	7272	524	5466
2012	12	14	PWR	3798	29699	55	60	19	0	196	0	331	2622	165	1311
			BWR	<u>2202</u>	<u>17699</u>	0	0	18	689	0	0	<u>707</u>	<u>5688</u>	<u>354</u>	<u>2844</u>
TOTALS				6000	47398							1038	8310	519	5985
2013	10	13	PWR	3815	33514	61	60	19	0	191	0	331	2953	166	1476
			BWR	<u>2185</u>	<u>19884</u>	0	0	23	679	0	0	<u>702</u>	<u>6390</u>	<u>351</u>	<u>3195</u>
TOTALS				6000	53398							1033	9343	517	6501
2014	10	11	PWR	3821	37335	62	58	13	0	200	0	332	3285	166	1643
			BWR	<u>2178</u>	<u>22062</u>	0	0	11	682	0	0	<u>692</u>	<u>7084</u>	<u>347</u>	<u>3542</u>
TOTALS				6000	59397							1026	10369	513	7014
2015	9	11	PWR	3645	40980	50	50	16	0	199	0	315	3600	158	1800
			BWR	<u>2355</u>	<u>24417</u>	0	0	34	719	0	0	<u>753</u>	<u>7837</u>	<u>376</u>	<u>3918</u>
TOTALS				6000	65397							1068	11437	534	7548
2016	8	10	PWR	3419	44399	43	49	17	0	185	0	294	3895	147	1947
			BWR	<u>2581</u>	<u>26998</u>	0	0	0	824	0	0	<u>824</u>	<u>8661</u>	<u>412</u>	<u>4330</u>
TOTALS				6000	71397							1119	12555	559	8108
2017	8	9	PWR	3625	48024	37	33	12	0	224	0	306	4201	153	2100
			BWR	<u>2375</u>	<u>29873</u>	0	0	0	757	0	0	<u>757</u>	<u>9417</u>	<u>378</u>	<u>4709</u>
TOTALS				6000	77397							1063	13618	531	8639
2018	7	9	PWR	3920	51944	52	54	18	0	215	0	339	4539	169	2270
			BWR	<u>2080</u>	<u>31453</u>	0	0	0	659	0	0	<u>659</u>	<u>10076</u>	<u>329</u>	<u>5038</u>
TOTALS				6000	83397							997	14616	499	9138
2019	7	8	PWR	3510	55454	24	39	0	0	235	0	298	4838	149	2419
			BWR	<u>2490</u>	<u>33943</u>	0	0	0	777	0	0	<u>777</u>	<u>10854</u>	<u>389</u>	<u>5427</u>
TOTALS				6000	89397							1075	15691	538	9675
2020	6	8	PWR	3804	59257	25	31	0	0	264	0	319	5157	160	2579
			BWR	<u>2196</u>	<u>36139</u>	0	0	0	694	0	0	<u>694</u>	<u>11548</u>	<u>347</u>	<u>5774</u>
TOTALS				6000	95396							1014	16705	507	10182
2021	6	7	PWR	3774	63032	24	37	0	0	262	0	322	5479	161	2740
			BWR	<u>2226</u>	<u>38365</u>	0	0	0	704	0	0	<u>704</u>	<u>12252</u>	<u>352</u>	<u>6126</u>
TOTALS				6000	101396							1026	17731	513	10696
2022	6	7	PWR	2406	65438	11	13	0	0	179	0	203	5682	54	1525
			BWR	<u>1694</u>	<u>40058</u>	0	0	0	536	0	0	<u>536</u>	<u>12788</u>	<u>144</u>	<u>3431</u>
TOTALS				4100	105496							739	18471	198	10894
2023	6	7	PWR	2004	67441	9	16	0	0	146	0	171	5853	0	0
			BWR	<u>996</u>	<u>41054</u>	0	0	0	317	0	0	<u>317</u>	<u>13105</u>	<u>0</u>	<u>0</u>
TOTALS				3000	108496							488	18958	0	10894

Table 5.16. (Cont'd.)

Year	Cooling Fuel		Metric Tons	Canisters by Fuel Vendor							Canisters		Repository No. 1		
	MY	MX		Type	Annual	Cum.	BW	CE	EX	GE	WE	QT	Annual	Cum.	Annual
2024	7	7	PWR	1783	69225	6	9	0	0	135	0	150	6003	0	0
			BWR	1217	42271	0	0	0	387	0	0	387	13492	0	0
			TOTALS	3000	111496							537	19495	0	10894
2025	7	8	PWR	1791	71016	6	8	0	0	137	0	151	6155	0	0
			BWR	1208	43479	0	0	0	384	0	0	384	13876	0	0
			TOTALS	3000	114495							535	20031	0	10894

disassembly waste decreases from 25 to 28 years at startup of the first repository to 6 to 7 years when the first repository is filled (62,000 MTU of commercial spent fuel plus 8,000 MTU-equivalent of defense high-level waste).

The number of canisters of non-fuel wastes are shown by vendor in columns 7 through 12. The vendors include Babcock and Wilcox, Combustion Engineering, Exxon, General Electric, Westinghouse, and a sixth category referred to as "others". The "others" category includes the small quantities of fuel manufactured by Gulf-United Nuclear, Allis Chalmers, Nuclear Fuel Services, and United Nuclear. The non-fuel wastes from these vendors were assumed to have the same characteristics as Westinghouse fuel for PWR fuels and General Electric fuel for BWR fuels. Likewise, the generic reactors added to meet the growth projection requirements were assumed to have the characteristics of Westinghouse and General Electric fuel for PWR and BWR fuel, respectively.

The total annual and cumulative number of canisters for repository disposal are shown in columns 13 and 14, respectively. The annual and cumulative number of canisters for just the first repository are shown in columns 15 and 16. These two sets are identical until the second repository starts up in 2006.

For the low-range estimate (Table 5.14) and after the first five-year startup period the first repository receipt rates range from 291 to 318 canisters per year. The comparable rates for the mid-range estimates (Table 5.15) range from 399 to 433 canisters per year. For the high-range estimates these values range from 499 to 559 canisters per year. Thus the uncertainty in basic quantities and volume of waste as illustrated by the difference between these three cases (25 to 30%) is greater than the year-to-year annual rate variations of approximately $\pm 10\%$ within each case.

Based on these results, the receiving and emplacement capabilities of the first repository should be designed to handle up to 600 of these canisters per year. However, for system planning purposes and life cycle cost estimates a receipt rate on the order of 425 canisters per year would be appropriate.

6.0 PROPOSED ACCEPTANCE REQUIREMENTS FOR SPENT FUEL DISASSEMBLY HARDWARE AND NON-FUEL ASSEMBLY COMPONENTS AT A GEOLOGIC REPOSITORY

This section presents proposed requirements applicable to acceptance of non-fuel wastes (both non-fuel-assembly components and spent fuel disassembly hardware) at a repository. The requirements apply specifically to the waste form and primary or innermost waste package (canister) for acceptance at a repository. Depending on the repository media, an additional overpack container and possibly some backfill material may be required to provide long term corrosion resistance and structural stability. This section also suggests ways in which waste producers could certify that their wastes meet each of the proposed waste acceptance requirements.

The approach to establishing the proposed waste acceptance requirements consisted of the following steps. The first step was to develop a list of technical areas in which waste acceptance requirements were needed to adequately protect the health and safety of the public and waste handling personnel. This list was compiled primarily from the waste acceptance requirements developed by others (Westinghouse 1984, ONWI 1983a, Randklev, et al. 1983, and Oversby, 1984). The technical areas were then categorized as either waste form requirements or packaged waste requirements. The purpose of each requirement was established based on information in the above documents and then, if it was applicable to acceptance of non-fuel waste at a repository, was retained for further development. The final list of technical areas and the purpose for a requirement in each area is presented in Figure 6.1.

The proposed non-fuel waste acceptance requirements were primarily based on information in the literature and on regulations promulgated by the Department of Transportation (DOT), Nuclear Regulatory commission (NRC) and Environmental Protection Agency (EPA). The principal references used to establish the proposed requirements were Westinghouse (1984), ONWI (1983a), Randklev, et al. (1983) and Oversby (1984). These requirements were adapted, where necessary, to address the concerns related to disposal of non-fuel waste. The Federal regulatory requirements used to develop the proposed requirements are listed below:

Figure 6.1. Purpose of Each Non-Fuel Component Waste Acceptance Requirement

- 10 CFR Part 20 - Standards for Protection Against Radiation, U.S. Nuclear Regulatory Commission.
- 10 CFR Part 50 - Appendix B--Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants, U.S. Nuclear Regulatory Commission.
- 10 CFR 60 - Disposal of High-Level Radioactive Wastes in Geologic Repositories, Technical Criteria, Final Rule. U.S. Nuclear Regulatory Commission, Federal Register Vol. 48, No. 120, June 21, 1983.
- 10 CFR Part 71 - Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions, U.S. Nuclear Regulatory Commission.
- 49 CFR Part 173 - Shippers--General Requirements for Shipments and Packagings, U.S. Department of Transportation.
- 40 CFR 191 - Environmental Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes, U.S. Environmental Protection Agency, proposed rule, 1982.

Development of the waste acceptance requirements for non-fuel waste was closely coordinated with development of the TRU waste acceptance requirements in a companion report (Daling, et al. 1985). The proposed requirements presented here were initially developed for TRU wastes and were then modified or adjusted to address these non-fuel wastes. In many cases, the purpose of the non-fuel waste requirement as well as the proposed requirement is identical to the corresponding TRU waste acceptance requirement. The principal reason for this is because remote-handled TRU waste and non-fuel waste will likely be handled by the same waste handling systems at the repository. In other cases, adjustments to the TRU waste requirements were needed to address the concerns related to disposal of non-fuel waste.

Suggested methods for waste producers to certify that their wastes meet these acceptance requirements were also developed. Most of this information was based on efforts in the defense TRU waste program to certify CH-TRU wastes for disposal at the WIPP. It is assumed that all waste producers will be required

to perform a detailed characterization of the quantities and properties of the non-fuel waste generated at their facilities. This waste characterization will include assessments of the chemical, physical, and radiological properties of each distinctly separate waste form that will be produced. The detailed characterization must also describe any treatment processes that will be used, the effects of treatment on the waste form and waste package, and the properties of the treated waste form. Waste producers will then be required to describe the controls that will be used to ensure that their wastes meet all of the acceptance requirements. Collectively, this information can be called a "Waste Certification Plan." A description of a conceptual waste certification plan is presented in the companion TRU waste document (Daling, et al. 1985).

The next section of this report describes and discusses the proposed requirements in each of the technical areas shown on Figure 6.1. The format for these requirements includes sections for a statement of the requirement, a discussion of the objectives and bases of the requirement, and a section on how waste producers can certify that their wastes meet each requirement ("Assuring Compliance"). Acceptance and certification requirements for packaged non-fuel waste are presented in Section 6.1 and for non-fuel waste forms are presented in Section 6.2. Some additional technical areas that were considered but dismissed because they were not applicable to non-fuel waste are discussed in Section 6.3. A summary of the proposed requirements is shown in Figure 6.2.

6.1 PROPOSED ACCEPTANCE REQUIREMENTS FOR WASTE PACKAGE

The proposed requirements for disposal of packaged non-fuel waste are presented in the section.

6.1.1 Classification

Requirement

Fuel assembly components separated from the spent fuel assemblies during fuel consolidation and other non-fuel waste such as control rods and burnable poison rod components that may be packaged separately from the fuel for repository disposal shall be classed as non-fuel waste, Class NS-2.

Figure 6.2. Summary of Proposed Non-Fuel Component Waste Acceptance Requirements for Repository Disposal

Discussion

Appendix E of 10 CFR 961 provides for the classification of "Standard Fuel" and several categories of "Non-standard Fuel" as well as "Failed Fuel" for purposes of identification and characterization when delivered to DOE by a utility for disposal. Non-fuel waste separated from the fuel assemblies are classed as Class NS-2. Although it is not necessarily the intent of this regulation that this classification be maintained for repository disposal there is no obvious reason to introduce an additional classification for purposes of disposal. Thus it appears appropriate to retain the NS-2 classification for repository disposal of these non-fuel waste.

Assuring Compliance

It will be necessary for waste producers to accurately describe the contents of each waste canister and to certify that the documentation related to each waste package is accurate. This will be accomplished primarily through administrative controls, such as instructing operators to prepare a waste-form check list that describes the materials placed in each waste canister and instructing operators not to load non-fuel waste into canisters intended for loose fuel rods. Compliance with this specification could also be demonstrated using X-ray real-time radiography.

6.1.2 Documentation

Requirement

Complete documentation and detailed descriptions of the non-fuel waste shall precede delivery to the repository by a minimum of 60 days and shall also accompany the shipment of nuclear waste materials. Canisters of non-fuel waste shall not contain spent fuel and shall provide the following data pertaining to each waste package:

- Identification number of waste package, color code
- Name of waste producer (origin of waste materials)
- Date of packaging
- Prior storage time
- Description and quantity of contents:
 - Description (end fittings, number of assemblies, etc.)
 - Materials (types and weights)

- Routine and special handling requirements
- Certification of irradiation, temperature, and storage history
- Irradiation history
- Container description and specification number
- Description of unusual operating conditions experienced by contained components
- Weight
- Maximum surface dose rate
- Composition (Chemical and Radiochemical quantities)
- Proposed shipment date (on documents that precede shipment)
- Actual shipment date and carrier
- Certification that waste form meets all process control specifications
- Certification that canister meets design specifications and regulatory requirements
- Certification of compliance with acceptance specifications contained herein
- Items of noncompliance with acceptance specifications
- Any other data routinely required or provided by transportation operations.

Discussion

Documentation is necessary to satisfy NRC requirements for nuclear material accountability and quality assurance requirements in 10 CFR 50 for traceability as well as for conformance with written procedures for quality control. Rationale presented in the Labeling and Color Coding requirement address the need for package identification. Guidance for the subjects to be included in such documentation is presented in the standard contract for waste acceptance, 10 CFR 961.11, VI, A2(a), which states:

"Purchaser shall provide to DOE a detailed description of the SNF and/or HLW to be delivered hereunder in the form and content as set forth in Appendix F, annexed hereto and made a part hereof. Purchaser shall promptly advise DOE of any changes in said SNF and/or HLW as soon as they become known to the purchaser."

Appendix F in 10 CFR 961 indicates the types of details needed and a requirement that this information must be received no later than 60 days before the scheduled transportation date.

Documentation needs stated in this requirement are also based on a number of sources of proposed criteria within the waste management program [DOE (1981);

ONWI (1983a); Randklev, et al. (1983), and Ross, et al.^(a)] and are applicable acceptance conditions throughout the waste management system.

Assuring Compliance

A data package with the requested information or a completed DOE form will be developed for the presentation of the information in a standardized format. The producer will be required to certify that the data package is correct.

6.1.3 Labeling and Color Coding

Requirement

The waste package (drum, canister, container) shall be labeled in code with characters at least 8.75 cm in dimension and 17 mm thickness that contrast with their surroundings to uniquely identify the contained waste and provide a means of relating it to the records supplied prior to the arrival of the waste. The character sequence shall signify the Waste Source (code must include sufficient information to uniquely identify each package; TBD) and the surface dose rate.

The waste canister shall be consistently color-coded, with two, 2-inch wide bands around its diameter or width, to identify the surface dose rate. Coding shall be as follows: $<10^2$ R/hr (white/blue), 10^2 - 10^3 R/hr (white/yellow), 10^3 - 10^4 R/hr (white/orange), $>10^4$ R/hr (white/red). The color bands may be painted, etched, affixed by a separate color band, or applied by other suitable means.

The label and color code shall not adversely affect the performance of the canister, shall remain permanently affixed, shall be made of a non-interacting material, and shall have a minimum functional lifetime as specified in the container durability criterion.

(a) Ross, W. A., et al. 1984. Draft Acceptability Specifications for Disposal of High-Level Waste Solidified as Borosilicate Glass. Draft Report, Pacific Northwest Laboratory, Richland, Washington.

Discussion of Labeling

This criterion is based on a number of sources within the waste management program [Westinghouse (1984); DOE (1981); ONWI (1983a); Randklev, et al. (1983); Ross, et al.^(a)] and are applicable acceptance requirements throughout the waste management system. Package identification is necessary for material management to assure traceability and satisfy quality assurance requirements.

The proposed character size is conservatively large (in comparison with the sizes proposed by others) to provide easy identification by workers and will provide visibility by the eye at 20' with vision of no more than 20/200. Vision of 20/200 is defined as that necessary to identify characters 8.75 cm in dimension with a thickness that subtends an arc of 16 minutes of angle (17 mm). These size specifications provide a basis for relating the character size to the vision necessary for identification.

It is anticipated (by inference to identification and information requirements for spent fuel promulgated in Appendix E of 10 CFR 961) that identification and other information requirements will be needed for labeling containers of non-fuel waste. This subject matter is also addressed in 10 CFR 60 for HLW, as follows:

"Unique Identification. A label or other means of identification shall be provided for each waste package. The identification shall not impair the integrity of the waste package and shall be applied in such a way that the information shall be legible at least to the end of the period of retrievability. Each waste package identification shall be consistent with the waste package's permanent written records."

The proposed labeling is consistent with these other labeling requirements.

Discussion of Color Coding

To assure appropriate waste handling and the safety of personnel, radiation levels of the waste canisters must be established. Once the radiation levels of the packages are established and coded, unnecessary reevaluation will be eliminated. Regulations applicable to operators handling these wastes require

(a) Ross, W. A., et al. 1984. Draft Acceptability Specifications for Disposal of High-Level Waste Solidified as Borosilicate Glass. Draft Report, Pacific Northwest Laboratory, Richland, Washington.

that the whole body dose to personnel not exceed 5 R/yr and that radiation exposures meet ALARA requirements.

Personnel exposures from operations will depend upon the radiation dose from each waste canister, the designs of waste handling of facilities, and the handling procedures. Relatively high dose rate wastes may be strategically positioned to take advantage of shielding from other waste packages. In general, segregation of wastes with high dose rates may be necessary to allow maximum freedom for personnel access that is consistent with acceptable levels of dose accumulation as well as minimizing exposures. Color coding will provide a visual warning to alert personnel of the magnitude of the hazard as well as to quickly identify the correct location for waste emplacement.

Assuring Compliance

Detailed specifications on appropriate labeling and color-coding requirements are expected to be established by the DOE. A standardized system of labeling and color-coding should be developed to ensure compatibility of waste canister identification systems among the various facilities of the waste management system. Accelerated durability testing of alternative labeling and color-coding concepts may be necessary to assure their expected lifetimes in a repository environment are consistent with the stated requirements. Producers will be required to use approved concepts for application of labels and color-coding to waste containers. Administrative controls are necessary for assuring that accurate labeling and color-coding is applied to each waste canister. For example, radiation dose rate measurements are required for each waste canister. The appropriate color-coding should be applied to the waste canister as soon as practical after the dose rate is measured. This will help to assure that the color-coding applied to each waste canister is accurate.

6.1.4 Maximum Dimensions, Weight, Geometry Requirement

For receipt at a repository, non-fuel waste shall be packaged within standardized cylindrical steel canisters. Maximum external dimensions of the canisters shall be approximately 66 cm OD by 450 cm long (26" OD x 180" long).

The maximum weight of loaded canisters shall be approximately 6,000 kg (13,200 lb).

Discussion

The purpose of this requirement is to ensure that waste generators produce waste canisters that are compatible with the repository receiving and handling facilities. Current plans include the potential for shredding spent fuel hardware into drums. The most commonly used type of drum is the 55-gallon steel drum. For this reason, the waste canister is sized to accommodate stacked 55-gallon drums within the canister. This packaging would be accomplished prior to delivery to the repository. Alternatively, non-fuel waste may be loaded, with or without treatment, directly into the larger waste canisters. Use of standardized waste containers will increase handling efficiency at the repository, and possibly improve storage efficiency. The canisters of non-fuel waste will be remote-handled and must be lifted from the top to be compatible with waste handling facilities. Thus, the maximum canister height must include an allocation for a lifting device.

The maximum allowable dimensions and weights of waste canisters were obtained from DOE (1984) and from reviews of repository and MRS facility designs. The review indicated that the designs of waste handling facilities are not far enough along to provide firm details on sizes and capacities of waste handling equipment. A review of the MRS facility design indicated that the maximum allowable weight for canisters and drums is 5,000 kg (11,000 lb) and 637 kg (1,400 lb), respectively, and the maximum dimensions for canisters and drums is 61 cm OD x 450 cm long (24" OD by 180" long) and 61 cm OD x 92 cm long (24" OD x 36" long). It is assumed here that the canister OD can be increased to 66 cm (26 inches) to allow accommodation of 55-gallon drums.

Assuring Compliance

The designs of the MRS facility, repository, and waste producers must be coordinated. Additional research is needed to establish the most cost-effective canister design. After this is done, all waste generators can be required to use canisters of the established size.

Administrative controls and control of purchase orders is all that is deemed necessary to ensure compliance with this specification. The control of purchase orders, including surveillance of vendors and their supplies, will be performed by the waste packager. All waste canisters will be inspected at the source or upon receipt of the waste packaging facilities. The surveillance procedures and results as well as the results of inspections of the waste canisters will be documented. These procedures should ensure that waste canisters meet the applicable specifications.

6.1.5 Handling Features

Requirement

Remote-handled waste canisters of non-fuel waste shall be provided with a standardized axial lifting pintle whose design has been approved by the receiving facility and the waste producers or packagers.

Discussion

Remote handled wastes must be handled when they are within specially-designed shielded hot cells, transfer casks, or transportation casks. This equipment will only handle standardized waste canisters because of difficulties in repetitively changing connectors and handling attachments, e.g., handling attachments on cranes, in a remote environment.

Remote handled waste facilities will be designed to handle the waste canisters in a vertical orientation; also, conceptual designs of transfer casks and transportation casks typically incorporated top-loading features. Thus the canisters must be designed to be lifted from the top. This has been accomplished in the past through incorporation of an axial lifting pintle. The lifting pintle should be of a standardized design that is used throughout the waste management system, i.e., waste generators, MRS and repository facilities. This would preclude the need for several different lifting attachments for remote-handled canisters at these facilities. Therefore, MRS and repository operators will require waste generators to provide remote-handled waste canisters that are compatible with their lifting equipment. Canisters for all types of remote-handled wastes, including spent fuel, HLW, and TRU waste should incorporate the same design of lifting pintle. Furthermore, coordination of the design of the waste package and the designs of the waste handling systems,

i.e., at the MRS facility and repository, should be undertaken to ensure that no mismatches occur.

Assuring Compliance

It is anticipated that repository operators will issue detailed specifications regarding lifting attachments and waste canister handling features after detailed designs of the facilities are completed. Alternatively, waste producers may generate their own designs which would then be subject to review and approval by the DOE and waste producers/packagegers. At this time, these specifications have not been developed. After the specifications are developed, it will be the responsibility of the waste generators to ensure that their waste canisters are compatible with the repository handling facilities.

Waste generators are expected to obtain fabricated waste canisters from qualified vendors. Administrative controls and inspections of the vendors and their products are needed to ensure that these requirements are met. The waste generators will perform surveillance audits and will visually inspect each waste canister. The inspections may be performed at the vendor's facility or at the waste generator's facility. The results of the surveillance audits and inspections shall be documented.

6.1.6 Surface Dose Rate

Requirement

The radiation level of a canister of non-fuel waste shall not exceed a gamma surface dose rate of 1×10^5 R/hr.

Discussion

The purpose of this requirement is to define the maximum radiation level for which shielding and handling equipment must be designed to assure personnel safety. Although the radiation level for non-fuel waste (hardware, cladding, etc.) associated with the spent fuel is not expected to approach that estimated for spent fuel, potential volume reduction techniques for these components will concentrate the waste and increase radiation doses. It is important that these doses do not exceed the safety design basis of the facility.

The waste acceptance requirement in this area is based on the waste type that is expected to deliver the highest radiation dose rate to the repository. Current plans call for disposal (and/or interim storage) of spent nuclear fuel, which will be the highest dose rate material received at the repository.

The reference spent fuel waste package conceptual designs for salt and tuff include inner canisters that contain the rods from 6 PWR or 18 PWR assemblies (Westinghouse 1983b and 1983c). The gamma surface dose rate of these canisters is estimated at approximately $1 \times 10^{+5}$ R/hr. These canister capacities are approximately two times the capacities of the inner canister of the reference basalt waste package (Westinghouse 1982) and the design criteria for the potential MRS facility where consolidated canisters include the rods from either 3 PWR or 7 BWR assemblies. (However, the MRS FDC (PNL 1984) indicates that shielding design will be based on a maximum surface radiation level of 1×10^5 R/hr).

The radiation intensity is based on PWR fuel with an initial uranium content of 0.46 MTU, a 3.2 wt% enrichment, and an exposure of 33,000 MWd/MTU and BWR fuel with an initial uranium content of 0.19 MTU, a 2.75 wt% enrichment, and exposures of 28,000 MWd/MTU. The assemblies are assumed to be ten years out of reactor. The gamma radiation intensity represents a preliminary acceptance requirement, and is subject to change when results of detailed analyses of the waste management system determine the most cost-effective configuration for spent fuel. However, this intensity is believed to represent a reasonable approximation of the upper radiation dose rate limits for the designs of waste handling facilities.

Assuring Compliance

The waste producer will be required to certify that the surface dose rates of their waste canisters are below the acceptable limits. This can be accomplished by a combination of administrative controls and nondestructive tests. Administrative controls will track the contents of each canister as it proceeds through the waste producer's facility. Surface dose rate measurements will also be taken prior to the release of each waste canister from the producer's facility. The purpose of these measurements will be to determine compliance with the above criteria, to obtain the information needed

for the Data Packages, and to facilitate color coding of waste canisters. Measurement equipment must be maintained in accordance with an approved calibration and maintenance plan.

6.1.7 Surface Contamination

Requirement

The level of radioactive contamination on the external surfaces of non-fuel waste canisters shall be kept as low as practical but shall not exceed 220 disintegrations/min/100 cm² for alpha activity and 2,200 disintegrations/min/100 cm² for beta-gamma. The method of measuring surface contamination levels shall be equivalent to the methods presented in 49 CFR 173.443.

Discussion

The external surfaces of waste canisters are often contaminated with low levels of radioactive materials. This radioactive contamination is difficult to avoid completely in a waste production or waste handling facility. Allowable surface contamination levels for shipping containers for off-site transport are specified by the Department of Transportation (DOT) in 49 CFR 173.433. DOT considers these levels adequate for transportation. These limits are stated in the requirement above and will not be repeated here.

The non-fuel waste canister to be shipped to commercial waste storage or disposal facilities will be handled using hot cells and shielded transfer equipment. Therefore, surface contamination of these waste canisters is not a direct problem. However, these facilities and components should be kept as "clean" (i.e., free of radioactive contamination) as possible to permit hands-on maintenance as long as practical and to prevent the buildup of contamination within shipping casks. Therefore, the maximum surface contamination levels of non-fuel waste canisters should be kept at or below the DOT limits.

Assuring Compliance

The waste producer and/or packager will be required to measure the removable (nonfixed) surface contamination levels of waste canisters before they are placed in a shipping cask for off-site transport. Procedures for measuring surface contamination will require smear sampling of the external surface of the waste canister as described in 49 CFR 173.443. These procedures

as well as the results of the measurements must be documented. The performance of the measurement procedures must be in accordance with an approved quality assurance plan. The results of these measurements must also be documented and the appropriate information must be recorded in each waste canister's Data Package.

6.1.8 Canister Durability

Requirement

Non-fuel waste canisters shall meet the requirements in 49 CFR 173 specified for a Type A package at the time of production and for a minimum of 110 years in air storage.

Discussion

The purpose of this requirement is to ensure that waste packages remain intact without showing indications of significant degradation (e.g., extensive external corrosion, visible failure of seal or container, contents spilled). To avoid having to repackage or overpack non-fuel waste canisters prior to repository disposal, the waste packages should remain intact during maximum potential producer (10 years) and MRS facility (100 years) storage. Routine overpacking or repackaging will be prevented if the functional lifetimes of waste canisters exceed these storage periods. Both the effects of air storage and any potential corrosion mechanism of the canister materials, including internal corrosion caused by the waste form, must be taken into consideration when demonstrating compliance with this requirement.

This requirement does not specify that waste canisters must remain intact for any length of time after emplacement at the repository. It is assumed here that repository operators will repackage or overpack wastes in more durable containers if waste packages are required to remain intact for a specified period of time, such as through the retrievability period.

Assuring Compliance

Proposed canister designs which have not already been certified as Type A shipping containers will be tested to show that they meet these requirements. Laboratory testing could be done to determine the anticipated degradation rate of each canister type in air storage. This information would be used to

show that proposed canisters will meet the canister durability requirements. Based on this information, the DOE or waste producer will establish appropriate fabrication specifications for vendors that will be fabricating waste canisters. The control of purchase orders, including surveillance of vendors and their supplies, will be used by waste producers to certify that the waste canisters are fabricated in accordance with the specifications. Limited visual inspections of waste canisters fabricated by vendors will be performed by the waste producer to identify potentially out-of-compliance waste canisters.

6.1.9 Impact Resistance

Requirement

Waste canisters shall remain leak tight (see Section 6.1.13) if dropped a minimum of one canister-length onto an unyielding surface. The canisters shall be oriented to produce the most severe damage during the drop.

Discussion

The purpose of this requirement is to ensure that waste canisters can withstand credible transportation and handling accidents without releasing their contents. The specified drop height is based on the highest expected lift of waste canisters during handling operations. The highest lift is approximately one canister length. This may occur if it is necessary to lift one canister over another, e.g., when one canister is in lag storage in a vertical position and a second canister must be lifted over it. In most cases this will not occur because designs of hot cell facilities should provide for recessed lag storage sleeves which protrude only a short distance above the floor of the hot cell. In other words, most of the length of the lag storage sleeve, and thus most of the length of the canister, is located below the floor of the hot cell. As a result a drop height of one canister length is considered to be adequate.

Assuring Compliance

Waste producers will be required to provide evidence that the waste canisters they plan to use can meet these specifications. In general, the producer will be required to produce experimental or analytical results that support the acceptance of their particular canister designs. This may be done by appropriate references to tests and analyses of waste canisters conducted

by the DOE. If the canister design is determined to be acceptable by the DOE, then that particular design will be considered acceptable for use. Thereafter that particular waste canister design will be considered acceptable if it is manufactured within appropriate specifications and is undamaged.

The waste producer will be required to verify, by implementation of a quality assurance program, that the waste canisters were fabricated in accordance with their design specifications and within dimensional tolerances. Administrative controls and control of purchase orders, such as inspection and surveillance of vendors, will be necessary to ensure compliance with fabrication specifications. Each waste canister will be inspected at the vendor's facility and/or upon its receipt and after packaging operations at the waste producer's facility. The surveillance procedures and results, as well as the results of inspections of the waste canisters, will be documented.

6.1.10 Fire Resistance

Requirement

Non-fuel waste canisters shall not be combustible and shall have sufficient burst strength to withstand in 800C fire for fifteen minutes duration without resulting in a breach.

Discussion

There is a low probability that waste canisters will be involved in a petroleum or electrical fire during transport and handling operations. Fires could potentially cause waste canisters to fail due to overpressurization or thermal degradation and could also contribute to the dispersal of contaminated materials from a breached canister. Therefore, a requirement in this area is needed to mitigate the effects of potential fires.

In the event of an accidental fire, the non-fuel waste canister must not act as a means of fire propagation by adding fuel to the fire and must have sufficient burst strength to resist a breach due to over-pressurization. NRC transportation regulations (10 CFR 71) require Type B shipping containers to be capable of withstanding the effects of an 800C fire for 30 minutes without releasing its contents. This particular choice of fire temperature and duration is representative of an extremely low probability but credible transportation

accident environment and considers the availability of fuel to sustain the fire and the availability of resources to extinguish it. Because of the interior location of the canister in the cask and because large quantities of fuel are not expected to be stored near waste canisters at waste management facilities and fire equipment is more readily available, the hypothetical fire would not be expected to last as long. Therefore, a fire duration of fifteen minutes is adequate and is in agreement with similar specifications for HLW canisters presented in BMI/ONWI-521 (ONWI 1983a) and ONWI-462 (ONWI 1983b).

Assuring Compliance

The waste producer will be required to demonstrate the capability of waste canisters to satisfy the fire resistance requirement. Results of tests or calculations to show that this specification is satisfied shall include the maximum internal pressure caused by the fire, and the maximum temperature of the canister wall during the specified fire conditions. If a test is conducted the integrity of the canister shall be verified by a leak test. The leak rate of the canister after the fire test must be at or below the maximum allowable leak rate defined in Section 6.1.13. If a calculation is used to verify compliance with the fire resistance specification, the burst strength shall be assumed to be no greater than the yield strength of the canister material at the maximum temperature. The results of these tests and/or calculations must be submitted to the DOE for approval before the canister will be accepted for disposal. Alternatively, DOE may ultimately conduct waste canister acceptance tests and analyses that could be referenced by waste producers in the waste certification plan.

After approval of a particular waste canister design, administrative controls and inspections of canisters fabricated by vendors are necessary to ensure that this requirement is met. The administrative controls and inspection requirements shall be described in the waste producer's waste certification plan.

6.1.11 Maximum Temperature of Waste Canister

Requirement

The maximum surface temperature of waste canisters fabricated of stainless steel shall not exceed 375C and of carbon steel shall not exceed 250C.

Discussion

Thermal degradation of waste canisters may compromise their ability to provide radionuclide containment. As a result, the maximum temperature of waste canister materials must be specified. The two most common waste canister materials are stainless and carbon steels. These two steels behave differently and have different properties at elevated temperatures and so separate temperature limits are established for each material.

The surface temperature limit for stainless steel waste canisters is 375C based on information developed by Jenks (1977). At higher temperatures (greater than 400C) during long-term storage in air, austenitic stainless steels exhibit an increased susceptibility to stress corrosion cracking. A conservative temperature limit of 250C for carbon steels was chosen based on information in Rahn, et al. (1984).

Assuring Compliance

Waste producers will be required to provide evidence that the surface temperature of waste canisters does not exceed the specified limits. This could be done by analysis or by testing of a representative sample of radioactive production canisters. The waste producer will be required to describe the chemical and physical properties of the waste form and the expected radionuclide content of waste canisters. This information could be used to determine the thermal output of the waste form which could then be used to estimate the surface temperature of the waste canister. The waste producer would then be required to certify that the radionuclide concentration (which determines the thermal output) of the waste form does not exceed the concentrations used to calculate the surface temperature. The radionuclide content can be estimated from surface dose rate measurements and conversion factors. Administrative controls are needed to assure proper application of conversion factors.

6.1.12 Canister Leak Tightness

Requirement

The leak rate of a non-fuel waste canister shall be less than 1×10^{-7} atm-cc/sec for radionuclides, including fission gases, at a pressure differential of 1 atmosphere at 25C.

Discussion

The purpose of this requirement is to ensure the integrity of the canisters at the time of waste form production. Canisters of non-fuel waste (high activity wastes) will probably have to comply with requirements that are similar to those for HLW. This value is based upon the stated needs by Ross, et al.^(a); Randklev, et al. (1983); and ONWI (1983a) for HLW canisters and are appropriate, by inference, to other canistered materials. Acceptable leak test procedures are defined in ANSI N14.5-1977, "Leak Tests on Packages for Shipment of Radioactive Materials." In this standard, finely divided particulate solids are considered to have similar flow properties as water and at least 1×10^{-4} atm-cc/sec is considered water tight. This value is based on ensuring that the canister is better than water tight and that any outward leak of materials will be sufficiently low to assure the safety of the operators and the public.

Assuring Compliance

Leak tightness of closure welds will be demonstrated by testing the integrity of closure welds made during nonradioactive testing of the welding method. The influences of welding parameters on the weld's performance can be determined and these parameters monitored during actual radioactive processing to assure the quality of the closure. Leak testing of closures made on radioactive canisters should not be required except for demonstrating on a limited number of production canisters that leak tightness requirements have been met.

6.1.13 Quality Assurance

Requirement

The waste producer shall implement a quality assurance (QA) program with respect to waste package production that is based on the criteria in 10 CFR 50, Appendix B. This requirement applies to all waste types and all potential waste producers.

(a) Ross, W. A., et al. 1984. Draft Acceptability Specifications for Disposal of High-Level Waste Solidified as Borosilicate Glass. Draft Report, Pacific Northwest Laboratory, Richland, Washington.

Discussion

The purpose of QA is to provide adequate confidence that the subsystems and components of a facility, such as a repository, perform satisfactorily in service. The performance of the waste forms and waste canisters is an important aspect of the interim storage and/or geologic isolation system.

NRC regulations in 10 CFR 60 indicate that the repository must implement a QA program based on the criteria of 10 CFR 50, Appendix B. Consequently, the waste producer will also be required to implement a QA program for all aspects of waste production based on the requirements of 10 CFR 50, Appendix B.

Assuring Compliance

The DOE will be responsible for establishing QA programs that comply with the requirements of 10 CFR 50, Appendix B for the repository. Waste producers are responsible for establishing a QA program that addresses all aspects of their waste production and processing activities that are important to safety. The NRC is the agency responsible for approving the QA programs. In all cases the applicant (DOE or waste producer) must document the QA program to be applied to the design, fabrication, construction, and testing of the structures, systems, and components of the facility. The applicant must also include information related to managerial and administrative controls for implementing the program used to assure safe operation. The description of the QA program shall include a discussion of how the applicable requirements of 10 CFR 50, Appendix B are satisfied. Approval of the QA program by the NRC will constitute compliance with this requirement.

6.2 PROPOSED ACCEPTANCE REQUIREMENTS FOR WASTE FORM

The proposed waste form acceptance requirements for disposal of non-fuel waste are presented in this section.

6.2.1 Thermal Output

Requirement

The maximum heat generation rate for each canister of non-fuel waste received by a repository facility shall be TBD watts.

Discussion

The thermal output or heat generation rate of waste canisters strongly influences the designs of interim storage and disposal systems. For example, the thermal loading of waste canisters and the thermomechanical properties of the repository host rock determine the minimum allowable canister spacing at an MRS facility or in repository emplacement rooms. The heat generation rates must be limited to ensure that temperatures reached in other components of the disposal system (including other waste package components such as the backfill or overpack container) do not significantly reduce their performance capabilities. The specification will depend on the geologic medium selected for the repository and repository design considerations as well as MRS handling requirements.

At the repositories, engineering studies on waste configuration and emplacement optimization will define acceptable thermal load values for each candidate site. The MRS Functional Design Criteria (PNL 1984) specifies 1,650 watts as the maximum heat generation rate for canistered consolidated fuel (PWR), 220 watts per linear foot for HLW, and by inference are applicable to similar canisters of non-fuel waste at an MRS facility. Current heat generation limits for spent-fuel containers are 2.2 kw for basalt, 3.3 kw for tuff and 6.6 kw for salt.

Assuring Compliance

Administrative controls will be the primary method of assuring compliance with this requirement. It is assumed that the waste producers will track and analyze waste streams, including sampling and laboratory analysis. Accurate inventories of significant radionuclides contained in each waste stream will be maintained. The heat generation rates of waste forms can then be calculated from the radionuclide inventory.

6.2.2 Nonradioactive Hazardous Materials

Requirement

The waste form shall not contain explosives, compressed gases, or toxic or other hazardous materials (as defined in 49 CFR 173) in an amount that would compromise the function of the waste package or the performance objectives.

Discussion

Requirements related to a number of nonradioactive materials are considered separately in this document because of considerations unique to the subject matter of each. Discussions concerning these materials are not repeated here. Adding nonradioactive hazardous materials to waste streams for disposal is not allowed. This is primarily because the repository is not designed to mitigate the unique hazards of such materials. It is expected that such hazardous nonradioactive materials will be disposed of, where possible, by other means (e.g., shallow land burial).

The requirements stated below were specified in 10 CFR 60.135 for HLW and, by inference, are applicable throughout the waste management system:

- "Packages for HLW shall be designed so that the in-situ chemical, physical, and nuclear properties of the waste package and its interactions with the emplacement environment do not compromise the function of the waste packages ..."
- The waste package shall not contain explosive ... or chemically reactive materials in an amount that could compromise the function of the waste packages ..."
- The design criteria shall include but not be limited to consideration of the following factors: oxidation/reduction reactions, corrosion, gas generation, fire and explosion hazards ..."

Assuring Compliance

Administrative controls are needed to provide training to operators to guard against the disposal of nonradioactive hazardous materials in the waste.

Administrative controls would include requiring operators to fill in a waste-form checklist that describes the contents of each waste canister as well as instructing them not to load such materials into waste canisters. X-ray real-time radiography could be used as a backup method to verify the effectiveness of the administrative controls.

The waste producer will be required to provide the chemical composition for nonradioactive materials in wt. % for all components greater than 1%, as

Oversby suggested in criteria developed for the NNWSI for such materials in HLW (Oversby 1984). Samples from the product waste stream will be used for these analyses. These data will be used to show that hazardous materials are not in the waste form or in the free volume of the canister.

6.2.3 Pyrophoric Materials

Requirement

Pyrophoric materials within the waste package shall be rendered safe by mixing with chemically and physically stable materials.

Discussion

Pyrophoric materials (as defined in 49 CFR 173 Subpart E) are those that may ignite spontaneously under ambient conditions of shipment or storage. This could contribute to a breach of the canister followed by release of contained radioactive materials and exposure of operating personnel and the public to radionuclides in the waste form.

Zirconium from spent fuel hardware, if in the form of small particulates, is pyrophoric. Larger pieces of zirconium-containing materials are not considered pyrophoric. However, provisions must be taken, by fixation, to prevent metallic fines of zirconium from concentrating into pockets in the waste package and becoming a fire hazard.

Regulatory guidance can be inferred throughout the waste management system from current HLW design criteria presented in 10 CFR 60.135b, that states:

"The waste package will not contain ... pyrophoric materials or chemically reactive materials in an amount that could compromise the ability of the underground facility to contribute to waste isolation or the ability of the geologic repository to satisfy the performance objectives."

Recently, WIPP (Westinghouse 1984) draft waste acceptance criteria established a conservative limit of 1% for pyrophoric forms of radionuclide metals (plutonium or uranium fines) distributed in a moderately homogeneous manner in the TRU waste form. This is based on studies at the Rocky Flats Plant 1974) that indicated that a thoroughly dispersed distribution of 3% pyrophoric plutonium in plutonium oxide would not self-ignite.

Assuring Compliance

Presumably, the waste producers will be required to identify the physical properties of the wastes they plan to dispose of at a repository and thus will characterize in detail their waste streams prior to disposal. Any pyrophoric materials that would be present in the wastes would be identified at that time. If the waste producer determines there are no pyrophoric materials in the wastes, treatment to render the pyrophorics nonhazardous would not be required. Administrative controls would then be used to ensure that operators do not load pyrophoric materials into waste canisters. If pyrophoric materials will be present in the waste in amounts that would be hazardous, the waste producer must define and describe in detail an appropriate treatment method and provide evidence that treatment will render the material safe. Administrative controls, process monitoring, and feed sample analysis would then be used to verify that the composition of the waste form is within acceptable limits and the danger of a pyrophoric reaction has been eliminated. Demonstration of the waste treatment process using nonradioactive simulated waste followed by destructive evaluation of the simulated waste form may be used as evidence that the treatment process adequately mitigates the hazards of pyrophoric materials. Destructive evaluation of actual radioactive waste forms should not be required.

6.2.4 Free Liquids

Requirement

The canistered materials shall not contain any amounts of water or aqueous solutions that could be drained from the waste canister or that would compromise the integrity of the canister.

Discussion

Zirconium is present in the hardware of spent fuel storage assemblies. Internal gas pressure will be produced from the reaction of zirconium-cladding material with water or water vapor and this must be minimized to prevent potential overpressurization of waste canisters. Water will also provide a mechanism for pressure buildup due to radiolysis. Residual water in waste canisters could also contribute to waste canister degradation and brine

formation and enhance the mobility of radionuclides. As a result, free liquids in an amount that could be drained from a breached waste canister is prohibited.

Assuming Compliance

Waste producers will be required to certify that their wastes meet the free liquids requirement. Detailed characterization of the physical and chemical properties of the as-generated wastes will be needed, including an assessment of the free liquid content. Spent fuel consolidation operations are not expected to introduce free liquids into waste canisters, although it is possible. Therefore, administrative controls that specify that operators shall introduce no free liquids into non-fuel waste canisters should be used to certify that this requirement is met. X-ray real-time-radiography could be used as a backup method to verify that free liquids are not present in waste canisters.

6.2.5 Maximum Temperature of Waste Form

Requirement

The maximum temperature of metallic non-fuel waste forms shall not exceed the temperature at which thermally induced transformations will occur which will significantly degrade the waste form's radionuclide release behavior.

Discussion

The purpose of this requirement is to help ensure the mechanical integrity and radionuclide release properties of non-fuel waste forms. The limit identified in the requirement ensures that metallic waste forms will not be significantly altered by heat generated by the encapsulated waste. Thermally induced transformations would include phase changes that affect the mechanical properties and/or specific gravity of the metals, a change of compositions of a metal oxide, or a change in microstructure. The specified temperature limit is below any temperatures where any significant physical or chemical changes could occur. Also, the maximum temperature of the waste form must be below the temperature that would produce a temperature at the surface of the waste canister that exceeds the specified limits (see Section 6.1.11).

Assuring Compliance

The composition of a waste form could be determined from process measurements, particularly from feed analyses. These analyses would include determinations of the amounts and types of heat generating radionuclides. With this information, the heat generation rate of the waste form could be determined. With a knowledge of the thermal properties of the waste form/canister the maximum expected temperature of the waste form could be calculated. The waste producer would then be required to certify that the radionuclide content of the wastes produced do not exceed the limits at which an unacceptable temperature of the waste form would be reached. This could be demonstrated by measuring the radionuclide content of each waste package prior to releasing it for transport. Radionuclide content could be estimated by measuring the surface dose rate and applying conversion factors that are determined by the waste producer for each isotope or by processing waste packages through gamma and neutron assay systems.

6.2.6 Canister/Waste Form Compatibility

Non-fuel waste canisters must meet the requirements specified for a Type A shipping container as found in DOT transportation regulations (49 CFR 173), both at the time of production and after 110 years in air storage.

Discussion

The purpose of this requirement is to ensure that waste canisters remain intact without showing indications of significant degradation (e.g., extensive external corrosion, visible failure of seal or container contents spilled). To avoid having to repackage or overpack non-fuel waste prior to repository disposal, the waste canisters should remain intact during maximum potential producer (10 years) and MRS facility (100 years) storage. Both the effects of air storage and any potential corrosion mechanism of the canister materials, including internal corrosion caused by the waste form, must be taken into consideration when demonstrating compliance with this requirement.

The DOT canister/waste form compatibility requirement is presented in 49 CFR 173.412. The regulation states that the materials must be physically and chemically compatible with each other and that radiation effects must be considered. This is important in the repository environment because any

reactions (e.g., galvanic corrosion) could potentially reduce the leach resistance of the metal waste form(s) or the structural integrity of the waste canister.

This requirement does not specify that waste canisters must remain intact for any length of time after emplacement at the repository; e.g., the retrievability period. It is assumed that if waste canisters are required to be overpacked for long-term corrosion resistance and structural stability, the overpack (container) will be placed on the waste canister at the repository. Therefore, the waste canisters are required to meet DOT Type A packaging requirements until the time they are delivered to the repository. This could be for as long as 110 years, including 10 years at the waste producer's/packager's facility and up to 100 years at the potential MRS facility.

Assuring Compliance

Waste producers must present evidence to the DOE that the particular waste canister they plan to use will meet this requirement. Proposed waste canisters that have not already been certified as a Type A package, will be tested to show that they meet these requirements. These test results and supporting analyses must be submitted to the DOT for review and approval. Testing programs to certify waste canisters must consider the effects of long-term (110 years) storage in air, including thermally-induced and radiation-induced degradation of the waste canister materials. The effects of internal corrosion caused by the waste form must also be considered.

Waste producers are expected to obtain fabricated waste canisters from qualified vendors. Administrative controls and control of purchase orders is all that should be needed to ensure these requirements are met by the as-fabricated canisters. Surveillance of vendors and their suppliers, including quality assurance inspections, should be performed by the waste producer. The surveillance procedures and results as well as the results of inspections of canisters will be documented.

6.2.7 Leach Resistance

Requirement

The average release rate of radionuclides from non-fuel waste forms shall be less than or equal to one part in 1000 per year as indicated by the slope at 28 days of the MCC-1 leach test (Kuhn, Peters, and Simonsen 1983) performed in deionized water. This requirement does not apply to any radionuclide which is released at a rate less than 0.1 percent of the release rate limit.

Discussion

This requirement is needed to ensure that a minimum level of radionuclide containment is provided by the waste form. This is needed in the event of a preclosure accident involving a flood in the repository or a severe transportation accident involving a body of water, or in the event of flooding at the potential MRS facility. It is also needed to help ensure radionuclide containment after the waste form is emplaced at the repository. Testing of waste forms, which is implied by this requirement, is not meant to demonstrate a repository-relevant radionuclide release rate. Demonstration of the radionuclide release that will occur from a repository must be determined for each candidate repository media as part of the site characterization process.

The release rate exemption for radionuclides with release rates less than 0.1 percent of the release rate limit is based on the similar exemption found in 10 CFR 60.113 (NRC 1983).

Release rates of radionuclides can be limited by the solubilities of the radionuclides themselves, by mass transfer resistance in groundwater (e.g., sorption by the host geology) and/or by the rate at which they are leached from the waste form. Solubility and mass transfer resistance will limit the release rates of most actinides and many other radioisotopes from the waste package (Kuhn, et al. 1983). Such releases will be several orders of magnitude lower than the rate of release due to waste form leaching alone, and should easily meet the NRC radionuclide release limit of less than one part in 10⁵ per year (10 CFR 60). The release of some elements, such as Cs, may be limited only by the durability of the waste form. The limit set in this requirement of one part in 1000 is based on the performance that could be achieved by cement or borosilicate glass waste forms. Other engineered barriers and the repository's

geochemistry will be available to further limit the release rate from the repository.

Assuring Compliance

Testing of doped simulated waste form material will be performed to demonstrate the waste form's leach rate in the MCC-1 test. This testing should be performed with the purpose of qualifying the range of waste form compositions, waste loadings, etc. which are anticipated from the process for producing a particular waste form. The task of assuring compliance with this requirement then becomes one of demonstrating that the material produced is within the range of compositions which has been qualified. This would be done through the use of process measurements such as feed sample analyses.

6.2.8 Organic Materials

Requirement

Organic material shall not be present in the canister.

Discussion

Organic materials are of concern in a repository environment for the following reasons:

1. organic materials are combustible
2. organic materials could cause formation of explosive concentrations of gases or cause formation of sufficient quantities of gases that could overpressurize the waste container
3. organic materials could enhance waste form leach rates and/or radio nuclide mobility in the repository.

Organic materials are not expected to be a concern in the acceptance of non-fuel waste because they are not present in fuel assemblies, control rods, etc., and are not expected to be introduced into waste canisters during treatment and handling operations. Certain decontamination agents are organic and should be removed to the extent practical from the external surfaces of waste canisters.

Assuming Compliance

Waste producers will be required to certify that their wastes meet the organic materials requirement. Detailed characterization of the physical and chemical properties of the as-generated wastes will be needed, including an

assessment of the organic content. Spent fuel consolidation operations are not expected to introduce organic material into waste canisters, although it is possible. Therefore, administrative controls that specify that operators shall introduce no organics into non-fuel waste canisters should be used to certify that this requirement is met. A waste-form checklist could be used to verify that organic materials are not placed in canisters.

6.2.9 Immobilization

Requirement

The waste form shall be immobilized in order to preclude radionuclide dispersibility and inhalation after a waste container is breached during an accident.

Discussion

Non-fuel waste are, in general, of such a form as to preclude any necessity for immobilization. They are mostly metallic components. Any items, including fines from machining or grinding operations or from pulverized dried crud packaged with them must be evaluated in order to determine whether they will require any immobilization.

Assuming Compliance

Waste producers will be required to certify that their wastes meet the immobilization requirement. Detailed characterization of the physical and chemical properties of the as-generated wastes will be needed, including an assessment of the dispersibility of the waste form. Spent fuel consolidation operations may produce fines that could potentially require immobilization. Administrative controls, including a waste-form checklist, could be used to certify that this requirement is met.

6.2.10 Maximum Pressure, Volatility Limit, and Gas Generation

Requirement

Steps will be taken to ensure that a maximum internal gas pressure of 7 psig at 25°C will not be exceeded after closure.

Discussion

The purpose of these three potential requirements is to prevent overpressurization of waste canisters due to generation of gases. Gases could

be released from the waste form due to radiolytic decomposition of water, alpha decay, decomposition of organic materials, or release of volatile radionuclides caused by elevated temperatures (e.g., in a fire).

Assuming Compliance

Waste producers will be required to certify that their wastes meet these requirements. Detailed characterization of the physical and chemical properties of the as-generated wastes will be needed, including an assessment of the gas generation potential. Spent fuel consolidation operations are not expected to add volatile into waste canisters, although it is possible. Administrative controls could be implemented that specify that operators shall introduce no free liquids, organic materials, or other materials that could generate gases into non-fuel waste canisters. X-ray real-time-radiography could be used as a backup method to verify that these materials are not present in waste canisters.

6.2.11 Criticality Safety

Requirement

The canistered waste form shall remain subcritical ($<0.95 k_{eff}$) under all credible conditions that might be encountered, after allowance for bias in calculational method and uncertainties.

Discussion

A requirement in this area is needed for other waste types, such as spent fuel, HLW, and TRU waste, to ensure that any assembly of canisters or waste packages remains subcritical during storage, transportation, and disposal. Criticality must be prevented to protect the health and safety of waste handling personnel and the public. However, non-fuel wastes do not contain fissile materials in any significant concentration.

Assuming Compliance

Waste producers will be required to certify that their wastes meet the criticality requirement. Detailed characterization of the radionuclide properties of the as-generated wastes will be needed, including an assessment of the fissile material content. Administrative controls that specify that operators shall introduce no fissile materials into non-fuel waste canisters

should be used to certify that this requirement is met. X-ray real-time-radiography could be used as a backup method to verify that fissile materials are not present in waste canisters.

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APPENDIX A

10 CFR 61.55 EXCERPT

APPENDIX A

10 CFR 61.55 EXCERPT

This appendix contains all of paragraph 61.55 of 10 CFR 61. It is titled Waste Classification and includes the Tables I and II referred to in text of this report as well as other information relating to the classification requirements for low level wastes.

Appendix A

Chapter I—Nuclear Regulatory Commission

Title 10—Energy

§ 61.55 Waste classification.

(a) Classification of waste for near surface disposal.

(1) *Considerations.* Determination of the classification of radioactive waste involves two considerations. First, consideration must be given to the concentration of long-lived radionuclides (and their shorter-lived precursors) whose potential hazard will persist long after such precautions as institutional controls, improved waste form, and deeper disposal have ceased to be effective. These precautions delay the time when long-lived radionuclides could cause exposures. In addition, the magnitude of the potential dose is limited by the concentration and availability of the radionuclide at the time of exposure. Second, consideration must be given to the concentration of shorter-lived radionuclides for which requirements on institutional controls, waste form, and disposal methods are effective.

(2) *Classes of waste.* (i) Class A waste is waste that is usually segregated from other waste classes at the disposal site. The physical form and characteristics of Class A waste must meet the minimum requirements set forth in § 61.56(a). If Class A waste also meets the stability requirements set forth in § 61.56(b), it is not necessary to segregate the waste for disposal.

(ii) Class B waste is waste that must meet more rigorous requirements on waste form to ensure stability after disposal. The physical form and characteristics of Class B waste must meet both the minimum and stability requirements set forth in § 61.56.

(iii) Class C waste is waste that not only must meet more rigorous requirements on waste form to ensure stability but also requires additional measures at the disposal facility to protect against inadvertent intrusion. The physical form and characteristics of Class C waste must meet both the minimum and stability requirements set forth in § 61.56.

(iv) Waste that is not generally acceptable for near-surface disposal is waste for which waste form and disposal methods must be different, and in general more stringent, than those specified for Class C waste. In the absence of specific requirements in this part, proposals for disposal of this waste may be submitted to the Commission for approval, pursuant to § 61.58 of this part.

(3) Classification determined by long-lived radionuclides. If radioactive waste contains only radionuclides listed in Table 1, classification shall be determined as follows:

(i) If the concentration does not exceed 0.1 times the value in Table 1, the waste is Class A.

(ii) If the concentration exceeds 0.1 times the value in Table 1 but does not exceed the value in Table 1, the waste is Class C.

(iii) If the concentration exceeds the value in Table 1, the waste is not generally acceptable for near-surface disposal.

(iv) For wastes containing mixtures of radionuclides listed in Table 1, the total concentration shall be determined by the sum of fractions rule described in paragraph (a)(7) of this section.

TABLE 1

Radionuclide	Concentration, curies per cubic meter
C-14	8
C-14 in activated metal	80
H-3 in activated metal	220
H-3 in activated metal	0.1
Ti-62	3
U-235	0.06
Alpha emitting transuranic radionuclides with half-life greater than five years	100
Pu-241	3,500
Cm-244	20,000

¹Units are nanocuries per gram.

(4) Classification determined by short-lived radionuclides. If radioactive waste does not contain any of the radionuclides listed in Table 1, classification shall be determined based on the concentrations shown in Table 2. However, as specified in paragraph (a)(6) of this section, if radioactive waste does not contain any radionuclides listed in either Table 1 or 2, it is Class A.

(i) If the concentration does not exceed the value in Column 1, the waste is Class A.

(ii) If the concentration exceeds the value in Column 1, but does not exceed the value in Column 2, the waste is Class B.

(iii) If the concentration exceeds the value in Column 2, but does not exceed the value in Column 3, the waste is Class C.

(iv) If the concentration exceeds the value in Column 3, the waste is not generally acceptable for near-surface disposal.

(v) For wastes containing mixtures of the radionuclides listed in Table 2, the total concentration shall be determined by the sum of fractions rule described in paragraph (a)(7) of this section.

TABLE 2

Radionuclide	Concentration, curies per cubic meter		
	Col. 1	Col. 2	Col. 3
Total of all radionuclides with less than 5 year half-life	700	(1)	(1)
H-3	40	(1)	(1)
Co-60	700	(1)	(1)
Ni-63	3.5	70	700
Ni-63 in activated metal	35	700	7000
Sr-90	0.04	150	7000
Ce-137	1	44	4600

¹There are no limits established for these radionuclides in Class B or C wastes. Practical considerations such as the effects of external radiation and internal heat generation on

transportation, handling, and disposal will limit the concentrations for these wastes. These wastes shall be Class B unless the concentrations of other radionuclides in Table 2 determine the waste to be Class C independent of these radionuclides.

(5) Classification determined by both long- and short-lived radionuclides. If radioactive waste contains a mixture of radionuclides, some of which are listed in Table 1, and some of which are listed in Table 2, classification shall be determined as follows:

(i) If the concentration of a nuclide listed in Table 1 does not exceed 0.1 times the value listed in Table 1, the class shall be that determined by the concentration of nuclides listed in Table 2.

(ii) If the concentration of a nuclide listed in Table 1 exceeds 0.1 times the value listed in Table 1 but does not exceed the value in Table 1, the waste shall be Class C, provided the concentration of nuclides listed in Table 2 does not exceed the value shown in Column 3 of Table 2.

(6) Classification of wastes with radionuclides other than those listed in Tables 1 and 2. If radioactive waste does not contain any nuclides listed in either Table 1 or 2, it is Class A.

(7) The sum of the fractions rule for mixtures of radionuclides. For determining classification for waste that contains a mixture of radionuclides, it is necessary to determine the sum of fractions by dividing each nuclide's concentration by the appropriate limit and adding the resulting values. The appropriate limits must all be taken from the same column of the same table. The sum of the fractions for the column must be less than 1.0. If the waste class is to be determined by that column. Example: A waste contains Sr-90 in a concentration of 50 Ci/m³ and Cs-137 in a concentration of 22 Ci/m³. Since the concentrations both exceed the values in Column 1, Table 2, they must be compared to Column 2 values. For Sr-90 fraction 50/150=0.33; for Cs-137 fraction 22/44=0.5; the sum of the fractions=0.83. Since the sum is less than 1.0, the waste is Class B.

(8) *Determination of concentrations in wastes.* The concentration of a radionuclide may be determined by indirect methods such as use of scaling factors which relate the inferred concentration of one radionuclide to another that is measured, or radionuclide material accountability, if there is reasonable assurance that the indirect methods can be correlated with actual measurements. The concentration of a radionuclide may be averaged over the volume of the waste, or weight of the waste if the units are expressed as nanocuries per gram.

APPENDIX B

RADIOACTIVITY AND DECAY HEAT IN THE SPENT FUEL DISASSEMBLY
HARDWARE NON-FUEL-ASSEMBLY COMPONENTS OF
BWR & PWR SPENT FUEL ASSEMBLIES

APPENDIX B

RADIOACTIVITY AND DECAY HEAT IN THE SPENT FUEL DISASSEMBLY HARDWARE NON-FUEL-ASSEMBLY COMPONENTS OF BWR & PWR SPENT FUEL ASSEMBLIES

This appendix contains a series of figures and tables presenting ORIGEN2 calculational results estimating decay heat and radioactivity levels in the non-fuel components of PWR and BWR spent fuel assemblies.

Figures B.1 presents the decay heat due to non-fuel components of PWR fuel assemblies from 1 to 10,000 years after irradiation. The fuel assemblies were exposed to 33 GWD/MTU over 1100 days. Figure B.2 presents the decay heat due to non-fuel components of BWR fuel assemblies exposed to 28 GWD/MTU over 1460 days. Figure B.3 presents the decay heat due to BWR Cruciform exposed to 28 GWD over 1460 days.

Tables B.1 through B.3 present the radioactivity in the non-fuel components of PWR spent fuel assemblies exposed to 33 GWD/MTU over 1100 days. Table B.4 through B.9 present the radioactivity of the non-fuel components of BWR fuel assemblies exposed to 28 GWD/MTU and cruciform components exposed to 28 GWD over 1460 days.

Figure B.1. Decay Heat Due to PWR Non-Fuel Hardware Exposed to 33 GWD/MTU

Figure B.2. Decay Heat due to BWR Non-Fuel Hardware Exposed to 28 GWD/MTU

Figure B.3. Decay Heat Due to BWR Cruciform Components Exposed to 28 GWD/MTU

Table B.1. Total Radioactivity in PWR Fuel Assembly Components
Curies/MTU

OUTPUT UNIT = 8

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*PWR, 3.2 W/D ENRICHMENT, 33GWD/MT BURNUP, COMPLETE FUEL ASSEMBLY
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
H 3	6.383E-05	6.016E-05	5.888E-05	4.808E-05	3.830E-05	2.071E-05	3.844E-08	2.323E-07	3.094E-12	0.0	0.0	0.0
H 4	9.381E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 8	2.014E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LI 8	3.769E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 8	4.117E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 10	5.834E-08	5.834E-08	5.834E-08	5.834E-08	5.834E-08	5.834E-08	5.834E-08	5.834E-08	5.834E-08	5.834E-08	5.834E-08	5.834E-08
BE 11	1.183E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 12	2.921E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 14	5.051E-01	5.051E-01	5.051E-01	5.051E-01	5.051E-01	5.051E-01	5.051E-01	5.051E-01	5.051E-01	5.051E-01	5.051E-01	5.051E-01
C 15	0.032E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N 18	2.765E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N 19	2.272E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F 20	1.870E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE 23	4.705E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24	2.792E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24M	2.208E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 25	7.108E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 27	1.337E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 28	1.220E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 29	3.827E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 30	6.787E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 31	4.72E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 31	4.204E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 32	1.818E-07	1.818E-07	1.818E-07	1.818E-07	1.818E-07	1.818E-07	1.818E-07	1.818E-07	1.818E-07	1.818E-07	1.818E-07	1.818E-07
P 32	7.289E-02	1.510E-05	1.814E-07	1.808E-07	1.799E-07	1.780E-07	1.724E-07	1.634E-07	1.320E-07	6.258E-08	7.417E-09	4.250E-12
P 33	1.024E-03	4.098E-08	1.838E-12	1.048E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.250E-12
P 34	5.282E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 35	8.81E-01	3.300E-02	1.858E-03	3.317E-07	1.877E-13	6.012E-26	0.0	0.0	0.0	0.0	0.0	0.0
S 37	1.520E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 38	1.320E-07	1.320E-07	1.320E-07	1.320E-07	1.320E-07	1.320E-07	1.320E-07	1.320E-07	1.320E-07	1.320E-07	1.320E-07	1.320E-07
CL 38M	1.748E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 37	2.078E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 39	4.193E-10	3.042E-13	2.207E-18	8.425E-26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 41	2.440E-12	2.434E-12	2.428E-12	2.409E-12	2.378E-12	2.318E-12	2.145E-12	1.886E-12	1.126E-12	8.55E-13	0.72E-15	1.573E-23
AR 42	3.584E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K 40	1.138E-15	1.15E-15	1.092E-15	1.025E-15	9.228E-16	7.480E-16	3.983E-16	1.394E-16	2.089E-16	8.597E-25	0.0	0.0
K 42	9.004E-25	9.004E-25	9.004E-25	9.004E-25	9.004E-25	9.004E-25	9.004E-25	9.004E-25	9.004E-25	9.004E-25	9.004E-25	9.004E-25
K 43	8.438E-08	1.15E-15	1.092E-15	1.025E-15	9.228E-16	7.480E-16	3.983E-16	1.394E-16	2.089E-16	8.597E-25	0.0	0.0
K 44	4.490E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CA 45	7.993E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CA 47	2.853E-02	5.11E-03	1.87E-03	1.23E-05	4.750E-09	8.508E-16	0.0	0.0	0.0	0.0	0.0	0.0
SC 48	3.91E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 48M	3.324E-00	1.820E-01	7.898E-03	9.142E-07	2.514E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 47	4.437E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 48	5.292E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 49	4.922E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 49	4.983E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 50	8.486E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TI 51	8.800E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 50	8.115E-15	8.115E-15	8.115E-15	8.115E-15	8.115E-15	8.115E-15	8.115E-15	8.115E-15	8.115E-15	8.115E-15	8.115E-15	8.115E-15
V 52	4.849E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 53	1.340E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

B.5

Table B.1. (cont'd) Total Radioactivity in PWR Fuel Assembly Components
Curies/MTU

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, COMPLETE FUEL ASSEMBLY
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, Curies		METRIC TON URANIUM METAL AS LOADED									
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
Y 54	1.526E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 51	2.783E-04	2.895E+00	3.223E-04	4.018E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 55	4.248E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 54	7.843E-02	3.533E+02	1.571E+02	1.383E+01	2.407E-01	7.298E-05	2.031E-15	0.0	0.0	0.0	0.0
MN 56	3.179E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 57	2.774E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 58	2.105E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	2.223E-03	4.000E+03	3.064E+03	1.377E+03	3.831E+02	2.525E+01	8.487E-03	1.380E-08	0.0	0.0	0.0
FE 59	3.183E-02	1.151E+00	4.147E-03	1.939E-10	1.177E-23	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	6.043E-03	1.889E+02	4.723E+00	1.632E-04	1.762E-12	0.0	0.0	0.0	0.0	0.0	0.0
CO 60	7.527E-03	6.599E+03	5.788E+03	3.889E+03	2.020E+03	5.421E+02	1.048E+01	1.451E-02	5.455E-14	0.0	0.0
CD 60M	1.377E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD 61	1.517E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD 62	8.656E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 59	5.094E+00	5.094E+00	5.094E+00	5.094E+00	5.093E+00	5.092E+00	5.090E+00	5.081E+00	5.050E+00	4.863E+00	4.871E+00
NI 63	6.950E-02	6.898E+02	8.848E+02	8.603E+02	8.448E+02	8.978E+02	4.769E+02	3.272E+02	7.251E+01	3.716E-01	1.082E-07
NI 65	1.077E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CJ 86	9.485E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 84	3.318E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 86	7.710E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 87	1.280E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 85	1.875E-01	8.840E-02	2.351E-02	1.044E-03	5.818E-06	1.803E-10	5.389E-24	0.0	0.0	0.0	0.0
ZN 89	2.819E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 89M	1.894E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 70	1.999E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	6.377E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	1.970E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71	1.364E-11	6.562E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71M	1.215E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 89	8.718E-05	4.466E-07	2.968E-09	8.718E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 90	7.910E-08	7.724E-08	7.542E-08	7.022E-08	8.234E-08	4.914E-08	2.408E-08	7.319E-09	8.287E-11	1.840E-18	0.0
SR 91	1.056E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 93	3.801E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 89M	2.770E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 90	6.927E-01	7.728E-08	7.544E-08	7.024E-08	8.236E-08	4.915E-08	2.407E-08	7.321E-09	8.289E-11	3.841E-18	0.0
Y 90M	6.834E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 91	1.880E-04	2.193E-08	2.895E-08	8.605E-14	2.875E-23	0.0	0.0	0.0	0.0	0.0	0.0
Y 92	1.494E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 93	3.801E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 94	7.553E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 96	4.783E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 89	2.780E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 93	8.083E-08	8.083E-06	8.083E-06	8.083E-06	8.083E-06	8.083E-06	8.083E-06	8.082E-06	8.080E-06	8.072E-06	8.047E-06
ZR 95	1.413E-01	2.702E-03	5.187E-05	3.612E-10	9.233E-19	0.0	0.0	0.0	0.0	0.0	0.0
ZR 97	7.137E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 92	2.265E-01	3.413E-10	5.143E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 93M	5.344E-07	8.894E-07	1.227E-06	2.142E-06	3.387E-06	5.101E-06	7.120E-06	7.835E-06	7.878E-06	7.869E-06	7.844E-06
NB 94	1.284E+00	1.284E+00	1.284E+00	1.283E+00	1.283E+00	1.281E+00	1.279E+00	1.271E+00	1.241E+00	1.159E+00	9.123E-01
NB 95	1.453E+03	1.088E+00	9.248E-04	8.023E-10	2.050E-18	0.0	0.0	0.0	0.0	0.0	0.0
NB 95M	1.006E+03	2.005E-05	3.833E-07	2.580E-12	8.849E-21	0.0	0.0	0.0	0.0	0.0	0.0
NB 96	1.851E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97	1.478E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.1. (cont'd) Total Radioactivity in PWR Fuel Assembly Components
Curies/MTU

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, COMPLETE FUEL ASSEMBLY
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.58E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED													
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
NB 97M	8.754E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 98	1.184E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB100	5.782E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 93M	1.807E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 93	2.529E-02	2.529E-02	2.528E-02	2.527E-02	2.524E-02	2.519E-02	2.504E-02	2.480E-02	2.383E-02	2.075E-02	1.398E-02	3.488E-03	
MO 99	1.128E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO101	2.793E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC 98	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.178E-10	4.175E-10	4.170E-10	
TC 99	1.049E-03	1.054E-03	1.054E-03	1.054E-03	1.054E-03	1.054E-03	1.054E-03	1.054E-03	1.053E-03	1.051E-03	1.044E-03	1.021E-03	
TC100	2.815E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	2.793E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU103	5.652E-02	8.898E-05	1.429E-07	8.730E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU105	4.418E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU108	2.599E-13	1.307E-13	8.571E-14	8.350E-15	2.882E-18	2.884E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU107	3.214E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH102	1.094E-09	8.817E-10	8.785E-10	3.312E-10	1.003E-10	9.185E-12	7.083E-15	4.558E-20	0.0	0.0	0.0	0.0	0.0
RH104	1.408E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH104M	1.020E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105	4.078E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105M	1.237E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH108	2.307E-08	1.307E-13	8.571E-14	8.350E-15	2.882E-18	2.894E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH108M	1.121E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH107	3.214E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD107	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.853E-18	7.851E-18	7.848E-18		
PD107M	4.584E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109	4.497E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109M	7.300E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD111	1.014E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG108	2.088E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG109M	4.498E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG110	4.618E-15	2.594E-19	9.417E-20	4.873E-21	3.074E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG110M	5.388E-17	1.950E-17	7.055E-18	3.864E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG111	3.858E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG111M	1.051E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD111M	2.107E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA182	3.402E-03	3.784E-04	4.184E-05	5.822E-08	8.320E-13	2.581E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA182M	8.921E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA183	1.029E-02	2.841E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W181	4.052E-02	5.016E-03	8.209E-04	1.179E-08	3.427E-11	2.894E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W183M	5.612E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185	1.128E+00	3.874E-02	1.331E-03	5.394E-08	2.580E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185M	1.285E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W187	2.093E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W188	5.708E-02	1.486E-03	3.869E-05	8.832E-10	8.181E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W189	2.947E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE186	7.409E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE187	7.882E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	
RE188	7.115E+00	1.501E-03	3.909E-05	8.903E-10	8.285E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE188M	8.907E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE189	3.494E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS190M	6.155E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191	5.899E-04	4.420E-11	3.222E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.1. (cont'd) Total Radioactivity in PWR Fuel Assembly Components

Curies/MTU

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, COMPLETE FUEL ASSEMBLY
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.50E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

	7 SUMMARY TABLE: RADIOACTIVITY, CURIES											
	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
OS191M	4.524E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS193	9.283E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS194	2.808E-12	2.323E-12	2.070E-12	1.484E-12	8.214E-13	2.587E-13	8.085E-15	2.510E-17	0.0	0.0	0.0	0.0
IR192	1.584E-04	5.113E-08	1.873E-07	1.823E-10	1.542E-10	1.498E-10	1.374E-10	1.190E-10	8.898E-11	8.943E-12	2.841E-14	5.127E-23
IR192M	1.588E-10	1.581E-10	1.578E-10	1.583E-10	1.541E-10	1.497E-10	1.373E-10	1.189E-10	8.890E-11	8.935E-12	2.838E-14	5.122E-23
IR194	6.408E-08	2.324E-12	2.071E-12	1.484E-12	8.217E-13	2.588E-13	8.088E-15	2.511E-17	0.0	0.0	0.0	0.0
IR194M	3.378E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT193	1.041E-09	1.047E-09	1.045E-09	1.041E-09	1.034E-09	1.019E-09	9.778E-10	9.123E-10	8.914E-10	2.820E-10	1.838E-11	8.995E-18
PT193M	3.130E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT195M	3.491E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197	1.054E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197M	7.142E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU198	8.649E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU199	2.089E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU200	8.829E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HG199M	3.372E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	1.013E+05	1.182E+04	9.703E+03	5.968E+03	3.035E+03	1.172E+03	4.944E+02	3.342E+02	7.946E+01	7.211E+00	8.551E+00	5.786E+00
TOTAL	1.013E+05	1.182E+04	9.703E+03	5.968E+03	3.035E+03	1.172E+03	4.944E+02	3.342E+02	7.946E+01	7.211E+00	8.551E+00	5.786E+00

B.1.8

Table B.2 Radioactivity in PWR Fuel Assembly Grids, Sleeves and Other Components
Curies/MTU

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, GRIDS & SLEEVES
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES													
DISCHG.	METRIC TON URANIUM METAL AS LOADED												
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
8. 251E-05	5. 810E-05	5. 587E-05	4. 721E-05	3. 568E-05	2. 034E-05	3. 777E-06	2. 262E-07	3. 039E-12	0. 0	0. 0	0. 0		
9. 381E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
1. 978E-03	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
3. 769E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
4. 111E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
5. 736E-08	5. 736E-08	5. 736E-08	5. 736E-08	5. 736E-08	5. 736E-08	5. 736E-08	5. 736E-08	5. 736E-08	5. 736E-08	5. 736E-08	5. 736E-08		
1. 163E-07	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
2. 918E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
2. 874E-01	5. 873E-01	5. 873E-01	5. 871E-01	5. 867E-01	5. 860E-01	5. 839E-01	5. 804E-01	5. 665E-01	5. 205E-01	4. 088E-01	1. 752E-01		
5. 995E-05	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
2. 754E-04	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
2. 272E-08	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
1. 847E-10	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
4. 595E-05	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
2. 792E-00	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
2. 158E-08	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
8. 940E-05	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
1. 337E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
1. 220E-08	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
3. 821E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
8. 582E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
8. 274E-04	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
4. 200E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
1. 818E-07	1. 814E-07	1. 812E-07	1. 807E-07	1. 797E-07	1. 778E-07	1. 722E-07	1. 632E-07	1. 319E-07	8. 252E-08	7. 410E-09	4. 246E-12		
7. 283E-02	1. 509E-05	1. 812E-07	1. 807E-07	1. 797E-07	1. 778E-07	1. 722E-07	1. 633E-07	1. 319E-07	8. 253E-08	7. 410E-09	4. 246E-12		
7. 003E-03	4. 008E-08	1. 803E-12	1. 025E-25	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
5. 150E-03	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
5. 736E-01	3. 230E-02	1. 818E-03	3. 246E-07	1. 837E-13	5. 884E-26	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
1. 488E-03	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
1. 292E-07	1. 292E-07	1. 292E-07	1. 292E-07	1. 292E-07	1. 292E-07	1. 292E-07	1. 292E-07	1. 291E-07	1. 289E-07	1. 283E-07	1. 282E-07		
1. 709E-06	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
2. 034E-08	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
4. 103E-10	2. 977E-13	2. 160E-18	8. 248E-28	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
2. 388E-12	2. 382E-12	2. 376E-12	2. 358E-12	2. 327E-12	2. 268E-12	2. 099E-12	1. 846E-12	1. 102E-12	1. 815E-13	1. 049E-15	1. 539E-23		
3. 584E-07	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
1. 138E-15	1. 115E-15	1. 092E-15	1. 025E-15	9. 226E-18	7. 480E-18	3. 983E-18	1. 394E-18	2. 089E-18	8. 597E-25	0. 0	0. 0		
8. 812E-25	8. 812E-25	8. 812E-25	8. 812E-25	8. 812E-25	8. 812E-25	8. 812E-25	8. 812E-25	8. 812E-25	8. 812E-25	8. 812E-25	8. 812E-25		
6. 416E-09	1. 115E-15	1. 092E-15	1. 025E-15	9. 226E-18	7. 480E-18	3. 983E-18	1. 394E-18	2. 089E-18	8. 598E-25	0. 0	0. 0		
4. 490E-08	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
7. 993E-07	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
2. 653E-02	5. 811E-03	1. 187E-03	1. 123E-05	4. 751E-09	8. 506E-16	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
3. 191E-04	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
3. 324E+00	1. 820E-01	7. 896E-03	9. 142E-07	2. 514E-13	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
4. 437E-04	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
5. 292E+00	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
4. 922E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
4. 963E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
8. 486E-03	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
9. 798E+00	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
8. 042E-15	8. 042E-15	8. 042E-15	8. 042E-15	8. 042E-15	8. 042E-15	8. 042E-15	8. 042E-15	8. 042E-15	8. 042E-15	8. 042E-15	8. 042E-15		
4. 791E+02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		
1. 324E+00	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0		

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Table B.2. (cont'd) Radioactivity in PWR Fuel Assembly Grids, Sleeves and Other Components

Curies/MTU

OUTPUT UNIT = 8

PAGE 30

*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, GRIDS & SLEEVES
 POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.50E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISCHG.	METRIC TON URANIUM METAL AS LOADED											
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
1.507E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.750E-04	2.950E+00	3.184E-04	3.888E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.107E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.787E-02	3.455E+02	1.537E+02	1.352E+01	2.354E-01	7.135E-05	1.988E-15	0.0	0.0	0.0	0.0	0.0	
3.113E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.713E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.934E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.113E-03	3.910E+03	3.000E+03	1.348E+03	3.555E+02	2.472E+01	8.311E-03	1.351E-08	0.0	0.0	0.0	0.0	
3.128E-02	1.128E+00	4.055E-03	1.898E-10	1.151E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.020E-03	1.685E+02	4.710E+00	1.029E-04	1.757E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.509E-03	6.884E+03	5.772E+03	3.890E+03	2.015E+03	5.409E+02	1.046E+01	1.459E-02	5.484E-14	0.0	0.0	0.0	
1.368E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.513E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.832E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.080E-00	5.080E+00	5.080E+00	5.079E+00	5.079E+00	5.079E+00	5.079E+00	5.075E+00	5.066E+00	5.038E+00	4.949E+00	4.858E+00	
6.931E-02	6.879E+02	8.827E+02	8.875E+02	8.428E+02	5.981E+02	4.755E+02	3.263E+02	7.230E+01	3.705E-01	1.058E-07	0.0	
1.088E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.458E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.318E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.708E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.280E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.875E-01	8.840E-02	2.351E-02	1.044E-03	5.813E-06	1.802E-10	5.386E-24	0.0	0.0	0.0	0.0	0.0	
2.810E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.894E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.890E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.377E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.870E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.364E-11	8.582E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.215E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.718E-05	4.485E-07	2.968E-09	8.717E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.899E-08	7.713E-08	7.532E-08	7.013E-08	8.228E-08	4.907E-08	2.403E-08	7.309E-09	8.259E-11	3.835E-10	0.0	0.0	
1.056E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.801E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.778E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.917E-01	7.715E-04	7.534E-08	7.015E-08	8.228E-08	4.908E-08	2.403E-08	7.311E-09	8.261E-11	3.838E-10	0.0	0.0	
8.834E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.650E-04	2.192E-06	2.895E-08	8.884E-14	2.875E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.493E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.601E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.553E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.793E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.780E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.072E-08	8.072E-08	8.072E-08	8.072E-08	8.072E-08	8.072E-08	8.072E-08	8.072E-08	8.071E-08	8.069E-08	8.061E-08	8.038E-08	
1.413E-01	2.702E-03	5.187E-05	3.812E-10	9.233E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.137E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.263E-01	3.410E-10	5.137E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.337E-07	8.882E-07	1.225E-08	2.139E-08	3.383E-08	5.094E-06	7.111E-08	7.825E-06	7.688E-06	7.605E-06	7.658E-06	7.834E-06	
1.282E-00	1.282E+00	1.282E+00	1.282E+00	1.281E+00	1.281E+00	1.283E+00	1.277E+00	1.269E+00	1.239E+00	1.157E+00	9.110E-01	
1.451E-03	1.087E+00	9.234E-04	8.023E-10	2.050E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.000E-03	2.005E-05	3.833E-07	2.880E-12	6.849E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.848E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.478E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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Table B.2. (cont'd) Radioactivity in PWR Fuel Assembly Grids, Sleeves and Other Components

Curies/MTU

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33QWD/MT BURNUP GRIDS & SLEEVES
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

	7 SUMMARY TABLE: RADIOACTIVITY, CURIES											
	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
NB 97M	6.754E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 98	1.184E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB100	5.782E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 93M	1.807E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 93	2.529E-02	2.528E-02	2.528E-02	2.527E-02	2.524E-02	2.519E-02	2.504E-02	2.480E-02	2.383E-02	2.075E-02	1.398E-02	3.488E-03
MO 99	1.128E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO101	2.793E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC 98	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.177E-10	4.178E-10	4.175E-10	4.170E-10
TC 99	1.049E-03	1.054E-03	1.054E-03	1.054E-03	1.054E-03	1.054E-03	1.054E-03	1.054E-03	1.053E-03	1.051E-03	1.044E-03	1.021E-03
TC100	2.815E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	2.793E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU103	5.652E-02	8.955E-05	4.18E-07	5.884E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU105	4.418E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU106	2.599E-13	1.307E-13	8.570E-14	8.350E-15	2.882E-18	2.897E-19	0.0	0.0	0.0	0.0	0.0	0.0
RU107	3.214E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH102	1.094E-09	8.817E-10	8.785E-10	3.312E-10	1.003E-10	9.185E-12	7.063E-15	4.558E-20	0.0	0.0	0.0	0.0
RH104	1.408E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH104M	1.020E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105	4.078E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105M	1.237E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH106	2.307E-08	1.307E-13	8.570E-14	8.350E-15	2.882E-18	2.897E-19	0.0	0.0	0.0	0.0	0.0	0.0
RH106M	1.121E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH107	3.214E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD107	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.854E-18	7.853E-18	7.851E-18	7.846E-18
PD107M	4.584E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109	4.497E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109M	7.300E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD111	1.014E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG108	2.088E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG109M	4.495E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG110	4.818E-15	2.594E-19	9.417E-20	4.873E-21	3.074E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG110M	5.388E-17	1.950E-17	7.055E-18	3.884E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG111	3.858E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG111M	1.051E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD111M	2.107E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA182	3.402E-03	3.764E-04	4.164E-05	5.848E-08	9.359E-13	2.572E-22	0.0	0.0	0.0	0.0	0.0	0.0
TA182M	6.921E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA183	1.029E-02	2.841E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W181	4.052E-02	5.016E-03	8.209E-04	1.178E-06	3.423E-11	2.891E-20	0.0	0.0	0.0	0.0	0.0	0.0
W183M	5.612E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185	1.128E-00	3.874E-02	1.331E-03	5.394E-08	2.580E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185M	1.285E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W187	2.093E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W188	5.708E-02	1.486E-03	3.869E-05	8.832E-10	8.181E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W189	2.947E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE186	7.409E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE187	7.682E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10	7.874E-10
RE188	7.115E-00	1.501E-03	3.909E-05	8.903E-10	8.265E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE188M	6.907E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE189	3.494E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS190M	8.158E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191	5.899E-04	4.420E-11	3.222E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 8.2. (cont'd) Radioactivity in PWR Fuel Assembly Grids, Sleeves and Other Components
Curies/MTU

OUTPUT UNIT = 0

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*PWR, 3.2 W/O ENRICHMENT, 33GW0/MT BURNUP, GRIDS & SLEEVES
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.89E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED												
DISCHO.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
OS191M	4.524E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS193	9.283E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS194	2.606E-12	2.323E-12	2.070E-12	1.404E-12	8.214E-13	2.587E-13	8.085E-15	2.808E-17	0.0	0.0	0.0	0.0
IR192	1.564E-04	8.113E-08	1.873E-07	1.823E-10	1.542E-10	1.498E-10	1.374E-10	1.190E-10	8.898E-11	8.943E-12	2.840E-14	5.121E-23
IR192M	1.588E-10	1.581E-10	1.576E-10	1.563E-10	1.541E-10	1.497E-10	1.373E-10	1.189E-10	8.890E-11	8.935E-12	2.838E-14	5.117E-23
IR194	6.408E-08	2.324E-12	2.071E-12	1.464E-12	8.217E-13	2.588E-13	8.088E-15	2.509E-17	0.0	0.0	0.0	0.0
IR194M	3.376E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT193	1.041E-09	1.047E-09	1.045E-09	1.041E-09	1.034E-09	1.019E-09	8.778E-10	8.123E-10	8.914E-10	2.820E-10	1.638E-11	9.995E-18
PT193M	3.130E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT195M	3.491E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197	1.054E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197M	7.142E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU198	8.646E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU199	2.089E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU200	8.829E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HG199M	3.372E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	1.001E+05	1.171E+04	9.820E+03	5.928E+03	3.021E+03	1.169E+03	4.930E+02	3.332E+02	7.923E+01	7.187E+00	8.530E+00	5.749E+00
TOTAL	1.001E+05	1.171E+04	9.820E+03	5.928E+03	3.021E+03	1.169E+03	4.930E+02	3.332E+02	7.923E+01	7.187E+00	8.530E+00	5.749E+00

Table B.3. Radioactivity in PWR Fuel Assembly End Fittings

Curies/MTU

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33GW0/MT BURNUP END FITTINGS
 POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.50E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES		METRIC TON URANIUM METAL AS LOADED											
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
H 3	1.123E-08	1.082E-08	1.004E-08	8.488E-07	6.409E-07	3.858E-07	6.788E-08	4.101E-09	5.463E-14	0.0	0.0	0.0	0.0
H 4	5.734E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 6	3.570E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LI 8	2.438E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 8	8.180E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 10	9.751E-10	9.751E-10	9.751E-10	9.751E-10	9.751E-10	9.751E-10	9.751E-10	9.751E-10	9.751E-10	9.751E-10	9.751E-10	9.751E-10	9.751E-10
BE 11	1.978E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 12	4.941E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 14	7.718E-03	7.718E-03	7.717E-03	7.714E-03	7.709E-03	7.700E-03	7.872E-03	7.826E-03	7.444E-03	8.839E-03	5.369E-03	2.302E-03	0.0
C 15	3.703E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C 16	1.160E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F 20	2.323E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE 23	1.098E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24	3.690E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24M	5.150E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 25	1.657E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 27	5.047E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 28	4.604E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 28	8.035E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 29	2.050E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 30	1.978E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 31	3.958E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 32	1.711E-10	1.709E-10	1.707E-10	1.702E-10	1.693E-10	1.675E-10	1.622E-10	1.538E-10	1.243E-10	5.890E-11	8.880E-12	4.060E-15	0.0
P 33	6.092E-01	1.264E-08	1.707E-10	1.702E-10	1.693E-10	1.675E-10	1.622E-10	1.538E-10	1.243E-10	5.890E-11	8.880E-12	4.000E-15	0.0
P 34	2.181E-05	8.722E-10	3.488E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 35	1.122E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 35	1.250E-02	7.038E-04	3.983E-05	7.074E-09	4.003E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 37	3.242E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 38	2.815E-09	2.815E-09	2.815E-09	2.815E-09	2.815E-09	2.815E-09	2.815E-09	2.815E-09	2.813E-09	2.809E-09	2.798E-09	2.751E-09	0.0
CL 38M	3.724E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 39	4.433E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 37	8.942E-12	6.487E-15	4.708E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 39	5.203E-14	5.189E-14	5.178E-14	5.138E-14	5.070E-14	4.941E-14	4.574E-14	4.021E-14	2.402E-14	1.955E-15	2.285E-17	1.353E-25	0.0
AR 41	2.578E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 42	4.678E-25	4.678E-25	4.676E-25	4.676E-25	4.676E-25	4.676E-25	4.678E-25	4.678E-25	4.678E-25	4.678E-25	4.678E-25	4.678E-25	0.0
K 42	4.360E-16	4.677E-25	4.677E-25	4.677E-25	4.677E-25	4.677E-25	4.678E-25	4.678E-25	4.678E-25	4.678E-25	4.678E-25	4.678E-25	0.0
K 43	7.204E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K 44	5.791E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CA 45	1.380E-09	2.818E-10	6.172E-11	5.836E-13	2.471E-16	4.424E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CA 47	2.047E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 48	1.613E-11	7.801E-13	3.831E-14	4.438E-18	1.220E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 48M	8.702E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 47	7.823E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 48	8.881E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 49	2.097E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 50	1.810E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TI 51	2.557E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 50	7.329E-17	7.329E-17	7.329E-17	7.329E-17	7.329E-17	7.329E-17	7.329E-17	7.329E-17	7.329E-17	7.329E-17	7.329E-17	7.329E-17	7.329E-17
V 52	5.820E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 53	1.608E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 54	1.830E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 51	3.339E-02	3.593E-02	3.867E-08	4.818E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Table B.3. (cont'd) Radioactivity in PWR Fuel Assembly End Fittings

Curies/MTU

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, END FITTINGS
 POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.50E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
CR 55	5.183E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 54	1.769E+01	7.825E+00	3.481E+00	3.063E-01	8.332E-03	1.818E-08	4.498E-17	0.0	0.0	0.0	0.0	0.0
MN 56	8.624E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 57	8.145E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 58	1.705E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	1.087E+02	8.330E+01	8.380E+01	2.887E+01	7.581E+00	8.258E-01	1.768E-04	2.873E-10	0.0	0.0	0.0	0.0
FE 59	6.720E+00	2.422E-02	8.738E-05	4.086E-12	2.480E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	1.703E+01	4.760E-01	1.331E-02	2.808E-07	4.865E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 60	1.750E+01	1.540E+01	1.350E+01	8.088E+00	4.713E+00	1.265E+00	2.445E-02	3.412E-05	1.283E-18	0.0	0.0	0.0
CO 60M	3.221E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 61	3.865E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 62	2.400E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 59	1.435E-02	1.435E-02	1.435E-02	1.435E-02	1.435E-02	1.435E-02	1.435E-02	1.434E-02	1.432E-02	1.423E-02	1.399E-02	1.318E-02
NI 63	1.858E+00	1.844E+00	1.929E+00	1.886E+00	1.818E+00	1.864E+00	1.344E+00	8.219E-01	2.043E-01	1.047E-03	2.801E-10	0.0
NI 65	3.014E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 66	2.871E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 64	1.314E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 66	1.741E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 67	2.890E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 65	1.808E+06	8.402E-07	2.287E-07	1.006E-08	5.601E-11	1.730E-15	0.0	0.0	0.0	0.0	0.0	0.0
ZN 69	1.898E+10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 69M	1.141E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 70	4.358E+13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	2.188E+18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	8.755E+20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71	5.443E+19	2.818E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71M	4.925E+17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 69	3.876E+10	2.443E-12	1.824E-14	4.771E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 90	3.115E+12	3.042E-12	2.870E-12	2.766E-12	2.465E-12	1.835E-12	8.478E-13	2.883E-13	2.468E-15	1.434E-22	0.0	0.0
SR 91	4.775E+13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 93	5.069E+22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 90	2.914E+05	3.043E-12	2.971E-12	2.766E-12	2.458E-12	1.836E-12	8.470E-13	2.883E-13	2.468E-15	1.434E-22	0.0	0.0
Y 90M	4.247E+18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 91	1.213E+09	1.802E-11	2.115E-13	4.870E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 92	8.657E+10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 93	8.069E+22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 94	2.835E+13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 96	6.747E+22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 93	3.192E+10	3.192E-10	3.192E-10	3.192E-10	3.192E-10	3.192E-10	3.192E-10	3.191E-10	3.191E-10	3.190E-10	3.187E-10	3.177E-10
ZR 95	1.382E+09	2.803E-11	4.978E-13	3.480E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 97	9.737E+18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 92	7.224E+04	1.086E-14	1.840E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 93M	2.112E+11	3.514E-11	4.848E-11	8.457E-11	1.338E-10	2.014E-10	2.811E-10	3.015E-10	3.032E-10	3.031E-10	3.028E-10	3.018E-10
NB 94	5.417E+05	5.417E-05	5.417E-05	5.416E-05	5.415E-05	5.413E-05	5.408E-05	5.399E-05	5.382E-05	5.235E-05	4.890E-05	3.850E-05
NB 95	8.131E+02	4.566E-05	3.400E-08	2.177E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 95M	9.858E+12	1.931E-13	3.893E-15	2.582E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 96	8.938E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97	4.126E+12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97M	9.214E+18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 98	8.516E+18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 99	8.241E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 101	4.981E+18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Table B.3. (cont'd) Radioactivity in PWR Fuel Assembly End Fittings
Curies/MTU

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, END FITTINGS
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED													
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
TC 98	1.437E-24	1.437E-24	1.437E-24	1.437E-24	1.437E-24	1.437E-24	1.437E-24	1.437E-24	1.437E-24	1.437E-24	1.437E-24	1.437E-24	1.437E-24
TC 99	1.350E-17	1.386E-17	1.386E-17	1.386E-17	1.386E-17	1.386E-17	1.386E-17	1.386E-17	1.386E-17	1.386E-17	1.382E-17	1.373E-17	1.342E-17
TC100	3.621E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	4.981E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	1.214E+03	1.090E+02	8.275E+01	3.999E+01	1.412E+01	3.497E+00	1.390E+00	9.440E-01	2.261E-01	2.217E-02	1.940E-02	1.550E-02	
TOTAL	1.214E+03	1.090E+02	8.275E+01	3.999E+01	1.412E+01	3.497E+00	1.390E+00	9.440E-01	2.261E-01	2.217E-02	1.940E-02	1.550E-02	

Table B.4. Total Radioactivity in BWR Fuel Assembly components including Fuel Channel

Curies/MTU

+BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, FUEL ASSEMBLY W/FUEL CHANNEL
POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES										
		METRIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
H 3		1.402E-04	1.326E-04	1.253E-04	1.059E-04	7.999E-05	4.563E-05	8.471E-06	5.116E-07	8.818E-12	0.0	0.0
H 4		3.133E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 6		1.878E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LI 8		1.898E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 8		2.019E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 10		1.055E-07	1.055E-07	1.055E-07	1.055E-07	1.055E-07	1.055E-07	1.055E-07	1.055E-07	1.054E-07	1.053E-07	1.050E-07
BE 11		1.501E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 12		1.181E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CC 14		5.568E-01	5.567E-01	5.567E-01	5.565E-01	5.561E-01	5.534E-01	5.501E-01	5.369E-01	4.933E-01	3.873E-01	1.661E-01
15		3.580E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16		2.108E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19		3.468E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20		1.007E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23		7.484E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24		4.244E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24M		3.433E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25		1.131E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27		2.034E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28		1.301E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28		7.133E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29		1.930E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30		1.861E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31		4.082E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32		1.790E-09	1.788E-09	1.786E-09	1.780E-09	1.771E-09	1.752E-09	1.697E-09	1.609E-09	1.300E-09	8.162E-10	7.302E-11
32		1.844E-01	3.792E-07	1.780E-09	1.781E-09	1.771E-09	1.752E-09	1.697E-09	1.609E-09	1.300E-09	8.162E-10	7.302E-11
33		1.763E-03	7.051E-08	2.820E-12	1.803E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34		6.724E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35		1.028E-00	5.790E-02	3.260E-03	5.820E-07	3.294E-13	1.055E-25	0.0	0.0	0.0	0.0	0.0
37		2.520E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36		3.278E-07	3.278E-07	3.278E-07	3.278E-07	3.278E-07	3.278E-07	3.277E-07	3.278E-07	3.271E-07	3.256E-07	3.204E-07
38		2.949E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38M		3.511E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37		1.059E-09	7.685E-13	5.575E-16	2.129E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39		5.637E-12	5.622E-12	5.608E-12	5.585E-12	5.493E-12	5.354E-12	4.955E-12	4.356E-12	2.802E-12	4.285E-13	2.475E-15
41		7.452E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42		2.358E-16	2.309E-16	2.261E-16	2.123E-16	1.911E-16	1.549E-16	8.249E-17	2.886E-17	4.318E-19	1.777E-25	0.0
42		2.749E-24	2.749E-24	2.749E-24	2.749E-24	2.749E-24	2.749E-24	2.749E-24	2.749E-24	2.749E-24	2.749E-24	2.749E-24
40		1.430E-09	2.309E-16	2.261E-16	2.123E-16	1.911E-16	1.549E-16	8.249E-17	2.886E-17	4.324E-19	1.778E-25	0.0
43		9.350E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44		1.663E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45		7.931E-03	1.577E-03	3.547E-04	3.356E-08	1.420E-09	2.543E-16	0.0	0.0	0.0	0.0	0.0
47		8.984E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46M		9.717E-01	4.736E-02	2.308E-03	2.872E-07	7.350E-14	0.0	0.0	0.0	0.0	0.0	0.0
47		1.343E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48		1.520E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48		1.416E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49		1.419E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50		2.429E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51		3.780E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51		3.276E-15	3.276E-15	3.276E-15	3.276E-15	3.276E-15	3.276E-15	3.276E-15	3.276E-15	3.276E-15	3.276E-15	3.276E-15
52		2.544E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53		2.233E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.4. (cont'd) Total Radioactivity in DWR Fuel Assembly Components including Fuel Channel

Curies/MTU

*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP FUEL ASSEMBLY W/FUEL CHANNEL
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
Y 54	2.655E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 54	8.331E+03	8.813E-01	7.331E-05	8.134E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 55	8.617E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 54	1.850E+02	8.875E+01	3.850E+01	3.398E+00	5.911E-02	1.792E-05	4.988E-18	0.0	0.0	0.0	0.0	0.0
MN 56	1.105E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 57	8.184E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 58	1.752E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	1.878E+03	1.437E+03	1.101E+03	4.948E+02	1.304E+02	8.089E+00	3.044E-03	4.956E-09	0.0	0.0	0.0	0.0
FE 59	9.408E+01	3.391E-01	1.222E-03	5.715E-11	3.469E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	7.894E+02	2.207E+01	8.170E-01	1.348E-05	2.302E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 60	1.909E+03	1.873E+03	1.487E+03	9.888E+02	5.123E+02	1.375E+02	2.658E+00	3.684E-03	1.385E-14	0.0	0.0	0.0
CO 60M	2.652E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 61	2.888E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 62	8.341E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 59	8.955E-01	8.955E-01	8.955E-01	8.955E-01	8.954E-01	8.954E-01	8.951E-01	8.947E-01	8.932E-01	8.878E-01	8.725E-01	8.212E-01
NI 63	1.375E+02	1.385E+02	1.355E+02	1.324E+02	1.275E+02	1.183E+02	9.435E+01	8.473E+01	1.435E+01	7.350E-02	2.100E-08	0.0
NI 85	1.527E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 86	9.490E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 84	1.098E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 86	2.448E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 87	2.848E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 85	8.973E-02	2.489E-02	8.743E-03	3.882E-04	2.161E-08	8.898E-11	1.995E-24	0.0	0.0	0.0	0.0	0.0
ZN 89	8.707E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 89M	8.954E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 70	2.735E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	1.988E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	6.173E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71	4.434E-12	2.133E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71M	3.816E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 89	2.580E+01	1.715E+01	1.140E+03	3.348E+10	4.348E+21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 90	1.148E+03	1.121E+03	1.094E+03	1.019E+03	9.048E+04	7.130E+04	3.491E+04	1.062E+04	9.094E+07	5.282E+14	0.0	0.0
SR 91	4.984E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 93	1.708E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 90	0.453E+02	1.121E+03	1.095E+03	1.019E+03	9.048E+04	7.131E+04	3.492E+04	1.062E+04	9.098E+07	5.283E+14	0.0	0.0
Y 90M	5.884E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 91	6.544E+01	8.844E+01	1.141E+02	2.828E+08	1.055E+17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 92	1.188E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 93	1.708E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 94	3.551E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 96	2.273E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 93	1.483E+01	1.463E+01	1.463E+01	1.463E+01	1.463E+01	1.463E+01	1.463E+01	1.463E+01	1.463E+01	1.462E+01	1.461E+01	1.456E+01
ZR 95	3.021E+04	5.778E+02	1.104E+01	7.721E-05	1.974E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 97	4.395E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 92	9.480E+02	1.425E+12	2.148E+23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 93M	1.288E+02	1.913E+02	2.508E+02	4.123E+02	6.322E+02	9.347E+02	1.291E+01	1.382E+01	1.390E+01	1.389E+01	1.388E+01	1.384E+01
NB 94	8.878E+02	8.878E+02	8.878E+02	8.877E+02	8.875E+02	8.872E+02	8.883E+02	8.848E+02	8.788E+02	8.580E+02	8.014E+02	6.310E+02
NB 95	3.009E+04	1.300E+03	2.539E+01	1.714E+04	4.382E+13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 95M	2.127E+02	4.285E+00	8.193E+02	8.728E+07	1.484E+15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 96	2.387E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97	4.395E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97M	4.155E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 98	1.584E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.4. (cont'd) Total Radioactivity in BWR Fuel Assembly Components including Fuel Channel

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, FUEL ASSEMBLY W/FUEL CHANNEL
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES													
DISCHG.	METRIC TON URANIUM METAL AS LOADED												
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
NB100	1.214E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MO 99	9.459E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MO101	7.952E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TC 98	6.142E-13	6.142E-13	6.142E-13	6.142E-13	6.142E-13	6.142E-13	6.142E-13	6.142E-13	6.142E-13	6.141E-13	6.139E-13	6.132E-13	
TC 99	4.349E-08	4.391E-08	4.391E-08	4.391E-08	4.391E-08	4.390E-08	4.390E-08	4.389E-08	4.386E-08	4.377E-08	4.348E-08	4.250E-08	
TC100	8.067E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TC101	7.952E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU103	4.403E-09	6.984E-12	1.111E-14	4.453E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU105	2.332E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU102	2.112E-17	1.663E-17	1.309E-17	6.389E-18	1.938E-18	1.748E-19	1.344E-22	0.0	0.0	0.0	0.0	0.0	
RU104	9.167E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU104M	3.794E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU105	2.209E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU105M	6.529E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU106	4.641E-10	1.875E-23	1.875E-23	1.875E-23	1.875E-23	1.875E-23	0.0	0.0	0.0	0.0	0.0	0.0	
RU106M	4.265E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD107	1.632E-16	1.632E-16	1.632E-16	1.632E-16	1.632E-16	1.631E-16	1.631E-16	1.631E-16	1.631E-16	1.631E-16	1.631E-16	1.630E-16	
PD107M	1.554E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD109	6.370E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD109M	1.035E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD111	1.198E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD111M	1.669E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AG106	1.747E-08	2.027E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AG108	3.143E-04	1.951E-08	1.940E-08	1.909E-08	1.857E-08	1.759E-08	1.493E-08	1.137E-08	3.816E-09	8.364E-11	1.521E-15	0.0	
AG108M	2.204E-07	2.192E-07	2.180E-07	2.145E-07	2.087E-07	1.978E-07	1.878E-07	1.277E-07	4.287E-08	9.398E-10	1.709E-14	0.0	
AG109M	2.420E-03	1.402E-03	8.124E-04	1.581E-04	1.033E-05	4.411E-08	3.433E-15	0.0	0.0	0.0	0.0	0.0	
AG110	1.215E-03	2.170E-07	7.879E-08	3.771E-09	2.379E-11	9.468E-16	0.0	0.0	0.0	0.0	0.0	0.0	
AG110M	4.494E-05	1.632E-05	5.924E-08	2.835E-07	1.768E-09	7.118E-14	0.0	0.0	0.0	0.0	0.0	0.0	
AG111	2.284E-06	3.986E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AG111M	1.242E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AG112	1.587E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD107	2.295E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD109	2.419E-03	1.402E-03	8.124E-04	1.581E-04	1.033E-05	4.411E-08	3.433E-15	0.0	0.0	0.0	0.0	0.0	
CD111M	3.903E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD115	5.850E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD115M	4.934E-02	1.690E-04	5.781E-07	2.319E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD117	3.241E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD117M	5.788E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD119	4.679E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD121	1.472E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN113M	5.992E-02	6.846E+01	7.368E+00	1.004E-02	1.678E-07	4.703E-17	0.0	0.0	0.0	0.0	0.0	0.0	
IN114	1.990E-02	4.823E-01	2.902E-03	6.323E-10	4.987E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN114M	8.372E-01	5.039E-01	3.033E-03	6.607E-10	5.211E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN115	8.860E-17	1.008E-16	1.007E-16	1.007E-16	1.007E-16	1.007E-16	1.007E-16	1.007E-16	1.007E-16	1.007E-16	1.007E-16	1.007E-16	
IN116	2.334E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN116M	3.207E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN117	2.037E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN117M	3.040E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN118	6.422E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN119	4.666E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN119M	4.679E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN120	8.779E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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Table B.4. (cont'd) Total Radioactivity in BWR Fuel Assembly Components including Fuel Channel

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.6 W/O ENRICHMENT, 28 GWD/MT BURNUP FUEL ASSEMBLY W/FUEL CHANNEL
POWER= 1.01800E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
IN120M	1.183E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN121	1.287E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN113	5.881E+02	8.842E+01	7.383E+00	1.001E-02	1.877E-07	4.700E-17	0.0	0.0	0.0	0.0	0.0	0.0
SN113M	2.881E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN117M	4.537E+03	8.534E-05	9.208E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN119M	4.654E+03	1.856E+03	5.893E+02	2.858E+01	1.518E-01	4.934E-06	1.702E-19	0.0	0.0	0.0	0.0	0.0
SN121	2.212E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN121M	6.340E-01	8.253E-01	8.187E-01	8.815E-01	5.518E-01	4.804E-01	3.189E-01	1.584E-01	9.884E-03	8.000E-07	5.373E-18	0.0
SN123	2.183E+02	3.075E+01	4.332E+00	1.210E-02	8.708E-07	2.062E-15	0.0	0.0	0.0	0.0	0.0	0.0
SN123M	8.712E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN125	1.444E+03	5.878E-09	2.230E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN125M	1.144E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB122	2.723E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB122M	2.401E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB124	1.380E+01	2.057E-01	3.088E-03	1.017E-08	7.491E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB124M	4.288E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB125	1.483E+03	1.105E+03	9.073E+02	4.282E+02	1.225E+02	1.003E+01	5.509E-03	2.028E-08	0.0	0.0	0.0	0.0
SB126	8.155E+01	3.787E-08	5.121E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB126M	8.088E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE123	3.784E-13	4.378E-13	4.452E-13	4.462E-13	4.462E-13	4.462E-13	4.462E-13	4.462E-13	4.462E-13	4.462E-13	4.462E-13	4.462E-13
TE123M	2.131E+00	2.569E-01	3.097E-02	5.434E-05	1.385E-09	8.998E-19	0.0	0.0	0.0	0.0	0.0	0.0
TE125M	3.271E+02	2.838E+02	2.214E+02	1.045E+02	2.990E+01	2.448E+00	1.344E-03	4.947E-09	0.0	0.0	0.0	0.0
TE127	2.682E-01	1.803E-03	1.868E-04	1.757E-07	1.590E-12	1.302E-22	0.0	0.0	0.0	0.0	0.0	0.0
TE127M	1.982E-02	1.843E-03	1.905E-04	1.784E-07	1.823E-12	1.329E-22	0.0	0.0	0.0	0.0	0.0	0.0
TE129	4.191E-07	4.137E-12	2.210E-15	3.186E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE129M	1.180E-08	6.356E-12	3.395E-15	5.171E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I128	1.008E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I129	1.302E-14	1.309E-14	1.309E-14	1.309E-14	1.309E-14	1.309E-14	1.309E-14	1.309E-14	1.309E-14	1.309E-14	1.309E-14	1.309E-14
I130	9.558E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I130M	4.051E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I131	8.654E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I132	5.999E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE127	1.753E-08	1.876E-11	1.802E-14	1.398E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE129M	2.785E-08	4.987E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE131M	3.450E-10	1.981E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE133	1.198E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE133M	3.779E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS132	1.384E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS134	3.734E-18	2.808E-16	1.907E-16	8.954E-17	1.295E-17	4.807E-19	1.921E-23	0.0	0.0	0.0	0.0	0.0
CS134M	3.316E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS135	1.198E-23	1.198E-23	1.198E-23	1.198E-23	1.198E-23	1.198E-23	1.198E-23	1.198E-23	1.198E-23	1.198E-23	1.198E-23	1.195E-23
CS136	6.311E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA135M	4.808E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA136M	1.040E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ER169	6.208E-14	1.247E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ER171	2.606E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ER172	5.566E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IM170	1.373E-14	1.817E-15	2.677E-16	7.949E-19	4.217E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IM170M	1.373E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IM171	8.200E-16	5.723E-16	3.989E-18	1.351E-18	2.220E-17	5.874E-19	1.162E-23	0.0	0.0	0.0	0.0	0.0
IM172	1.544E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IM173	1.616E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.4. (cont'd) Total Radioactivity in BWR Fuel Assembly Components including Fuel Channel

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP FUEL ASSEMBLY W/FUEL CHANNEL
POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

DISCHG.	7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
YB175	8.537E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YB175M	8.041E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU178	3.038E-11	3.038E-11	3.038E-11	3.038E-11	3.038E-11	3.038E-11	3.038E-11	3.038E-11	3.038E-11	3.038E-11	3.038E-11
LU178M	4.830E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU177	1.770E+00	2.181E-04	4.280E-05	3.173E-07	9.008E-11	7.281E-18	0.0	0.0	0.0	0.0	0.0
LU177M	4.858E-03	8.486E-04	1.852E-04	1.389E-06	3.917E-10	3.157E-17	0.0	0.0	0.0	0.0	0.0
HF175	9.988E+00	2.678E-01	7.195E-03	1.396E-07	1.955E-15	0.0	0.0	0.0	0.0	0.0	0.0
HF178M	1.101E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF179M	1.890E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF180M	1.938E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF181	1.505E+02	8.940E-01	2.283E-03	3.785E-11	4.082E-24	0.0	0.0	0.0	0.0	0.0	0.0
HF182	1.058E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07
TA182	4.81E-01	3.823E+00	2.37E-01	5.727E-04	3.153E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07	3.058E-07
TA182M	4.69E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA183	2.62E-01	2.005E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W181	2.642E-01	8.984E-02	8.846E-03	1.842E-05	4.771E-10	4.030E-19	0.0	0.0	0.0	0.0	0.0
W183M	1.801E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185	1.580E-01	5.160E-01	1.841E-02	7.463E-07	3.569E-14	0.0	0.0	0.0	0.0	0.0	0.0
W185M	1.748E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W187	2.868E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W188	6.18E-01	1.463E-02	3.810E-04	8.727E-09	8.055E-17	0.0	0.0	0.0	0.0	0.0	0.0
W189	4.758E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE188	1.024E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE187	1.482E-08	1.484E-08	1.484E-08	1.484E-08	1.484E-08	1.484E-08	1.484E-08	1.484E-08	1.484E-08	1.484E-08	1.484E-08
RE188	9.546E-01	1.478E-02	3.849E-04	8.796E-09	8.138E-17	0.0	0.0	0.0	0.0	0.0	0.0
RE188M	2.87E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE189	3.288E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS190M	7.989E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191	8.206E-03	6.134E-10	4.471E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191M	5.744E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS193	1.505E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS194	4.198E-11	3.740E-11	3.332E-11	2.356E-11	1.322E-11	4.185E-12	1.302E-13	4.036E-18	0.0	0.0	0.0
IR192	2.457E-03	8.033E-05	2.828E-06	1.151E-09	3.018E-09	2.930E-09	2.888E-09	2.328E-09	1.310E-09	1.749E-10	5.558E-13
IR192M	3.101E-09	3.092E-09	3.084E-09	3.057E-09	3.013E-09	2.828E-09	2.886E-09	2.326E-09	1.308E-09	1.748E-10	5.551E-13
IR194	7.354E-05	3.741E-11	3.333E-11	2.357E-11	1.323E-11	4.187E-12	1.302E-13	4.040E-18	0.0	0.0	0.0
IR194M	3.877E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT193	2.400E-08	2.409E-08	2.405E-08	2.395E-08	2.379E-08	2.346E-08	2.250E-08	2.100E-08	1.591E-08	6.030E-09	3.769E-10
PT193M	5.075E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT195M	4.052E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197	1.236E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197M	8.374E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU198	1.082E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU199	1.834E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU200	4.208E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HG199M	4.246E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	2.381E+05	8.517E+03	4.519E+03	2.181E+03	9.252E+02	2.796E+02	9.915E+01	6.871E+01	1.616E+01	1.826E+00	1.625E+00
TOTAL	2.381E+05	8.517E+03	4.519E+03	2.181E+03	9.252E+02	2.796E+02	9.915E+01	6.871E+01	1.616E+01	1.826E+00	1.625E+00

Table B.5. Radioactivity in BWR Fuel Assembly Grids, Springs and Other Components

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, GRIDS & SPRINGS & THINGS
 POWER= 1.91600E+01 MW, BURNUP= 2.60000E+04 MWD, FLUX= 1.85E+14 N/CM+2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISCHQ.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
7.458E-08	7.051E-08	8.888E-08	5.833E-08	4.255E-08	2.427E-08	4.508E-07	2.722E-08	3.827E-13	0.0	0.0	0.0	
1.313E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.133E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.114E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9.087E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.313E-09	8.313E-09	8.313E-09	8.313E-09	8.313E-09	8.313E-09	8.313E-09	8.313E-09	8.312E-09	8.310E-09	8.305E-09	8.288E-09	
8.981E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.325E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.793E-02	8.792E-02	8.791E-02	8.789E-02	8.785E-02	8.776E-02	8.752E-02	8.711E-02	8.551E-02	8.019E-02	4.725E-02	2.028E-02	
1.514E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.913E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.468E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.255E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.557E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.185E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.925E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.294E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.514E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9.887E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.981E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.208E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.129E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.687E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.184E-10	1.182E-10	1.181E-10	1.177E-10	1.171E-10	1.159E-10	1.122E-10	1.084E-10	8.596E-11	4.075E-11	4.829E-12	2.787E-15	
7.250E-01	1.496E-08	1.181E-10	1.177E-10	1.171E-10	1.159E-10	1.122E-10	1.084E-10	8.597E-11	4.075E-11	4.829E-12	2.787E-15	
8.842E-05	3.538E-09	1.414E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.72E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.57E-02	2.804E-03	1.835E-04	2.918E-08	1.852E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.314E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.644E-08	1.644E-08	1.644E-08	1.644E-08	1.644E-08	1.644E-08	1.644E-08	1.643E-08	1.643E-08	1.640E-08	1.632E-08	1.606E-08	
1.479E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.761E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.312E-11	3.854E-14	2.798E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.828E-13	2.821E-13	2.813E-13	2.792E-13	2.768E-13	2.888E-13	2.488E-13	2.188E-13	1.305E-13	2.150E-14	1.242E-18	1.822E-24	
8.820E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.158E-18	2.113E-18	2.089E-18	1.943E-18	1.749E-18	1.418E-18	7.550E-17	2.841E-17	1.952E-19	1.827E-25	0.0	0.0	
1.379E-25	1.379E-25	1.379E-25	1.379E-25	1.379E-25	1.379E-25	1.379E-25	1.379E-25	1.379E-25	1.379E-25	1.379E-25	1.379E-25	
1.309E-09	2.113E-18	2.089E-18	1.943E-18	1.749E-18	1.418E-18	7.550E-17	2.842E-17	1.958E-19	1.827E-25	0.0	0.0	
8.557E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.522E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.250E-03	1.535E-03	3.247E-04	3.072E-08	1.300E-09	2.327E-18	0.0	0.0	0.0	0.0	0.0	0.0	
8.221E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.894E-01	4.335E-02	2.113E-03	2.446E-07	8.727E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.229E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.391E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.293E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.288E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.222E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.410E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.788E-16	3.788E-16	3.788E-16	3.788E-16	3.788E-16	3.788E-16	3.788E-16	3.788E-16	3.788E-16	3.788E-16	3.788E-16	3.788E-16	
2.745E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.693E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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Table B.5. (cont'd) Radioactivity in BWR Fuel Assembly Grids, Springs and Other Components

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GND/MT BURNUP GRIDS & SPRINGS & THINGS
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM*2-SEC

ACTIVATION PRODUCTS

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES METALIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
Y 54	5.363E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 55	1.328E+03	1.430E-01	1.539E-05	1.818E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 56	2.003E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 54	7.979E+00	3.649E+00	1.879E+00	1.389E-01	2.418E-03	7.329E-07	2.041E-17	0.0	0.0	0.0	0.0	0.0
MN 56	1.367E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 57	2.823E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 58	1.035E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	1.121E+03	8.585E+01	8.576E+01	2.855E+01	7.793E+00	5.419E-01	1.822E-04	2.981E-10	0.0	0.0	0.0	0.0
FE 58	5.560E+00	2.004E-03	7.221E-05	3.377E-12	2.050E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	8.118E+02	1.710E+01	4.782E-01	1.045E-08	1.784E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 60	1.290E+03	1.131E+03	9.818E+02	8.884E+02	3.463E+02	9.294E+01	1.797E+00	2.503E-03	9.408E-15	0.0	0.0	0.0
CO 60M	1.791E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 61	1.808E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 62	7.044E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 59	2.940E+01	8.940E-01	8.940E-01	8.940E-01	8.940E-01	8.939E-01	8.937E-01	8.934E-01	8.922E-01	8.880E-01	8.782E-01	8.384E-01
NI 63	1.068E+02	1.058E+02	1.050E+02	1.028E+02	9.883E+01	9.188E+01	7.312E+01	5.017E+01	1.112E+01	5.898E-02	1.828E-08	0.0
NI 65	1.182E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 66	7.346E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 64	2.305E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 66	5.518E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 67	0.418E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 65	1.440E+02	5.097E-03	1.805E-03	8.014E-05	4.462E-07	1.383E-11	4.119E-25	0.0	0.0	0.0	0.0	0.0
ZN 69	1.832E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 69M	1.232E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 70	5.728E+10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	4.181E+15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	1.286E+16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71	9.255E+13	4.452E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71M	7.555E+14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 89	1.129E+00	7.507E-03	4.990E-05	1.488E-11	1.902E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 90	5.024E+05	4.805E-05	4.790E-05	4.480E-05	3.980E-05	3.121E-05	1.528E-05	4.848E-06	3.980E-08	2.312E-15	0.0	0.0
SR 91	2.173E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 93	7.478E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 90	4.138E+01	4.907E-05	4.791E-05	4.481E-05	3.981E-05	3.122E-05	1.529E-05	4.850E-06	3.981E-08	2.312E-15	0.0	0.0
Y 90M	2.575E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 91	2.864E+00	3.783E-02	4.898E-04	1.150E-09	4.817E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 92	5.114E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 93	7.478E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 94	1.554E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 96	9.951E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 93	8.404E+03	8.404E-03	8.404E-03	8.404E-03	8.404E-03	8.404E-03	8.404E-03	8.404E-03	8.403E-03	8.401E-03	8.395E-03	8.375E-03
ZR 95	1.322E+03	2.528E+01	4.815E+01	3.380E+08	8.639E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 97	1.924E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 92	3.870E+02	5.755E-13	8.871E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 93M	5.829E+04	8.372E-04	1.098E-03	1.805E-03	2.787E-03	4.091E-03	5.852E-03	8.050E-03	8.083E-03	8.081E-03	8.075E-03	8.056E-03
NB 94	3.585E+02	3.585E-02	3.585E-02	3.584E-02	3.584E-02	3.582E-02	3.579E-02	3.573E-02	3.548E-02	3.485E-02	3.238E-02	2.648E-02
NB 95	1.343E+03	5.890E+01	1.111E+00	7.504E+08	1.918E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 95M	9.311E+00	1.878E-01	3.587E-03	2.507E-08	6.409E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 96	1.065E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97	1.924E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97M	1.870E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 98	8.934E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.5. (cont'd) Radioactivity in BWR Fuel Assembly Grids, Springs and Other Components

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, GRIDS & SPRINGS & THINGS
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM*2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES													
DISCHG.	METRIC TON URANIUM METAL AS LOADED												
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
NB100	5.312E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MO 99	4.141E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MO101	3.481E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TC 99	2.889E-14	2.889E-14	2.889E-14	2.889E-14	2.889E-14	2.889E-14	2.889E-14	2.889E-14	2.889E-14	2.889E-14	2.889E-14	2.889E-14	
TC 99	1.904E-07	1.922E-07	1.922E-07	1.922E-07	1.922E-07	1.922E-07	1.922E-07	1.921E-07	1.920E-07	1.918E-07	2.887E-14	2.884E-14	
TC100	3.531E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TC101	3.481E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU103	1.927E-10	3.059E-13	4.849E-18	1.944E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU105	8.925E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH102	9.004E-19	7.109E-19	5.813E-19	2.886E-19	8.584E-20	1.387E-20	1.051E-23	0.0	0.0	0.0	0.0	0.0	
RH104	3.819E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH104M	1.861E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH105	9.401E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH105M	2.779E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH108	2.011E-11	7.013E-25	7.013E-25	7.013E-25	7.013E-25	7.013E-25	0.0	0.0	0.0	0.0	0.0	0.0	
RH108M	1.815E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD107	6.728E-18	8.776E-18	8.776E-18	8.776E-18	8.776E-18	8.776E-18	8.776E-18	8.776E-18	8.776E-18	8.775E-18	8.774E-18	8.789E-18	
PD107M	8.454E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD109	2.846E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD109M	4.300E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD111	4.978E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD111M	8.931E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AG108	7.258E-10	8.419E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AG108	1.105E-05	8.103E-10	8.059E-10	7.928E-10	7.715E-10	7.305E-10	8.202E-10	4.721E-10	1.595E-10	3.474E-12	8.318E-17	0.0	
AG108M	9.154E-09	9.105E-09	9.055E-09	8.908E-09	8.668E-09	8.208E-09	6.888E-09	5.304E-09	1.781E-09	3.903E-11	7.098E-16	0.0	
AG109M	1.005E-04	5.823E-05	3.374E-05	8.868E-06	4.290E-07	1.832E-09	1.428E-16	0.0	0.0	0.0	0.0	0.0	
AG110	5.047E-05	9.013E-09	3.273E-09	1.566E-10	9.885E-13	3.935E-17	0.0	0.0	0.0	0.0	0.0	0.0	
AG110M	1.867E-06	8.777E-07	2.461E-07	1.178E-08	7.433E-11	2.958E-15	0.0	0.0	0.0	0.0	0.0	0.0	
AG111	9.485E-08	1.656E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AG111M	5.180E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AG112	8.508E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD107	9.533E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD109	1.005E-04	5.823E-05	3.374E-05	8.566E-06	4.290E-07	1.832E-09	1.426E-16	0.0	0.0	0.0	0.0	0.0	
CD111M	1.621E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD115	2.435E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD115M	2.054E-03	7.034E-06	2.409E-08	9.684E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD117	1.359E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD117M	2.404E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD119	2.062E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD121	8.222E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI13M	2.533E+01	2.809E+00	3.114E-01	4.242E-04	7.078E-09	1.984E-18	0.0	0.0	0.0	0.0	0.0	0.0	
INI14	8.412E+00	2.038E+02	1.226E-04	2.671E-11	2.107E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI14M	3.539E+00	2.129E+02	1.281E-04	2.791E-11	2.201E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI15	3.707E-18	4.207E-16	4.209E-18	4.209E-18	4.209E-18	4.209E-18	4.209E-18	4.209E-18	4.209E-18	4.209E-18	4.209E-18	4.209E-18	
INI18	9.847E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI18M	1.387E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI17	8.605E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI17M	1.274E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI18	2.714E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI19	1.972E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI19M	2.062E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
INI20	3.711E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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Table B.5. (cont'd) Radioactivity in BWR Fuel Assembly Grids, Springs and Other Components

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, GRIDS & SPRINGS & THINGS
 POWER= 1.01600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CN*2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
IN120M	5.001E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN121	5.102E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN113	2.532E+01	2.807E+00	3.112E-01	4.225E-04	7.073E-09	1.883E-18	0.0	0.0	0.0	0.0	0.0	0.0
SN113M	1.125E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN117M	1.950E+02	2.752E-06	3.892E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN119M	1.957E+02	7.000E+01	2.481E+01	1.122E+00	8.405E-03	2.085E-07	7.194E-21	0.0	0.0	0.0	0.0	0.0
SN121	9.349E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN121M	2.850E+02	2.843E-02	2.808E-02	2.500E-02	2.333E-02	2.031E-02	1.339E-02	8.894E-03	4.177E-04	2.536E-08	2.271E-20	0.0
SN123	9.228E+00	1.300E+00	1.831E-01	5.119E-04	2.838E-08	8.723E-17	0.0	0.0	0.0	0.0	0.0	0.0
SN123M	3.682E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN125	8.105E+01	2.399E-10	8.428E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN125M	4.834E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SD122	1.151E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SD122M	1.015E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB124	5.832E-01	8.898E-03	1.297E-04	4.297E-10	3.168E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB124M	1.812E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB125	6.268E+01	4.925E+01	3.834E+01	1.810E+01	5.179E+00	4.241E-01	2.328E-04	8.870E-10	0.0	0.0	0.0	0.0
SB126	1.190E+00	1.808E-09	2.185E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB126M	1.187E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE123	1.591E-14	1.850E-14	1.888E-14	1.888E-14	1.888E-14	1.888E-14	1.888E-14	1.888E-14	1.888E-14	1.888E-14	1.888E-14	1.888E-14
TE123M	9.005E-02	1.088E-02	1.309E-03	2.285E-08	8.848E-11	3.799E-20	0.0	0.0	0.0	0.0	0.0	0.0
TE125M	1.383E+01	1.200E+01	9.353E+00	4.418E+00	1.264E+00	1.035E-01	5.881E-05	2.091E-10	0.0	0.0	0.0	0.0
TE127	1.133E-02	8.044E-06	7.885E-08	7.428E-08	6.719E-14	5.502E-24	0.0	0.0	0.0	0.0	0.0	0.0
TE127M	8.378E-04	8.213E-05	8.050E-06	7.581E-09	6.860E-14	5.817E-24	0.0	0.0	0.0	0.0	0.0	0.0
TE129	1.771E-08	1.748E-13	8.338E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE129M	5.030E-16	2.688E-13	1.435E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I128	4.252E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I128M	5.502E-16	5.533E-18	5.533E-18	5.533E-18	5.533E-18	5.533E-18	5.533E-18	5.533E-18	5.532E-18	5.532E-18	5.530E-18	0.0
I130	4.040E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I130M	1.712E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I131	3.657E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
I132	2.535E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE127	7.408E-10	7.082E-13	6.789E-16	5.910E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE129M	1.169E-07	2.108E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE131M	1.458E-11	8.372E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE133	3.062E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE133M	1.589E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS132	5.894E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS134	1.573E-17	1.124E-17	8.028E-18	2.818E-18	5.396E-19	2.523E-20	1.052E-24	0.0	0.0	0.0	0.0	0.0
CS134M	1.492E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS135	4.838E-26	4.838E-25	4.838E-25	4.838E-25	4.838E-25	4.838E-25	4.838E-25	4.838E-25	4.838E-25	4.838E-25	4.838E-25	4.838E-25
CS136	2.443E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS136M	1.068E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA136M	4.027E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ER169	2.633E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ER171	1.105E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ER172	2.360E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TM170M	5.822E-16	8.131E-17	1.144E-17	8.388E-20	3.389E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TM171	5.822E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TM171	3.479E-17	2.429E-17	1.691E-17	5.730E-18	9.291E-19	1.772E-20	3.505E-25	0.0	0.0	0.0	0.0	0.0
TM172	8.549E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TM173	8.852E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.5. (cont'd) Radioactivity in BWR Fuel Assembly Grids, Springs and Other Components

Curies/MTU

OUTPUT UNIT = 8

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*BWR 2.5 W/D ENRICHMENT, 28 GWD/MT BURNUP GRIDS & SPRINGS & THINGS
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

DISCHG.	7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
YB175	3.621E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YB175M	2.562E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU176	1.288E-12	1.288E-12	1.288E-12	1.288E-12	1.288E-12	1.288E-12	1.288E-12	1.288E-12	1.288E-12	1.288E-12	1.288E-12
LU176M	1.964E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU177	7.505E-02	9.252E-08	1.807E-08	1.345E-08	3.819E-12	3.079E-10	0.0	0.0	0.0	0.0	0.0
LU177M	2.080E-04	4.023E-05	7.856E-05	5.850E-05	1.661E-11	1.339E-18	0.0	0.0	0.0	0.0	0.0
HF175	4.227E-01	1.136E-02	3.052E-04	5.921E-09	8.293E-17	0.0	0.0	0.0	0.0	0.0	0.0
HF178M	4.689E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF179M	8.015E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF180M	7.788E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF181	1.487E+01	3.789E-02	9.862E-05	1.802E-12	1.728E-25	0.0	0.0	0.0	0.0	0.0	0.0
HF182	1.297E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08
TA182	1.468E+00	1.824E-01	1.797E-02	2.430E-05	1.337E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08	1.297E-08
TA182M	2.319E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA183	3.080E+00	8.502E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W181	2.365E-02	2.928E-03	3.824E-04	8.888E-07	1.995E-11	1.885E-20	0.0	0.0	0.0	0.0	0.0
W183M	3.271E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185	8.540E-01	2.247E-02	7.717E-04	3.128E-08	1.496E-15	0.0	0.0	0.0	0.0	0.0	0.0
W185M	7.321E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W187	1.201E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W188	2.355E-02	8.132E-04	1.597E-05	2.820E-10	3.378E-18	0.0	0.0	0.0	0.0	0.0	0.0
W189	1.994E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE186	4.293E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE187	8.129E-10	8.135E-10	8.135E-10	8.135E-10	8.135E-10	8.135E-10	8.135E-10	8.135E-10	8.135E-10	8.135E-10	8.135E-10
RE188	4.001E+00	8.195E-04	1.813E-05	2.849E-10	3.411E-18	0.0	0.0	0.0	0.0	0.0	0.0
RE188M	3.893E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE189	1.378E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS190M	3.349E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191	3.439E-04	2.571E-11	1.874E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191M	2.407E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS193	8.310E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS194	1.760E-12	1.588E-12	1.397E-12	9.878E-13	5.543E-13	1.748E-13	5.458E-15	1.692E-17	0.0	0.0	0.0
IR192	1.030E-04	3.387E-06	1.102E-07	1.321E-10	1.284E-10	1.228E-10	1.127E-10	9.758E-11	5.490E-11	7.332E-12	2.328E-14
IR192M	1.300E-10	1.298E-10	1.292E-10	1.281E-10	1.283E-10	1.227E-10	1.128E-10	9.750E-11	5.485E-11	7.328E-12	2.326E-14
IR194	3.083E-06	1.566E-12	1.397E-12	9.880E-13	5.545E-13	1.748E-13	5.458E-15	1.693E-17	0.0	0.0	0.0
IR194M	1.825E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT193	1.008E-09	1.010E-09	1.008E-09	1.004E-09	9.971E-10	9.833E-10	9.433E-10	8.801E-10	8.870E-10	2.527E-10	1.580E-11
PT193M	2.127E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT195M	1.698E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197	5.181E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197M	3.510E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AI198	4.537E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AI199	7.688E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU200	1.783E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HQ199M	1.780E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	1.620E+04	1.565E+03	1.240E+03	8.252E+02	4.602E+02	1.865E+02	7.574E+01	5.098E+01	1.192E+01	8.523E-01	7.883E-01
TOTAL	1.620E+04	1.565E+03	1.240E+03	8.252E+02	4.602E+02	1.865E+02	7.574E+01	5.098E+01	1.192E+01	8.523E-01	7.883E-01

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Table B.6. Radioactivity in BWR Fuel Assembly End Fittings

Curies/MTU

OUTPUT UNIT = B

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, END FITTINGS
POWER = 1.91600E+01 MW, BURNUP = 2.80000E+04 MWD, FLUX = 1.85E+14 N/CM*2-SEC

ACTIVATION PRODUCTS

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
H 3	8.940E-06	8.452E-06	7.991E-06	6.752E-06	5.100E-06	2.908E-06	5.401E-07	3.263E-08	4.347E-13	0.0	0.0	0.0
H 4	2.554E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 8	2.078E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LI 8	1.539E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 8	3.597E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 10	1.133E-08	1.133E-08	1.133E-08	1.133E-08	1.133E-08	1.133E-08	1.133E-08	1.133E-08	1.133E-08	1.133E-08	1.132E-08	1.128E-08
BE 11	1.812E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 12	3.682E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CC 14	1.199E-01	1.199E-01	1.199E-01	1.198E-01	1.198E-01	1.196E-01	1.192E-01	1.185E-01	1.156E-01	1.063E-01	8.342E-02	3.578E-02
CC 15	3.227E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CC 16	1.303E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CC 20	9.798E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE 23	6.627E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24	2.213E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24M	3.040E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 25	1.001E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 27	4.207E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 28	2.682E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 28	5.030E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 29	1.708E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 30	1.648E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 31	3.771E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 32	1.662E-08	1.660E-09	1.658E-09	1.653E-09	1.644E-09	1.627E-09	1.578E-09	1.494E-09	1.207E-09	5.721E-10	8.781E-11	3.885E-14
SI 32	5.991E+00	1.243E-07	1.859E-09	1.653E-09	1.644E-09	1.627E-09	1.578E-09	1.494E-09	1.207E-09	5.722E-10	8.781E-11	3.885E-14
P 33	2.449E-04	9.792E-09	3.918E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 34	8.337E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 35	1.428E-01	8.041E-03	4.527E-04	8.082E-08	4.574E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 37	3.638E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 36	4.552E-08	4.552E-08	4.552E-08	4.552E-08	4.552E-08	4.552E-08	4.552E-08	4.551E-08	4.549E-08	4.542E-08	4.521E-08	4.448E-08
CL 38	4.085E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 38M	4.875E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 37	1.471E-10	1.067E-13	7.742E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 39	7.627E-13	7.607E-13	7.767E-13	7.727E-13	7.628E-13	7.434E-13	6.881E-13	6.049E-13	3.613E-13	5.950E-14	3.438E-18	5.045E-24
AR 41	1.154E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 42	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24
K 40	3.818E-25	3.816E-25	3.816E-25	3.816E-25	3.816E-25	3.816E-25	3.816E-25	3.816E-25	3.816E-25	3.816E-25	3.816E-25	3.816E-25
K 42	1.960E-15	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24	1.011E-24
K 43	2.292E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K 44	2.534E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CA 45	9.288E-09	1.964E-09	4.155E-10	3.930E-12	1.663E-15	2.978E-22	0.0	0.0	0.0	0.0	0.0	0.0
CA 47	1.229E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 46	1.197E-10	5.835E-12	2.844E-13	3.292E-17	9.055E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 46M	5.793E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 47	4.608E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 48	7.159E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 49	1.284E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 50	1.088E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TI 51	2.118E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 50	8.533E-16	8.533E-16	8.533E-16	8.533E-16	8.533E-16	8.533E-16	8.533E-16	8.533E-16	8.533E-16	8.533E-16	8.533E-16	8.533E-16
V 52	5.938E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 53	1.328E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 54	1.520E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

R.29

Table B.6. (cont'd) Radioactivity in BWR Fuel Assembly End Fittings

Curies/MTU

OUTPUT UNIT = 0

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, END FITTINGS
 POWER = 1.91600E+01 MW, BURNUP = 2.80000E+04 MWD, FLUX = 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISCHQ.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
3.760E+03	4.052E-01	4.381E-05	5.433E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.785E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.608E+02	7.153E+01	3.182E+01	2.800E+00	4.874E-03	1.477E-05	4.113E-16	0.0	0.0	0.0	0.0	0.0	
9.174E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.083E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.419E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.818E+03	1.163E+03	8.905E+02	4.002E+02	1.055E+02	7.338E+00	2.467E-03	4.010E-09	0.0	0.0	0.0	0.0	
7.614E+01	2.743E-01	8.884E-04	4.822E-11	2.808E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.768E+02	4.910E+00	1.373E-01	2.999E-08	5.122E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.850E+02	3.375E+02	2.959E+02	1.994E+02	1.033E+02	2.773E+01	5.381E-01	7.475E-04	2.810E-15	0.0	0.0	0.0	
5.368E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.389E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.002E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.993E-01	1.993E-01	1.992E-01	1.992E-01	1.992E-01	1.993E-01	1.992E-01	1.991E-01	1.987E-01	1.975E-01	1.941E-01	1.827E-01	
3.059E+01	3.038E+01	3.014E+01	2.948E+01	2.837E+01	2.831E+01	2.099E+01	1.440E+01	3.182E+00	1.838E-02	4.674E-09	0.0	
3.391E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.109E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.951E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.916E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.229E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.115E-05	1.103E-05	3.908E-06	1.734E-07	8.854E-10	2.892E-14	0.0	0.0	0.0	0.0	0.0	0.0	
1.754E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.179E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.419E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.304E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.118E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.861E-15	2.877E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.882E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.523E-10	2.343E-12	1.557E-14	4.574E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.478E-11	2.418E-11	2.381E-11	2.199E-11	1.952E-11	1.538E-11	7.533E-12	2.291E-12	1.962E-14	1.140E-21	0.0	0.0	
2.848E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.131E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.297E-04	2.419E-11	2.362E-11	2.199E-11	1.952E-11	1.539E-11	7.535E-12	2.292E-12	1.963E-14	1.140E-21	0.0	0.0	
4.032E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.704E-08	8.952E-11	1.169E-12	2.891E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.685E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.131E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.473E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.837E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.530E-09	3.530E-09	3.530E-09	3.530E-09	3.530E-09	3.530E-09	3.530E-09	3.530E-09	3.529E-09	3.528E-09	3.525E-09	3.514E-09	
1.092E-08	2.089E-10	3.904E-12	2.792E-17	7.138E-26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.484E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9.236E-04	1.392E-14	2.097E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.111E-10	4.822E-10	8.059E-10	9.954E-10	1.528E-09	2.256E-09	3.115E-09	3.335E-09	3.353E-09	3.352E-09	3.349E-09	3.338E-09	
8.669E-04	8.609E-04	8.668E-04	8.667E-04	8.668E-04	8.663E-04	8.654E-04	8.639E-04	8.580E-04	8.378E-04	7.825E-04	8.161E-04	
8.963E-01	5.185E-04	3.861E-07	2.215E-18	1.585E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.879E-11	1.550E-12	2.963E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.523E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.251E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.190E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.548E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.908E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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Table B.6. (cont'd) Radioactivity in BWR Fuel Assembly End Fittings

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, END FITTINGS
POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
MO101	1.854E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IC 98	7.107E-23	7.107E-23	7.107E-23	7.107E-23	7.107E-23	7.107E-23	7.107E-23	7.107E-23	7.107E-23	7.105E-23	7.096E-23	7.096E-23
IC 99	9.002E-18	9.174E-18	9.174E-18	9.174E-18	9.174E-18	9.174E-18	9.173E-18	9.171E-18	9.165E-18	9.145E-18	9.085E-18	8.881E-18
IC100	1.870E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IC101	1.854E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	1.800E+04	1.808E+03	1.249E+03	8.322E+02	2.376E+02	8.170E+01	2.185E+01	1.472E+01	3.507E+00	3.210E-01	2.783E-01	2.191E-01
TOTAL	1.800E+04	1.808E+03	1.249E+03	8.322E+02	2.376E+02	8.170E+01	2.185E+01	1.472E+01	3.507E+00	3.210E-01	2.783E-01	2.191E-01

Table 8.7. Radioactivity in BWR Fuel Channel

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP FUEL CHANNEL
 PDWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISCHG.	1 YR	METRIC TON URANIUM METAL AS LOADED	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1. 238E-04	1. 171E-04	1. 107E-04	9. 352E-05	7. 083E-05	4. 029E-05	7. 480E-06	4. 519E-07	6. 020E-12	0. 0	0. 0	0. 0	0. 0
3. 001E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 555E-03	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 624E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 893E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
8. 784E-08	8. 784E-08	8. 784E-08	8. 784E-08	8. 783E-08	8. 783E-08	8. 783E-08	8. 783E-08	8. 783E-08	8. 782E-08	8. 780E-08	8. 772E-08	8. 746E-08
1. 250E-07	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 081E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
3. 889E-01	3. 889E-01	3. 889E-01	3. 887E-01	3. 885E-01	3. 881E-01	3. 867E-01	3. 845E-01	3. 558E-01	3. 269E-01	2. 566E-01	1. 100E-01	0. 0
3. 428E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
2. 018E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
3. 321E-03	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
8. 839E-08	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
8. 790E-10	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 087E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
2. 893E-13	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
4. 425E-10	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
5. 195E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
3. 324E-10	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 681E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
4. 521E-05	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
2. 055E-09	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
2. 171E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
9. 568E-12	9. 556E-12	9. 546E-12	9. 515E-12	9. 465E-12	9. 384E-12	9. 070E-12	8. 599E-12	8. 947E-12	3. 293E-12	3. 903E-13	2. 236E-16	0. 0
1. 172E-01	2. 400E-07	9. 551E-12	9. 516E-12	9. 465E-12	9. 385E-12	9. 070E-12	8. 599E-12	8. 948E-12	3. 293E-12	3. 903E-13	2. 236E-16	0. 0
1. 430E-03	5. 719E-08	2. 287E-12	1. 463E-25	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
5. 453E-03	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
8. 340E-01	4. 698E-02	2. 844E-03	4. 720E-07	2. 871E-13	8. 558E-26	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
2. 125E-03	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
2. 659E-07	2. 659E-07	2. 659E-07	2. 659E-07	2. 658E-07	2. 658E-07	2. 658E-07	2. 658E-07	2. 657E-07	2. 652E-07	2. 640E-07	2. 598E-07	0. 0
2. 392E-06	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
2. 847E-08	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
8. 591E-10	6. 233E-13	4. 522E-16	1. 726E-25	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
4. 571E-12	4. 580E-12	4. 548E-12	4. 513E-12	4. 455E-12	4. 342E-12	4. 018E-12	3. 533E-12	2. 110E-12	3. 475E-13	2. 008E-15	2. 947E-23	0. 0
6. 318E-09	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 999E-17	1. 957E-17	1. 916E-17	1. 799E-17	1. 820E-17	1. 313E-17	8. 993E-18	2. 446E-18	3. 887E-20	0. 0	0. 0	0. 0	0. 0
2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24	2. 229E-24
1. 212E-10	1. 957E-17	1. 917E-17	1. 800E-17	1. 820E-17	1. 313E-17	8. 993E-18	2. 447E-18	3. 887E-20	0. 0	0. 0	0. 0	0. 0
7. 923E-08	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 409E-08	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
8. 721E-04	1. 421E-04	3. 008E-05	2. 844E-07	1. 203E-10	2. 155E-17	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
7. 618E-06	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
8. 235E-02	4. 014E-03	1. 958E-04	2. 265E-08	8. 229E-15	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 138E-05	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 288E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 225E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
1. 203E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
2. 080E-04	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
3. 293E-01	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15	2. 044E-15
1. 876E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0
4. 362E-02	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0	0. 0

Table B.7. (cont'd) Radioactivity in BWR Fuel Channel

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, FUEL CHANNEL
 POWER = 1.91800E+01 MW, BURNUP = 2.80000E+04 MWD, FLUX = 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES		METRIC TON URANIUM METAL AS LOADED									
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
V 54	4.988E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 51	1.218E+03	1.330E-01	1.431E-05	1.783E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 55	1.849E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MM 54	4.625E+01	1.167E+01	5.193E+00	4.589E-01	7.855E-03	2.411E-06	8.712E-17	0.0	0.0	0.0	0.0
MM 56	4.915E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MM 57	8.284E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MM 58	2.301E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	2.481E+02	1.885E+02	1.444E+02	8.489E+01	1.711E+01	1.180E+00	4.000E-04	8.501E-10	0.0	0.0	0.0
FE 58	1.236E+01	4.449E-02	1.803E-04	7.485E-12	4.549E-24	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	1.985E+00	8.494E-02	1.535E-03	3.358E-08	8.730E-18	0.0	0.0	0.0	0.0	0.0	0.0
CO 60	2.334E+02	2.048E+02	1.794E+02	1.209E+02	8.284E+01	1.881E+01	3.250E-01	4.488E-04	1.690E-15	0.0	0.0
CO 60M	2.233E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 61	2.192E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 62	2.949E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 59	2.229E+03	2.229E-03	2.229E-03	2.229E-03	2.229E-03	2.228E-03	2.227E-03	2.223E-03	2.210E-03	2.172E-03	2.044E-03
NI 63	5.181E+01	3.492E-01	3.466E-01	3.388E-01	3.283E-01	3.028E-01	2.414E-01	1.858E-01	3.870E-02	1.881E-04	8.375E-11
NI 65	8.02E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 66	8.06E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 64	8.58E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 66	8.77E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 67	2.184E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 68	5.30E+02	1.058E-02	8.934E-03	3.079E-04	1.714E-08	5.314E-11	1.583E-24	0.0	0.0	0.0	0.0
CU 69M	8.57E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 68	4.810E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 70	2.158E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	1.580E+14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	4.881E+16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
71	3.503E+12	1.885E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
71M	8.59E+13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
89	2.487E+01	1.840E-01	1.090E-03	3.202E-10	4.156E-21	0.0	0.0	0.0	0.0	0.0	0.0
90	1.097E+03	1.072E-03	1.046E-03	9.743E-04	8.650E-04	8.818E-04	3.338E-04	1.015E-04	8.895E-07	5.050E-14	0.0
91	4.747E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
93	1.833E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
90M	9.039E+02	1.072E-03	1.047E-03	9.745E-04	8.852E-04	8.819E-04	3.339E-04	1.016E-04	8.897E-07	5.051E-14	0.0
91	5.828E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92	6.258E+01	8.285E-01	1.091E-02	2.812E-08	1.008E-17	0.0	0.0	0.0	0.0	0.0	0.0
93	1.117E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94	1.833E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
94	3.398E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96	2.174E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
93	1.398E+01	1.398E-01	1.398E-01	1.398E-01	1.398E-01	1.398E-01	1.398E-01	1.398E-01	1.398E-01	1.397E-01	1.393E-01
95	2.889E+04	5.523E-02	1.058E-01	7.384E-05	1.887E-13	0.0	0.0	0.0	0.0	0.0	0.0
97	4.203E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92	5.548E+02	8.358E-13	1.259E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
93M	1.230E+02	1.829E-02	2.398E-02	3.943E-02	8.045E-02	8.938E-02	1.235E-01	1.322E-01	1.329E-01	1.328E-01	1.327E-01
94	5.205E+02	5.205E-02	5.205E-02	5.204E-02	5.203E-02	5.201E-02	5.186E-02	5.187E-02	5.152E-02	5.030E-02	4.888E-02
95	8.74E+04	1.243E+03	2.428E+01	1.830E-04	4.190E-13	0.0	0.0	0.0	0.0	0.0	0.0
95M	2.034E+02	4.098E+00	7.835E-02	5.478E-07	1.400E-15	0.0	0.0	0.0	0.0	0.0	0.0
96	2.280E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97	4.203E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97M	3.977E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
98	1.515E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.7. (cont'd) Radioactivity in BWR Fuel Channel

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, FUEL CHANNEL
 POWER= 1.91800E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES		METRIC TON URANIUM METAL AS LOADED									
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
NR100	1.180E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO99	9.045E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO101	7.004E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC98	5.874E-13	5.874E-13	5.874E-13	5.874E-13	5.874E-13	5.874E-13	5.874E-13	5.874E-13	5.873E-13	5.871E-13	5.864E-13
TC99	4.159E-06	4.199E-06	4.199E-06	4.199E-06	4.198E-06	4.198E-06	4.197E-06	4.194E-06	4.185E-06	4.158E-06	4.084E-06
TC100	7.714E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	7.804E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU103	4.210E-09	8.698E-12	1.065E-14	4.267E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU105	2.233E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU106	1.605E-23	1.605E-23	1.605E-23	1.605E-23	1.605E-23	1.605E-23	0.0	0.0	0.0	0.0	0.0
RU102	2.020E-17	1.590E-17	1.252E-17	6.109E-18	1.853E-18	1.872E-19	1.288E-22	0.0	0.0	0.0	0.0
RH104	8.785E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH104M	3.628E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105	2.115E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105M	6.251E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH108	4.040E-10	1.605E-23	1.605E-23	1.605E-23	1.605E-23	1.605E-23	0.0	0.0	0.0	0.0	0.0
RH108M	4.083E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD107	1.564E-16	1.564E-16	1.564E-16	1.564E-16	1.564E-16	1.564E-16	1.564E-16	1.564E-16	1.564E-16	1.563E-16	1.562E-16
PD107M	1.489E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109	6.108E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109M	9.924E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD111	1.149E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD111M	1.599E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG106	1.674E-08	1.943E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG108	3.013E-04	1.870E-08	1.860E-08	1.830E-08	1.780E-08	1.888E-08	1.431E-08	1.089E-08	3.657E-09	8.017E-11	1.457E-15
AG108M	2.113E-07	2.101E-07	2.090E-07	2.056E-07	2.000E-07	1.894E-07	1.808E-07	1.224E-07	4.109E-08	9.007E-10	1.538E-14
AG109M	2.319E-03	1.344E-03	7.788E-04	1.515E-04	9.900E-06	4.230E-08	3.292E-15	0.0	0.0	0.0	0.0
AG110	1.165E-03	2.080E-07	7.552E-08	3.814E-09	2.281E-11	9.078E-18	0.0	0.0	0.0	0.0	0.0
AG110M	4.307E-05	1.564E-05	5.878E-08	2.718E-07	1.715E-09	8.828E-14	0.0	0.0	0.0	0.0	0.0
AG111	2.189E-06	3.820E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG111M	1.191E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG112	1.501E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD107	2.200E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD109	2.319E-03	1.344E-03	7.788E-04	1.515E-04	9.900E-06	4.229E-08	3.292E-15	0.0	0.0	0.0	0.0
CD111M	3.741E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD115	5.606E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD115M	4.729E-02	1.821E-04	5.549E-07	2.226E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD117	3.105E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD117M	5.548E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD119	4.673E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD121	1.410E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN113M	5.739E-02	6.365E+01	7.056E+00	8.613E-03	1.604E-07	4.496E-17	0.0	0.0	0.0	0.0	0.0
IN114	1.908E-02	4.817E-01	2.778E-03	8.053E-10	4.774E-21	0.0	0.0	0.0	0.0	0.0	0.0
IN114M	8.018E+01	4.825E-01	2.903E-03	8.325E-10	4.988E-21	0.0	0.0	0.0	0.0	0.0	0.0
IN115	8.489E-17	9.841E-17	9.645E-17	9.645E-17	9.645E-17	9.645E-17	9.645E-17	9.645E-17	9.645E-17	9.645E-17	9.645E-17
IN116	2.235E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN118M	3.130E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN117	1.951E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN117M	2.912E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN118	6.151E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN119	4.469E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN119M	4.673E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table B.7. (cont'd) Radioactivity in BWR Fuel Channel

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/D ENRICHMENT, 28 GWD/MT BURNUP, FUEL CHANNEL
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.05E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

DISCHQ.	7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL, AS LOADED															
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS					
IN120	8.408E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
IN120M	1.133E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
IN121	1.155E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SM113	5.739E+02	8.381E+01	7.052E+00	8.574E-03	1.803E-07	4.494E-17	0.0	0.0	0.0	0.0	0.0					
SM113M	2.549E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SM117M	4.441E+03	8.258E-05	8.818E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SM119M	4.467E+03	1.888E+03	5.844E+02	2.543E+01	1.451E-01	4.725E-08	1.830E-19	0.0	0.0	0.0	0.0					
SN121	2.118E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SN121M	6.072E-01	8.989E-01	8.908E-01	5.885E-01	5.288E-01	4.801E-01	3.035E-01	1.517E-01	9.486E-03	5.748E-07	5.148E-19					
SN123	2.081E+02	2.945E+01	4.149E+00	1.181E-02	8.438E-07	1.879E-15	0.0	0.0	0.0	0.0	0.0					
SN123M	8.344E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SN125	1.383E+03	5.436E-09	2.138E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SN125M	1.095E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SB122	2.808E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SB122M	2.300E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SB124	1.322E+01	1.970E-01	2.938E-03	9.737E-09	7.174E-18	0.0	0.0	0.0	0.0	0.0	0.0					
SB124M	4.108E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SB125	1.420E+03	1.118E+03	8.888E+02	4.101E+02	1.174E+02	8.810E+00	5.276E-03	1.842E-08	0.0	0.0	0.0					
SB126	2.889E+01	3.838E-08	4.908E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
SB126M	2.889E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
TE123	3.605E-13	4.193E-13	4.284E-13	4.273E-13	4.273E-13	4.273E-13	4.273E-13	4.273E-13	4.273E-13	4.273E-13	4.273E-13					
TE123M	2.041E+00	2.460E-01	2.907E-02	8.208E-05	1.327E-09	8.818E-18	0.0	0.0	0.0	0.0	0.0					
TE125M	3.133E+02	2.718E+02	2.120E+02	1.051E+02	2.883E+01	2.345E+00	1.287E-03	4.738E-09	0.0	0.0	0.0					
TE127	2.868E-01	1.823E-03	1.787E-04	1.683E-07	1.623E-12	1.247E-22	0.0	0.0	0.0	0.0	0.0					
TE127M	1.899E-02	1.861E-03	1.824E-04	1.718E-07	1.555E-12	1.273E-22	0.0	0.0	0.0	0.0	0.0					
TE129	4.014E-07	3.983E-12	2.118E-15	3.224E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
TE129M	1.140E-08	8.087E-12	3.251E-15	4.853E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
TE129M	9.835E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
TE129	1.247E-14	1.254E-14	1.254E-14	1.254E-14	1.254E-14	1.254E-14	1.254E-14	1.254E-14	1.254E-14	1.254E-14	1.253E-14					
TE130	8.154E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
TE130M	3.880E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
TE131	2.888E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
TE132	7.455E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
XE127	1.879E-08	1.805E-11	1.534E-14	1.339E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
XE129M	2.848E-08	4.770E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
XE131M	3.305E-10	1.897E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
XE133	1.147E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
XE133M	3.820E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
CO132	1.370E-18	2.555E-18	8.26E-18	8.860E-17	1.240E-17	4.412E-19	1.840E-23	0.0	0.0	0.0	0.0					
CO134M	3.178E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
CO135	1.147E-23	1.147E-23	1.147E-23	1.147E-23	1.147E-23	1.147E-23	1.147E-23	1.147E-23	1.147E-23	1.147E-23	1.145E-23					
CO135M	4.044E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
BA135M	4.605E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
BA135M	9.61E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
FR179	9.45E-14	1.195E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
FR171	4.95E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
FR172	1.30E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
IM170M	1.315E-14	1.835E-15	2.563E-18	7.898E-19	4.030E-23	0.0	0.0	0.0	0.0	0.0	0.0					
IM170M	1.315E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					
IM171	7.853E-16	5.481E-18	3.820E-18	1.293E-16	2.126E-17	5.824E-19	1.113E-23	0.0	0.0	0.0	0.0					
IM172	1.479E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					

Table B.7. (cont'd) Radioactivity in BWR Fuel Channel

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP FUEL CHANNEL
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
TM173	1.549E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YB175	8.175E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YB175M	5.784E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU178	2.909E-11	2.909E-11	2.909E-11	2.909E-11	2.909E-11	2.909E-11	2.909E-11	2.909E-11	2.909E-11	2.909E-11	2.909E-11	2.909E-11
LU178M	4.434E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU177	1.895E+00	2.089E-04	4.079E-05	3.037E-07	8.023E-11	8.951E-18	0.0	0.0	0.0	0.0	0.0	0.0
LU177M	4.852E-03	9.084E-04	1.774E-04	1.321E-06	3.750E-10	3.023E-17	0.0	0.0	0.0	0.0	0.0	0.0
HF175	9.543E+00	2.564E-01	8.890E-03	1.337E-07	1.872E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF178M	1.054E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF175M	1.810E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF180M	1.758E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF181	3.358E+02	8.570E-01	2.185E-03	3.823E-11	3.907E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF182	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07
TA182	3.314E+01	3.867E+00	4.057E-01	5.489E-04	3.019E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07	2.928E-07
TA182M	5.237E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA183	8.654E+01	1.920E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W181	5.408E+01	8.892E-02	8.283E-03	1.589E-05	4.581E-10	3.852E-19	0.0	0.0	0.0	0.0	0.0	0.0
W183M	7.474E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185	1.495E+01	5.135E-01	1.764E-02	7.150E-07	3.420E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185M	1.073E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W187	2.748E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W188	5.383E-01	1.402E-02	3.850E-04	8.445E-09	7.717E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W189	4.557E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE188	9.813E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE187	1.401E-08	1.402E-08	1.402E-08	1.402E-08	1.402E-08	1.402E-08	1.402E-08	1.402E-08	1.402E-08	1.402E-08	1.402E-08	1.402E-08
RE188	9.146E+01	1.416E-02	3.888E-04	8.511E-09	7.797E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE188M	8.897E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE189	3.150E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DS190M	7.654E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191	7.862E-03	5.877E-10	4.284E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191M	5.503E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DS193	1.442E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS194	4.022E-11	3.583E-11	3.192E-11	2.257E-11	1.267E-11	3.990E-12	1.247E-13	3.868E-18	0.0	0.0	0.0	0.0
IR192	2.354E-03	7.698E-05	2.519E-06	3.019E-09	2.889E-09	2.808E-09	2.575E-09	2.231E-09	1.255E-09	1.876E-10	8.322E-13	9.601E-22
IR192M	2.971E-09	2.983E-09	2.954E-09	2.929E-09	2.867E-09	2.805E-09	2.573E-09	2.229E-09	1.254E-09	1.874E-10	5.318E-13	9.593E-22
IR194	7.046E-05	3.585E-11	3.194E-11	2.258E-11	1.267E-11	3.992E-12	1.247E-13	3.868E-18	0.0	0.0	0.0	0.0
IR194M	3.714E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT193	2.299E-08	2.308E-08	2.304E-08	2.295E-08	2.279E-08	2.248E-08	2.158E-08	2.012E-08	1.525E-08	5.777E-09	3.611E-10	2.204E-14
PT193M	4.882E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT195M	3.882E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197	1.184E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197M	8.023E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU198	1.037E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU199	1.757E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU200	4.030E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HG199M	4.068E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SIIMTOT	2.059E+05	5.344E+03	2.030E+03	7.235E+02	2.274E+02	3.137E+01	1.562E+00	1.009E+00	7.285E-01	8.523E-01	5.782E-01	4.206E-01
TOTAL	2.059E+05	5.344E+03	2.030E+03	7.235E+02	2.274E+02	3.137E+01	1.562E+00	1.009E+00	7.285E-01	8.523E-01	5.782E-01	4.206E-01

Table B.8. Radioactivity in BWR Cruciform w/out Pins & Rollers

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, CRUCIFORM W/OUT STELLITE
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM^2+2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
6.944E-04	6.505E-04	6.208E-04	5.245E-04	3.981E-04	2.260E-04	4.195E-05	2.534E-08	3.378E-11	0.0	0.0	0.0	
3.819E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.819E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.066E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.067E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.840E-05	2.540E-05	2.540E-05	2.540E-05	2.540E-05	2.540E-05	2.540E-05	2.539E-05	2.539E-05	2.538E-05	2.538E-05	2.529E-05	
3.513E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.231E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.588E-01	5.587E-01	5.588E-01	5.584E-01	5.581E-01	5.574E-01	5.554E-01	5.520E-01	5.388E-01	4.951E-01	3.887E-01	1.666E-01	
1.503E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.071E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.563E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.088E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.031E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.418E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.862E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.959E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.254E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.342E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.958E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.675E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.758E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.747E-09	7.739E-09	7.731E-09	7.706E-09	7.665E-09	7.584E-09	7.345E-09	6.984E-09	6.628E-09	6.287E-09	5.811E-10	1.811E-13	
2.798E-01	5.800E-07	7.731E-09	7.706E-09	7.665E-09	7.584E-09	7.345E-09	6.984E-09	6.628E-09	6.287E-09	5.811E-10	1.811E-13	
1.143E-03	4.570E-08	1.827E-12	1.189E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.357E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.884E-01	3.752E-02	2.113E-03	3.772E-07	2.134E-13	8.837E-28	0.0	0.0	0.0	0.0	0.0	0.0	
1.698E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.124E-07	2.124E-07	2.124E-07	2.124E-07	2.124E-07	2.124E-07	2.124E-07	2.124E-07	2.123E-07	2.119E-07	2.110E-07	2.078E-07	
1.911E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.275E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.865E-10	4.980E-13	3.813E-16	1.379E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.853E-12	3.643E-12	3.834E-12	3.606E-12	3.560E-12	3.489E-12	3.211E-12	2.823E-12	1.686E-12	2.777E-13	1.804E-15	2.354E-23	
5.373E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.127E-21	8.127E-21	8.127E-21	8.127E-21	8.127E-21	8.420E-21	3.849E-21	1.829E-21	0.0	0.0	0.0	0.0	
1.781E-24	1.781E-24	1.781E-24	1.781E-24	1.781E-24	1.781E-24	1.781E-24	1.781E-24	1.781E-24	1.781E-24	1.781E-24	1.781E-24	
9.128E-15	8.127E-21	8.127E-21	8.127E-21	8.127E-21	8.587E-21	3.849E-21	1.829E-21	2.740E-23	0.0	0.0	0.0	
1.087E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.180E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.325E-08	9.148E-09	1.935E-09	1.830E-11	7.745E-15	1.387E-21	0.0	0.0	0.0	0.0	0.0	0.0	
7.255E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.575E-10	2.717E-11	1.324E-12	1.533E-18	4.217E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.698E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.145E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.334E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.981E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.089E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9.884E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.974E-15	3.974E-15	3.974E-15	3.974E-15	3.974E-15	3.974E-15	3.974E-15	3.974E-15	3.974E-15	3.974E-15	3.974E-15	3.974E-15	
2.764E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.184E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.078E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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Table B.B. (cont'd) Radioactivity in BWR Cruciform w/out Pins & Rollers

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP CRUCIFORM W/OUI STELLITE
POREA= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES										
		METRIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
CR 51	1.754E+04	1.887E+00	2.031E-04	2.530E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 55	2.685E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 54	7.489E+02	3.331E+02	1.482E+02	1.304E+01	2.270E-01	8.879E-05	1.915E-15	0.0	0.0	0.0	0.0	0.0
MN 56	4.272E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 57	2.387E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 58	6.808E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	7.088E+03	5.414E+03	4.147E+03	1.884E+03	4.914E+02	3.417E+01	1.149E+02	1.887E+08	0.0	0.0	0.0	0.0
FE 59	3.548E+02	1.277E+00	4.805E-03	2.164E-10	1.307E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	6.180E+02	2.287E+01	8.393E-01	1.397E-05	2.385E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 60	1.792E+03	1.571E+03	1.377E+03	9.284E+02	4.809E+02	1.291E+02	2.495E+00	3.493E-03	1.313E-14	0.0	0.0	0.0
CO 60M	2.497E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 61	2.508E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 62	9.324E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 59	9.279E-01	9.279E-01	9.279E-01	9.279E-01	9.278E-01	9.278E-01	9.275E-01	9.271E-01	9.255E-01	9.199E-01	9.041E-01	8.509E-01
NI 63	1.425E+02	1.414E+02	1.403E+02	1.372E+02	1.321E+02	1.225E+02	9.775E+01	8.707E+01	1.485E+01	7.814E-02	2.175E-08	0.0
NI 65	1.879E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 66	9.817E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 64	9.088E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 66	8.821E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 67	1.038E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 65	1.451E-04	8.137E-05	8.19E-05	8.077E-07	4.498E-09	1.394E-13	0.0	0.0	0.0	0.0	0.0	0.0
ZN 69M	9.170E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 70	2.059E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	1.073E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	3.315E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71	2.785E-14	1.340E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71M	2.273E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 89	1.644E+09	1.093E-11	7.288E-14	2.134E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 90	1.158E-10	1.128E-10	1.102E-10	1.028E-10	9.109E-11	7.179E-11	3.515E-11	1.069E-11	9.157E-14	5.319E-21	0.0	0.0
SR 91	1.235E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 93	9.948E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 90	1.077E-03	1.129E-10	1.102E-10	1.028E-10	9.111E-11	7.181E-11	3.518E-11	1.070E-11	9.180E-14	5.320E-21	0.0	0.0
Y 90M	1.881E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 91	3.128E+08	4.131E-10	5.455E-12	1.258E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 92	7.864E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 93	9.946E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 94	8.873E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 96	1.324E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 93	1.847E+08	1.847E+08	1.847E+08	1.847E+08	1.847E+08	1.847E+08	1.847E+08	1.847E+08	1.847E+08	1.847E+08	1.845E+08	1.840E+08
ZR 95	5.088E+08	9.749E+10	1.884E+11	1.303E+16	3.331E+25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 97	2.559E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 92	4.310E-03	8.494E-14	9.785E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 93M	1.452E+09	2.157E+09	2.828E+09	4.845E+09	7.121E+09	1.053E+08	1.454E+08	1.558E+08	1.585E+08	1.584E+08	1.563E+08	1.558E+08
NB 94	4.045E+03	4.045E+03	4.045E+03	4.045E+03	4.044E+03	4.043E+03	4.039E+03	4.032E+03	4.004E+03	3.910E+03	3.852E+03	2.875E+03
NB 95	3.249E+00	2.420E-03	1.802E-08	1.034E-16	7.395E-28	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 95M	3.584E-10	7.232E-12	1.303E-13	9.887E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 96	2.577E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97	1.517E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97M	2.422E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 96	3.055E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 99	1.824E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Table B.8. (cont'd) Radioactivity in BWR Cruciform w/out Pins & Rollers

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, CRUCIFORM W/OUT STELLITE
POWER= 1.81600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM*+2-SEC

ACTIVATION PRODUCTS

DISCHG.	7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
MO101	7.716E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC 98	3.317E-22	3.317E-22	3.317E-22	3.317E-22	3.317E-22	3.317E-22	3.317E-22	3.317E-22	3.317E-22	3.318E-22	3.312E-22
TC 99	4.201E-15	4.281E-15	4.281E-15	4.281E-15	4.281E-15	4.281E-15	4.281E-15	4.280E-15	4.277E-15	4.287E-15	4.240E-15
TC100	7.793E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	7.716E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU103	6.480E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	7.541E+04	7.487E+03	5.815E+03	2.944E+03	1.106E+03	2.873E+02	1.017E+02	8.856E+01	1.833E+01	1.495E+00	1.296E+00
TOTAL	7.541E+04	7.487E+03	5.815E+03	2.944E+03	1.106E+03	2.873E+02	1.017E+02	8.856E+01	1.833E+01	1.495E+00	1.020E+00

Table B.9. Radioactivity in BWR Upper Pins & Rollers

Curies/MTU

OUTPUT UNIT = B

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, UPPER PINS & ROLLERS[†]
 POWER= 1.91800E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, Curies		METRIC TON URANIUM METAL AS LOADED									
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
H 3	2.508E-08	2.359E-08	2.240E-08	1.893E-08	1.430E-08	8.155E-07	1.514E-07	9.147E-09	1.219E-13	0.0	0.0
H 4	4.151E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H 5	8.44E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 6	1.350E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 8	1.008E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEE 10	3.188E-09	3.188E-09	3.188E-09	3.188E-09	3.188E-09	3.188E-09	3.188E-09	3.188E-09	3.188E-09	3.188E-09	3.174E-09
BEE 11	4.535E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEE 12	2.597E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEE 14	1.580E-07	1.580E-07	1.580E-07	1.579E-07	1.578E-07	1.576E-07	1.571E-07	1.581E-07	1.524E-07	1.400E-07	1.099E-07
BEE 15	8.050E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BEE 16	2.818E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F 20	8.750E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE 23	5.925E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24	9.78E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24M	2.718E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 25	9.50E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NG 27	7.81E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NG 28	4.06E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 28	4.37E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 29	1.528E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 30	1.473E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ST 31	1.945E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	8.572E-12	8.583E-12	8.554E-12	8.526E-12	8.481E-12	8.391E-12	8.127E-12	7.705E-12	6.225E-12	2.951E-12	3.497E-13
32	3.475E-03	7.988E-11	8.554E-12	8.527E-12	8.482E-12	8.392E-12	8.127E-12	7.705E-12	6.225E-12	2.951E-12	3.497E-13
33	5.30E-07	8.120E-12	2.447E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	5.838E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	8.925E-05	5.025E-08	2.830E-07	5.051E-11	2.859E-17	0.0	0.0	0.0	0.0	0.0	0.0
37	2.274E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	2.845E-11	2.845E-11	2.845E-11	2.845E-11	2.845E-11	2.845E-11	2.845E-11	2.844E-11	2.843E-11	2.839E-11	2.825E-11
38	2.560E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38M	3.047E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	9.194E-14	8.870E-17	4.839E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39	4.892E-18	4.879E-18	4.867E-18	4.829E-16	4.768E-16	4.646E-16	4.301E-16	3.781E-16	2.258E-16	3.719E-17	2.149E-19
41	1.680E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42	2.918E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44	3.835E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45	1.408E-10	2.973E-11	8.287E-12	5.948E-14	2.517E-17	4.508E-24	0.0	0.0	0.0	0.0	0.0
47	1.860E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46	1.812E-12	8.830E-14	4.304E-15	4.983E-19	1.370E-25	0.0	0.0	0.0	0.0	0.0	0.0
46M	8.787E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	8.970E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	1.082E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	1.944E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	1.647E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	3.200E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	1.291E-17	1.291E-17	1.291E-17	1.291E-17	1.291E-17	1.291E-17	1.291E-17	1.291E-17	1.291E-17	1.291E-17	1.291E-17
52	8.958E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53	2.009E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	2.295E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	5.689E-01	8.122E-03	8.588E-07	8.208E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55	8.548E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54	6.265E-02	2.787E-02	1.239E-02	1.091E-03	1.899E-05	5.755E-09	1.802E-19	0.0	0.0	0.0	0.0

[†] Niobium not included in this run due to lack of nominal value.

Table B.9. (cont'd) Radioactivity in BWR Upper Pins & Rollers

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, UPPER PINS & ROLLERS†
 POWER= 1.91800E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
MN 66	1.283E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 67	1.988E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 68	5.833E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	0.253E-01	4.789E-01	3.689E-01	1.849E-01	4.348E-02	3.023E-03	1.016E-06	1.852E-12	0.0	0.0	0.0	0.0
FE 59	1.081E-01	3.887E-04	1.404E-08	6.87E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	0.204E-01	1.751E-02	4.895E-04	1.070E-08	1.826E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 60	2.133E+03	1.870E+03	6.39E+03	1.105E+03	5.724E+02	1.536E+02	2.970E+00	4.125E-03	1.851E-14	0.0	0.0	0.0
CO 60M	2.953E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 61	2.915E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 62	7.142E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 59	7.105E-04	7.105E-04	7.105E-04	7.105E-04	7.105E-04	7.104E-04	7.102E-04	7.099E-04	7.087E-04	7.044E-04	6.923E-04	6.516E-04
NI 63	1.091E-01	1.083E-01	1.075E-01	1.051E-01	1.012E-01	9.384E-02	7.488E-02	5.136E-02	1.138E-02	5.833E-05	1.888E-11	0.0
NI 65	1.209E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 66	7.617E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 84	0.959E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 86	0.831E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 87	7.945E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 65	1.111E-07	3.234E-08	1.393E-08	8.185E-10	3.443E-12	1.087E-18	0.0	0.0	0.0	0.0	0.0	0.0
ZN 65M	0.151E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 70	4.200E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	1.570E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	0.063E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71	2.481E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71M	2.133E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA 82	1.741E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA 82M	7.580E-02	8.384E-03	9.253E-04	1.253E-08	2.077E-11	5.707E-21	0.0	0.0	0.0	0.0	0.0	0.0
TA 83	1.188E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W 181	1.580E-01	4.370E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W 183M	0.847E-01	8.476E-02	1.049E-02	1.889E-05	5.781E-10	4.883E-19	0.0	0.0	0.0	0.0	0.0	0.0
W 185M	0.264E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W 187	1.891E-01	8.495E-01	2.231E-02	0.044E-07	4.325E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W 188	2.118E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W 189	3.478E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W 189M	8.618E-01	1.775E-02	4.823E-04	8.164E-09	9.775E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE 186	5.772E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE 187	1.242E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE 188	1.774E-08	1.776E-08	1.776E-08	1.776E-08	1.776E-08	1.776E-08	1.776E-08	1.776E-08	1.776E-08	1.776E-08	1.776E-08	1.776E-08
RE 188M	1.158E-02	1.794E-02	4.871E-04	8.248E-09	9.878E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE 189	1.127E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS 190M	3.990E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS 191	0.695E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS 191M	0.958E-03	7.444E-10	5.426E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS 193	0.970E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS 194	1.827E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IR 192	5.095E-11	4.839E-11	4.044E-11	2.859E-11	1.805E-11	5.055E-12	1.580E-13	4.903E-18	0.0	0.0	0.0	0.0
IR 192M	2.981E-03	0.748E-05	3.191E-06	3.825E-09	3.880E-09	3.558E-09	1.282E-09	2.825E-09	1.589E-09	2.123E-10	8.741E-13	1.218E-21
IR 194	3.764E-09	3.753E-09	3.742E-09	3.710E-09	3.857E-09	3.853E-09	1.280E-09	2.823E-09	1.588E-09	2.121E-10	8.731E-13	1.215E-21
IR 194M	8.925E-05	4.541E-11	4.045E-11	2.860E-11	1.805E-11	5.058E-12	1.580E-13	4.904E-18	0.0	0.0	0.0	0.0
PT 193	4.705E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT 193M	2.913E-08	2.923E-08	2.919E-08	2.907E-08	2.887E-08	2.847E-08	2.731E-08	2.548E-08	1.931E-08	7.318E-09	4.573E-10	2.791E-14
PT 195M	8.159E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT 195M	4.917E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

† Niobium not included in this run due to lack of nominal value.

Table B.9. (cont'd) Radioactivity in BWR Upper Pins & Rollers

Curies/MTU

OUTPUT UNIT = 8

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*BWR, 2.5 W/D ENRICHMENT, 28 GWD/MT BURNUP, UPPER PINS & ROLLERS
POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
PT197	1.500E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197M	1.016E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU198	1.314E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU199	2.225E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU200	1.104E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HG199M	5.152E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	5.912E+03	1.871E+03	1.840E+03	1.105E+03	5.725E+02	1.537E+02	3.045E+00	5.820E-02	1.209E-02	7.829E-04	6.924E-04	8.518E-04
TOTAL	5.912E+03	1.871E+03	1.840E+03	1.105E+03	5.725E+02	1.537E+02	3.045E+00	5.820E-02	1.209E-02	7.829E-04	6.924E-04	8.518E-04

APPENDIX C

RADIOACTIVITY AND DECAY HEAT
FOR INC-718, SS-304, AND ZIRC-4

APPENDIX C

RADIOACTIVITY AND DECAY HEAT FOR INC-718, SS-304, AND ZIRC-4

Figure C.1 presents the decay heat in one cubic meter of each of the representative alloys exposed to 33 GWD in a PWR core over 1100 days. Likewise, Figure C.2 presents the decay heat in one cubic meter of each of the representative alloys exposed to 28 GWD in a BWR core over 1460 days. Table C.1 through C.6 present the radioactivity levels for the same three representative alloys on similar basis as the figures.

WATTS/CUBIC METER

Figure C.1. Decay Heat for Representative Alloys
in PWR Fuel Region Exposed to 33 GWD/MTU

WATTS/CUBIC METER

Figure C.2. Decay Heat for Representative Alloys
in BWR Fuel Region Exposed to 28 GWD/MTU

Table C.1. Radioactivity in Inconel-718 Exposed to 33 GWD in PWR Core

Curies/m³

OUTPUT UNIT = 8

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*PWR, 3.2 W/D ENRICHMENT, 33GWD/MT BURNUP 1.M+3 INC-718 IN-CORE
 POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM+2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
1.545E-02	1.461E-02	1.381E-02	1.167E-02	8.816E-03	5.029E-03	9.336E-04	5.841E-05	7.514E-10	0.0	0.0	0.0	
1.533E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.873E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.850E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.489E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.331E-05	1.331E-05	1.331E-05	1.331E-05	1.331E-05	1.331E-05	1.331E-05	1.331E-05	1.331E-05	1.330E-05	1.329E-05	1.325E-05	
2.700E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.349E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.107E+02	2.107E+02	2.107E+02	2.108E+02	2.105E+02	2.102E+02	2.085E+02	2.082E+02	2.032E+02	1.867E+02	1.466E+02	8.285E+01	
1.011E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.187E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9.289E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.268E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.984E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.780E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.808E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
9.048E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.514E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.767E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.073E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.118E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.078E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.005E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.343E-07	4.338E-07	4.334E-07	4.320E-07	4.297E-07	4.251E-07	4.117E-07	3.904E-07	3.154E-07	1.495E-07	1.772E-08	1.015E-11	
1.530E+03	3.188E-05	4.334E-07	4.320E-07	4.297E-07	4.252E-07	4.118E-07	3.904E-07	3.154E-07	1.495E-07	1.772E-08	1.015E-11	
1.389E-01	8.553E-08	2.221E-10	1.420E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.145E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.958E+01	4.481E+00	2.523E-01	4.504E-05	2.549E-11	8.184E-24	0.0	0.0	0.0	0.0	0.0	0.0	
2.064E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.792E-05	1.792E-05	1.792E-05	1.792E-05	1.792E-05	1.792E-05	1.792E-05	1.792E-05	1.791E-05	1.788E-05	1.780E-05	1.752E-05	
2.371E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.822E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.893E-08	4.130E-11	2.998E-14	1.144E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.317E-10	3.308E-10	3.300E-10	3.274E-10	3.233E-10	3.150E-10	2.918E-10	2.583E-10	1.531E-10	2.522E-11	1.457E-13	2.138E-21	
2.288E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.286E-13	7.115E-13	8.907E-13	8.542E-13	5.890E-13	4.774E-13	2.542E-13	8.894E-14	1.333E-15	5.485E-22	0.0	0.0	
4.107E-08	7.115E-13	8.907E-13	8.542E-13	5.890E-13	4.774E-13	2.542E-13	8.894E-14	1.333E-15	5.485E-22	0.0	0.0	
2.865E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.101E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.693E+01	3.581E+00	7.574E-01	7.168E-03	3.032E-08	5.429E-13	0.0	0.0	0.0	0.0	0.0	0.0	
2.038E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.122E+03	1.034E+02	5.040E+00	5.835E-04	1.805E-10	1.214E-23	0.0	0.0	0.0	0.0	0.0	0.0	
2.832E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.377E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.139E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.167E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.399E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.188E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.998E-12	1.998E-12	1.998E-12	1.998E-12	1.998E-12	1.998E-12	1.998E-12	1.998E-12	1.998E-12	1.998E-12	1.998E-12	1.998E-12	
1.583E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.379E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.982E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

C.5

Curies/m³

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ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISQHQ.	METRIC TON URANIUM METAL AS LOADED											
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
0.089E+08	0.781E+02	1.052E-01	1.311E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.389E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.254E+05	5.578E+04	2.481E+04	2.183E+03	3.801E+01	1.152E-02	3.207E-13	0.0	0.0	0.0	0.0	0.0	0.0
2.588E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.381E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.415E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.283E+05	7.111E+05	5.447E+05	2.448E+05	6.455E+04	4.486E+03	1.508E+00	2.453E-08	0.0	0.0	0.0	0.0	0.0
3.577E+04	2.009E+02	7.239E-01	3.395E-08	2.055E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.708E+08	7.571E+04	2.117E+03	4.624E-02	7.897E-10	2.303E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.171E+08	3.857E+08	3.06E+06	1.151E+08	1.19E+05	3.004E+05	5.808E+03	8.123E+00	3.054E-11	0.0	0.0	0.0	0.0
7.587E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8.348E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.710E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.283E+02	2.283E+03	2.283E+03	2.283E+03	2.283E+03	2.282E+03	2.282E+03	2.281E+03	2.277E+03	2.263E+03	2.224E+03	2.093E+03	0.0
3.117E+05	3.993E+05	3.070E+05	3.002E+05	2.891E+05	2.681E+05	2.138E+05	1.487E+05	3.252E+04	1.685E+02	4.758E-05	0.0	0.0
4.844E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.192E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.103E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.582E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.808E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.200E+03	4.251E+02	1.505E+02	5.883E+00	3.721E-02	1.153E-06	3.435E-20	0.0	0.0	0.0	0.0	0.0	0.0
1.774E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.192E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.681E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.049E+10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.251E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8.848E+08	4.158E+17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.701E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8.482E+03	5.825E+05	3.740E+07	1.099E+13	1.426E+24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.944E+05	4.827E+05	4.714E+05	4.389E+05	3.896E+05	3.071E+05	1.804E+05	4.574E+08	3.917E+08	2.275E+15	0.0	0.0	0.0

Table C.1. (cont'd) Radioactivity in Inconel-718 Exposed to 33 GWD in PWR Core

Curies/m³

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP 1.M+3 INC-718 IN-CORE
 POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWd, FLUX= 2.59E+14 N/CM+2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
NB 98	7.445E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB100	3.887E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 93M	1.028E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 93	1.818E+01	1.818E+01	1.818E+01	1.817E+01	1.815E+01	1.812E+01	1.802E+01	1.587E+01	1.525E+01	1.328E+01	8.932E+00	2.232E+00
MO 99	7.205E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO101	1.787E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC 98	2.873E-07	2.873E-07	2.873E-07	2.873E-07	2.873E-07	2.873E-07	2.873E-07	2.873E-07	2.873E-07	2.872E-07	2.871E-07	2.868E-07
TC 99	8.714E-01	8.748E-01	8.748E-01	8.748E-01	8.745E-01	8.745E-01	8.745E-01	8.743E-01	8.739E-01	8.724E-01	8.680E-01	8.530E-01
TC100	1.801E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	1.787E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU103	3.818E+01	5.758E-02	9.157E-05	3.871E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU105	2.827E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU106	1.883E-10	8.382E-11	4.204E-11	5.343E-12	1.718E-13	1.779E-18	1.954E-25	0.0	0.0	0.0	0.0	0.0
RU107	2.056E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH102	7.002E-07	5.513E-07	4.341E-07	2.119E-07	8.415E-08	5.877E-09	4.519E-12	2.917E-17	0.0	0.0	0.0	0.0
RH104	9.010E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH104M	8.524E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105	2.808E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105M	7.815E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH106	1.478E-05	8.382E-11	4.204E-11	5.343E-12	1.718E-13	1.779E-18	1.954E-25	0.0	0.0	0.0	0.0	0.0
RH106M	7.171E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH107	2.056E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD107	4.897E-15	4.897E-15	4.897E-15	4.897E-15	4.897E-15	4.897E-15	4.897E-15	4.897E-15	4.897E-15	4.896E-15	4.892E-15	0.0
PD107M	2.833E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109	2.877E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109M	4.871E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD111	8.783E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG108	1.389E-16	9.809E-22	9.809E-22	9.809E-22	9.545E-22	8.035E-22	7.658E-22	5.766E-22	1.998E-22	1.394E-23	0.0	0.0
AG109M	2.878E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG110	2.954E-12	1.882E-16	8.033E-17	2.887E-18	1.888E-20	7.433E-25	0.0	0.0	0.0	0.0	0.0	0.0
AG110M	3.441E-14	1.249E-14	4.538E-15	2.171E-16	1.404E-18	5.589E-23	0.0	0.0	0.0	0.0	0.0	0.0
AG111	2.472E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG111M	7.032E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD111M	1.349E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	3.327E+07	4.815E+06	4.088E+06	2.711E+06	1.476E+06	5.763E+05	2.230E+05	1.501E+05	3.582E+04	3.423E+03	3.121E+03	2.742E+03
TOTAL	3.327E+07	4.815E+06	4.088E+06	2.711E+06	1.476E+06	5.763E+05	2.230E+05	1.501E+05	3.582E+04	3.423E+03	3.121E+03	2.742E+03

C.7

Table C.2. Radioactivity in Stainless Steel-304 Exposed to 33 GWD in PWR Core

Curie/m³

OUTPUT UNIT = 6

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP 1.M**3 SS-304 IN-CORE
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
H 3	3	3.003E-02	2.840E-02	2.685E-02	2.289E-02	1.713E-02	9.774E-03	1.815E-03	1.098E-04	1.460E-09	0.0	0.0
H 4	4	1.533E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 8	8	9.543E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LI 8	8	8.512E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 8	8	1.652E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 10	10	2.607E-05	2.607E-05	2.607E-05	2.607E-05	2.607E-05	2.607E-05	2.607E-05	2.607E-05	2.606E-05	2.603E-05	2.598E-05
BE 11	11	5.287E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 12	12	1.321E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C 14	14	2.063E+02	2.063E+02	2.063E+02	2.062E+02	2.061E+02	2.058E+02	2.051E+02	2.039E+02	1.990E+02	1.828E+02	1.435E+02
C 15	15	9.898E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N 16	16	3.102E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
F 20	20	6.218E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE 23	23	2.934E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24	24	9.885E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24M	24M	1.377E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 25	25	4.431E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 27	27	1.349E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 28	28	1.231E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 28	28	1.612E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 29	29	5.480E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 30	30	5.284E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 31	31	1.038E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 32	32	4.487E-06	4.482E-06	4.477E-06	4.463E-06	4.439E-06	4.392E-06	4.254E-06	4.033E-06	3.258E-06	1.545E-06	1.830E-07
SI 32	32	1.594E+04	3.307E-04	4.477E-06	4.463E-06	4.439E-06	4.392E-06	4.254E-06	4.033E-06	3.258E-06	1.545E-06	1.830E-07
P 33	33	5.831E-01	2.332E-05	9.324E-10	5.883E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 34	34	3.000E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 35	35	3.341E+02	1.881E+01	1.059E+00	1.891E-04	1.070E-10	3.428E-23	0.0	0.0	0.0	0.0	0.0
S 37	37	8.667E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 36	36	7.528E-05	7.528E-05	7.526E-05	7.520E-05	7.526E-05	7.526E-05	7.525E-05	7.524E-05	7.521E-05	7.509E-05	7.474E-05
CL 38	38	9.958E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 38M	38M	1.185E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 37	37	2.381E-07	1.734E-10	1.258E-13	4.804E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 39	39	1.391E-09	1.387E-09	1.384E-09	1.373E-09	1.355E-09	1.321E-09	1.223E-09	1.078E-09	8.420E-10	1.057E-10	8.111E-13
AR 41	41	6.891E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 42	42	1.513E-17	1.481E-17	1.450E-17	1.362E-17	1.228E-17	9.938E-18	5.291E-18	1.851E-18	2.707E-20	0.0	0.0
K 40	40	5.133E-22	5.133E-22	5.133E-22	5.133E-22	5.133E-22	5.133E-22	5.133E-22	5.133E-22	5.133E-22	5.133E-22	5.133E-22
K 42	42	1.168E-11	1.481E-17	1.451E-17	1.362E-17	1.228E-17	9.939E-18	5.292E-18	1.851E-18	2.773E-20	0.0	0.0
K 43	43	1.928E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K 44	44	1.548E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CA 45	45	3.689E-05	7.801E-08	1.850E-06	1.581E-08	6.805E-12	1.183E-18	0.0	0.0	0.0	0.0	0.0
CA 47	47	5.473E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 46	46	4.312E-07	2.102E-06	1.024E-09	1.188E-13	3.281E-20	0.0	0.0	0.0	0.0	0.0	0.0
SC 46M	46M	2.326E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 47	47	2.038E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 48	48	2.321E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 49	49	5.607E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 50	50	4.839E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TI 51	51	8.836E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 50	50	1.959E-12	1.959E-12	1.959E-12	1.959E-12	1.959E-12	1.959E-12	1.959E-12	1.959E-12	1.959E-12	1.959E-12	1.959E-12
V 52	52	1.557E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 53	53	4.294E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 54	54	4.893E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Table C.2. (cont'd) Radioactivity in Stainless Steel-304 Exposed to 33 GWD in PWR Core

Curie/m³

OUTPUT UNIT = 8

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP 1.M+3 SS-304 IN-CORE
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM+2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES

DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
CR 51	0.927E+08	9.808E+02	1.034E-01	1.288E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 55	1.391E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 54	4.703E+05	2.092E+05	9.305E+04	8.188E+03	1.428E+02	4.321E-02	1.203E-12	0.0	0.0	0.0	0.0
MN 56	2.194E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 57	1.643E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 58	4.558E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	2.907E+08	2.227E+08	1.706E+08	7.888E+05	2.021E+05	1.408E+04	4.725E+00	7.680E-08	0.0	0.0	0.0
FE 59	1.797E+05	8.477E+02	2.331E+00	1.090E-07	8.618E-20	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	4.552E+05	1.273E+04	1.858E+02	7.774E-03	1.327E-10	0.0	0.0	0.0	0.0	0.0	0.0
CO 60	6.087E+05	8.126E+05	5.371E+05	3.620E+05	1.875E+08	8.033E+04	9.729E+02	1.351E+00	5.079E-12	0.0	0.0
CO 60M	1.276E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 61	1.398E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 62	6.410E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 59	3.837E+02	3.837E+02	3.837E+02	3.837E+02	3.837E+02	3.838E+02	3.834E+02	3.827E+02	1.804E+02	1.739E+02	1.519E+02
NI 83	5.236E+04	5.198E+04	5.157E+04	5.042E+04	4.858E+04	4.503E+04	3.592E+04	2.465E+04	8.462E+03	2.799E+01	7.896E-08
NI 85	8.059E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 88	7.140E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 64	3.512E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 80	4.854E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 87	7.725E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 85	4.833E+02	1.711E-02	6.060E-03	2.691E-04	1.499E-06	4.844E-11	1.383E-24	0.0	0.0	0.0	0.0
ZN 89	4.540E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 89M	3.051E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CA 70	1.104E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	5.846E+14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	1.806E+15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71	1.454E+11	8.993E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71M	1.317E+12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 89	9.828E+08	5.534E+08	4.343E+10	1.278E+16	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 90	8.328E+08	8.132E+08	7.841E+08	7.394E+08	8.564E+08	5.174E+08	2.533E+08	7.706E+09	8.598E+11	1.832E+18	0.0
SR 91	1.277E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 93	1.355E+17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 90	7.791E+01	8.134E+08	7.943E+08	7.398E+08	8.568E+08	5.175E+08	2.534E+08	7.708E+09	8.600E+11	1.833E+18	0.0
Y 90M	1.135E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 91	3.243E+05	4.282E+07	5.855E+09	1.302E+14	5.225E+24	0.0	0.0	0.0	0.0	0.0	0.0
Y 92	2.314E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 93	1.355E+17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 94	7.043E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 98	1.804E+17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 93	8.532E+08	8.532E+08	8.532E+08	8.532E+08	8.532E+08	8.532E+08	8.532E+08	8.532E+08	8.531E+08	8.528E+08	8.494E+08
ZR 95	3.640E+05	8.980E+07	1.331E+08	9.304E+14	2.378E+22	0.0	0.0	0.0	0.0	0.0	0.0
ZR 97	2.603E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 92	1.931E+01	2.910E+10	4.384E+21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 93M	5.647E+07	9.394E+07	1.295E+08	2.281E+06	3.576E+06	5.384E+08	7.516E+08	8.059E+08	8.105E+08	8.102E+08	8.095E+08
NB 94	1.448E+00	1.448E+00	1.448E+00	1.448E+00	1.448E+00	1.447E+00	1.448E+00	1.443E+00	1.400E+00	1.307E+00	1.029E+00
NB 95	1.839E+03	1.221E+00	9.090E+04	5.820E+13	5.280E+22	0.0	0.0	0.0	0.0	0.0	0.0
NB 95M	2.582E+07	5.183E+09	9.873E+11	8.902E+18	1.784E+24	0.0	0.0	0.0	0.0	0.0	0.0
NB 98	1.855E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97	1.103E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97M	2.463E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 98	2.277E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 99	2.203E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Table C.2. (cont'd) Radioactivity in Stainless Steel-304 Exposed to 33 GWD in PWR Core

Curie/m³

OUTPUT UNIT = g

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*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP 1.M+3 SS-304 IN-CORE
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.58E+14 N/CM+2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
MO101	1.328E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC 98	3.933E-20	3.933E-20	3.933E-20	3.933E-20	3.933E-20	3.933E-20	3.933E-20	3.933E-20	3.933E-20	3.933E-20	3.931E-20	3.927E-20
TC 99	3.808E-13	3.705E-13	3.705E-13	3.705E-13	3.705E-13	3.705E-13	3.704E-13	3.702E-13	3.693E-13	3.689E-13	3.587E-13	
TC100	9.879E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	1.328E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU103	1.058E-18	3.253E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	3.734E+07	3.115E+06	2.388E+06	1.188E+06	4.390E+05	1.100E+05	3.749E+04	2.524E+04	8.045E+03	5.927E+02	5.187E+02	4.145E+02
TOTAL	3.734E+07	3.115E+06	2.388E+06	1.188E+06	4.390E+05	1.100E+05	3.749E+04	2.524E+04	8.045E+03	5.927E+02	5.187E+02	4.145E+02

Table C.3. Radioactivity in Zircaloy-4 Exposed to 33 GWD in PWR Core

Curies/m³

+PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, 1.M-3 ZIRC-4 IN-CORE
 POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MW, FLUX= 2.59E+14 N/CM**2-SEC

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
5.363E-03	5.070E-03	4.794E-03	4.051E-03	3.059E-03	1.745E-03	3.240E-04	1.957E-05	2.808E-10	0.0	0.0	0.0	
1.588E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.171E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.379E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.398E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.314E-06	3.314E-06	3.314E-06	3.314E-06	3.314E-06	3.314E-06	3.314E-06	3.314E-06	3.314E-06	3.313E-06	3.310E-06	3.300E-06	
6.721E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.984E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.040E+01	1.039E+01	1.039E+01	1.039E+01	1.038E+01	1.037E+01	1.033E+01	1.027E+01	1.003E+01	9.211E+00	7.232E+00	3.100E+00	
1.887E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.111E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.349E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.999E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.571E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.605E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.688E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.275E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.723E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.484E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.529E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.193E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.111E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.142E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.835E-10	4.929E-10	4.924E-10	4.908E-10	4.882E-10	4.830E-10	4.878E-10	4.435E-10	3.584E-10	1.899E-10	2.013E-11	1.153E-14	
1.884E+02	1.262E-05	4.927E-10	4.909E-10	4.882E-10	4.831E-10	4.879E-10	4.436E-10	3.584E-10	1.899E-10	2.013E-11	1.154E-14	
5.574E-02	2.229E-08	8.913E-11	5.700E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.888E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.194E+01	1.799E+00	1.013E-01	1.808E-05	1.023E-11	3.277E-24	0.0	0.0	0.0	0.0	0.0	0.0	
8.285E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
7.194E-06	7.194E-06	7.194E-06	7.194E-06	7.194E-06	7.194E-06	7.194E-06	7.193E-06	7.189E-06	7.178E-06	7.145E-06	7.031E-06	
9.517E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.133E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.285E-08	1.858E-11	1.203E-14	4.592E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.330E-10	1.328E-10	1.323E-10	1.313E-10	1.298E-10	1.283E-10	1.189E-10	1.028E-10	8.138E-11	1.011E-11	5.842E-14	8.572E-22	
4.580E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.455E-15	1.424E-15	1.395E-15	1.310E-15	1.170E-15	9.557E-18	5.089E-18	1.781E-18	2.869E-18	1.099E-24	0.0	0.0	
4.907E-23	4.907E-23	4.907E-23	4.907E-23	4.907E-23	4.907E-23	4.907E-23	4.907E-23	4.907E-23	4.907E-23	4.907E-23	4.907E-23	
8.223E-09	1.424E-15	1.395E-15	1.310E-15	1.179E-15	9.557E-18	5.089E-18	1.781E-18	2.869E-18	1.099E-24	0.0	0.0	
5.736E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.021E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3.390E-02	7.169E-03	1.516E-03	1.434E-05	8.070E-09	1.087E-15	0.0	0.0	0.0	0.0	0.0	0.0	
4.078E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4.247E+00	2.070E-01	1.009E-02	1.168E-06	3.212E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.669E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.762E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
8.428E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
6.342E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.082E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
1.300E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
5.849E-14	5.849E-14	5.849E-14	5.849E-14	5.849E-14	5.849E-14	5.849E-14	5.849E-14	5.849E-14	5.849E-14	5.849E-14	5.849E-14	
6.597E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2.310E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table C.3. (cont'd) Radioactivity in Zircaloy-4 Exposed to 33 GWD in PWR Core

Curies/m³

*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP 1.M+3 ZIRC-4 IN-CORE
POWER= 3.00000E+01 MW, BURNUP= 3.00000E+04 MWD, FLUX= 2.50E+14 N/CM+2-SEC

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISCHG.	METRIC TON URANIUM METAL AS LOADED											
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
2. 830E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. 799E+04	8.163E+00	5.556E-04	8.823E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7. 240E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 257E+03	8.593E+02	2.488E+02	2.189E+01	3.811E-01	1.155E-04	3.218E-15	0.0	0.0	0.0	0.0	0.0	0.0
1. 977E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. 391E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 210E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7. 704E+03	8.901E+03	4.520E+03	2.032E+03	5.357E+02	3.725E+01	1.252E-02	2.035E-08	0.0	0.0	0.0	0.0	0.0
4. 773E+02	1.720E+00	8.194E-03	2.897E-10	1.758E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8. 330E+01	2.330E+00	8.518E-02	1.424E-05	2.431E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7. 084E+03	8.211E+02	5.445E+03	1.670E+03	1.901E+03	5.103E+02	8.884E+00	1.175E-02	8.169E-14	0.0	0.0	0.0	0.0
1. 284E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 378E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5. 546E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7. 027E-02	7.027E-02	7.027E-02	7.027E-02	7.026E-02	7.026E-02	7.024E-02	7.021E-02	7.009E-02	6.986E-02	6.847E-02	6.444E-02	6.444E-02
9. 948E+00	9.874E+00	9.800E+00	9.581E+00	8.228E+00	6.557E+00	6.828E+00	4.883E+00	1.038E+00	5.118E-03	1.810E-09	0.0	0.0
3. 282E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. 022E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. 364E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7. 294E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 211E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 922E+00	8.805E-01	2.410E-01	1.070E-02	5.858E-05	1.846E-09	5.498E-23	0.0	0.0	0.0	0.0	0.0	0.0
2. 837E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 806E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9. 088E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6. 478E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. 002E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 383E-10	8.852E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 232E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 332E+03	8.857E+00	5.888E-02	1.730E-08	2.245E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. 274E-02	4.174E-02	4.078E-02	3.785E-02	3.189E-02	2.855E-02	1.306E-02	1.955E-03	3.388E-05	1.987E-12	0.0	0.0	0.0
2. 586E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8. 897E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4. 928E+04	4.175E-02	4.077E-02	3.798E-02	3.370E-02	2.656E-02	1.301E-02	1.956E-03	3.387E-05	1.987E-12	0.0	0.0	0.0
3. 083E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. 373E+03	4.455E+01	5.883E-01	1.354E-06	5.438E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. 920E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8. 897E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 850E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 184E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. 726E+00	3.726E+00	3.726E+00	3.726E+00	3.726E+00	3.726E+00	3.726E+00	3.725E+00	3.725E+00	3.724E+00	3.721E+00	3.709E+00	3.709E+00
1. 151E+06	2.201E+04	4.208E+02	2.942E-03	7.520E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 709E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 895E+01	2.855E-10	4.302E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2. 460E-01	4.097E-01	5.852E-01	9.889E-01	1.581E+00	2.351E+00	3.282E+00	3.519E+00	3.539E+00	3.538E+00	1.535E+00	1.523E+00	1.523E+00
1. 421E+00	1.421E+00	1.421E+00	1.421E+00	1.421E+00	1.420E+00	1.419E+00	1.418E+00	1.407E+00	1.373E+00	1.283E+00	1.910E+00	1.910E+00
1. 134E+08	4.950E+04	9.873E+02	8.531E-03	1.889E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8. 197E+03	1.833E+02	3.122E+00	2.182E-05	5.578E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 284E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 709E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1. 617E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8. 729E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table C.3. (cont'd) Radioactivity in Zircaloy-4 Exposed to 33 GWD in PWR Core

Curies/m³

*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, 1.M**3 ZIRC-4 IN-CORE
POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM**2-SEC

	7 SUMMARY TABLE: RADIOACTIVITY, CURIES											
	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
NR100	2.088E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 99	8.495E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO101	1.012E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC 98	5.440E-12	5.440E-12	5.440E-12	5.440E-12	5.440E-12	5.440E-12	5.440E-12	5.440E-12	5.440E-12	5.440E-12	5.438E-12	5.432E-12
TC 99	2.787E-05	2.825E-05	2.825E-05	2.825E-05	2.824E-05	2.824E-05	2.824E-05	2.824E-05	2.822E-05	2.815E-05	2.797E-05	2.734E-05
TC100	7.476E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	1.012E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU103	4.187E-08	6.845E-11	1.052E-13	4.219E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU105	7.991E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU106	4.871E-19	2.673E-19	1.487E-19	8.599E-21	8.599E-21	1.278E-20	0.0	0.0	0.0	0.0	0.0	0.0
RH102	2.001E-18	1.575E-18	1.240E-18	8.058E-17	1.833E-17	1.884E-18	1.295E-21	0.0	0.0	0.0	0.0	0.0
RH104	4.438E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH104M	3.813E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105	7.389E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105M	2.237E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH106	2.031E-08	2.673E-19	1.487E-19	1.884E-20	8.599E-21	1.278E-20	0.0	0.0	0.0	0.0	0.0	0.0
RH106M	2.034E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD107	5.924E-15	5.924E-15	5.924E-15	5.924E-15	5.924E-15	5.924E-15	5.924E-15	5.924E-15	5.924E-15	5.924E-15	5.922E-15	5.918E-15
PD107M	7.865E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109	2.443E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109M	3.982E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD111	3.777E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD111M	5.288E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG108	8.785E-07	1.017E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG108	1.190E-02	5.204E-07	5.175E-07	5.091E-07	4.954E-07	4.891E-07	3.983E-07	3.032E-07	1.018E-07	2.231E-09	4.056E-14	0.0
AG108M	5.879E-06	5.847E-08	5.815E-08	5.721E-08	5.567E-08	5.271E-08	4.475E-08	3.408E-08	1.144E-08	2.507E-08	4.587E-13	0.0
AG109M	7.388E-02	4.287E-02	2.473E-02	4.812E-03	3.144E-04	1.342E-08	1.045E-13	1.482E-25	0.0	0.0	0.0	0.0
AG110	3.783E-02	5.871E-08	2.059E-08	9.854E-08	6.217E-10	2.475E-14	0.0	0.0	0.0	0.0	0.0	0.0
AG110M	1.174E-03	4.284E-04	1.548E-04	7.409E-08	4.875E-08	1.881E-12	1.173E-25	0.0	0.0	0.0	0.0	0.0
AG111	8.553E-05	1.493E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG111M	3.915E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG112	8.323E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD107	8.383E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD109	7.384E-02	4.267E-02	2.473E-02	4.812E-03	3.144E-04	1.342E-08	1.045E-13	1.482E-25	0.0	0.0	0.0	0.0
CD111M	1.414E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD115	2.124E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD115M	1.758E+00	8.012E-03	2.058E-05	8.258E-13	3.881E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD117	1.418E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD117M	2.105E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD119	2.454E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD121	7.404E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INI13M	2.187E-04	2.403E+03	2.864E+02	3.830E-01	6.043E-08	1.894E-15	0.0	0.0	0.0	0.0	0.0	0.0
INI14	7.189E-03	1.898E+01	1.022E-01	2.228E-08	1.758E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INI14M	2.949E-03	1.775E+01	1.068E-01	2.328E-08	1.835E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INI15	2.539E-15	2.987E-15	2.988E-15	2.988E-15	2.988E-15	2.988E-15	2.988E-15	2.988E-15	2.988E-15	2.988E-15	2.988E-15	2.988E-15
INI18	1.138E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INI18M	1.326E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INI17	1.013E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INI17M	1.328E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INI18	3.231E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INI19	2.335E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INI19M	2.454E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table C.3. (cont'd) Radioactivity in Zircaloy-4 Exposed to 33 GWD in PWR Core

Curies/m³

*PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, 1.M+3 ZIRC-4 IN-CORE
 POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.69E+14 N/CM+2-SEC

7 SUMMARY TABLE: RADIOACTIVITY, CURIES		METRIC TON URANIUM METAL AS LOADED											
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
IN120	8.267E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN120M	8.442E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IN121	8.071E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN113	2.187E-04	2.402E+03	2.883E+02	3.807E-01	8.038E-08	1.693E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN113M	9.850E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN117M	1.715E-08	2.418E-03	3.404E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN119M	1.812E-08	8.735E-04	2.041E-04	9.198E-02	5.248E+00	1.708E-04	8.894E-18	0.0	0.0	0.0	0.0	0.0	0.0
SN121	8.293E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN121M	1.700E-01	1.878E+01	1.853E+01	1.586E+01	1.480E+01	1.288E+01	8.498E+00	4.248E+00	2.850E-01	1.809E-05	1.441E-17	0.0	0.0
SN123	8.046E-03	1.133E+03	1.598E+02	4.484E-01	2.469E-05	7.500E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN123M	3.237E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN125	8.357E-04	2.106E-07	8.271E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SN125M	4.232E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB122	1.048E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB122M	9.117E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB124	4.850E-02	7.231E+00	1.078E-01	3.574E-07	2.833E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB124M	1.855E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB125	4.382E-04	3.452E+04	2.888E+04	1.269E+04	3.830E+03	2.972E+02	1.832E-01	8.007E-07	0.0	0.0	0.0	0.0	0.0
SB126	1.157E-03	1.881E-08	2.106E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SB126M	1.183E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE123	1.014E-11	1.231E-11	1.257E-11	1.261E-11	1.261E-11	1.261E-11	1.261E-11	1.261E-11	1.261E-11	1.261E-11	1.261E-11	1.261E-11	1.261E-11
TE123M	7.515E-01	9.081E+00	1.093E+00	1.911E-03	4.871E-08	3.184E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE125M	9.435E-03	8.405E-03	8.557E-03	3.095E-03	8.857E-02	7.253E-01	3.982E-02	1.468E-07	0.0	0.0	0.0	0.0	0.0
TE127	1.006E-01	8.396E-02	8.289E-03	8.904E-08	8.342E-11	4.374E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE127M	6.881E-01	6.529E-02	6.400E-03	8.028E-08	5.454E-11	4.466E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE129	1.820E-05	1.493E-10	7.971E-14	1.214E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE129M	4.293E-07	2.293E-10	1.225E-13	1.865E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE128	3.788E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE129	3.585E-13	3.812E-13	3.812E-13	3.812E-13	3.812E-13	3.812E-13	3.812E-13	3.812E-13	3.812E-13	3.812E-13	3.812E-13	3.812E-13	3.812E-13
TE130	3.820E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE130M	1.588E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE131	4.948E-11	1.047E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TE132	4.870E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE127	8.541E-07	8.163E-10	7.802E-13	8.813E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE129M	1.058E-04	1.909E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE131M	1.251E-08	7.182E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE133	5.210E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
XE133M	1.632E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS132	6.187E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS134	1.230E-14	8.793E-15	8.283E-15	2.292E-15	4.268E-16	1.480E-17	8.171E-22	0.0	0.0	0.0	0.0	0.0	0.0
CS134M	1.444E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CS135	4.183E-22	4.183E-22	4.183E-22	4.183E-22	4.183E-22	4.183E-22	4.183E-22	4.183E-22	4.183E-22	4.183E-22	4.183E-22	4.183E-22	4.183E-22
CS138	2.533E-17	1.027E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA135M	1.620E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BA136M	4.174E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ER159	2.312E-12	4.846E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ER171	9.709E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ER172	2.956E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IM170	4.455E-13	8.220E-14	8.684E-15	2.380E-17	1.252E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IM170M	5.088E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
IM171	2.428E-14	1.896E-14	1.182E-14	4.001E-15	6.580E-16	1.780E-17	3.522E-22	0.0	0.0	0.0	0.0	0.0	0.0
IM172	5.720E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table C.3. (cont'd) Radioactivity in Zircaloy-4 Exposed to 33 GWD in PWR Core

Curies/m³

*PWR, 3.2 W/D ENRICHMENT, 33GWD/MT BURNUP, 1.M**3 ZIRC-4 IN-CORE
 POWER= 3.00000E+01 MW, BURNUP= 3.30000E+04 MWD, FLUX= 2.59E+14 N/CM**2-SEC

7 SUMMARY TABLE: RADIOACTIVITY, CURIES													
METRIC TON URANIUM METAL AS LOADED													
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
YB173	5.947E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YB175	3.182E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YB175M	2.251E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU176	7.827E-10	7.827E-10	7.827E-10	7.827E-10	7.827E-10	7.827E-10	7.827E-10	7.827E-10	7.827E-10	7.827E-10	7.827E-10	7.827E-10	7.827E-10
LU176M	1.701E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU177	6.581E-01	7.287E-03	1.419E-03	1.057E-05	3.000E-09	2.418E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU177M	1.618E-01	3.160E-02	6.171E-03	4.595E-05	1.305E-08	1.052E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF175	3.696E-02	9.937E-00	2.870E-01	5.180E-08	7.256E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF178M	3.971E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF179M	6.886E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF180M	6.811E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF181	1.291E-04	3.298E-01	8.408E-02	1.394E-09	1.504E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF182	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.096E-05	1.096E-05
TA182	9.878E-02	1.093E-02	1.209E-01	1.639E-02	1.124E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.097E-05	1.096E-05	1.096E-05
TA182M	2.020E-00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA183	2.888E-03	8.249E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W181	2.042E-01	2.527E-00	3.128E-01	5.933E-04	1.724E-08	1.456E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W183M	2.877E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185	5.691E-02	1.955E-01	6.715E-01	2.722E-05	1.302E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185M	6.488E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W187	1.054E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W188	2.875E-01	7.486E-01	1.849E-02	3.442E-07	4.122E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W189	1.485E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE186	3.735E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE187	3.881E-07	3.886E-07	3.886E-07	3.886E-07	3.886E-07	3.886E-07	3.886E-07	3.886E-07	3.886E-07	3.886E-07	3.886E-07	3.886E-07	3.886E-07
RE188	3.585E-03	7.563E-01	1.970E-02	3.478E-07	4.164E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE188M	3.480E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE189	1.780E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS190M	3.102E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191	2.972E-01	2.227E-08	1.823E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191M	2.279E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS193	4.677E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS194	1.314E-09	1.171E-09	1.043E-09	7.374E-10	4.139E-10	1.304E-10	4.074E-12	1.265E-14	1.188E-24	0.0	0.0	0.0	0.0
IR192	7.879E-02	2.576E-03	8.431E-05	8.178E-08	7.769E-08	7.549E-08	8.925E-08	5.997E-08	3.374E-08	4.506E-09	1.431E-11	2.583E-20	2.583E-20
IR192M	7.989E-08	7.986E-08	7.943E-08	7.875E-08	7.762E-08	7.542E-08	8.919E-08	5.992E-08	3.371E-08	4.502E-09	1.430E-11	2.581E-20	2.581E-20
IR194	3.228E-03	1.171E-09	1.043E-09	7.377E-10	4.140E-10	1.304E-10	4.075E-12	1.265E-14	1.189E-24	0.0	0.0	0.0	0.0
IR194M	1.701E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT193	5.243E-07	5.273E-07	5.268E-07	5.244E-07	5.208E-07	5.136E-07	4.927E-07	4.597E-07	3.484E-07	1.320E-07	8.251E-09	5.038E-13	5.038E-13
PT193M	1.577E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT195M	1.759E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197	5.312E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197M	3.598E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU198	4.358E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU199	1.052E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU200	3.441E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HQ199M	1.699E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	8.251E-08	1.909E+05	6.820E+04	2.247E+04	7.000E+03	9.567E+02	4.428E+01	2.795E+01	2.007E+01	1.792E+01	1.584E+01	1.141E+01	1.141E+01
TOTAL	8.251E-08	1.909E+05	6.820E+04	2.247E+04	7.000E+03	9.567E+02	4.428E+01	2.795E+01	2.007E+01	1.792E+01	1.584E+01	1.141E+01	1.141E+01

Table C.4. Radioactivity in Inconel-718 Exposed to 2B GWD in BWR Core

Curies/m³

OUTPUT UNIT = B

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*BWR, 2.5 W/O ENRICHMENT, 2B GWD/MT 1M+3 INC-718 IN-CORE
POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES		METRIC TON URANIUM METAL AS LOADED									
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
H 3	7.691E-03	7.272E-03	8.875E-03	5.809E-03	4.388E-03	2.503E-03	4.847E-04	2.807E-05	3.740E-10	0.0	0.0
H 4	4.225E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 6	1.768E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LI 8	2.622E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 8	2.074E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 10	9.842E-06	9.842E-06	9.842E-06	9.842E-06	9.842E-06	9.842E-06	9.842E-06	9.842E-06	9.841E-08	9.838E-08	9.830E-06
B 11	1.372E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 12	6.286E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 14	6.043E-02	2.043E+02	2.042E+02	2.042E+02	2.040E+02	2.038E+02	2.030E+02	2.018E+02	1.970E+02	1.810E+02	1.421E+02
B 16	4.97E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 18	2.20E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 19	3.50E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 20	3.331E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 23	2.53E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 24	6.257E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 24M	1.034E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 25	3.408E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 27	4.427E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 28	2.833E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 29	1.449E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 30	5.810E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 31	5.604E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 32	7.055E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 33	3.108E-07	3.105E-07	3.102E-07	3.092E-07	3.075E-07	3.043E-07	2.947E-07	2.794E-07	2.257E-07	1.070E-07	1.268E-08
B 34	7.991E-02	1.887E-05	3.102E-07	3.092E-07	3.075E-07	3.043E-07	2.947E-07	2.794E-07	2.257E-07	1.070E-07	1.268E-08
B 35	9.743E-02	3.896E-06	1.558E-10	9.965E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 36	3.715E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 37	5.882E-01	3.200E+00	1.802E-01	3.216E-05	1.820E-11	5.829E-24	0.0	0.0	0.0	0.0	0.0
B 38	1.448E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 39	1.811E-05	1.811E-05	1.811E-05	1.811E-05	1.811E-05	1.811E-05	1.811E-05	1.811E-05	1.810E-05	1.807E-05	1.799E-05
B 40	1.830E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 41	1.940E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 42	5.854E-08	4.247E-11	3.081E-14	1.176E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 43	3.116E-10	3.108E-10	3.100E-10	3.077E-10	3.037E-10	2.980E-10	2.740E-10	2.409E-10	1.439E-10	2.389E-11	1.389E-13
B 44	8.809E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 45	2.724E-13	2.687E-13	2.812E-13	2.452E-13	2.208E-13	1.790E-13	9.530E-14	3.334E-14	4.995E-18	2.056E-22	0.0
B 46	1.652E-06	2.686E-13	2.812E-13	2.453E-13	2.208E-13	1.790E-13	9.531E-14	3.334E-14	4.998E-18	2.058E-22	0.0
B 47	1.080E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 48	1.921E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 49	9.163E-00	1.938E+00	4.098E-01	3.877E-03	1.840E-06	2.937E-13	0.0	0.0	0.0	0.0	0.0
B 50	1.038E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 51	1.123E-03	5.472E+01	2.867E+00	3.086E-04	8.492E-11	8.423E-24	0.0	0.0	0.0	0.0	0.0
B 52	1.551E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 53	1.756E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 54	1.633E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 55	1.640E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 56	2.806E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 57	4.330E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 58	1.451E-12	1.451E-12	1.451E-12	1.451E-12	1.451E-12	1.451E-12	1.451E-12	1.451E-12	1.451E-12	1.451E-12	1.451E-12
B 59	1.007E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 60	2.258E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 61	2.580E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Table C.4. (cont'd) Radioactivity in Inconel-718 Exposed to 28 GWD in BWR Core

Curies/m³

OUTPUT UNIT = B

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BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT IM+3 INC-718 IN-CORE
 POWER= 1.91800E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM+2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES

METRIC TON URANIUM METAL AS LOADED

D/SCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
CR 51	8.398E+06	8.882E+02	7.406E-02	8.227E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 55	8.553E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 59	7.150E+04	3.180E+04	1.415E+04	1.245E+03	2.167E+01	6.568E-03	1.829E-13	0.0	0.0	0.0	0.0
MN 54	1.784E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 57	2.280E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 58	7.220E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	7.783E+05	5.948E+05	4.555E+05	2.047E+05	5.398E+04	3.753E+03	1.262E+00	2.051E-08	0.0	0.0	0.0
FE 59	3.878E+04	1.398E+02	8.040E-01	2.357E-08	1.431E-20	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	1.742E+00	4.871E+04	1.182E+03	2.875E+02	5.080E-10	1.481E-25	0.0	0.0	0.0	0.0	0.0
CO 60	1.830E+00	3.358E+00	2.844E+00	1.984E+00	1.028E+00	2.758E+05	5.333E+03	7.463E+00	2.806E-11	0.0	0.0
CO 60M	5.317E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 61	3.600E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 62	2.450E+03	1.878E+03	1.878E+03	1.878E+03	1.878E+03	1.878E+03	1.875E+03	1.871E+03	1.859E+03	1.826E+03	1.812E+03
NI 59	1.878E+03	3.013E+05	2.891E+05	2.824E+05	2.818E+05	2.812E+05	2.833E+05	1.429E+05	1.167E+04	1.823E+02	4.638E-05
NI 63	3.398E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 65	2.112E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 68	1.478E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 64	3.218E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 67	3.744E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 65	8.429E+02	3.339E+02	1.182E+02	8.250E+00	2.823E-02	8.060E-07	2.898E-20	0.0	0.0	0.0	0.0
ZN 69	1.770E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 69H	7.869E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 70	3.882E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	2.894E+10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	8.326E+12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71	5.878E+06	2.874E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71M	4.877E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 69	1.480E+03	9.704E-08	8.451E-08	1.895E-14	2.459E-25	0.0	0.0	0.0	0.0	0.0	0.0
SR 90	2.481E+05	2.404E-05	2.347E-05	2.185E-05	1.840E-05	1.529E-05	7.487E-08	2.278E-06	1.950E-08	1.133E-15	0.0
SR 91	2.194E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 93	1.728E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 85H	9.237E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 90	2.174E+02	2.404E-05	2.348E-05	2.186E-05	1.841E-05	1.530E-05	7.489E-08	2.278E-06	1.951E-08	1.133E-15	0.0
Y 90M	2.223E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 91	8.527E+03	8.819E-05	1.138E-05	2.820E-12	1.052E-21	0.0	0.0	0.0	0.0	0.0	0.0
Y 92	8.977E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 93	1.728E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 94	1.528E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 98	2.300E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 89	9.252E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 93	3.512E+03	3.512E-03	3.512E-03	3.512E-03	3.512E-03	3.512E-03	3.511E-03	3.511E-03	3.510E-03	3.507E-03	3.496E-03
ZR 95	3.131E+01	5.987E-01	1.145E-02	8.003E-08	2.048E-18	0.0	0.0	0.0	0.0	0.0	0.0
ZR 97	7.302E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 92	2.718E+03	4.892E-08	8.165E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 93M	3.092E+04	4.595E-04	8.025E-04	9.900E-04	1.518E-03	2.244E-03	3.099E-03	3.317E-03	3.336E-03	3.335E-03	3.332E-03
NB 94	8.203E+02	8.203E+02	8.203E+02	8.203E+02	8.200E+02	8.197E+02	8.180E+02	8.175E+02	8.119E+02	7.928E+02	5.830E+02
NB 95	8.589E+05	4.920E+02	3.917E+01	1.778E-07	4.542E-18	0.0	0.0	0.0	0.0	0.0	0.0
NB 95M	2.205E+01	4.441E-03	8.492E-05	5.937E-10	1.518E-18	0.0	0.0	0.0	0.0	0.0	0.0
NB 96	5.911E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97	2.514E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97M	8.910E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table C.4. (cont'd) Radioactivity in Inconel-718 Exposed to 28 GWD in BWR Core
Curies/m³

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT, 1M*3 INC-718, IN-CORE
POWER= 1.91800E+01 MW, BURNUP= 2.80000E+04 MW0, FLUX= 1.85E+14 N/CM*2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
NB 08	3.792E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB100	1.917E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 93M	7.213E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO 93	1.591E+01	1.590E+01	1.590E+01	1.588E+01	1.588E+01	1.584E+01	1.575E+01	1.580E+01	1.489E+01	1.305E+01	8.779E+00	2.193E+00
MO 99	2.265E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO101	1.258E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC 98	8.823E-07	8.823E-07	8.823E-07	8.823E-07	8.823E-07	8.823E-07	8.823E-07	8.823E-07	8.823E-07	8.822E-07	8.819E-07	8.809E-07
TC 99	2.984E+00	2.994E+00	2.994E+00	2.994E+00	2.994E+00	2.994E+00	2.994E+00	2.993E+00	2.991E+00	2.985E+00	2.985E+00	2.988E+00
TC100	5.536E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	1.258E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU103	2.491E+01	3.975E-02	8.310E-05	2.530E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU105	1.382E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU108	7.489E-11	3.765E-11	1.893E-11	2.408E-12	7.727E-14	8.008E-17	8.796E-28	0.0	0.0	0.0	0.0	0.0
RU107	8.574E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH102	4.761E-07	3.749E-07	2.952E-07	1.441E-07	4.362E-08	3.998E-09	3.073E-12	1.983E-17	0.0	0.0	0.0	0.0
RH104	6.043E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH104M	4.493E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105	1.307E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH105M	3.869E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH108	5.007E-06	3.785E-11	1.893E-11	2.408E-12	7.727E-14	8.008E-17	8.796E-28	0.0	0.0	0.0	0.0	0.0
RH106M	2.523E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RH107	8.574E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD107	3.828E-15	3.826E-15	3.826E-15	3.826E-15	3.826E-15	3.826E-15	3.826E-15	3.826E-15	3.826E-15	3.826E-15	3.825E-15	3.822E-15
PD107M	1.601E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109	1.432E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD109M	2.330E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PD111	3.117E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG108	9.365E-17	9.650E-22	9.650E-22	9.650E-22	9.390E-22	8.888E-22	7.534E-22	5.872E-22	1.986E-22	1.372E-23	0.0	0.0
AG109M	1.431E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG110	1.399E-12	1.026E-16	3.726E-17	1.783E-18	1.154E-20	4.592E-25	0.0	0.0	0.0	0.0	0.0	0.0
AG110M	2.125E-14	7.715E-15	2.801E-15	1.341E-16	8.875E-19	3.453E-23	0.0	0.0	0.0	0.0	0.0	0.0
AG111	1.088E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AG111M	3.231E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CD111M	6.188E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	2.605E+07	4.339E+06	3.717E+06	2.485E+06	1.366E+06	5.438E+05	2.187E+05	1.460E+05	3.467E+04	3.111E+03	2.820E+03	2.481E+03
TOTAL	2.605E+07	4.339E+06	3.717E+06	2.485E+06	1.366E+06	5.438E+05	2.187E+05	1.460E+05	3.467E+04	3.111E+03	2.820E+03	2.481E+03

Table C.5. Radioactivity in Stainless Steel-304 Exposed to 28 GWD in BWR Core

Curies/m³

OUTPUT UNIT = B

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT IM+3 SS-304 IN-CORE
POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES

DISCHG.		METRIC TON URANIUM METAL AS LOADED										
		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
H 3	1	4.90E-02	1.409E-02	1.332E-02	1.125E-02	8.489E-03	4.848E-03	8.001E-04	5.438E-05	7.244E-10	0.0	0.0
H 4	4	2.60E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 6	3	4.62E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LI 8	2	5.67E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 8	5	9.95E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 10	1	8.88E-05	1.888E-05	1.888E-05	1.888E-05	1.888E-05	1.888E-05	1.888E-05	1.888E-05	1.888E-05	1.888E-05	1.888E-05
BE 11	2	6.87E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 12	8	1.88E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C 14	2	0.00E+02	2.000E+02	2.000E+02	1.999E+02	1.998E+02	1.998E+02	1.978E+02	1.929E+02	1.772E+02	1.392E+02	5.988E+01
C 15	5	3.83E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C 16	2	1.74E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N 20	1	6.34E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE 23	1	1.05E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24	3	6.90E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24M	5	0.89E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 25	1	6.69E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 27	7	0.14E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MC 28	4	4.88E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 28	9	3.87E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 29	2	8.49E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 30	2	7.48E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 31	8	2.94E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 32	2	7.74E-06	2.771E-06	2.768E-06	2.759E-06	2.744E-06	2.715E-06	2.630E-06	2.493E-06	2.014E-06	9.549E-07	1.132E-07
P 32	1	0.01E+04	2.077E-04	2.768E-08	2.759E-08	2.745E-08	2.715E-08	2.630E-08	2.493E-08	2.014E-08	9.549E-07	1.132E-07
P 33	4	0.91E-01	1.838E-05	8.543E-10	4.184E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 34	1	5.60E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 35	2	3.88E-02	1.343E+01	7.584E-01	1.350E-04	7.842E-11	2.448E-23	0.0	0.0	0.0	0.0	0.0
S 37	8	0.79E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 36	7	8.06E-05	7.806E-05	7.808E-05	7.808E-05	7.806E-05	7.805E-05	7.804E-05	7.801E-05	7.888E-05	7.553E-05	7.433E-05
CL 38	6	8.43E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 38M	8	1.46E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 37	2	4.58E-07	1.783E-10	1.294E-13	4.939E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 39	1	3.08E-09	1.304E-09	1.301E-09	1.291E-09	1.275E-09	1.242E-09	1.150E-09	1.011E-09	8.037E-10	5.842E-11	5.745E-13
AR 41	1	9.24E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 42	4	1.48E-18	4.081E-18	3.975E-18	3.733E-18	3.381E-18	2.724E-18	1.450E-18	5.078E-19	8.295E-21	0.0	0.0
K 40	8	3.78E-22	8.378E-22	8.378E-22	8.378E-22	8.378E-22	8.378E-22	8.378E-22	8.378E-22	8.378E-22	8.378E-22	8.378E-22
K 42	3	2.68E-12	4.062E-18	3.978E-18	3.733E-18	3.381E-18	2.725E-18	1.451E-18	5.078E-19	8.298E-21	0.0	0.0
K 43	3	8.21E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K 44	4	2.25E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CA 45	1	5.49E-05	3.275E-06	6.927E-07	8.553E-08	2.773E-12	4.985E-19	0.0	0.0	0.0	0.0	0.0
CA 47	2	0.50E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 48	1	9.88E-07	9.729E-09	4.742E-10	5.490E-14	1.510E-20	0.0	0.0	0.0	0.0	0.0	0.0
SC 46M	9	6.59E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 47	7	8.80E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 48	1	1.94E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 49	2	1.42E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SC 50	1	8.15E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TI 51	3	5.32E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 50	1	4.23E-12	1.423E-12	1.423E-12	1.423E-12	1.423E-12	1.423E-12	1.423E-12	1.423E-12	1.423E-12	1.423E-12	1.423E-12
V 52	9	8.97E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 53	2	2.14E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 54	2	5.34E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Table C.5. (cont'd) Radioactivity in Stainless Steel-304 Exposed to 28 GWD in BWR Core

Curies/m³

OUTPUT UNIT = B

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT, IM+3 SS-304, IN-CORE
POWER= 1.91800E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES											
		METRIC TON URANIUM METAL AS LOADED											
		DISCHQ.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
CR	51	6.278E+06	6.767E+02	7.271E-02	9.059E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	55	9.813E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR	55	2.881E+05	1.193E+05	5.305E+04	4.688E+03	8.127E+01	2.483E-02	8.858E-13	0.0	0.0	0.0	0.0	0.0
MN	58	1.530E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN	57	6.474E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN	58	2.365E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE	55	2.530E+08	1.938E+06	1.485E+06	8.873E+05	1.760E+05	1.223E+04	4.113E+00	8.885E-06	0.0	0.0	0.0	0.0
FE	59	1.270E+08	4.573E+02	1.848E+00	7.709E-08	4.880E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	58	2.928E+05	8.187E+03	2.289E+03	5.001E-03	8.540E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	80	6.418E+05	5.825E+05	4.932E+05	3.324E+05	1.722E+05	4.621E+04	8.934E+02	1.245E+00	4.881E-12	0.0	0.0	0.0
CO	80M	8.942E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	81	8.880E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO	62	3.338E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI	59	3.322E+02	3.322E+02	3.322E+02	3.322E+02	3.322E+02	3.322E+02	3.321E+02	3.319E+02	3.314E+02	3.294E+02	3.237E+02	3.047E+02
NI	63	5.101E+04	8.063E+04	8.025E+04	4.913E+04	4.731E+04	4.388E+04	3.500E+04	2.401E+04	8.322E+03	2.727E+01	7.791E-06	0.0
NI	65	5.655E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI	66	3.515E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU	64	3.254E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU	68	3.194E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU	67	3.717E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN	65	5.194E+02	1.839E-02	8.513E-03	2.892E-04	1.810E-06	4.992E-11	1.487E-24	0.0	0.0	0.0	0.0	0.0
ZN	69	2.925E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN	69M	1.868E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA	70	7.388E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA	72	3.841E+14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA	72M	1.187E+15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE	71	9.973E+12	4.796E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CE	71M	8.140E+13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR	89	6.687E-07	3.914E-09	2.802E-11	7.842E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR	90	4.138E-08	4.040E-08	3.945E-08	1.873E-08	1.281E-08	2.570E-08	1.259E-09	3.829E-09	3.278E-11	1.804E-18	0.0	0.0
SR	91	4.420E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR	93	3.581E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y	90	3.838E-01	4.041E-06	3.948E-08	3.874E-08	3.282E-08	2.571E-08	1.259E-08	3.830E-09	3.279E-11	1.806E-18	0.0	0.0
Y	90M	8.738E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y	91	1.120E-05	1.479E-07	1.953E-09	4.485E-15	1.804E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y	92	2.815E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y	93	3.561E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y	94	2.481E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y	96	4.740E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	93	5.898E+08	5.898E+06	5.898E+06	5.898E+06	5.898E+06	5.898E+06	5.898E+06	5.898E+06	5.897E+06	5.895E+06	5.890E+06	5.871E+06
ZR	95	1.825E+05	3.490E-07	8.674E-09	4.868E-14	1.193E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR	97	9.163E+12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB	92	1.543E+00	2.325E-11	3.503E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB	93M	5.198E-07	7.723E-07	1.012E-08	1.883E-08	2.549E-06	3.769E-06	5.205E-08	5.572E-08	5.803E-08	5.801E-06	5.595E-06	5.578E-06
NB	94	1.448E+00	1.448E+00	1.448E+00	1.448E+00	1.448E+00	1.447E+00	1.448E+00	1.443E+00	1.434E+00	1.400E+00	1.307E+00	1.029E+00
NB	95	1.163E+03	8.883E+01	6.452E+04	3.700E-13	2.848E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB	95M	1.283E-07	2.589E-09	4.951E-11	3.481E-18	8.847E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB	96	9.228E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB	97	5.432E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB	97M	8.871E+12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB	98	1.094E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MO	99	8.530E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

C.24

Table C.5. (cont'd) Radioactivity in Stainless Steel-304 Exposed to 28 GWD in BWR Core

Curies/m³

OUTPUT UNIT = 8

PAGE 36

*BWR, 2.5 W/D ENRICHMENT, 28 GWD/MT 1M*3 SS-304 IN-CORE
POWER= 1.91800E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM*2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
MO101	2.783E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC 98	1.188E-19	1.188E-19	1.188E-19	1.188E-19	1.188E-19	1.188E-19	1.188E-19	1.188E-19	1.188E-19	1.188E-19	1.187E-19	1.188E-19
TC 99	1.504E-12	1.533E-12	1.533E-12	1.533E-12	1.533E-12	1.533E-12	1.533E-12	1.532E-12	1.531E-12	1.528E-12	1.518E-12	1.484E-12
TC100	2.790E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TC101	2.783E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RU103	3.093E-16	3.534E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	2.687E+07	2.681E+06	2.082E+06	1.054E+06	3.961E+05	1.029E+05	3.843E+04	2.455E+04	5.847E+03	5.353E+02	4.842E+02	3.653E+02
TOTAL	2.687E+07	2.681E+06	2.082E+06	1.054E+06	3.961E+05	1.029E+05	3.843E+04	2.455E+04	5.847E+03	5.353E+02	4.842E+02	3.653E+02

Table C.6. Radioactivity in Zircaloy-4 Exposed to 28 GWD in BWR Core

Curies/m³

OUTPUT UNIT = 8

PAGE 80

*BWR, 2.5 W/D ENRICHMENT, 28 GWD/MT IM-3 ZIRC-4 WITH 120PPM NB IN-CORE
POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
METRIC TON URANIUM METAL AS LOADED												
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
H 3	3.377E-03	3.193E-03	3.019E-03	2.551E-03	1.927E-03	1.099E-03	2.040E-04	1.233E-05	1.842E-10	0.0	0.0	0.0
H 4	8.254E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HE 5	4.247E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LI 6	4.467E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 7	5.199E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BE 10	2.400E-08	2.400E-08	2.400E-08	2.400E-08	2.400E-08	2.400E-08	2.400E-08	2.400E-08	2.399E-08	2.397E-08	2.390E-08	
BE 11	3.415E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
BE 12	2.971E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
C 13	1.008E+01	1.008E+01	1.008E+01	1.007E+01	1.007E+01	1.005E+01	1.002E+01	9.957E+00	9.719E+00	8.930E+00	7.011E+00	3.008E+00
C 14	8.13E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C 15	5.778E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C 16	5.67E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C 17	2.759E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NE 20	2.404E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 23	2.562E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 24	7.364E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NA 25	1.208E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 26	1.416E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MG 27	8.060E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 28	4.582E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 29	1.237E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AL 30	5.619E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 31	9.38E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SI 32	2.818E-10	2.813E-10	2.811E-10	2.802E-10	2.588E-10	2.561E-10	2.480E-10	2.352E-10	1.800E-10	9.68E-11	1.067E-11	8.118E-15
P 33	3.208E+02	8.563E-08	2.812E-10	2.802E-10	2.588E-10	2.561E-10	2.481E-10	2.352E-10	1.800E-10	9.67E-11	1.067E-11	8.118E-15
P 34	3.911E-02	1.584E-08	8.254E-11	4.000E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 35	1.491E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S 36	2.281E+01	1.284E+00	7.231E-02	1.291E-05	7.305E-12	2.340E-24	0.0	0.0	0.0	0.0	0.0	0.0
S 37	5.811E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 38	7.271E-06	7.271E-06	7.271E-06	7.271E-06	7.271E-06	7.270E-06	7.270E-06	7.269E-06	7.268E-06	7.254E-06	7.221E-06	7.105E-06
CL 39	6.541E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CL 40	7.787E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 41	2.350E-08	1.705E-11	1.237E-14	4.721E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AR 42	1.250E-10	1.247E-10	1.244E-10	1.234E-10	1.218E-10	1.187E-10	1.099E-10	9.862E-11	5.771E-11	9.504E-12	5.491E-14	8.057E-22
AR 43	1.724E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K 44	5.453E-16	9.340E-16	5.229E-18	4.910E-18	4.420E-18	3.583E-18	1.908E-18	8.875E-17	1.000E-18	4.118E-25	0.0	0.0
K 45	6.097E-23	6.097E-23	6.097E-23	6.097E-23	6.097E-23	6.097E-23	6.097E-23	6.097E-23	6.097E-23	6.097E-23	6.097E-23	6.097E-23
K 46	3.307E-09	9.340E-18	5.229E-18	4.910E-18	4.421E-18	3.583E-18	1.908E-18	8.878E-17	1.000E-18	4.118E-25	0.0	0.0
K 47	2.182E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
K 48	3.848E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CA 49	1.834E-02	8.879E-03	8.205E-04	7.783E-06	3.285E-09	5.882E-18	0.0	0.0	0.0	0.0	0.0	0.0
CA 50	2.079E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 51	2.47E-03	1.095E-01	5.339E-03	8.181E-07	1.700E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 52	1.05E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 53	5.15E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 54	3.44E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 55	2.83E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 56	8.22E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 57	9.87E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
U 58	5.579E-14	5.579E-14	5.579E-14	5.579E-14	5.579E-14	5.579E-14	5.579E-14	5.579E-14	5.579E-14	5.579E-14	5.579E-14	5.579E-14
V 59	4.575E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
V 60	1.191E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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Table C.6. (cont'd) Radioactivity in Zircaloy-4 Exposed to 28 GWD in BWR Core

Curies/m³

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT, IM-3 ZIRCO-4 WITH 120PPM NB IN-CORE
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

		7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED										
DISCHG.		1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
Y 54	1.382E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 51	3.378E+04	3.633E+00	3.809E-04	4.871E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CR 55	5.050E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 54	7.188E+02	3.188E+02	1.418E+02	1.248E+01	2.173E-01	8.585E-05	1.833E-15	0.0	0.0	0.0	0.0	0.0
MN 56	1.155E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 57	2.265E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MN 58	8.283E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FE 55	8.720E+03	8.148E+03	3.943E+03	1.772E+03	4.673E+02	3.248E+01	1.092E-02	1.775E-08	0.0	0.0	0.0	0.0
FE 59	3.375E+02	1.218E+00	4.384E-03	2.050E-10	1.244E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 58	5.363E+01	1.499E+00	4.181E-02	9.158E-07	1.564E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 60	8.527E+03	5.723E+03	5.018E+03	3.382E+03	1.752E+03	4.702E+02	9.089E+00	1.271E-02	4.778E-14	0.0	0.0	0.0
CO 60M	9.048E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 61	8.927E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 62	8.049E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 59	8.084E-02	8.084E-02	8.084E-02	8.083E-02	8.083E-02	8.083E-02	8.081E-02	8.078E-02	8.088E-02	8.031E-02	5.928E-02	5.579E-02
NI 63	9.802E+00	9.530E+00	9.458E+00	9.247E+00	8.905E+00	8.259E+00	8.588E+00	4.520E+00	1.002E+00	5.134E-03	1.487E-09	0.0
NI 65	1.583E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NI 66	9.842E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 64	2.363E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 66	5.123E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CU 67	5.981E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 65	1.509E+00	8.345E-01	1.893E-01	8.403E-03	4.678E-05	1.450E-09	4.319E-23	0.0	0.0	0.0	0.0	0.0
ZN 69	1.871E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZN 69M	1.256E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 70	5.888E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72	4.311E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GA 72M	1.332E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71	9.589E-11	4.597E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GE 71M	7.802E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 89	8.088E+02	4.846E+00	3.088E-02	9.072E-09	1.177E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 90	3.109E-02	3.036E-02	2.984E-02	2.760E-02	2.450E-02	1.931E-02	9.457E-03	2.877E-03	2.483E-05	1.431E-12	0.0	0.0
SR 91	1.145E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SR 93	4.827E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 90	2.581E+04	3.037E-02	2.885E-02	2.781E-02	2.451E-02	1.932E-02	9.459E-03	2.877E-03	2.404E-05	1.431E-12	0.0	0.0
Y 90M	1.594E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 91	1.773E+03	2.341E+01	3.091E-01	7.117E-07	2.857E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 92	3.105E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 93	4.827E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 94	9.619E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Y 96	8.158E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 93	3.963E+00	3.963E+00	3.963E+00	3.963E+00	3.963E+00	3.963E+00	3.963E+00	3.963E+00	3.963E+00	3.981E+00	3.958E+00	3.945E+00
ZR 95	8.183E+05	1.885E+04	2.892E+02	2.092E-03	5.348E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ZR 97	1.191E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 92	1.514E+00	2.282E-11	3.438E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 93M	3.484E-01	5.181E-01	8.795E-01	1.117E+00	1.713E+00	2.532E+00	3.498E+00	3.744E+00	3.765E+00	3.783E+00	3.780E+00	3.748E+00
NB 94	1.421E+00	1.421E+00	1.421E+00	1.421E+00	1.421E+00	1.420E+00	1.419E+00	1.418E+00	1.407E+00	1.374E+00	1.283E+00	1.010E+00
NB 95	8.142E+05	3.520E+04	8.878E+02	4.644E-03	1.187E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 95M	5.782E+03	1.181E+02	2.219E+00	1.552E-05	3.966E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 96	8.459E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97	1.191E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 97M	1.127E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NB 98	4.291E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

C.28

Table C.6. (cont'd) Radioactivity in Zircaloy-4 Exposed to 28 GWD in BWR Core

Curies/m³

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT, 1M+3 ZIRC-4 WITH 120PPM NB IN-CORE
 POWER= 1.91600E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM+2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISCHG.	METRIC TON URANIUM METAL AS LOADED											
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
NB100	3.287E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MO 99	2.582E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MO101	2.154E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TC 98	1.864E-11	1.864E-11	1.864E-11	1.864E-11	1.864E-11	1.864E-11	1.864E-11	1.864E-11	1.864E-11	1.863E-11	1.881E-11	
TC 99	1.178E-04	1.189E-04	1.189E-04	1.189E-04	1.189E-04	1.189E-04	1.189E-04	1.189E-04	1.188E-04	1.178E-04	1.151E-04	
TC100	2.185E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TC101	2.154E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU103	1.193E-07	1.907E-10	3.023E-13	1.212E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU105	8.124E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RU108	2.489E-19	1.386E-19	1.266E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH102	5.722E-18	4.508E-18	3.548E-18	1.732E-18	5.243E-17	4.800E-18	3.891E-21	0.0	0.0	0.0	0.0	
RH104	2.351E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH104M	1.028E-10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH105	5.801E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH105M	1.715E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH108	1.237E-08	1.386E-19	5.867E-20	5.421E-21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
RH108M	1.120E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD107	4.170E-15	4.170E-15	4.170E-15	4.170E-15	4.170E-15	4.170E-15	4.170E-15	4.170E-15	4.170E-15	4.169E-15	4.188E-15	
PD107M	1.972E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD109	1.628E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD109M	2.848E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD111	3.063E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
PD111M	4.285E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AQ108	4.485E-07	5.181E-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AQ108	8.033E-03	4.986E-07	4.959E-07	4.879E-07	4.747E-07	4.495E-07	3.818E-07	2.905E-07	9.752E-08	2.138E-09	3.886E-14	
AQ108M	5.633E-08	5.803E-08	5.572E-08	5.482E-08	5.334E-08	5.051E-08	4.288E-08	3.284E-08	1.096E-06	2.402E-08	4.367E-13	
AQ109M	8.185E-02	3.582E-02	2.076E-02	4.040E-03	2.640E-04	1.128E-06	8.779E-14	1.248E-25	0.0	0.0	0.0	
AQ110	3.106E-02	5.547E-08	2.014E-08	9.838E-08	8.081E-10	2.420E-14	0.0	0.0	0.0	0.0	0.0	
AQ110M	1.149E-03	4.170E-04	1.514E-04	7.247E-08	4.572E-08	1.820E-12	1.147E-25	0.0	0.0	0.0	0.0	
AQ111	5.837E-05	1.019E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AQ111M	3.175E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
AQ112	4.004E-08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD107	5.867E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD109	8.183E-02	3.583E-02	2.076E-02	4.040E-03	2.640E-04	1.128E-06	8.779E-14	1.248E-25	0.0	0.0	0.0	
CD111M	9.978E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD115	1.500E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD115M	1.265E+00	4.329E-03	1.482E-05	5.944E-13	2.794E-25	0.0	0.0	0.0	0.0	0.0	0.0	
CD117	8.387E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD117M	1.480E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD119	1.276E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CD121	3.850E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN113M	1.587E+04	1.738E+03	1.927E+02	2.825E-01	4.285E-06	1.229E-15	0.0	0.0	0.0	0.0	0.0	
IN114	5.206E+03	1.281E+01	7.588E-02	1.653E-08	1.304E-19	0.0	0.0	0.0	0.0	0.0	0.0	
IN114M	2.190E+03	1.318E+01	7.929E-02	1.727E-08	1.362E-19	0.0	0.0	0.0	0.0	0.0	0.0	
IN115	2.287E-15	2.595E-15	2.598E-15	2.596E-15	2.598E-15	2.596E-15	2.596E-15	2.596E-15	2.596E-15	2.596E-15	2.596E-15	
IN118	8.091E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN116M	8.433E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN117	5.324E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN117M	7.865E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN118	1.880E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN119	1.220E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN119M	1.276E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Table C.6. (cont'd) Radioactivity in Zircaloy-4 Exposed to 28 GWD in BWR Core

Curies/m³

OUTPUT UNIT = B

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/WT, 1M+3 ZIRC-4 WITH 120PPM NB IN-CORE
 POWER= 1.81800E+01 MW, BURMUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM+2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES												
DISCHQ.	METRIC TON URANIUM METAL AS LOADED											
	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS	
IN120	2.298E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN120M	3.095E-09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IN121	3.157E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SN113	1.507E-04	1.737E+03	1.928E+02	2.817E-01	4.382E-08	1.228E-15	0.0	0.0	0.0	0.0	0.0	
SN113M	6.861E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SN117M	1.213E+05	1.709E-03	2.408E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SN119M	1.217E-05	4.332E+04	1.541E+04	6.848E+02	3.983E+00	1.290E-04	4.451E-18	0.0	0.0	0.0	0.0	
SN121	5.788E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SN121M	1.658E+01	1.638E+01	1.613E+01	1.547E+01	1.444E+01	1.257E+01	8.289E+00	4.143E+00	2.585E-01	1.569E-05	1.405E-17	
SN123	5.711E-03	8.044E+02	1.133E+02	3.166E-01	1.755E-05	5.395E-14	0.0	0.0	0.0	0.0	0.0	
SN123M	2.279E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SN125	3.778E-04	1.485E-07	5.833E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SN125M	2.992E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SB122	7.123E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SB122M	6.281E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SB124	3.609E-02	5.381E+00	8.023E-02	2.859E-07	1.959E-18	0.0	0.0	0.0	0.0	0.0	0.0	
SB124M	1.121E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SB125	3.878E-04	3.048E+04	3.733E+04	1.120E+04	3.205E+03	2.825E+02	1.441E-01	5.304E-07	0.0	0.0	0.0	
SB126	7.362E-02	9.931E-07	1.340E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
SB126M	7.345E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TE123	9.845E-12	1.145E-11	1.164E-11	1.167E-11	1.167E-11	1.167E-11	1.167E-11	1.167E-11	1.167E-11	1.167E-11	1.167E-11	
TE123M	5.573E-01	6.719E+00	8.102E+01	1.420E+03	3.819E+08	2.351E-17	0.0	0.0	0.0	0.0	0.0	
TE125M	8.557E+03	7.424E+03	5.790E+03	2.733E+03	7.820E+02	6.404E+01	3.518E-02	1.294E-07	0.0	0.0	0.0	
TE127	7.014E+00	4.978E-02	4.880E-03	4.686E-06	4.158E-11	3.405E-21	0.0	0.0	0.0	0.0	0.0	
TE127M	5.185E-01	5.083E-02	4.982E-03	4.892E-06	4.245E-11	3.478E-21	0.0	0.0	0.0	0.0	0.0	
TE129	1.098E-05	1.082E-10	5.780E-14	8.804E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
TE129M	3.113E-07	1.863E-10	8.879E-14	1.353E-23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
I128	2.631E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
I129	3.405E-13	3.424E-13	3.424E-13	3.424E-13	3.424E-13	3.424E-13	3.424E-13	3.424E-13	3.424E-13	3.424E-13	3.423E-13	
I130	2.500E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
I130M	1.080E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
I131	2.263E-11	4.788E-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
I132	1.569E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
XE127	4.585E-07	4.383E-10	4.189E-13	3.658E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
XE129M	7.233E-05	1.304E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
XE131M	9.025E-09	5.181E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
XE133	3.133E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
XE133M	9.886E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CS132	3.621E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CS134	9.787E-15	8.979E-15	4.987E-15	1.819E-15	3.388E-16	1.174E-17	4.898E-22	0.0	0.0	0.0	0.0	
CS134M	8.674E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
CS135	3.145E-22	3.145E-22	3.145E-22	3.145E-22	3.145E-22	3.145E-22	3.145E-22	3.145E-22	3.145E-22	3.145E-22	3.136E-22	
CS136	1.857E-17	8.718E-26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
BA135M	1.261E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
BA136M	2.731E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ER169	1.624E-12	3.284E-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ER171	6.817E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
ER172	1.456E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IM170	3.592E-13	5.015E-14	7.001E-15	1.901E-17	1.008E-21	0.0	0.0	0.0	0.0	0.0	0.0	
IM170M	3.591E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
IM171	2.145E-14	1.497E-14	1.044E-14	3.533E-15	5.811E-16	1.572E-17	3.111E-22	0.0	0.0	0.0	0.0	
IM172	4.040E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

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Table C.6. (cont'd) Radioactivity in Zircaloy-4 Exposed to 28 GWD in BWR Core

Curies/m³

OUTPUT UNIT = 8

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*BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT IM+3 ZIRC-4 WITH 120PPM NB IN-CORE
 POWER= 1.91800E+01 MW, BURNUP= 2.80000E+04 MWD, FLUX= 1.85E+14 N/CM**2-SEC

ACTIVATION PRODUCTS

7 SUMMARY TABLE: RADIOACTIVITY, CURIES METRIC TON URANIUM METAL AS LOADED													
DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
TM173	4.233E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YB175	2.234E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
YB175M	1.580E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU176	7.947E-10	7.947E-10	7.947E-10	7.947E-10	7.947E-10	7.947E-10	7.947E-10	7.947E-10	7.947E-10	7.947E-10	7.947E-10	7.947E-10	7.947E-10
LU176M	1.211E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU177	4.630E+01	5.707E-03	1.114E-03	8.298E-06	2.358E-09	1.899E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LU177M	1.271E-01	2.482E-02	4.840E-03	3.808E-05	1.024E-08	8.258E-18	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF175	2.607E+02	7.008E+00	1.882E-01	3.652E-06	5.115E-14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF178M	2.880E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF178M	4.944E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF180M	4.803E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF181	9.170E+03	2.337E+01	5.885E-02	8.893E-10	1.087E-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HF182	8.000E-06	8.000E-06	8.000E-06	8.000E-06	8.000E-06	8.000E-06	7.999E-06	7.999E-06	7.999E-06	7.999E-06	7.999E-06	7.999E-06	7.999E-06
TA182	9.055E+02	1.002E+02	1.108E+01	1.497E-02	8.248E-06	8.000E-06	7.999E-06	7.999E-06	7.999E-06	7.999E-06	7.999E-06	7.999E-06	7.999E-06
TA182M	1.431E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TA183	1.900E+03	5.244E-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W181	1.475E+01	1.828E+00	2.281E-01	4.288E-04	1.248E-08	1.053E-17	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W183M	2.040E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185	4.080E+02	1.401E+01	4.814E-01	1.951E-05	9.333E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W185M	4.567E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W187	7.493E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W188	1.489E+01	3.825E-01	9.961E-03	1.759E-07	2.108E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
W188	1.244E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE186	2.678E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE187	3.823E-07	3.827E-07	3.827E-07	3.827E-07	3.827E-07	3.827E-07	3.827E-07	3.827E-07	3.827E-07	3.827E-07	3.827E-07	3.827E-07	3.827E-07
RE188	2.498E+03	3.885E-01	1.006E-02	1.777E-07	2.128E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE188M	2.428E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RE189	8.597E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS190M	2.089E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191	2.148E-01	1.804E-08	1.169E-15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS191M	1.502E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS193	3.938E-06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OS194	1.098E-09	9.779E-10	8.713E-10	8.161E-10	3.458E-10	1.089E-10	3.403E-12	1.058E-14	9.757E-25	0.0	0.0	0.0	0.0
IR192	6.424E-02	2.100E-03	8.878E-05	8.240E-08	7.888E-08	7.882E-08	7.029E-08	8.087E-08	3.425E-08	4.574E-09	1.453E-11	2.821E-20	2.819E-20
IR192M	8.109E-08	8.088E-08	8.063E-08	7.993E-08	7.879E-08	7.858E-08	7.023E-08	8.082E-08	3.422E-08	4.570E-09	1.451E-11	2.819E-20	2.819E-20
IR194	1.923E-03	9.783E-10	8.718E-10	8.163E-10	3.459E-10	1.089E-10	3.405E-12	1.058E-14	9.760E-25	0.0	0.0	0.0	0.0
IR194M	1.014E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT193	8.275E-07	8.298E-07	8.289E-07	8.263E-07	8.220E-07	8.134E-07	5.884E-07	5.490E-07	4.161E-07	1.577E-07	9.854E-09	8.014E-13	8.014E-13
PT193M	1.327E-04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT195M	1.059E-07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197	3.232E-11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PT197M	2.190E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU198	2.830E-12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU199	4.795E-13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AU200	1.100E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HG199M	1.110E-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SUMTOT	5.809E+06	1.479E+05	5.558E+04	1.984E+04	8.251E+03	8.881E+02	4.313E+01	2.782E+01	2.017E+01	1.809E+01	1.807E+01	1.176E+01	1.176E+01
TOTAL	5.809E+06	1.479E+05	5.558E+04	1.984E+04	8.251E+03	8.881E+02	4.313E+01	2.782E+01	2.017E+01	1.809E+01	1.807E+01	1.176E+01	1.176E+01

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APPENDIX D

PHOTON SOURCES

APPENDIX D

PHOTON SOURCES

This appendix presents the photon source as calculated by ORIGEN-2 as a function of time. Each table is in fact two tables. The upper table is the absolute photons per second in each of eighteen energy groups, the average energy being given in column one. The lower table is the same data as the upper table with one change. The units are in MeV/watt-sec (the values are normalized to one watt). The total power is given at the top of the page. As an example, in Table D.1, at discharge there are 2.472×10^{17} photons per second with an average energy of 0.015 MeV per photon. These values are in the upper table. This is equivalent to 3.708×10^{15} MeV per second $[(2.472 \times 10^{17}) \times (0.015)]$. Dividing this number by $30. \times 10^6$ watts, found at the top (POWER = 30.00 MW) results in 1.236×10^8 MeV per second per watt, which is found in the lower table. Under the upper table is given the total unnormalized MeV per second summed over all energy groups, and under the lower table is given the total unnormalized watts of gamma power (1 watt = 6.24×10^{12} MeV/sec) summed over all groups.

Tables D.1 through D.3 present the photon source for three representative alloys exposed to 33 GWD over 1100 days in a PWR. Tables D.4 through D.6 present the photon source for the three representative alloys exposed to 28 GWD over 1460 days in a BWR. Tables D.7 through D.13 present the photon source for non-fuel components of PWR fuel assemblies exposed to 33 GWD/MTU over 1100 days and BWR fuel assemblies exposed to 28 GWD over 1460 days. Tables D.14 and D.15 present the photon source for BWR Cruciform components exposed to 28 GWD over 1460 days.

Table D.1. Photon Source Due to Inconel-718 Exposed to
33 GWD in PWR Core (Photons/M³)

OUTPUT UNIT = 8

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, 1.M+3 INC-718 IN-CORE
POWER= 30.00 MW, BURNUP= 33000. MWD, FLUX= 2.59E+14 N/CM**2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	2.472E+17	8.164E+15	8.498E+15	4.312E+15	2.257E+15	6.472E+14	5.847E+13	3.336E+13	9.936E+12	3.167E+12	2.765E+12	1.942E+12
2.500E-02	2.286E+18	1.278E+16	1.082E+16	7.364E+14	3.834E+14	1.058E+14	8.128E+12	2.323E+12	8.828E+11	4.766E+11	4.308E+11	3.398E+11
3.750E-02	1.520E+18	7.301E+14	6.218E+14	4.101E+14	2.176E+14	5.808E+13	1.958E+12	6.840E+11	3.717E+11	2.824E+11	2.818E+11	2.030E+11
5.750E-02	3.037E+18	8.295E+14	7.010E+14	4.720E+14	2.447E+14	8.589E+13	1.877E+12	3.937E+11	3.601E+11	3.430E+11	3.191E+11	2.488E+11
8.500E-02	1.319E+18	3.328E+14	2.758E+14	1.858E+14	9.823E+13	2.585E+13	8.827E+11	1.647E+11	1.628E+11	1.589E+11	1.482E+11	1.163E+11
1.250E-01	1.018E+18	1.328E+14	1.081E+14	7.130E+13	3.887E+13	9.881E+12	2.708E+11	7.931E+10	7.850E+10	7.664E+10	7.157E+10	5.833E+10
2.250E-01	1.445E+18	5.824E+13	3.824E+13	2.347E+13	1.218E+13	3.305E+12	1.120E+11	4.907E+10	4.885E+10	4.750E+10	4.436E+10	3.483E+10
3.750E-01	3.987E+18	2.011E+13	9.918E+12	6.573E+12	3.408E+12	9.158E+11	1.988E+10	2.350E+09	2.309E+09	2.255E+09	2.108E+09	1.858E+09
5.750E-01	5.788E+18	7.487E+14	2.161E+13	3.841E+11	1.955E+11	5.245E+10	1.014E+09	1.421E+08	3.274E+02	2.570E+02	2.198E+02	2.115E+02
8.500E-01	2.322E+17	4.794E+15	1.041E+15	1.414E+14	6.058E+13	5.804E+13	5.593E+13	5.555E+13	5.424E+13	5.066E+13	3.988E+13	3.988E+13
1.250E+00	3.283E+17	2.706E+17	2.372E+17	1.599E+17	8.282E+16	2.233E+16	4.207E+14	8.010E+11	7.193E+00	1.150E+00	1.363E+01	7.847E-05
1.750E+00	3.635E+18	1.380E+13	3.875E+11	8.467E+08	1.948E+02	1.534E+02	7.512E+01	2.288E+01	1.998E+01	1.875E+03	2.222E-04	1.273E-07
2.250E+00	1.351E+18	1.434E+12	1.257E+12	8.472E+11	4.358E+11	1.178E+11	2.277E+09	3.185E+06	3.360E+05	1.269E+12	0.0	0.0
2.750E+00	1.875E+15	4.437E+09	3.890E+09	2.822E+08	1.389E+09	3.645E+08	7.047E+08	9.856E+03	4.233E+08	2.171E+15	0.0	0.0
3.500E+00	1.553E+14	8.719E-05	4.388E-05	5.802E-08	4.028E-07	1.821E-07	9.888E-08	3.388E-08	5.077E-10	2.090E-18	0.0	0.0
5.000E+00	4.309E+10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	7.703E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	1.054E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.064E+18	2.878E+17	2.476E+17	1.862E+17	8.813E+16	2.320E+16	5.540E+14	9.357E+13	6.740E+13	5.879E+13	5.471E+13	4.283E+13
MEV/SEC	7.879E+17	3.430E+17	2.976E+17	2.001E+17	1.037E+17	2.785E+16	5.880E+14	4.894E+13	4.746E+13	4.823E+13	4.317E+13	3.399E+13

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	1.236E+08	4.082E+06	3.249E+06	2.155E+06	1.129E+06	3.236E+05	2.924E+04	1.658E+04	4.988E+03	1.584E+03	1.383E+03	9.710E+02
2.500E-02	1.905E+07	1.064E+06	9.097E+05	8.137E+05	3.195E+05	8.803E+04	4.272E+03	1.938E+03	7.440E+02	3.972E+02	3.685E+02	2.833E+02
3.750E-02	1.900E+07	9.126E+05	7.774E+05	5.238E+05	2.720E+05	7.388E+04	2.448E+03	8.300E+02	4.848E+02	3.530E+02	3.272E+02	2.538E+02
5.750E-02	5.821E+07	1.590E+06	1.344E+06	9.047E+05	4.891E+05	1.265E+05	3.215E+03	7.548E+02	8.903E+02	8.575E+02	8.115E+02	4.768E+02
8.500E-02	3.736E+07	9.424E+05	7.815E+05	5.259E+05	2.727E+05	7.362E+04	1.878E+03	4.888E+02	4.814E+02	4.502E+02	4.199E+02	3.295E+02
1.250E-01	4.246E+07	5.627E+05	4.420E+05	2.971E+05	1.541E+05	4.159E+04	1.127E+03	3.305E+02	3.271E+02	3.193E+02	2.982E+02	2.347E+02
2.250E-01	1.084E+08	4.143E+05	2.843E+05	1.760E+05	9.138E+04	2.478E+04	8.401E+02	3.880E+02	3.849E+02	3.582E+02	3.327E+02	2.820E+02
3.750E-01	4.984E+08	2.514E+05	1.240E+05	8.218E+04	4.258E+04	1.145E+04	2.499E+02	2.937E+01	2.888E+01	2.818E+01	2.832E+01	2.073E+01
5.750E-01	1.111E+09	1.435E+07	4.141E+05	7.363E+03	3.747E+03	1.005E+03	1.944E+01	2.724E+02	8.274E+08	4.928E+08	4.213E+08	4.054E+08
8.500E-01	6.578E+09	1.358E+08	2.950E+07	4.008E+06	1.716E+06	1.813E+06	1.588E+06	1.585E+06	1.574E+08	1.537E+08	1.435E+08	1.130E+08
1.250E+00	1.368E+10	1.127E+10	9.883E+09	8.681E+09	3.481E+09	1.700E+07	2.504E+04	2.997E+07	4.793E+08	5.880E+09	3.270E+12	7.426E+15
1.750E+00	2.120E+08	9.086E+05	2.281E+04	4.939E+01	1.136E+05	8.849E+08	4.382E+08	1.333E+08	1.164E+08	1.094E+10	1.298E+11	0.0
2.250E+00	1.014E+08	1.075E+05	9.429E+04	8.354E+04	3.202E+04	8.835E+03	1.708E+02	2.388E+01	2.520E+12	9.517E+20	0.0	0.0
2.750E+00	1.719E+08	4.087E+02	3.568E+02	2.403E+02	1.245E+02	3.341E+01	6.459E+01	9.034E+04	3.880E+15	1.990E+22	0.0	0.0
3.500E+00	1.812E+07	1.017E-11	5.129E-12	6.789E-13	4.699E-14	2.124E-14	1.130E-14	3.953E-15	5.923E-17	2.438E-23	0.0	0.0
5.000E+00	7.181E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	1.797E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	3.339E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	2.560E+10	1.143E+10	9.921E+09	8.870E+09	3.455E+09	9.285E+08	1.953E+07	1.831E+08	1.582E+08	1.541E+08	1.439E+08	1.133E+08
GAM POW	1.231E+05	5.489E+04	4.771E+04	3.208E+04	1.662E+04	4.465E+03	9.394E+01	7.844E+00	7.608E+00	7.410E+00	6.921E+00	5.449E+00

Table D.2. Photon Source Due to Stainless Steel-304 Exposed to 33 GWD in PWR Core (Photons/M³)

PHOTON SPECTRUM FOR ACTIVATION PRODUCTS													OUTPUT UNIT = 8	PAGE 89
PWR, 3.2 W/D ENRICHMENT, 33GWD/MT BURNUP, 1.M+3 SS-304 IN-CORE POWER= 30.00 MW, BURNUP= 33000. MWD, FLUX= 2.59E+14 N/CM**2-SEC														
18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND BASIS=METRIC TON URANIUM METAL AS LOADED														
EMEAN	DISCHQ.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
1.500E-02	4.831E+17	2.392E+15	1.542E+15	7.819E+14	3.786E+14	1.081E+14	9.437E+12	5.225E+12	1.294E+12	1.883E+11	1.283E+11	5.644E+10		
2.500E-02	8.788E+16	2.140E+14	1.828E+14	1.233E+14	8.417E+13	1.784E+13	8.034E+11	3.335E+11	9.327E+10	2.353E+10	1.832E+10	8.121E+09		
3.750E-02	5.828E+16	1.224E+14	1.041E+14	7.017E+13	3.641E+13	9.883E+12	2.815E+11	7.501E+10	2.599E+10	1.130E+10	8.889E+09	3.971E+09		
5.000E-02	8.650E+16	1.391E+14	1.174E+14	7.902E+13	4.095E+13	1.101E+13	2.316E+11	1.803E+10	1.120E+10	9.051E+09	7.188E+09	3.280E+09		
6.500E-02	5.317E+16	8.678E+13	4.618E+13	3.107E+13	1.809E+13	4.321E+12	8.533E+10	1.949E+09	1.794E+09	1.884E+09	1.348E+09	8.711E+08		
1.250E-01	3.565E+16	2.225E+13	1.778E+13	1.193E+13	6.181E+12	1.659E+12	3.232E+10	2.970E+08	2.488E+08	2.388E+08	2.059E+08	1.335E+08		
2.250E-01	5.043E+16	9.276E+12	5.894E+12	3.923E+12	2.032E+12	5.455E+11	1.083E+10	1.012E+08	8.592E+07	8.389E+07	7.835E+07	6.170E+07		
3.750E-01	5.144E+16	5.838E+12	1.661E+12	1.101E+12	6.702E+11	1.530E+11	2.962E+09	8.218E+06	4.083E+06	3.985E+06	3.722E+06	2.931E+06		
5.750E-01	1.788E+16	1.258E+14	3.808E+12	8.327E+10	3.274E+11	8.787E+09	1.899E+08	2.379E+08	1.800E+03	1.328E+03	9.506E+02	8.880E+02		
8.500E-01	8.375E+17	8.050E+15	3.384E+15	2.985E+14	8.795E+12	2.397E+11	1.016E+11	9.878E+10	9.809E+10	9.577E+10	8.945E+10	7.043E+10		
1.250E+00	8.285E+16	4.532E+16	3.973E+16	2.678E+16	1.387E+16	3.723E+15	7.197E+13	9.995E+10	2.545E+01	1.188E+01	1.408E+00	8.085E-04		
1.750E+00	2.296E+17	2.330E+12	8.614E+10	1.423E+06	4.078E+01	3.135E+01	1.799E-01	9.808E-02	4.119E-02	1.937E-02	2.295E-03	1.315E-06		
2.250E+00	1.095E+17	2.402E+11	2.108E+11	1.419E+11	7.353E+10	1.973E+10	3.815E+08	5.297E+05	2.028E+05	2.113E-15	0.0	0.0		
2.750E+00	1.534E+16	7.432E+06	8.616E+06	4.392E+08	2.275E+08	6.106E+07	1.180E+06	1.839E+03	8.183E-09	0.0	0.0	0.0		
3.500E+00	1.315E+15	5.644E-12	5.528E-12	8.189E-12	4.672E-12	3.787E-12	2.018E-12	7.053E-13	1.057E-14	0.0	0.0	0.0		
5.000E+00	8.252E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
7.000E+00	7.543E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
9.500E+00	1.032E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
TOTAL	2.160E+18	5.648E+16	4.515E+16	2.816E+16	1.442E+16	3.877E+15	8.297E+13	5.851E+12	1.525E+12	3.099E+11	2.538E+11	1.431E+11		
MEV/SEC	1.552E+18	8.363E+16	5.260E+16	3.375E+16	1.736E+16	4.658E+15	9.028E+13	2.988E+11	1.069E+11	8.585E+10	7.932E+10	8.134E+10		
18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WT11-SEC BASIS=METRIC TON URANIUM METAL AS LOADED														
EMEAN	DISCHQ.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS		
1.500E-02	2.315E+08	1.190E+00	7.708E+05	3.810E+05	1.892E+05	5.403E+04	4.719E+03	2.813E+03	8.469E+02	8.415E+01	8.414E+01	2.822E+01		
2.500E-02	7.307E+07	1.784E+05	1.523E+05	1.028E+05	5.347E+04	1.470E+04	8.695E+02	2.779E+02	7.772E+01	1.981E+01	1.527E+01	8.768E+00		
3.750E-02	7.282E+07	1.530E+05	1.302E+05	8.771E+04	4.552E+04	1.233E+04	3.844E+02	9.378E+01	3.249E+01	1.413E+01	1.111E+01	4.984E+00		
5.000E-02	1.660E+08	2.688E+05	2.250E+05	1.515E+05	7.848E+04	2.109E+04	4.439E+02	3.167E+01	2.147E+01	1.735E+01	1.378E+01	6.288E+00		
6.500E-02	1.508E+08	1.580E+05	1.308E+05	8.802E+04	4.580E+04	1.224E+04	2.418E+02	9.521E+00	5.082E+00	4.718E+00	3.820E+00	1.902E+00		
1.250E-01	1.485E+08	9.271E+04	7.399E+04	4.971E+04	2.875E+04	8.812E+03	1.347E+02	1.238E+00	1.037E+00	8.858E-01	8.577E-01	5.564E-01		
2.250E-01	3.782E+08	8.957E+04	4.421E+04	2.942E+04	1.824E+04	4.092E+03	7.973E+01	7.587E-01	8.444E-01	6.292E-01	5.877E-01	4.627E-01		
3.750E-01	8.431E+08	7.297E+04	2.077E+04	1.376E+04	7.127E+03	1.913E+03	3.703E+01	1.027E-01	5.103E-02	4.982E-02	4.652E-02	3.884E-02		
5.750E-01	3.426E+08	2.411E+06	8.914E+04	1.213E+03	8.275E+02	1.884E+02	3.256E+00	4.580E-03	3.451E-05	2.546E-05	1.822E-05	1.898E-05		
8.500E-01	2.373E+10	2.281E+08	8.817E+07	8.458E+06	1.842E+05	6.790E+03	2.879E+03	2.798E+03	2.779E+03	2.713E+03	2.534E+03	1.998E+03		
1.250E+00	2.819E+09	1.888E+09	1.856E+09	1.116E+09	5.780E+08	1.551E+08	2.999E+08	4.185E+03	1.060E+08	4.952E-07	5.868E-08	3.369E-11		
1.750E+00	1.339E+10	1.359E+05	3.800E+03	8.303E-02	2.379E+08	1.829E+08	1.049E+08	5.195E+09	2.403E+09	1.130E+09	1.339E-10	7.672E-14		
2.250E+00	8.218E+09	1.801E+04	1.579E+04	1.084E+04	5.614E+03	1.480E+03	2.881E+01	3.973E-02	1.521E-13	1.585E-22	0.0	0.0		
2.750E+00	1.408E+09	8.813E+01	5.973E+01	4.028E+01	2.088E+01	5.597E+00	1.082E-01	1.503E-04	5.849E-16	0.0	0.0	0.0		
3.500E+00	1.534E+08	8.584E-19	8.447E-18	8.054E-19	6.450E-19	4.418E-19	2.352E-19	8.229E-20	1.233E-21	0.0	0.0	0.0		
5.000E+00	1.042E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
7.000E+00	1.760E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
9.500E+00	3.269E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
TOTAL	5.172E+10	2.121E+09	1.753E+09	1.125E+09	5.787E+08	1.553E+08	3.009E+08	9.987E+03	3.585E+03	2.855E+03	2.844E+03	2.045E+03		
GAM POW	2.467E+05	1.020E+04	8.432E+03	5.411E+03	2.783E+03	7.467E+02	1.447E+01	4.803E-02	1.714E-02	1.373E-02	1.271E-02	9.833E-03		

D.4

Table D.3. Photon Source Due to Zircaloy-4 Exposed to
33GWD in PWR Core (Photons/m³)

PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

OUTPUT UNIT = 8

PAGE 119

PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, 1.0M+3 ZIRC-4 IN-CORE
POWER= 30.00 MW, BURNUP= 33000. MWD, FLUX= 2.59E+14 N/CM+2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	5.409E+16	3.184E+14	1.268E+14	4.838E+13	1.453E+13	1.915E+12	5.872E+10	3.985E+10	3.888E+10	3.785E+10	3.584E+10	3.134E+10
2.500E-02	1.918E+16	1.874E+15	1.011E+15	3.328E+14	9.128E+13	7.589E+12	9.698E+09	2.207E+09	2.100E+09	1.889E+09	1.675E+09	1.013E+09
3.750E-02	7.138E+15	2.337E+14	1.748E+14	8.251E+13	2.378E+13	2.017E+12	4.127E+09	1.128E+09	1.085E+09	1.023E+09	8.751E+08	5.389E+08
5.750E-02	1.007E+16	2.537E+13	8.238E+12	3.489E+12	1.172E+12	1.745E+11	3.331E+08	1.097E+08	1.058E+08	1.008E+08	8.785E+07	5.705E+07
8.500E-02	5.819E+15	6.887E+12	3.284E+12	1.489E+12	5.020E+11	7.184E+10	1.281E+08	3.724E+08	3.556E+08	3.427E+08	3.097E+08	2.242E+08
1.250E-01	4.042E+15	1.027E+13	5.378E+12	2.400E+12	7.319E+11	7.180E+10	5.238E+08	1.508E+08	1.415E+08	1.378E+08	1.279E+08	9.930E+07
2.250E-01	1.033E+16	8.472E+13	8.108E+13	2.857E+13	8.165E+12	8.742E+11	5.941E+08	9.578E+07	8.449E+07	8.240E+07	7.697E+07	6.083E+07
3.750E-01	5.781E+15	4.816E+14	3.590E+14	1.894E+14	4.848E+13	3.971E+12	2.229E+08	8.919E+08	4.087E+08	3.908E+08	3.649E+08	2.873E+08
5.750E-01	7.836E+15	5.935E+14	4.813E+14	2.177E+14	8.231E+13	5.102E+12	2.811E+08	2.810E+08	8.214E+04	1.088E+03	8.961E+01	8.790E+01
8.500E-01	1.286E+17	2.378E+15	5.492E+13	9.028E+11	1.183E+11	9.850E+10	9.711E+10	9.891E+10	9.825E+10	9.398E+10	8.778E+10	6.911E+10
1.250E+00	5.254E+15	4.835E+14	4.033E+14	2.715E+14	1.408E+14	3.775E+13	7.297E+11	1.018E+09	3.788E+05	3.788E+05	3.785E+05	3.783E+05
1.750E+00	1.419E+15	1.283E+11	1.921E+09	2.301E+08	1.685E+05	1.328E+05	8.484E+04	1.978E+04	1.692E+02	8.460E-04	6.681E-05	6.851E-05
2.250E+00	1.422E+14	1.715E+10	2.358E+09	1.439E+09	7.454E+08	2.001E+08	3.888E+08	5.393E+03	1.867E-02	1.084E-09	0.0	0.0
2.750E+00	1.415E+13	1.828E+07	8.785E+08	4.452E+08	2.307E+08	8.191E+05	1.197E+04	1.668E+01	7.327E-11	4.348E-18	0.0	0.0
3.500E+00	1.199E+12	5.430E-10	5.316E-10	4.900E-10	4.482E-10	3.641E-10	1.938E-10	8.784E-11	1.017E-12	4.185E-19	0.0	0.0
5.000E+00	2.433E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	2.898E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	3.019E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	3.305E+17	8.452E+15	2.669E+15	1.157E+15	3.817E+14	5.943E+13	9.101E+11	1.428E+11	1.400E+11	1.384E+11	1.276E+11	1.030E+11
MEV/SEC	1.717E+17	3.198E+15	9.986E+14	5.480E+14	2.354E+14	5.216E+13	9.989E+11	8.448E+10	8.282E+10	8.086E+10	7.533E+10	5.934E+10

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	2.704E+07	1.592E+05	6.339E+04	2.318E+04	7.268E+03	9.575E+02	2.938E+01	1.993E+01	1.944E+01	1.893E+01	1.782E+01	1.587E+01
2.500E-02	1.599E+07	1.581E+06	8.422E+05	2.771E+05	7.608E+04	8.324E+03	8.082E+00	1.838E+00	1.750E+00	1.641E+00	1.385E+00	8.444E-01
3.750E-02	8.924E+06	2.921E+05	2.185E+05	1.031E+05	2.972E+04	2.521E+03	5.158E+00	1.410E+00	1.358E+00	1.278E+00	1.094E+00	8.736E-01
5.750E-02	1.931E+07	4.863E+04	1.579E+04	6.849E+03	2.247E+03	3.344E+02	8.384E+00	2.103E+00	2.029E+00	1.929E+00	1.880E+00	1.093E+00
8.500E-02	1.649E+07	2.518E+04	9.305E+03	4.248E+03	1.422E+03	2.038E+02	3.574E+00	1.055E+00	1.007E+00	9.709E-01	8.774E-01	6.351E-01
1.250E-01	1.684E+07	4.280E+04	2.240E+04	1.025E+04	3.050E+03	2.992E+02	2.183E+00	8.264E-01	5.896E-01	5.741E-01	5.330E-01	4.138E-01
2.250E-01	7.747E+07	6.354E+05	4.582E+05	2.143E+05	8.139E+04	3.056E+03	4.455E+00	7.163E-01	6.338E-01	6.160E-01	5.773E-01	4.547E-01
3.750E-01	7.228E+07	5.770E+06	4.487E+06	2.118E+06	8.080E+05	4.984E+04	2.788E+01	1.115E-01	5.109E-02	4.885E-02	4.561E-02	3.592E-02
5.750E-01	1.502E+09	1.138E+07	8.842E+06	4.173E+06	1.194E+06	9.779E+04	5.388E+01	5.002E-02	1.210E-03	2.088E-05	1.717E-06	1.885E-06
8.500E-01	3.852E+09	8.737E+07	1.556E+08	2.558E+04	3.298E+03	2.794E+03	2.748E+03	2.748E+03	2.748E+03	2.748E+03	2.487E+03	1.958E+03
1.250E+00	2.189E+08	1.931E+07	1.680E+07	1.131E+07	5.880E+06	1.573E+06	3.041E+04	4.241E+01	1.578E-02	1.569E-02	1.569E-02	1.568E-02
1.750E+00	8.280E+07	7.487E+03	1.120E+02	1.342E-02	9.828E-03	7.737E-03	3.788E-03	1.152E-03	9.869E-08	4.935E-11	3.897E-12	3.880E-12
2.250E+00	1.087E+07	1.286E+03	1.766E+02	1.079E+02	5.591E+01	1.900E+01	2.901E-01	4.045E-04	1.400E-09	8.132E-17	0.0	0.0
2.750E+00	1.297E+06	1.878E+00	6.203E-01	4.081E-01	2.114E-01	5.675E-02	1.097E-03	1.529E-08	8.717E-18	3.986E-25	0.0	0.0
3.500E+00	1.399E+05	8.335E-17	6.202E-17	5.822E-17	5.241E-17	4.248E-17	2.262E-17	7.915E-18	1.188E-19	4.883E-28	0.0	0.0
5.000E+00	4.054E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	8.294E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	9.580E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	5.722E+09	1.066E+08	3.332E+07	1.827E+07	7.845E+06	1.739E+06	3.330E+04	2.816E+03	2.754E+03	2.689E+03	2.511E+03	1.978E+03
GAM POW	2.752E+04	5.127E+02	1.602E+02	8.785E+01	3.773E+01	8.382E+00	1.601E-01	1.354E-02	1.324E-02	1.293E-02	1.208E-02	9.512E-03

Table D.4. Photon Source Due to Inconel-718 Exposed to
28 GWD in BWR Core (Photons/M)

OUTPUT UNIT = 8

PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT, 1M+3 INC-718 IN-CORE
POWER= 19.18 MW, BURNUP= 28000. MWD, FLUX= 1.85E+14 N/CM+2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	1.932E+17	7.225E+15	5.021E+15	3.959E+15	2.076E+15	5.075E+14	5.840E+13	3.257E+13	9.753E+12	3.157E+12	2.780E+12	1.943E+12
2.500E-02	1.078E+16	1.183E+15	1.002E+15	8.764E+14	3.523E+14	9.721E+13	4.898E+12	2.275E+12	8.823E+11	4.788E+11	4.400E+11	3.404E+11
3.750E-02	1.362E+16	6.645E+14	5.709E+14	3.848E+14	1.998E+14	5.432E+13	1.850E+12	6.543E+11	3.698E+11	2.825E+11	2.819E+11	2.033E+11
5.000E-02	2.407E+16	7.831E+14	6.434E+14	4.334E+14	2.247E+14	6.082E+13	1.572E+12	3.927E+11	3.601E+11	3.432E+11	3.193E+11	2.492E+11
6.500E-02	1.093E+16	3.003E+14	2.531E+14	1.704E+14	8.837E+13	2.384E+13	6.220E+11	1.647E+11	1.830E+11	1.590E+11	1.483E+11	1.185E+11
1.250E-01	1.178E+16	1.185E+14	9.732E+13	6.547E+13	3.395E+13	9.171E+12	2.550E+11	7.935E+10	7.856E+10	7.870E+10	7.163E+10	5.839E+10
2.250E-01	1.451E+16	4.645E+13	3.224E+13	2.155E+13	1.119E+13	3.039E+12	1.089E+11	4.908E+10	4.867E+10	4.752E+10	4.439E+10	3.495E+10
3.750E-01	2.921E+16	1.018E+13	9.061E+12	6.035E+12	3.127E+12	8.411E+11	1.854E+10	2.348E+09	2.925E+09	2.255E+09	2.106E+09	1.658E+09
5.750E-01	3.954E+16	4.819E+12	1.408E+13	3.517E+11	1.785E+11	4.818E+10	9.310E+08	1.305E+08	2.925E+07	2.473E+07	2.204E+07	2.135E+07
8.500E-01	1.854E+17	2.060E+15	8.263E+14	1.068E+14	5.974E+13	8.680E+13	5.803E+13	3.945E+13	5.521E+13	5.558E+13	5.087E+13	3.990E+13
1.250E+00	2.967E+17	2.484E+17	2.178E+17	1.488E+17	7.804E+16	2.041E+16	3.945E+14	5.521E+14	5.558E+14	5.087E+14	3.990E+14	3.112E+14
1.750E+00	2.514E+16	8.918E+12	2.493E+11	5.447E+09	9.700E+01	7.638E+01	3.740E+01	1.38E+01	2.178E+05	6.299E+13	0.0	0.0
2.250E+00	9.328E+15	1.318E+12	1.154E+12	7.779E+11	4.030E+11	1.082E+11	2.091E+09	2.925E+08	2.178E+05	6.299E+13	0.0	0.0
2.750E+00	1.282E+15	4.074E+09	3.572E+09	2.407E+08	1.247E+08	3.347E+08	6.470E+06	9.054E+03	3.602E+08	8.139E+16	0.0	0.0
3.500E+00	1.071E+14	1.924E-05	1.978E-05	2.594E-08	1.844E-07	8.827E-08	3.631E-08	1.270E-08	1.903E-10	7.835E-17	0.0	0.0
5.000E+00	2.242E+10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	5.393E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	8.573E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	8.545E+17	2.821E+17	2.270E+17	1.528E+17	7.909E+16	2.131E+16	5.183E+14	9.288E+13	8.722E+13	5.879E+13	5.472E+13	4.284E+13
MEV/SEC	8.249E+17	3.136E+17	2.730E+17	1.837E+17	9.517E+16	2.558E+16	5.420E+14	4.887E+13	4.747E+13	4.824E+13	4.318E+13	3.400E+13

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	1.512E+08	5.656E+08	4.635E+08	3.099E+08	1.625E+08	4.878E+05	4.415E+04	2.550E+04	7.835E+03	2.472E+03	2.181E+03	1.521E+03
2.500E-02	2.579E+07	1.518E+06	1.308E+06	8.825E+05	4.598E+05	1.268E+05	6.388E+03	2.989E+03	1.151E+03	6.219E+02	5.742E+02	4.422E+02
3.750E-02	2.865E+07	1.300E+06	1.117E+06	7.532E+05	3.911E+05	1.083E+05	3.621E+03	1.281E+03	7.234E+02	5.529E+02	5.128E+02	3.979E+02
5.000E-02	7.223E+07	2.260E+06	1.931E+06	1.301E+06	6.744E+05	1.819E+05	4.718E+03	1.179E+03	1.081E+03	1.030E+03	9.583E+02	7.478E+02
6.500E-02	4.847E+07	1.332E+06	1.123E+06	7.580E+05	3.920E+05	1.057E+05	2.759E+03	7.309E+02	7.230E+02	7.055E+02	6.581E+02	5.188E+02
1.250E-01	7.687E+07	7.730E+05	6.349E+05	4.271E+05	2.215E+05	5.983E+04	1.884E+03	5.177E+02	5.126E+02	5.004E+02	4.873E+02	3.679E+02
2.250E-01	1.703E+08	5.455E+05	3.785E+05	2.531E+05	1.314E+05	3.568E+04	1.255E+03	5.784E+02	5.715E+02	5.581E+02	5.212E+02	4.104E+02
3.750E-01	5.718E+08	3.187E+05	1.774E+05	1.181E+05	6.121E+04	1.848E+04	3.029E+02	4.598E+02	4.520E+01	4.414E+01	4.122E+01	3.246E+01
5.750E-01	1.188E+09	1.448E+07	4.224E+05	1.056E+04	5.388E+03	1.445E+03	2.794E+02	3.915E+02	8.777E+06	7.423E+06	6.818E+06	6.407E+06
8.500E-01	7.338E+09	1.313E+08	2.778E+07	4.739E+06	2.850E+06	2.522E+06	2.487E+06	2.482E+06	4.485E+08	2.407E+08	2.248E+08	1.770E+08
1.250E+00	1.935E+10	1.621E+10	1.421E+10	9.575E+09	4.981E+09	1.331E+09	2.574E+07	1.038E+06	9.196E+09	1.228E+10	1.452E+11	8.322E+15
1.750E+00	2.296E+09	8.145E+05	2.277E+04	4.975E-01	8.860E-06	6.976E-06	3.418E-06	1.038E-01	2.558E+12	7.397E+20	0.0	0.0
2.250E+00	1.095E+09	1.546E+05	1.355E+05	9.135E+04	4.732E+04	1.270E+04	2.455E+02	3.438E+01	3.189E+15	1.168E+22	0.0	0.0
2.750E+00	1.840E+08	9.847E+02	5.128E+02	3.455E+02	1.798E+02	4.804E+01	9.286E-01	1.100E-03	3.189E+15	1.168E+22	0.0	0.0
3.500E+00	1.958E+07	7.186E-12	3.813E-12	4.738E-13	3.004E-14	1.247E-14	6.633E-15	2.321E-15	3.477E-17	1.431E-23	0.0	0.0
5.000E+00	5.850E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	1.970E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	3.259E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	3.262E+10	1.837E+10	1.425E+10	9.588E+09	4.987E+09	1.335E+09	2.829E+07	2.551E+06	2.477E+06	2.413E+06	2.254E+06	1.774E+06
GAM POW	1.002E+05	5.027E+04	4.378E+04	2.945E+04	1.526E+04	4.100E+03	8.688E+01	7.834E+00	7.809E+00	7.412E+00	6.922E+00	5.450E+00

Table D.5. Photon Source Due to Stainless Steel-304 Exposed to
28 GWD in BWR Core (Photons/m³)

PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

OUTPUT UNIT = B

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BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT, IM+3 SS-304, IN-CORE
POWER= 19.18 MW, BURNUP= 28000. MWD, FLUX= 1.85E+14 N/CM+2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	3.228E+17	1.794E+15	1.250E+15	6.857E+14	3.478E+14	9.975E+13	9.087E+12	5.090E+12	1.280E+12	1.633E+11	1.245E+11	5.482E+10
2.500E-02	8.111E+16	1.950E+14	1.679E+14	1.133E+14	5.896E+13	1.623E+13	7.842E+11	3.248E+11	9.077E+10	2.284E+10	1.778E+10	7.801E+09
3.750E-02	4.059E+16	1.114E+14	9.587E+13	6.444E+13	3.344E+13	9.083E+12	2.734E+11	7.303E+10	2.528E+10	1.097E+10	8.631E+09	3.861E+09
5.000E-02	4.031E+16	1.263E+14	1.077E+14	7.258E+13	3.780E+13	1.011E+13	2.137E+11	1.618E+10	1.088E+10	8.753E+09	6.985E+09	3.193E+09
6.250E-02	7.031E+16	5.035E+13	4.238E+13	2.853E+13	1.478E+13	3.868E+12	7.846E+10	1.892E+09	1.748E+09	1.622E+09	1.315E+09	8.569E+08
7.500E-01	4.631E+16	1.987E+13	1.629E+13	1.095E+13	6.155E+12	1.523E+12	2.989E+10	2.901E+08	2.455E+08	2.335E+08	2.034E+08	1.325E+08
8.750E-01	5.111E+16	7.794E+12	5.322E+12	3.802E+12	1.855E+12	5.010E+11	9.789E+09	1.000E+08	8.594E+07	8.391E+07	7.837E+07	8.171E+07
1.250E-01	3.602E+16	4.448E+12	1.518E+12	1.011E+12	5.236E+11	1.405E+11	2.721E+09	7.897E+08	4.083E+08	3.986E+08	3.722E+08	2.931E+08
2.500E-01	1.221E+16	8.099E+11	2.347E+11	1.508E+11	8.008E+10	8.089E+09	1.560E+08	2.190E+05	1.468E+03	1.178E+03	9.405E+02	8.949E+02
3.750E-01	8.999E+17	4.623E+15	1.936E+15	7.088E+14	3.527E+12	2.278E+11	1.014E+11	9.878E+10	9.811E+10	9.579E+10	8.947E+10	7.044E+10
5.000E-01	4.842E+16	1.161E+15	3.649E+14	2.459E+14	1.274E+13	1.419E+12	6.809E+13	9.211E+10	1.565E+01	7.347E+00	8.707E-01	5.004E-04
6.250E-01	1.604E+17	1.490E+12	4.191E+10	9.157E+05	2.129E-01	1.824E-01	9.584E-02	5.039E-02	2.542E-02	1.197E-02	1.419E-03	8.131E-07
7.500E-01	7.639E+16	2.208E+11	1.934E+11	1.303E+11	7.752E+10	1.812E+10	3.503E-08	4.882E-05	1.853E-06	1.050E-15	0.0	0.0
8.750E-01	1.068E+16	6.823E+08	5.984E+08	4.033E+08	2.089E+08	5.807E+07	1.084E+08	1.511E+03	5.879E-09	0.0	0.0	0.0
1.250E+00	9.187E+14	1.547E-12	1.515E-12	1.422E-12	1.281E-12	1.038E-12	5.527E-13	1.935E-13	3.161E-15	0.0	0.0	0.0
2.500E+00	3.253E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.750E+00	2.823E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.000E+00	6.436E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.514E+18	4.863E+16	4.011E+16	2.574E+16	1.324E+16	3.560E+15	7.685E+13	5.697E+12	1.487E+12	3.038E+11	2.489E+11	1.411E+11
MEV/SEC	1.093E+18	5.605E+16	4.729E+16	3.091E+16	1.594E+16	4.277E+15	8.289E+13	2.875E+11	1.063E+11	8.555E+10	7.924E+10	6.131E+10

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	2.525E+08	1.405E+06	9.788E+05	5.368E+05	2.723E+05	7.809E+04	7.114E+03	3.985E+03	9.884E+02	1.279E+02	9.745E+01	4.291E+01
2.500E-02	7.973E+07	2.544E+05	2.190E+05	1.478E+05	7.693E+04	2.118E+04	9.971E+02	4.238E+02	1.184E+02	2.960E+01	2.320E+01	1.030E+01
3.750E-02	7.945E+07	2.180E+05	1.871E+05	1.261E+05	6.548E+04	1.774E+04	5.352E+02	1.429E+02	4.948E+01	2.147E+01	1.689E+01	7.556E+00
5.000E-02	1.810E+08	3.789E+05	3.234E+05	2.178E+05	1.128E+05	3.033E+04	8.414E+02	4.899E+02	3.286E+01	2.639E+01	2.098E+01	9.581E+00
6.250E-02	1.643E+08	2.233E+05	1.880E+05	1.265E+05	6.556E+04	1.760E+04	3.481E+02	8.395E+00	7.753E+00	7.198E+00	5.833E+00	2.914E+00
7.500E-01	1.620E+08	1.299E+05	1.063E+05	7.147E+04	3.703E+04	9.938E+03	1.937E+02	1.892E+00	1.601E+00	1.523E+00	1.327E+00	8.645E-01
8.750E-01	4.123E+08	9.153E+04	6.332E+04	4.230E+04	2.192E+04	5.883E+03	1.147E+02	1.175E+00	1.009E+00	9.853E-01	9.203E-01	7.247E-01
1.250E+01	7.049E+08	6.702E+04	2.971E+04	1.978E+04	1.025E+04	2.750E+03	5.325E+01	1.548E-01	7.990E-02	7.801E-02	7.285E-02	5.737E-02
2.500E+01	3.664E+08	2.430E+08	7.042E+04	1.743E+03	9.022E+02	2.421E+02	4.681E+02	6.572E-03	4.405E-05	3.528E-05	2.822E-05	2.686E-05
3.750E+01	2.577E+10	2.051E+08	8.591E+07	7.568E+06	1.565E+05	1.010E+04	4.499E+03	4.362E+03	4.250E+03	3.969E+03	3.125E+03	2.125E+03
5.000E+01	3.578E+09	2.715E+09	2.380E+09	1.804E+09	8.311E+08	2.230E+08	4.312E+08	6.009E+03	1.034E+06	4.793E-07	5.880E-06	3.265E-11
6.250E+01	1.461E+10	1.389E+05	3.828E+03	8.363E-02	1.945E-08	1.484E-08	8.754E-09	4.602E-09	2.322E-09	1.094E-09	1.296E-10	7.427E-14
7.500E+01	8.970E+09	2.590E+04	2.271E+04	1.530E+04	7.928E+03	2.128E+03	4.114E+01	5.733E-02	2.178E-13	1.233E-22	0.0	0.0
8.750E+01	1.535E+09	9.799E+01	8.588E+01	5.788E+01	2.999E+01	8.048E+00	1.556E-01	2.188E-04	8.151E-18	0.0	0.0	0.0
1.250E+02	1.674E+08	2.827E-19	2.767E-19	2.598E-19	2.339E-19	1.896E-19	1.010E-19	3.534E-20	5.773E-22	0.0	0.0	0.0
2.500E+02	8.468E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.750E+02	1.930E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.000E+02	3.191E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	5.704E+10	2.925E+09	2.468E+09	1.613E+09	8.319E+08	2.232E+08	4.328E+06	1.500E+04	5.550E+03	4.465E+03	4.138E+03	3.200E+03
GAM POW	1.752E+05	8.985E+03	7.581E+03	4.954E+03	2.555E+03	8.857E+02	1.328E+01	4.608E-02	1.705E-02	1.371E-02	1.270E-02	9.829E-03

Table D.6. Photon Source Due to Zircaloy-4 Exposed to
28 GWD in BWR Core (Photons/m³)

OUTPUT UNIT = 8

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

BWR, 2.5 W/D ENRICHMENT, 28 GWD/MT 1M+3 ZIRC-4 WITH 120PPM NB IN-CORE
POWER= 19.16 MW, BURNUP= 28000 MWU, FLUX= 1.85E+14 N/CM+2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1 500E-02	3.784E+18	2.501E+14	1.073E+14	4.100E+13	1.298E+13	1.734E+12	5.830E+10	4.115E+10	4.024E+10	3.924E+10	3.728E+10	3.288E+10
2 500E-02	1.377E+18	1.523E+15	8.489E+14	2.918E+14	8.061E+13	6.708E+12	8.903E+09	2.164E+09	2.088E+09	1.938E+09	1.851E+09	1.006E+09
3 750E-02	5.012E+15	2.047E+14	1.543E+14	7.288E+13	2.101E+13	1.784E+12	3.823E+08	1.105E+08	1.057E+08	1.007E+08	8.629E+07	5.341E+07
5 750E-02	7.007E+13	2.035E+13	7.178E+12	3.091E+12	1.051E+12	1.584E+11	3.125E+09	1.077E+09	1.044E+09	9.933E+08	8.864E+08	5.662E+08
8 500E-02	4.040E+15	7.040E+12	2.872E+12	1.335E+12	4.495E+11	6.523E+10	1.180E+09	3.687E+08	3.533E+08	3.408E+08	3.080E+08	2.235E+08
1 250E-01	2.812E+15	8.580E+12	4.728E+12	2.178E+12	8.487E+11	6.405E+10	4.875E+08	1.485E+08	1.413E+08	1.376E+08	1.278E+08	9.925E+07
2 250E-01	7.244E+15	7.384E+13	5.387E+13	2.523E+13	7.228E+12	5.955E+11	5.331E+08	9.285E+07	8.445E+07	8.239E+07	7.696E+07	5.061E+07
3 750E-01	4.144E+15	4.075E+14	3.189E+14	1.496E+14	4.281E+13	3.508E+12	1.967E+09	7.627E+08	4.075E+08	3.909E+08	3.650E+08	2.874E+08
5 750E-01	5.472E+15	5.241E+14	4.073E+14	1.922E+14	5.501E+13	4.505E+12	2.481E+09	1.929E+08	5.568E+04	1.052E+03	8.960E+01	8.788E+01
8 500E-01	9.110E+16	1.888E+15	3.781E+14	5.601E+13	1.100E+11	8.850E+10	9.712E+10	9.693E+10	9.827E+10	9.400E+10	8.779E+10	6.913E+10
1 250E+00	3.782E+15	4.270E+14	3.718E+14	2.502E+14	1.298E+14	3.478E+13	6.724E+11	9.404E+08	2.762E+05	2.746E+05	2.745E+05	2.744E+05
1 750E+00	9.873E+14	9.548E+10	1.428E+09	1.780E+05	1.228E+05	9.847E+04	4.724E+04	1.437E+04	1.231E+02	7.922E-04	4.886E-05	4.849E-05
2 250E+00	8.840E+13	1.319E+10	2.131E+09	1.328E+08	8.889E+08	1.844E+08	3.564E+08	4.983E+03	1.358E+02	7.887E-10	0.0	0.0
2 750E+00	9.658E+12	1.495E+07	6.207E+08	4.103E+08	2.127E+06	5.704E+05	1.103E+04	1.541E+01	6.191E-11	1.830E-18	0.0	0.0
3 500E+00	8.232E+11	2.038E-10	1.993E-10	1.871E-10	1.684E-10	1.365E-10	7.269E-11	2.543E-11	3.812E-13	1.589E-19	0.0	0.0
5 000E+00	1.394E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 000E+00	1.403E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 500E+00	1.616E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	2.324E+17	5.134E+15	2.313E+15	1.030E+15	3.515E+14	5.400E+13	8.503E+11	1.440E+11	1.413E+11	1.377E+11	1.290E+11	1.045E+11
MEV/SEC	1.210E+17	2.492E+15	8.917E+14	4.987E+14	2.146E+14	4.789E+13	9.269E+11	8.442E+10	8.285E+10	8.070E+10	7.537E+10	5.938E+10

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1 500E-02	2.947E+07	1.958E+05	8.402E+04	3.210E+04	1.016E+04	1.358E+03	4.564E+01	3.222E+01	3.151E+01	3.072E+01	2.918E+01	2.574E+01
2 500E-02	1.796E+07	1.987E+06	1.108E+06	3.807E+05	1.052E+05	8.752E+03	1.182E+01	2.824E+00	2.696E+00	2.529E+00	2.155E+00	1.312E+00
3 750E-02	9.809E+06	4.006E+05	3.019E+05	1.426E+05	4.111E+04	3.492E+03	7.482E+00	2.184E+00	2.089E+00	1.971E+00	1.889E+00	1.045E+00
5 750E-02	2.103E+07	6.107E+04	2.153E+04	9.275E+03	3.154E+03	4.755E+02	9.379E+00	3.233E+00	3.134E+00	2.981E+00	2.600E+00	1.899E+00
8 500E-02	1.792E+07	3.123E+04	1.274E+04	5.923E+03	1.094E+03	2.894E+02	5.235E+00	1.827E+00	1.587E+00	1.511E+00	1.367E+00	9.915E-01
1 250E-01	1.835E+07	5.598E+04	3.085E+04	1.420E+04	4.232E+03	4.179E+02	3.181E+00	9.687E-01	9.220E-01	8.979E-01	8.338E-01	6.475E-01
2 250E-01	8.507E+07	8.871E+05	8.328E+05	2.983E+05	8.488E+04	6.993E+03	6.281E+00	1.090E+00	9.917E-01	9.875E-01	9.037E-01	7.118E-01
3 750E-01	8.111E+07	7.975E+06	6.203E+06	2.928E+06	8.378E+05	3.882E+04	3.850E+01	1.493E-01	7.975E-02	7.650E-02	7.143E-02	5.625E-02
5 750E-01	1.842E+09	1.573E+07	1.222E+07	5.769E+06	1.851E+06	1.352E+05	7.445E+01	5.789E-02	1.670E-03	3.157E-05	2.689E-08	2.637E-06
8 500E-01	4.042E+09	7.489E+07	1.877E+06	2.485E+04	4.878E+03	4.370E+03	4.309E+03	4.300E+03	4.271E+03	4.170E+03	3.895E+03	3.067E+03
1 250E+00	2.467E+08	2.786E+07	2.424E+07	1.832E+07	8.455E+06	2.269E+06	4.387E+04	6.135E+01	1.802E-02	1.791E-02	1.791E-02	1.790E-02
1 750E+00	9.017E+07	8.719E+03	1.304E+02	1.607E-02	1.120E-02	8.811E-03	4.314E-03	1.312E-03	1.124E-05	7.238E-11	4.445E-12	4.429E-12
2 250E+00	1.156E+07	1.549E+03	2.502E-02	1.657E-02	8.086E-01	2.185E-01	4.185E-01	5.852E-04	1.595E-09	9.261E-17	0.0	0.0
2 750E+00	1.386E+06	2.145E+00	8.909E-01	5.889E-01	3.051E-01	8.187E-02	1.583E-03	2.212E-08	8.886E-18	2.340E-25	0.0	0.0
3 500E+00	1.504E+05	3.719E-17	3.841E-17	3.417E-17	3.275E-17	2.494E-17	1.328E-17	4.648E-18	8.963E-20	2.866E-28	0.0	0.0
5 000E+00	3.638E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7 000E+00	5.126E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 500E+00	8.012E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	6.314E+09	1.301E+08	4.654E+07	2.592E+07	1.120E+07	2.499E+06	4.838E+04	4.406E+03	4.314E+03	4.212E+03	3.934E+03	3.099E+03
GAM POW	1.939E+04	3.995E+02	1.429E+02	7.962E+01	3.440E+01	7.676E+00	1.488E+01	1.353E-02	1.325E-02	1.294E-02	1.208E-02	9.518E-03

Table D.7. Photon Source Due to Non-Fuel Components of a PWR Fuel Assembly
Exposed to 33 GWD/MTU (Photons/second/MTU)

OUTPUT UNIT = 8

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, COMPLETE FUEL ASSEMBLY
POWER= 30.00 MW, BURNUP= 33000. MWG, FLUX= 2.59E+14 N/CM**2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	9.804E+14	1.832E+13	1.233E+13	7.857E+12	4.089E+12	1.191E+12	1.238E+11	7.240E+10	2.018E+10	5.182E+09	4.487E+09	3.108E+09
2.500E-02	1.471E+14	2.319E+12	1.972E+12	1.330E+12	8.933E+11	1.810E+11	1.930E+10	4.885E+09	1.898E+09	7.782E+08	7.110E+08	5.417E+08
3.750E-02	9.770E+13	1.327E+12	1.123E+12	7.685E+11	3.928E+11	1.089E+11	3.705E+09	1.301E+09	5.514E+08	4.581E+08	4.205E+08	3.224E+08
5.000E-02	5.579E+13	8.510E+11	1.265E+12	8.517E+11	4.410E+11	1.190E+11	2.977E+09	8.539E+08	5.810E+08	5.478E+08	5.079E+08	3.931E+08
6.500E-02	8.809E+13	8.062E+11	4.978E+11	3.348E+11	1.730E+11	4.679E+10	1.158E+09	2.589E+08	2.880E+08	2.505E+08	2.334E+08	1.820E+08
1.250E-01	8.115E+13	2.446E+11	1.910E+11	1.280E+11	6.670E+10	1.798E+10	4.685E+08	1.243E+08	1.230E+08	1.201E+08	1.121E+08	8.820E+07
2.250E-01	8.838E+13	1.063E+11	8.375E+10	4.234E+10	2.107E+10	5.953E+09	1.904E+08	7.882E+07	7.814E+07	7.434E+07	6.944E+07	5.487E+07
3.750E-01	1.348E+14	4.265E+10	1.797E+10	1.180E+10	6.146E+09	1.852E+09	3.881E+07	3.883E+06	3.814E+06	3.520E+06	3.298E+06	2.505E+06
5.000E-01	9.102E+13	1.670E+12	4.788E+10	8.820E+08	3.527E+08	9.485E+07	1.830E+06	2.587E+03	3.930E+01	1.898E+01	3.818E+00	1.588E+00
6.500E-01	1.486E+15	1.895E+13	5.979E+12	8.000E+11	1.021E+11	8.928E+10	8.772E+10	8.754E+09	8.695E+10	8.489E+10	7.929E+10	6.243E+10
1.250E+00	6.045E+14	4.882E+14	4.280E+14	2.889E+14	1.484E+14	4.011E+13	7.753E+11	1.073E+09	1.025E+00	4.817E-01	5.707E-02	3.270E-05
1.750E+00	3.481E+14	3.093E+10	8.648E+08	1.889E+04	3.140E-01	2.477E-01	1.223E-01	3.861E-02	1.969E-03	7.848E-04	9.301E-05	5.328E-08
2.250E+00	1.597E+14	2.887E+09	2.289E+08	1.520E+09	7.920E-08	2.122E-08	4.109E+08	5.890E+03	5.890E-08	2.030E-15	0.0	0.0
2.750E+00	2.233E+13	8.008E+08	7.020E+08	4.731E+08	2.451E+08	8.578E+05	1.272E+04	1.780E+01	7.445E-11	3.403E-18	0.0	0.0
3.500E+00	1.908E+12	1.383E-07	8.871E-08	8.069E-09	8.304E-10	2.853E-10	1.618E-10	5.309E-11	7.958E-13	3.278E-18	0.0	0.0
5.000E+00	1.219E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	1.801E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	1.513E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	4.447E+15	5.313E+14	4.515E+14	3.004E+14	1.554E+14	4.188E+13	1.005E+12	1.683E+11	1.105E+11	9.230E+10	8.583E+10	6.712E+10
MEV/SEC	3.207E+15	6.279E+14	5.406E+14	3.614E+14	1.870E+14	5.025E+13	1.048E+12	7.710E+10	7.438E+10	7.238E+10	6.758E+10	5.320E+10

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	4.902E+05	8.168E+03	6.185E+03	3.929E+03	2.049E+03	5.953E+02	8.178E+01	3.620E+01	1.010E+01	2.591E+00	2.244E+00	1.554E+00
2.500E-02	1.226E+05	1.933E+03	1.643E+03	1.109E+03	5.777E+02	1.800E+02	8.562E+00	4.070E+00	1.418E+00	6.488E-01	5.925E-01	4.514E-01
3.750E-02	1.221E+05	1.659E+03	1.404E+03	9.458E+02	4.911E+02	1.336E+02	4.832E+00	1.827E+00	8.142E-01	5.702E-01	5.257E-01	4.030E-01
5.000E-02	3.026E+05	2.895E+03	2.425E+03	1.832E+03	8.464E+02	2.282E+02	5.706E+00	1.253E+00	1.114E+00	1.050E+00	9.735E-01	7.534E-01
6.500E-02	2.496E+05	1.723E+03	1.411E+03	9.488E+02	4.919E+02	1.326E+02	3.282E+00	7.363E-01	7.278E-01	7.097E-01	6.812E-01	5.175E-01
1.250E-01	2.548E+05	1.019E+03	7.982E+02	5.380E+02	2.779E+02	7.497E+01	1.956E+00	5.181E-01	5.125E-01	5.003E-01	4.871E-01	3.675E-01
2.250E-01	6.477E+05	7.975E+02	4.781E+02	3.175E+02	1.648E+02	4.484E+01	1.428E+00	5.762E-01	5.711E-01	5.578E-01	5.208E-01	4.101E-01
3.750E-01	1.685E+08	5.331E+02	2.246E+02	1.482E+02	7.862E+01	2.065E+01	4.439E-01	4.604E-02	4.518E-02	4.411E-02	4.120E-02	3.244E-02
5.000E-01	1.749E+08	3.200E+04	9.136E+02	1.308E+01	8.760E+00	1.814E+00	3.507E-02	4.958E-05	7.532E-07	3.833E-07	8.932E-08	2.983E-08
6.500E-01	4.153E+07	5.389E+05	1.894E+05	1.703E+04	2.894E+03	2.530E+03	2.485E+03	2.480E+03	2.483E+03	2.405E+03	2.246E+03	1.768E+03
1.250E+00	2.519E+07	2.034E+07	1.783E+07	1.202E+07	8.227E+06	1.871E+06	3.231E+04	4.473E+04	4.271E+08	2.007E+08	2.378E+09	1.382E+12
1.750E+00	2.031E+07	1.804E+03	5.044E+01	1.102E+03	1.832E+08	1.445E+08	7.137E-09	2.252E-09	1.146E-10	4.578E-11	5.425E-12	3.109E-15
2.250E+00	1.198E+07	1.941E+02	1.701E+02	1.147E+02	5.940E+01	1.594E+01	3.082E-01	4.287E-04	4.200E-15	1.522E-22	0.0	0.0
2.750E+00	2.047E+08	7.339E-01	6.435E-01	4.337E-01	2.247E-01	8.029E-02	1.186E-03	1.814E-08	8.824E-18	3.119E-25	0.0	0.0
3.500E+00	2.223E+05	1.590E-14	8.016E-15	1.058E-15	7.355E-17	3.328E-17	1.771E-17	8.194E-18	9.284E-20	3.822E-26	0.0	0.0
5.000E+00	2.031E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	3.736E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	4.790E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.089E+08	2.093E+07	1.802E+07	1.205E+07	8.235E+06	1.875E+06	3.468E+04	2.570E+03	2.479E+03	2.412E+03	2.253E+03	1.773E+03
GAM POW	5.140E+02	1.007E+02	8.685E+01	5.793E+01	2.998E+01	8.055E+00	1.677E-01	1.236E-02	1.192E-02	1.180E-02	1.083E-02	8.528E-03

6.9

Table D.8. Photon Source Due to Grids, Springs, Sleeves, etc. of a PWR Fuel Assembly Exposed to 33 GWD/MTU (Photons/second/MTU)

OUTPUT UNIT = B

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

PWR, 3.2 W/O ENRICHMENT, 33GWD/MT BURNUP, GRIDS & SLEEVES
POWER= 30.00 MW, BURNUP= 33000. MWD, FLUX= 2.58E+14 N/CM**2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	9.861E+14	1.624E+13	1.228E+13	7.837E+12	4.089E+12	1.188E+12	1.232E+11	7.219E+10	2.014E+10	5.171E+09	4.477E+09	3.102E+09
2.500E-02	1.444E+14	2.314E+12	1.907E+12	1.327E+12	8.917E+11	1.015E+11	1.027E+10	4.871E+09	1.804E+09	7.743E+08	7.094E+08	5.407E+08
3.750E-02	9.594E+13	1.324E+12	1.120E+12	7.547E+11	3.808E+11	1.088E+11	3.888E+09	1.298E+09	6.498E+08	4.551E+08	4.198E+08	3.218E+08
5.750E-02	1.553E+14	1.807E+12	1.282E+12	8.407E+11	4.408E+11	1.188E+11	2.970E+09	6.823E+08	5.799E+08	6.467E+08	5.070E+08	3.924E+08
8.500E-02	8.847E+13	6.087E+11	4.968E+11	3.341E+11	1.732E+11	4.668E+10	1.158E+09	2.585E+08	2.564E+08	2.501E+08	2.330E+08	1.824E+08
1.250E-01	6.007E+13	2.439E+11	1.911E+11	1.283E+11	6.654E+10	1.795E+10	4.685E+08	1.242E+08	1.228E+08	1.189E+08	1.119E+08	8.807E+07
2.250E-01	8.482E+13	1.081E+11	8.360E+10	4.224E+10	2.192E+10	8.939E+09	1.800E+08	7.871E+07	7.803E+07	7.424E+07	6.934E+07	5.460E+07
3.750E-01	1.311E+14	4.245E+10	1.783E+10	1.183E+10	8.131E+09	1.648E+08	3.543E+07	3.678E+06	3.609E+06	3.524E+06	3.281E+06	2.581E+06
5.750E-01	9.044E+13	1.685E+12	1.754E+12	8.812E+11	3.519E+11	8.443E+07	1.828E+06	2.600E+03	3.923E+01	1.891E+01	3.581E+00	1.523E+00
8.500E-01	1.440E+15	1.855E+13	3.852E+12	5.896E+11	1.018E+11	8.915E+10	8.759E+10	8.742E+10	8.682E+10	8.477E+10	7.917E+10	6.234E+10
1.250E+00	8.028E+14	4.871E+14	4.270E+14	2.878E+14	1.491E+14	4.001E+13	7.735E+11	1.079E+09	1.024E+00	4.812E-01	5.701E-02	3.267E-05
2.250E+00	1.584E+14	2.588E+09	8.623E+08	1.884E+04	3.138E-01	2.474E-01	1.222E-01	3.858E-02	1.887E-03	7.840E-04	9.282E-05	5.324E-08
3.750E+00	2.187E+13	7.988E+08	2.263E+09	1.528E+09	7.902E+08	2.121E+08	4.100E+06	5.720E+03	5.808E-08	2.027E-15	0.0	0.0
5.750E+00	1.584E+14	2.588E+09	8.623E+08	1.884E+04	3.138E-01	2.474E-01	1.222E-01	3.858E-02	1.887E-03	7.840E-04	9.282E-05	5.324E-08
8.500E+00	1.868E+12	1.383E-07	8.871E-08	6.089E-09	3.04E-10	2.853E-10	1.618E-10	5.309E-11	7.958E-13	3.278E-19	0.0	0.0
1.250E+01	1.218E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.250E+01	1.598E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.750E+01	1.513E+06	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOTAL	4.381E+15	5.298E+14	4.503E+14	2.997E+14	1.551E+14	4.178E+13	1.003E+12	1.680E+11	1.103E+11	9.216E+10	8.570E+10	6.703E+10
MEV/SEC	3.180E+15	8.282E+14	5.392E+14	3.805E+14	1.888E+14	5.014E+13	1.044E+12	7.700E+10	7.428E+10	7.225E+10	6.748E+10	5.312E+10

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	4.830E+05	8.121E+03	8.143E+03	3.919E+03	2.045E+03	5.939E+02	8.181E+01	3.810E+01	1.007E+01	2.585E+00	2.239E+00	1.551E+00
2.500E-02	1.204E+05	1.928E+03	1.639E+03	1.108E+03	5.784E+02	1.898E+02	8.559E+00	4.059E+00	1.411E+00	8.452E-01	5.912E-01	4.508E-01
3.750E-02	1.199E+05	1.655E+03	1.400E+03	9.434E+02	4.900E+02	1.333E+02	4.820E+00	1.623E+00	8.122E-01	5.689E-01	5.248E-01	4.023E-01
5.750E-02	2.978E+05	2.888E+03	2.420E+03	1.629E+03	8.444E+02	2.278E+02	3.693E+00	1.250E+00	1.111E+00	1.048E+00	9.717E-01	7.522E-01
8.500E-02	2.450E+05	1.718E+03	1.407E+03	9.468E+02	4.907E+02	1.322E+02	3.275E+00	7.351E-01	7.264E-01	7.085E-01	6.801E-01	5.167E-01
1.250E-01	2.503E+05	1.018E+03	7.983E+02	5.347E+02	2.773E+02	7.479E+01	1.952E+00	5.173E-01	5.118E-01	4.998E-01	4.885E-01	3.870E-01
2.250E-01	6.382E+05	7.955E+02	4.770E+02	3.188E+02	1.844E+02	4.454E+01	1.425E+00	5.753E-01	5.702E-01	5.568E-01	5.200E-01	4.095E-01
3.750E-01	1.683E+06	5.308E+02	2.241E+02	1.479E+02	7.664E+01	2.060E+01	4.428E-01	4.588E-02	4.511E-02	4.405E-02	4.114E-02	3.239E-02
5.750E-01	1.733E+06	3.191E+04	9.113E+02	1.308E+01	6.744E+00	1.810E+00	3.499E-02	4.984E-05	7.519E-07	3.824E-07	8.863E-08	2.919E-08
8.500E-01	4.081E+07	5.284E+05	1.855E+05	1.871E+04	2.884E+03	2.828E+03	2.482E+03	2.477E+03	2.460E+03	2.402E+03	2.243E+03	1.766E+03
1.250E+00	2.512E+07	2.029E+07	1.779E+07	1.199E+07	6.212E+06	1.667E+06	3.223E+04	4.467E+01	4.267E-08	2.005E-09	2.375E-09	1.381E-12
2.250E+00	1.890E+07	1.769E+03	5.030E+01	1.098E-03	1.829E-08	1.443E-08	7.127E-09	2.249E-09	1.147E-10	4.574E-11	5.420E-12	3.106E-15
3.750E+00	1.173E+07	1.938E+02	1.697E+02	1.144E+02	5.248E+01	1.591E+01	3.075E-01	4.260E-04	4.205E-15	1.820E-22	0.0	0.0
5.750E+00	2.004E+08	7.322E-01	6.420E-01	4.328E-01	2.241E-01	6.015E-02	1.163E-03	1.622E-06	6.857E-18	3.119E-25	0.0	0.0
8.500E+00	2.177E+05	1.590E-14	8.016E-15	1.058E-15	7.355E-17	3.328E-17	1.771E-17	6.194E-18	9.284E-20	3.822E-28	0.0	0.0
1.250E+01	2.027E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.250E+01	3.729E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.750E+01	4.790E-01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOTAL	1.053E+08	2.087E+07	1.797E+07	1.202E+07	8.220E+06	1.671E+06	3.480E+04	2.567E+03	2.475E+03	2.408E+03	2.249E+03	1.771E+03
GAM POW	5.065E+02	1.004E+02	8.644E+01	5.779E+01	2.991E+01	8.037E+00	1.674E+01	1.234E+02	1.190E+02	1.158E+02	1.082E+02	8.516E+01

0.10

Table D.9. Photon Source Due to End Fittings of a PWR Fuel Assembly
Exposed to 33 GWD/MTU (Photons/second/MTU)

OUTPUT UNIT = 6

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

PWR, 3.2 W/D ENRICHMENT, 33GWD/MT BURNUP, END FITTINGS
POWER= 30.00 MW, BURNUP= 33000. MWD, FLUX= 2.59E+14 N/CM**2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	1.430E+13	7.472E+10	4.474E+10	1.979E+10	9.645E+09	2.831E+09	3.288E+08	1.954E+08	4.840E+07	6.295E+06	4.788E+06	2.111E+06
2.500E-02	2.862E+12	6.489E+09	4.605E+09	3.107E+09	1.821E+09	4.506E+08	2.501E+07	1.247E+07	3.489E+06	8.802E+05	6.853E+05	3.038E+05
3.750E-02	1.789E+12	3.125E+09	2.621E+09	1.765E+09	9.168E+08	2.404E+08	8.595E+06	2.803E+06	9.723E+05	4.228E+05	3.325E+05	1.486E+05
5.750E-02	2.622E+12	3.562E+09	2.952E+09	1.988E+09	1.029E+09	2.789E+08	6.058E+06	6.185E+05	4.180E+05	3.388E+05	2.889E+05	1.227E+05
8.500E-02	1.614E+12	1.441E+09	1.162E+09	7.808E+08	4.045E+08	1.086E+08	2.167E+06	7.148E+04	6.710E+04	8.228E+04	5.043E+04	2.511E+04
1.250E-01	1.083E+12	5.845E+08	4.470E+08	2.988E+08	1.553E+08	4.170E+07	6.184E+05	1.057E+04	9.307E+03	8.850E+03	7.700E+03	4.995E+03
2.250E-01	1.531E+12	2.855E+08	1.490E+08	9.850E+07	5.108E+07	1.371E+07	2.683E+05	3.808E+03	3.214E+03	3.138E+03	2.931E+03	2.308E+03
3.750E-01	1.757E+12	1.955E+08	4.211E+07	2.786E+07	1.433E+07	3.846E+06	7.451E+04	2.575E+02	1.527E+02	1.491E+02	1.392E+02	1.095E+02
5.750E-01	5.744E+11	4.704E+09	1.338E+08	1.591E+08	8.229E+05	2.208E+05	4.269E+03	6.034E+00	8.800E+02	5.000E+02	3.800E+02	3.314E+02
8.500E-01	2.553E+13	3.011E+11	1.266E+11	1.115E+10	2.104E+08	7.258E+06	3.768E+06	3.694E+06	3.689E+06	3.582E+06	3.348E+06	2.835E+06
1.250E+00	1.693E+12	1.139E+12	9.887E+11	6.730E+11	3.487E+11	9.358E+10	1.809E+09	2.524E+08	9.857E+04	4.532E+04	8.371E+03	3.083E+03
1.750E+00	6.937E+12	8.710E+07	2.437E+08	5.324E+01	1.530E+05	1.177E+05	6.767E+06	3.368E+01	1.870E+06	7.368E+07	8.753E+08	5.015E+11
2.250E+00	3.308E+12	6.037E+08	5.293E+08	3.567E+06	1.848E+06	4.900E+05	9.688E+03	1.338E+01	5.168E+11	7.903E+20	0.0	0.0
2.750E+00	4.631E+11	1.888E+04	1.638E+04	1.104E+04	5.718E+03	1.535E+03	2.907E+01	4.140E+02	1.558E+13	0.0	0.0	0.0
3.500E+00	3.969E+10	1.782E+19	1.782E+19	1.782E+19	1.782E+19	1.782E+19	1.782E+19	1.782E+19	1.782E+19	0.0	0.0	0.0
5.000E+00	2.339E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	2.822E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	3.862E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	6.588E+13	1.534E+12	1.182E+12	7.121E+11	3.627E+11	9.758E+10	2.188E+09	2.178E+08	5.703E+07	1.159E+07	9.492E+06	5.353E+06
MEV/SEC	4.691E+13	1.685E+12	1.358E+12	8.515E+11	4.384E+11	1.171E+11	2.271E+09	9.888E+08	4.000E+06	3.204E+06	2.967E+06	2.285E+06

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	7.151E+03	3.736E+01	2.237E+01	9.898E+00	4.823E+00	1.416E+00	1.648E-01	9.771E-02	2.420E-02	3.148E-03	2.399E-03	1.058E-03
2.500E-02	2.218E+03	4.549E+00	3.837E+00	2.589E+00	1.350E+00	3.755E-01	2.187E-02	1.039E-02	2.907E-03	7.335E-04	5.710E-04	2.532E-04
3.750E-02	2.211E+03	3.906E+00	3.276E+00	2.207E+00	1.148E+00	3.118E-01	1.074E-02	3.503E-03	1.215E-03	5.285E-04	4.156E-04	1.857E-04
5.750E-02	5.025E+03	6.828E+00	5.859E+00	3.807E+00	1.973E+00	5.307E-01	1.161E-02	1.185E-03	8.031E-04	8.489E-04	8.154E-04	2.351E-04
8.500E-02	4.574E+03	4.084E+00	3.292E+00	2.212E+00	1.148E+00	3.078E-01	8.141E-03	2.025E-04	1.901E-04	1.764E-04	1.429E-04	7.113E-05
1.250E-01	4.511E+03	2.435E+00	1.883E+00	1.249E+00	6.473E-01	1.737E-01	3.398E-03	4.404E-05	3.878E-05	3.209E-05	2.081E-05	1.370E-05
2.250E-01	1.149E+04	1.991E+00	1.118E+00	7.395E-01	3.831E-01	1.028E-01	2.012E-03	2.705E-05	2.411E-05	2.354E-05	2.198E-05	1.731E-05
3.750E-01	2.197E+04	2.444E+00	5.263E-01	3.458E-01	1.791E-01	4.808E-02	9.113E-04	3.219E-06	1.909E-06	1.863E-06	1.740E-06	1.370E-06
5.750E-01	1.101E+04	9.018E+01	2.564E+00	3.050E-02	1.577E-02	4.233E-03	8.163E-05	1.158E-07	1.303E-09	9.584E-10	8.823E-10	8.353E-10
8.500E-01	7.233E+05	8.532E+03	3.597E+03	3.180E+02	5.982E+00	2.058E-01	1.068E-01	1.047E-01	1.040E-01	1.015E-01	9.480E-02	7.465E-02
1.250E+00	7.054E+04	4.746E+04	4.161E+04	2.804E+04	1.453E+04	3.899E+03	7.538E+01	1.052E-01	4.024E-11	1.868E-11	2.238E-12	1.285E-15
1.750E+00	4.046E+05	5.085E+00	1.421E+01	3.108E+00	8.923E-13	8.864E-13	3.948E-13	1.965E-13	9.161E-14	4.309E-14	5.108E-15	2.928E-18
2.250E+00	2.481E+05	4.528E-01	3.970E-01	2.875E-01	1.388E-01	3.720E-02	7.191E-04	1.003E-06	3.874E-18	5.928E-27	0.0	0.0
2.750E+00	4.245E+04	1.712E-03	1.501E-03	1.012E-03	5.242E-04	1.407E-04	2.720E-08	3.755E-09	1.427E-20	0.0	0.0	0.0
3.500E+00	4.631E+03	2.079E-26	2.070E-26	2.079E-26	2.079E-26	2.079E-26	2.079E-26	2.079E-26	2.079E-26	0.0	0.0	0.0
5.000E+00	3.898E-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	6.584E-03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	1.223E-05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.564E+06	5.815E+04	4.525E+04	2.838E+04	1.455E+04	3.903E+03	7.571E+01	3.229E-01	1.333E-01	1.068E-01	9.890E-02	7.649E-02
GAM POW	7.520E+00	2.700E-01	2.176E-01	1.365E-01	8.995E-02	1.877E-02	3.841E-04	1.553E-06	6.412E-07	5.136E-07	4.756E-07	3.878E-07

Table D.10. Photon Source Due to Non-Fuel Components of a BWR Fuel Assembly
Exposed to 28 GWD/MTU (Photons/second/MTU)

OUTPUT UNIT = B

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, FUEL ASSEMBLY W/FUEL CHANNEL
POWER= 10.15 MW, BURNUP= 28000. MWD, FLUX= 1.85E+14 N/CM**2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	1.843E+15	1.292E+13	8.804E+12	3.295E+12	1.398E+12	3.249E+11	2.823E+10	1.500E+10	4.878E+09	1.714E+09	1.588E+09	1.341E+09
2.500E-02	5.608E+14	5.870E+13	3.289E+13	1.145E+13	3.234E+12	2.985E+11	2.338E+09	9.288E+08	2.969E+08	1.125E+08	9.537E+07	5.857E+07
3.750E-02	2.148E+14	8.105E+12	6.145E+12	2.953E+12	8.998E+11	9.188E+10	8.525E+08	2.277E+08	9.831E+07	5.897E+07	5.062E+07	3.178E+07
5.750E-02	3.043E+14	1.097E+12	5.528E+11	3.058E+11	1.374E+11	3.219E+10	8.700E+08	8.087E+07	6.560E+07	5.908E+07	5.175E+07	3.433E+07
8.500E-02	1.757E+14	3.964E+11	2.193E+11	1.248E+11	5.541E+10	1.276E+10	2.514E+08	2.239E+07	2.153E+07	2.079E+07	1.888E+07	1.379E+07
1.250E-01	1.219E+14	3.783E+11	2.229E+11	1.115E+11	3.948E+10	6.391E+09	9.817E+07	9.182E+06	8.788E+06	8.560E+06	7.954E+06	6.186E+06
2.250E-01	2.964E+14	2.841E+12	2.073E+12	9.738E+11	2.812E+11	2.408E+10	4.745E+07	5.831E+06	5.272E+06	5.145E+06	4.805E+06	3.784E+06
3.750E-01	1.829E+14	1.859E+13	1.212E+13	5.721E+12	1.838E+12	1.344E+11	8.231E+07	3.948E+05	2.528E+05	2.441E+05	2.280E+05	1.798E+05
5.750E-01	2.037E+15	2.028E+13	1.658E+13	7.350E+12	2.103E+12	1.722E+11	9.524E+07	7.205E+04	2.144E+03	4.178E+01	4.042E+00	3.848E+00
8.500E-01	3.785E+15	6.582E+13	2.635E+12	1.322E+11	9.838E+09	6.452E+09	6.073E+09	8.058E+09	8.014E+09	5.872E+08	5.484E+09	4.318E+09
1.250E+00	2.711E+14	1.239E+14	1.086E+14	7.315E+13	3.790E+13	1.017E+13	1.988E+11	2.728E+08	1.058E+04	1.049E+04	1.049E+04	1.049E+04
1.750E+00	1.488E+14	7.880E+09	1.673E+08	9.038E+03	4.528E+03	3.581E+03	1.744E+03	5.304E+02	4.543E+00	3.862E+05	2.771E+06	1.854E+06
2.250E+00	5.637E+13	1.075E+09	5.815E+08	3.777E+08	2.009E+08	5.391E+07	1.042E+06	1.445E+03	5.013E+04	2.912E+11	0.0	0.0
2.750E+00	7.745E+12	2.338E+06	1.785E+06	1.200E+06	6.215E+05	1.888E+05	3.224E+03	4.470E+00	1.851E+11	7.035E+19	0.0	0.0
3.500E+00	8.628E+11	8.797E+11	8.814E+11	8.088E+11	7.282E+11	5.902E+11	3.143E+11	1.100E+11	1.847E+13	8.772E+20	0.0	0.0
5.000E+00	8.000E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	5.119E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	5.921E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOTAL	9.808E+15	3.101E+14	1.878E+14	1.058E+14	4.788E+13	1.127E+13	2.333E+11	2.280E+10	1.119E+10	7.850E+09	7.302E+09	5.808E+09
MEV/SEC	5.388E+15	2.311E+14	1.531E+14	9.863E+13	4.942E+13	1.289E+13	2.518E+11	5.753E+09	5.201E+09	5.029E+09	4.698E+09	3.898E+09

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	1.287E+08	1.011E+04	5.327E+03	2.579E+03	1.093E+03	2.544E+02	2.053E+01	1.175E+01	3.862E+00	1.342E+00	1.244E+00	1.050E+00
2.500E-02	7.317E+05	7.659E+04	4.292E+04	1.494E+04	4.220E+03	3.894E+02	3.049E+00	1.212E+00	3.874E+01	1.488E+01	1.244E+01	7.642E+02
3.750E-02	4.200E+05	1.586E+04	1.203E+04	5.779E+03	1.741E+03	1.794E+02	1.869E+00	4.458E+01	1.824E+01	1.154E+01	9.907E+02	6.220E+02
5.750E-02	9.132E+05	3.291E+03	1.859E+03	9.177E+02	4.124E+02	9.880E+01	2.011E+00	2.421E+01	1.988E+01	1.772E+01	1.553E+01	1.030E+01
8.500E-02	7.798E+05	1.759E+03	9.731E+02	5.537E+02	2.458E+02	5.880E+01	1.115E+00	9.932E+02	9.552E+02	9.221E+02	8.385E+02	6.120E+02
1.250E-01	7.952E+05	2.488E+03	1.454E+03	7.277E+02	2.578E+02	4.189E+01	8.404E+01	5.991E+02	5.732E+02	5.584E+02	5.189E+02	4.038E+02
2.250E-01	3.480E+06	3.336E+04	2.435E+04	1.144E+04	3.302E+03	2.826E+02	5.572E+01	6.813E+02	8.180E+02	6.041E+02	5.643E+02	4.444E+02
3.750E-01	3.580E+06	3.051E+05	2.372E+05	1.120E+05	3.206E+04	2.631E+03	1.811E+00	7.722E+03	8.434E+05	4.778E+03	4.462E+03	3.513E+03
5.750E-01	6.112E+07	8.079E+05	4.875E+05	2.206E+05	6.312E+04	5.189E+03	2.858E+00	2.162E+03	8.434E+05	1.253E+06	1.213E+07	1.184E+07
8.500E-01	1.679E+08	2.920E+06	1.169E+06	5.883E+03	4.275E+02	2.882E+02	2.894E+02	2.888E+02	2.888E+02	2.888E+02	2.433E+02	1.818E+02
1.250E+00	1.789E+07	8.088E+06	7.082E+06	4.772E+06	2.472E+06	8.835E+05	1.283E+04	1.778E+01	6.885E+04	8.847E+04	8.848E+04	8.842E+04
1.750E+00	1.359E+07	7.015E+02	1.528E+01	8.255E+04	4.134E+04	3.253E+04	1.593E+04	4.845E+05	4.180E+07	3.527E+12	2.531E+13	1.693E+13
2.250E+00	6.620E+06	1.262E+02	8.829E+01	4.553E+01	2.359E+01	6.330E+00	1.224E+01	1.898E+04	5.887E+11	3.419E+18	0.0	0.0
2.750E+00	1.112E+08	3.353E+01	2.581E+01	1.722E+01	8.920E+02	2.384E+02	4.628E+04	8.415E+07	2.857E+18	1.010E+25	0.0	0.0
3.500E+00	1.211E+08	1.607E+17	1.574E+17	1.477E+17	1.330E+17	1.078E+17	5.741E+18	2.009E+18	3.009E+20	1.237E+28	0.0	0.0
5.000E+00	1.568E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	1.870E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	2.938E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOTAL	2.802E+08	1.206E+07	7.993E+06	5.148E+06	2.579E+06	8.729E+05	1.313E+04	3.003E+02	2.714E+02	2.625E+02	2.451E+02	1.930E+02
GAM POW	8.805E+02	3.705E+01	2.455E+01	1.581E+01	7.922E+00	2.087E+00	4.033E+02	9.222E+04	8.337E+04	8.062E+04	7.528E+04	5.928E+04

0.12

Table D.11. Photon Source Due to BWR Grids, Springs, Water Rods, etc.
Exposed to 28 GWD/MTU (Photons/second/MTU)

OUTPUT UNIT = 8

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, GRIDS & SPRINGS & THINGS
POWER= 19.16 MW, BURNUP= 28000. MMW, FLUX= 1.85E+14 N/CM+2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

E MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	1.178E+14	2.785E+12	2.134E+12	1.389E+12	7.147E+11	2.024E+11	1.889E+10	1.048E+10	2.484E+09	2.147E+08	1.848E+08	1.400E+08
2.500E-02	2.918E+13	2.849E+12	1.707E+12	6.974E+11	2.479E+11	4.324E+10	1.555E+09	6.549E+08	1.889E+08	2.792E+07	2.432E+07	1.709E+07
3.750E-02	1.266E+13	8.529E+11	4.400E+11	2.463E+11	1.007E+11	2.090E+10	5.801E+08	1.434E+08	4.409E+07	1.554E+07	1.386E+07	9.919E+06
5.750E-02	1.998E+13	2.848E+11	2.285E+11	1.497E+11	7.670E+10	2.041E+10	4.281E+08	3.150E+07	2.094E+07	1.741E+07	1.583E+07	1.168E+07
8.500E-02	1.057E+13	1.119E+11	8.918E+10	5.906E+10	3.021E+10	6.023E+09	1.619E+08	7.834E+06	7.545E+06	7.338E+06	6.786E+06	5.215E+06
1.250E-01	7.218E+12	8.357E+10	4.014E+10	2.537E+10	1.237E+10	3.145E+09	6.278E+07	3.878E+06	3.482E+06	3.378E+06	3.150E+06	2.471E+06
2.250E-01	1.545E+13	1.350E+11	9.781E+10	4.795E+10	1.540E+10	1.863E+09	2.218E+07	2.181E+06	2.127E+06	2.078E+06	1.939E+06	1.527E+06
3.750E-01	1.267E+13	8.638E+11	5.152E+11	2.437E+11	7.021E+10	5.946E+09	8.892E+08	1.150E+08	1.011E+08	9.855E+07	9.205E+07	7.248E+07
5.750E-01	8.565E+13	1.016E+12	6.630E+11	3.108E+11	8.885E+10	7.295E+09	4.320E+08	3.552E+08	9.037E+07	1.774E+07	2.023E+07	1.973E+07
8.500E-01	2.202E+14	3.450E+12	1.321E+12	6.348E+11	3.497E+11	2.708E+10	2.455E+09	2.445E+09	2.428E+09	2.371E+09	2.214E+09	1.744E+09
1.250E+00	1.039E+14	8.370E+13	7.337E+13	4.945E+13	2.582E+13	6.875E+12	1.320E+11	1.851E+08	4.477E+02	4.451E+02	4.450E+02	4.448E+02
1.750E+00	1.783E+13	3.285E+09	8.984E+07	2.197E+03	1.981E+02	1.559E+02	7.044E+05	6.812E+02	2.195E+05	1.790E+06	1.392E+07	7.864E+08
2.250E+00	6.976E+12	4.612E+08	3.891E+08	2.621E+08	1.358E+08	3.844E+07	7.044E+05	6.812E+02	2.195E+05	1.790E+06	1.392E+07	7.864E+08
2.750E+00	9.813E+11	1.385E+06	1.204E+06	1.110E+05	4.201E+05	1.125E+05	2.180E+03	3.036E+00	1.286E+11	6.439E+18	0.0	0.0
3.500E+00	8.316E+10	8.051E+11	7.884E+11	7.402E+11	6.804E+11	5.402E+11	2.877E+11	0.008E+11	5.08E+13	6.198E+20	0.0	0.0
5.000E+00	8.622E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	2.165E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	2.502E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOTAL 6.709E+14 9.580E+13 7.942E+13 5.283E+13 2.898E+13 7.192E+12 1.588E+11 1.395E+10 5.158E+09 2.859E+09 2.465E+09 1.932E+09

MEV/SEC 4.380E+14 1.088E+14 9.254E+13 6.217E+13 3.214E+13 8.811E+12 1.886E+11 2.492E+09 2.110E+09 2.022E+09 1.988E+09 1.487E+09

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

E MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	8.209E+04	2.180E+03	1.871E+03	1.086E+03	5.595E+02	1.585E+02	1.483E+01	8.204E+00	1.945E+00	1.681E+01	1.446E+01	1.098E+01
2.500E-02	3.808E+04	3.717E+03	2.227E+03	9.100E+02	3.234E+02	5.842E+01	2.029E+00	8.545E+01	2.178E+01	3.842E+02	3.173E+02	2.231E+02
3.750E-02	2.478E+04	1.092E+03	8.612E+02	4.820E+02	1.970E+02	4.103E+01	1.077E+00	2.807E+01	8.629E+02	3.042E+02	2.712E+02	1.941E+02
5.750E-02	5.988E+04	6.547E+02	6.798E+02	4.493E+02	2.302E+02	8.126E+01	1.288E+00	9.472E+02	6.253E+02	5.224E+02	4.751E+02	3.508E+02
8.500E-02	4.888E+04	4.983E+02	3.958E+02	2.820E+02	1.340E+02	3.559E+01	7.181E+01	3.478E+02	3.347E+02	3.258E+02	3.010E+02	2.313E+02
1.250E-01	4.709E+04	3.495E+02	2.619E+02	1.655E+02	8.071E+01	2.052E+01	4.098E+01	2.334E+02	2.259E+02	2.204E+02	2.055E+02	1.612E+02
2.250E-01	1.814E+05	1.885E+03	1.149E+03	5.631E+02	1.809E+02	2.305E+01	2.605E+01	2.581E+02	2.487E+02	2.438E+02	2.277E+02	1.793E+02
3.750E-01	2.479E+05	1.299E+04	1.008E+04	4.770E+03	1.374E+03	1.164E+02	1.701E+01	2.251E+03	1.978E+03	1.929E+03	1.802E+03	1.419E+03
5.750E-01	2.870E+06	3.040E+04	1.990E+04	9.328E+03	2.689E+03	2.189E+02	1.298E+01	1.086E+04	2.712E+06	5.324E+08	6.070E+09	5.921E+09
8.500E-01	9.787E+06	1.530E+05	5.860E+03	4.148E+02	1.581E+02	1.202E+02	1.089E+02	1.085E+02	1.077E+02	1.052E+02	9.823E+01	7.735E+01
1.250E+00	6.779E+06	5.460E+06	4.787E+06	3.228E+06	1.871E+06	4.488E+05	8.871E+03	1.208E+01	2.921E+05	2.904E+05	2.903E+05	2.902E+05
1.750E+00	1.628E+06	3.001E+02	8.206E+00	2.007E+01	1.809E+05	1.424E+05	8.972E+08	2.121E+06	1.818E+08	1.841E+13	1.272E+14	7.183E+15
2.250E+00	8.192E+05	5.416E+01	4.570E+01	3.078E+01	1.594E+01	4.279E+00	8.272E+02	1.152E+04	2.577E+12	1.497E+19	0.0	0.0
2.750E+00	1.408E+05	1.988E+01	1.727E+01	1.164E+01	6.030E+02	1.618E+02	3.129E+04	4.359E+07	1.883E+18	0.241E+28	0.0	0.0
3.500E+00	1.519E+04	1.471E+17	1.440E+17	1.352E+17	1.217E+17	9.868E+18	5.255E+18	1.838E+18	2.754E+20	1.132E+28	0.0	0.0
5.000E+00	2.250E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	7.908E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	1.240E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOTAL 2.278E+07 5.867E+06 4.830E+06 3.245E+06 1.877E+06 4.494E+05 8.801E+03 1.301E+02 1.101E+02 1.055E+02 9.858E+01 7.759E+01

GAM POW 6.990E+01 1.741E+01 1.483E+01 9.985E+00 5.151E+00 1.380E+00 2.703E+02 3.995E+04 3.362E+04 3.242E+04 3.027E+04 2.383E+04

0.13

Table D.12. Photon Source Due to BWR End Fittings
Exposed to 28 GWD/MTU (Photons/second/MTU)

OUTPUT UNIT = 8

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, END FITTINGS
POWER= 19.18 MW, BURNUP= 28000. MWD, FLUX= 1.85E+14 N/CM**2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

E MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1 500E-02	1.935E+14	1.077E+12	7.500E+11	4.114E+11	2.087E+11	5.985E+10	5.451E+09	3.053E+09	7.555E+08	9.790E+07	7.452E+07	3.286E+07
2 500E-02	3.685E+13	1.170E+11	1.007E+11	6.798E+10	3.539E+10	9.739E+09	4.584E+08	1.948E+08	5.443E+07	1.369E+07	1.086E+07	4.730E+06
3 750E-02	2.435E+13	6.684E+10	6.737E+10	3.867E+10	2.007E+10	5.439E+09	1.840E+08	4.379E+07	1.518E+07	8.877E+06	5.173E+06	2.314E+06
4 750E-02	3.617E+13	7.576E+10	6.488E+10	4.354E+10	2.256E+10	5.065E+09	1.282E+08	9.687E+06	6.525E+06	5.270E+06	4.187E+06	1.913E+06
5 500E-02	2.221E+13	3.021E+10	2.543E+10	1.712E+10	8.668E+09	2.381E+09	4.708E+07	1.134E+07	1.047E+06	9.721E+05	7.880E+05	3.935E+05
6 500E-01	1.488E+13	1.192E+10	9.776E+09	6.574E+09	3.406E+09	3.141E+08	1.782E+07	1.738E+05	1.470E+05	1.398E+05	1.218E+05	7.934E+04
7 250E-01	2.180E+13	4.678E+09	3.236E+09	2.162E+09	1.201E+09	3.006E+08	5.862E+06	5.989E+04	5.143E+04	5.022E+04	4.680E+04	3.693E+04
8 250E-01	2.180E+13	4.678E+09	3.236E+09	2.162E+09	1.201E+09	3.006E+08	5.862E+06	5.989E+04	5.143E+04	5.022E+04	4.680E+04	3.693E+04
9 750E-01	7.323E+12	4.855E+10	1.407E+09	3.485E+07	1.804E+07	4.842E+06	9.350E+04	1.315E+02	8.790E+01	7.038E+01	6.629E+01	5.356E+01
1 500E+00	3.484E+14	2.773E+12	1.181E+12	1.023E+11	2.119E+10	1.364E+08	6.070E+07	5.912E+07	8.872E+07	5.733E+07	5.355E+07	4.218E+07
2 500E+00	3.290E+13	2.497E+13	2.189E+13	1.476E+13	1.844E+12	2.052E+12	3.985E+10	5.530E+07	9.496E+03	4.402E+03	5.217E+04	2.998E+07
3 500E+00	8.593E+13	6.991E+08	2.514E+07	5.492E+02	2.275E+04	9.725E+05	5.739E+05	3.018E+05	1.523E+05	7.175E+06	8.503E+07	4.872E+10
4 500E+00	4.414E+12	1.323E+08	1.180E+08	7.820E+07	4.051E+07	1.087E+07	2.102E+05	2.931E+02	1.113E+09	6.283E+19	0.0	0.0
5 500E+00	4.581E+12	4.095E+05	3.591E+05	2.420E+05	1.254E+05	3.364E+04	8.504E+02	9.089E+01	3.409E+12	0.0	0.0	0.0
6 500E+00	5.498E+11	3.853E+19	3.853E+19	3.853E+19	3.853E+19	3.853E+19	3.853E+19	3.853E+19	3.853E+19	0.0	0.0	0.0
7 500E+00	1.951E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 500E+00	1.166E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 500E+00	3.858E+02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	9.078E+14	2.918E+13	2.407E+13	1.545E+13	7.947E+12	2.136E+12	4.599E+10	3.417E+09	8.917E+08	1.819E+08	1.491E+08	8.449E+07
MEV/SEC	6.554E+14	3.363E+13	2.838E+13	1.855E+13	9.585E+12	2.587E+12	4.974E+10	1.724E+08	6.367E+07	5.120E+07	4.743E+07	3.870E+07

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

E MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1 500E-02	1.515E+05	8.428E+02	5.872E+02	3.221E+02	1.834E+02	4.686E+01	4.267E+00	2.390E+00	5.915E+01	7.864E+02	5.841E+02	2.572E+02
2 500E-02	4.782E+04	1.527E+02	1.314E+02	8.888E+01	4.616E+01	1.271E+01	8.981E+01	2.541E+01	7.102E+02	1.788E+02	1.391E+02	6.171E+03
3 750E-02	4.785E+04	1.308E+02	1.123E+02	7.568E+01	3.928E+01	1.064E+01	3.211E+01	8.571E+02	2.987E+02	1.287E+02	1.013E+02	4.529E+03
4 750E-02	1.085E+05	2.274E+02	1.940E+02	1.307E+02	6.771E+01	1.820E+01	3.848E+01	2.907E+02	1.958E+02	1.582E+02	1.257E+02	5.742E+03
5 500E-02	9.853E+04	1.340E+02	1.128E+02	7.594E+01	3.934E+01	1.058E+01	2.089E+01	5.031E+03	4.846E+03	4.313E+03	3.498E+03	1.746E+03
6 500E-01	9.714E+04	7.777E+01	6.378E+01	4.289E+01	2.222E+01	5.984E+00	1.182E+01	1.134E+03	9.591E+04	9.124E+04	7.949E+04	5.176E+04
7 250E-01	2.473E+05	8.492E+01	3.800E+01	2.539E+01	1.315E+01	3.530E+00	6.884E+02	7.033E+04	6.040E+04	5.897E+04	5.508E+04	4.337E+04
8 250E-01	4.228E+05	5.220E+01	1.783E+01	1.187E+01	6.149E+00	1.850E+00	3.195E+02	9.264E+05	4.782E+05	4.889E+05	4.360E+05	3.434E+05
9 750E-01	2.198E+05	1.457E+03	4.224E+01	1.046E+00	5.414E+01	1.453E+01	2.809E+03	3.945E+08	2.838E+08	2.112E+08	1.889E+08	1.807E+08
1 500E+00	1.546E+07	1.230E+05	5.152E+04	4.539E+03	9.384E+01	6.053E+00	2.893E+00	2.623E+00	2.805E+00	2.543E+00	2.375E+00	1.870E+00
2 500E+00	2.147E+06	1.829E+06	1.428E+06	9.626E+05	4.987E+05	1.338E+05	2.587E+03	3.608E+00	6.195E+10	2.872E+10	3.404E+11	1.958E+14
3 750E+00	8.782E+06	8.212E+01	2.296E+00	5.016E+05	1.184E+11	8.882E+12	5.241E+12	2.758E+12	1.391E+12	8.553E+13	7.788E+14	4.450E+17
4 250E+00	5.380E+06	1.554E+01	1.363E+01	9.183E+00	4.758E+00	1.277E+00	2.468E+02	3.442E+05	1.307E+18	7.378E+28	0.0	0.0
5 750E+00	9.206E+05	5.878E+02	5.153E+02	3.473E+02	1.799E+02	4.829E+03	9.335E+05	1.302E+07	4.893E+19	0.0	0.0	0.0
6 500E+00	1.004E+05	7.039E+28	7.039E+28	7.039E+28	7.039E+28	7.039E+28	7.039E+28	7.039E+28	7.039E+28	0.0	0.0	0.0
7 500E+00	5.091E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8 500E+00	1.157E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9 500E+00	1.913E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	3.421E+07	1.755E+08	1.481E+08	9.679E+05	4.992E+05	1.340E+05	2.596E+03	8.996E+00	3.323E+00	2.872E+00	2.475E+00	1.915E+00
GAM POW	1.051E+02	5.391E+00	4.549E+00	2.973E+00	1.533E+00	4.114E+01	7.974E+03	2.763E+05	1.021E+05	8.208E+06	7.803E+06	5.883E+08

D.14

Table D.13. Photon Source Due to BWR Fuel Channel
Exposed to 28 GWD/MTU (Photons/second/MTU)

OUTPUT UNIT = 8

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, FUEL CHANNEL
POWER= 19.16 MW, BURNUP= 28000. MWD, FLUX= 1.85E+14 N/CM**2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	1.332E+15	8.058E+12	3.920E+12	1.498E+12	4.722E+11	8.288E+10	2.088E+09	1.471E+08	1.438E+08	1.401E+08	1.329E+08	1.188E+08
2.500E-02	4.950E+14	5.573E+13	3.108E+13	1.088E+13	2.951E+12	2.455E+11	3.232E+08	7.913E+07	7.857E+07	7.888E+07	6.038E+07	3.874E+07
3.750E-02	1.778E+14	7.485E+12	5.648E+12	2.688E+12	7.889E+11	6.528E+10	1.384E+08	4.045E+07	3.906E+07	3.885E+07	3.158E+07	1.954E+07
5.750E-02	2.482E+14	7.360E+11	2.618E+11	1.125E+11	3.818E+10	5.713E+09	1.127E+08	3.942E+07	3.823E+07	3.837E+07	3.172E+07	2.073E+07
8.500E-02	1.430E+14	2.543E+11	1.047E+11	4.864E+10	1.633E+10	2.354E+09	4.250E+07	1.342E+07	1.294E+07	1.247E+07	1.128E+07	8.184E+06
1.250E-01	9.978E+13	3.128E+11	1.730E+11	7.980E+10	2.370E+10	2.332E+09	1.757E+07	5.429E+06	5.175E+06	5.040E+06	4.680E+06	3.635E+06
2.250E-01	2.599E+14	2.701E+12	9.72E+12	9.237E+11	2.646E+11	2.180E+10	1.940E+07	3.390E+06	3.092E+06	3.017E+06	2.818E+06	2.220E+06
3.750E-01	1.487E+14	1.492E+13	1.160E+13	5.477E+12	1.587E+12	1.284E+11	7.199E+07	2.748E+05	1.492E+05	1.431E+05	1.337E+05	1.052E+05
5.750E-01	1.934E+15	1.919E+13	1.491E+13	7.039E+12	2.014E+12	1.649E+11	9.082E+07	6.837E+04	2.053E+03	3.928E+01	3.278E+00	3.213E+00
8.500E-01	3.217E+15	5.980E+13	1.342E+13	2.050E+12	4.023E+09	3.806E+09	3.557E+09	3.550E+09	3.525E+09	3.442E+09	3.215E+09	2.531E+09
1.250E+00	1.343E+14	1.527E+13	1.329E+13	8.846E+12	4.834E+12	1.244E+12	2.404E+10	3.328E+07	1.011E+04	1.005E+04	1.005E+04	1.004E+04
1.750E+00	3.503E+13	3.495E+09	5.228E+07	6.292E+03	4.328E+03	3.405E+03	1.687E+03	5.072E+02	4.344E+00	2.985E+05	1.781E+06	1.775E+06
2.250E+00	3.580E+12	4.811E+08	7.833E+07	4.741E+07	2.458E+07	6.592E+06	1.274E+06	1.763E+02	4.793E+04	2.784E+11	0.0	0.0
2.750E+00	3.503E+11	5.413E+05	2.221E+05	1.487E+05	7.600E+04	2.040E+04	3.943E+02	5.454E+01	2.197E+12	0.0	0.0	0.0
3.500E+00	2.988E+10	7.457E+12	7.302E+12	6.856E+12	6.173E+12	5.003E+12	2.884E+12	9.321E+13	1.405E+14	0.0	0.0	0.0
5.000E+00	4.843E+07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	4.902E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	5.871E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	8.228E+15	1.853E+14	8.431E+13	3.749E+13	1.275E+13	1.948E+12	3.050E+10	5.235E+09	5.137E+09	5.008E+09	4.687E+09	3.791E+09
MEV/SEC	4.276E+15	8.891E+13	3.222E+13	1.792E+13	7.718E+12	1.718E+12	3.322E+10	3.089E+09	3.020E+09	2.955E+09	2.759E+09	2.174E+09

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	1.043E+08	7.092E+03	3.069E+03	1.171E+03	3.697E+02	4.907E+01	1.833E+00	1.152E+00	1.125E+00	1.097E+00	1.040E+00	9.148E-01
2.500E-02	6.458E+05	7.272E+04	4.058E+04	1.394E+04	3.850E+03	3.203E+02	4.217E+01	1.033E+01	9.861E+02	9.240E+02	7.879E+02	4.793E+02
3.750E-02	3.478E+05	1.485E+04	1.105E+04	5.222E+03	1.505E+03	1.277E+02	2.709E+01	7.917E+02	7.844E+02	7.212E+02	6.181E+02	3.825E+02
5.750E-02	7.447E+05	2.209E+03	7.852E+02	3.377E+02	1.145E+02	1.714E+01	3.381E+01	1.183E+01	1.147E+01	1.091E+01	9.820E+02	6.221E+02
8.500E-02	6.342E+05	1.128E+03	4.648E+02	2.158E+02	7.245E+01	1.044E+01	1.885E+01	5.952E+02	5.739E+02	5.533E+02	5.004E+02	3.831E+02
1.250E-01	8.509E+05	2.041E+03	1.128E+03	5.193E+02	1.548E+02	1.521E+01	1.146E+01	3.542E+02	3.376E+02	3.288E+02	3.053E+02	2.371E+02
2.250E-01	3.052E+08	3.172E+04	2.316E+04	1.085E+04	3.108E+03	2.560E+02	2.279E+01	3.981E+02	3.832E+02	3.543E+02	3.109E+02	2.607E+02
3.750E-01	2.909E+08	2.920E+05	2.271E+05	1.072E+05	3.088E+04	2.513E+03	1.409E+00	5.379E+03	2.921E+03	2.802E+03	2.818E+03	2.060E+03
5.750E-01	5.803E+07	5.759E+05	4.476E+05	2.113E+05	8.045E+04	4.950E+03	2.726E+00	2.052E+03	6.160E+05	1.179E+08	9.833E+08	9.844E+08
8.500E-01	1.427E+08	2.844E+08	5.952E+04	9.095E+02	1.785E+02	1.800E+02	1.578E+02	1.575E+02	1.584E+02	1.527E+02	1.428E+02	1.123E+02
1.250E+00	8.783E+08	9.984E+05	8.889E+05	5.836E+05	3.023E+05	8.115E+04	1.589E+03	2.171E+00	6.593E+04	6.556E+04	6.555E+04	6.552E+04
1.750E+00	3.200E+08	3.192E+02	4.775E+00	5.747E+04	3.953E+04	3.110E+04	1.523E+04	4.633E+05	3.988E+07	2.708E+12	1.827E+13	1.821E+13
2.250E+00	4.204E+05	5.850E+01	8.963E+00	5.568E+00	2.884E+00	7.741E+01	1.497E+02	2.071E+05	5.829E+11	3.269E+18	0.0	0.0
2.750E+00	5.028E+04	7.789E+02	3.187E+02	2.108E+02	1.091E+02	2.928E+01	5.880E+05	7.829E+08	3.153E+19	0.0	0.0	0.0
3.500E+00	5.454E+03	1.382E+18	1.334E+18	1.252E+18	1.128E+18	9.140E+19	4.887E+19	1.703E+19	2.588E+21	0.0	0.0	0.0
5.000E+00	1.290E+01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	1.791E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	2.812E+00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	2.232E+08	4.841E+08	1.681E+06	9.352E+05	4.028E+05	8.958E+04	1.734E+03	1.812E+02	1.579E+02	1.542E+02	1.440E+02	1.135E+02
GAM POW	6.855E+02	1.425E+01	5.184E+00	2.872E+00	1.237E+00	2.751E+01	5.325E+03	4.952E+04	4.851E+04	4.736E+04	4.423E+04	3.485E+04

D.15

Table D.14. Photon Source Due to BWR Cruciform
Exposed to 28 GWD per MTU (Photons/second)

OUTPUT UNIT = 8

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

BWR, 2.5 W/D ENRICHMENT, 28 GWD/MT BURNUP, CRUCIFORM W/OUT STELLITE
POWER= 19.18 MW, BURNUP= 28000. MWD, FLUX= 1.85E+14 N/CM**2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS-METRIC TON URANIUM METAL AS LOADED

E MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	9.265E+14	5.012E+12	3.491E+12	1.915E+12	9.715E+11	2.788E+11	2.538E+10	1.422E+10	3.519E+09	4.583E+08	3.478E+08	1.532E+08
2.500E-02	1.768E+14	8.446E+11	4.688E+11	3.163E+11	1.847E+11	4.533E+10	2.134E+09	9.072E+08	2.836E+08	6.381E+07	4.969E+07	2.208E+07
3.500E-02	1.755E+14	3.111E+11	2.871E+11	1.800E+11	9.341E+10	2.531E+10	7.837E+08	2.040E+08	7.082E+07	3.086E+07	2.412E+07	1.080E+07
4.500E-02	1.749E+14	3.526E+11	3.009E+11	2.027E+11	1.050E+11	2.823E+10	5.989E+08	4.515E+07	3.042E+07	2.458E+07	1.953E+07	8.934E+06
5.500E-02	1.748E+14	1.408E+11	1.184E+11	7.987E+10	4.128E+10	1.108E+10	2.192E+08	5.295E+06	4.890E+06	4.538E+06	3.881E+06	1.843E+06
6.500E-02	7.258E+13	5.849E+10	4.550E+10	3.080E+10	1.585E+10	4.285E+09	8.294E+07	8.150E+05	8.899E+05	8.585E+05	8.725E+05	3.744E+05
7.500E-02	1.035E+14	2.777E+10	1.506E+10	1.008E+10	5.213E+09	1.399E+09	2.729E+07	2.828E+05	2.433E+05	2.378E+05	2.222E+05	1.766E+05
8.500E-02	1.040E+14	1.242E+10	4.239E+09	2.823E+09	1.462E+09	3.925E+08	7.599E+06	2.241E+04	1.171E+04	1.144E+04	1.070E+04	8.494E+03
9.500E-02	3.892E+13	2.261E+10	6.554E+09	1.622E+09	8.397E+07	2.254E+07	4.357E+05	6.182E+02	5.937E+00	5.120E+00	4.462E+00	4.129E+00
1.000E+00	1.824E+15	1.291E+13	5.409E+12	4.784E+11	9.850E+09	6.358E+08	2.833E+08	2.759E+08	2.740E+08	2.875E+08	2.499E+08	1.988E+08
1.250E+00	1.543E+14	1.182E+14	1.019E+14	8.888E+13	3.558E+13	9.548E+12	1.848E+11	2.584E+08	4.427E+02	2.052E+02	2.432E+03	1.398E+06
1.500E+00	4.477E+14	4.187E+09	1.711E+08	2.558E+03	8.948E+04	4.537E+04	2.877E+04	1.407E+04	7.101E+05	3.344E+05	3.984E+08	2.271E+09
2.500E+00	2.137E+14	6.180E+08	5.401E+08	3.640E+08	1.888E+08	5.081E+07	9.784E+05	1.370E+03	5.199E+09	2.932E+18	0.0	0.0
3.500E+00	3.012E+13	1.908E+08	1.871E+08	1.128E+08	5.835E+05	1.568E+05	3.027E+03	4.238E+00	1.593E+11	0.0	0.0	0.0
5.500E+00	3.053E+12	3.096E+15	3.096E+15	3.096E+15	3.096E+15	2.810E+15	1.390E+15	8.989E+16	1.044E+17	0.0	0.0	0.0
7.500E+00	2.318E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	5.098E+10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.000E+00	8.255E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	4.294E+15	1.358E+14	1.120E+14	7.189E+13	3.899E+13	9.844E+12	2.141E+11	1.591E+10	4.154E+09	8.483E+08	6.955E+08	3.942E+08
MEV/SEC	3.068E+15	1.566E+14	1.321E+14	8.832E+13	4.452E+13	1.195E+13	2.315E+11	8.043E+08	2.970E+08	2.389E+08	2.213E+08	1.713E+08

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS-METRIC TON URANIUM METAL AS LOADED

E MEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	7.264E+05	3.924E+03	2.733E+03	1.499E+03	7.608E+02	2.181E+02	1.987E+01	1.113E+01	2.755E+00	3.572E+01	2.723E+01	1.200E+01
2.500E-02	2.304E+05	7.108E+02	6.117E+02	4.127E+02	2.149E+02	5.915E+01	2.785E+00	1.184E+00	3.308E+01	8.328E+02	6.483E+02	2.879E+02
3.500E-02	2.300E+05	6.089E+02	5.227E+02	3.522E+02	1.828E+02	4.955E+01	1.495E+00	3.992E+01	1.382E+01	8.001E+02	4.721E+02	2.113E+02
4.500E-02	5.249E+05	1.058E+03	9.031E+02	6.082E+02	3.152E+02	8.471E+01	1.791E+00	1.355E+01	9.129E+02	7.375E+02	5.860E+02	2.881E+02
5.500E-02	4.784E+05	8.238E+02	5.251E+02	3.535E+02	1.831E+02	4.916E+01	9.722E+01	2.349E+02	2.169E+02	2.014E+02	1.633E+02	8.178E+01
6.500E-02	4.735E+05	3.820E+02	2.968E+02	1.998E+02	1.034E+02	2.778E+01	5.411E+01	5.317E+03	4.501E+03	4.283E+03	3.735E+03	2.442E+03
7.500E-02	1.218E+06	2.558E+02	1.769E+02	1.182E+02	6.121E+01	1.643E+01	3.205E+01	3.321E+03	2.857E+03	2.791E+03	2.809E+03	2.062E+03
8.500E-02	2.038E+06	2.430E+02	8.297E+01	5.525E+01	2.862E+01	7.882E+00	1.487E+01	4.388E+04	2.292E+04	2.239E+04	2.095E+04	1.882E+04
9.500E-02	1.108E+06	6.788E+03	1.987E+02	4.868E+00	2.520E+00	8.783E+01	1.307E+02	1.849E+05	1.782E+07	1.537E+07	1.339E+07	1.289E+07
1.000E+00	7.205E+07	5.728E+05	2.399E+05	2.114E+04	4.370E+02	2.821E+01	1.257E+01	1.224E+01	1.216E+01	1.187E+01	1.109E+01	8.729E+00
1.250E+00	1.008E+07	7.583E+08	6.848E+06	4.481E+05	2.321E+05	8.230E+05	1.204E+04	1.886E+01	2.888E+09	1.339E+09	1.587E+10	9.118E+14
1.500E+00	4.089E+07	3.824E+02	1.069E+01	2.338E+04	5.432E+11	4.144E+11	2.445E+11	1.285E+11	6.488E+12	3.055E+12	3.820E+13	2.074E+18
2.500E+00	2.510E+07	7.234E+01	6.342E+01	4.274E+01	2.214E+01	5.943E+00	1.149E+01	1.808E+04	6.108E+18	3.443E+25	0.0	0.0
3.500E+00	4.324E+06	2.736E+01	2.399E+01	1.817E+01	8.375E+02	2.248E+02	4.345E+04	6.083E+07	2.287E+18	0.0	0.0	0.0
5.500E+00	5.577E+05	6.656E+22	6.656E+22	6.656E+22	6.656E+22	6.656E+22	2.540E+22	1.273E+22	1.907E+24	0.0	0.0	0.0
7.500E+00	8.044E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	1.883E+04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.000E+00	4.093E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.601E+08	8.171E+06	8.894E+06	4.505E+06	2.324E+06	8.235E+05	1.208E+04	4.198E+01	1.550E+01	1.247E+01	1.155E+01	8.938E+00
GAM POW	4.918E+02	2.510E+01	2.117E+01	1.384E+01	7.136E+00	1.915E+00	3.711E+02	1.289E+04	4.761E+05	3.830E+05	3.548E+05	2.745E+05

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Table D.15. Photon Source Due to BWR Cruciform Upper Pins and Rollers
Exposed to 28 GWD per MTU (Photons/second)

OUTPUT UNIT = 8

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PHOTON SPECTRUM FOR ACTIVATION PRODUCTS

BWR, 2.5 W/O ENRICHMENT, 28 GWD/MT BURNUP, UPPER PINS & ROLLERS
POWER= 19.18 MW, BURNUP= 28000. MWD, FLUX= 1.85E+14 N/CM**2-SEC

18 GROUP PHOTON RELEASE RATES, PHOTONS/SECOND
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	3.847E+13	3.869E+12	3.214E+12	2.166E+12	1.122E+12	3.012E+11	8.837E+09	1.859E+07	2.328E+06	1.207E+04	1.086E+02	5.420E+01
2.500E-02	2.122E+12	6.338E+11	5.555E+11	3.743E+11	1.930E+11	8.205E+10	1.007E+09	2.038E+06	1.419E+05	7.470E+02	1.802E+01	8.322E+00
3.750E-02	1.325E+12	3.620E+11	3.171E+11	2.137E+11	1.107E+11	2.972E+10	5.747E+08	9.278E+05	2.877E+04	1.573E+02	8.038E+00	4.338E+00
5.000E-02	9.077E+11	4.108E+11	3.581E+11	2.411E+11	1.249E+11	3.352E+10	6.481E+08	9.134E+05	2.924E+03	2.419E+01	7.123E+00	4.210E+00
7.500E-02	2.303E+12	1.608E+11	1.407E+11	9.481E+10	4.912E+10	1.318E+10	2.548E+08	3.540E+05	3.649E+00	2.290E+00	1.882E+00	1.382E+00
1.250E-01	1.890E+12	6.178E+10	5.404E+10	3.641E+10	1.888E+10	5.063E+09	8.787E+07	1.380E+05	9.744E+01	8.699E+01	8.045E+01	5.873E+01
2.250E-01	1.167E+13	2.049E+10	1.778E+10	1.197E+10	6.203E+09	1.665E+09	3.218E+07	4.475E+04	2.301E+01	3.439E+00	4.289E+01	4.174E+01
3.750E-01	4.552E+11	5.725E+09	4.985E+09	3.359E+09	1.740E+09	4.871E+08	9.029E+06	1.284E+04	8.588E+01	7.509E+00	8.388E+02	3.961E+02
5.750E-01	9.135E+12	5.262E+08	2.918E+08	1.929E+08	9.993E+07	2.882E+07	5.185E+05	7.807E+02	3.404E+01	4.548E+00	1.510E+02	5.644E+04
8.500E-01	5.394E+12	8.810E+09	4.998E+09	3.092E+09	1.582E+09	4.245E+08	8.205E+06	1.140E+04	1.850E+01	2.482E+02	9.822E+05	1.174E+08
1.250E+00	1.581E+14	1.383E+14	1.213E+14	8.173E+13	4.234E+13	1.136E+13	2.197E+11	3.052E+08	3.053E+02	3.941E+03	1.513E+05	1.542E+09
1.750E+00	1.328E+12	4.493E+08	1.231E+08	2.653E+08	1.312E+08	4.135E+04	1.302E+05	1.367E+07	7.808E+08	3.701E+08	4.385E+09	2.513E+12
2.250E+00	6.326E+11	7.331E+08	8.428E+08	4.332E+08	2.244E+08	8.023E+07	1.164E+08	1.617E+03	6.081E+09	0.0	0.0	0.0
2.750E+00	8.832E+10	2.389E+08	1.989E+08	1.340E+08	8.944E+05	1.884E+05	3.603E+03	5.005E+00	1.882E+11	0.0	0.0	0.0
3.500E+00	7.570E+09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.000E+00	7.554E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	5.388E+05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	8.305E+08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	2.295E+14	1.437E+14	1.259E+14	8.488E+13	4.397E+13	1.180E+13	2.282E+11	3.282E+08	2.502E+06	1.302E+04	1.428E+02	7.348E+01
MEV/SEC	2.138E+14	1.731E+14	1.517E+14	1.023E+14	5.297E+13	1.422E+13	2.748E+11	3.820E+08	3.977E+04	2.135E+02	3.104E+00	1.723E+00

18 GROUP SPECIFIC ENERGY RELEASE RATES, MEV/WATT-SEC
BASIS=METRIC TON URANIUM METAL AS LOADED

EMEAN	DISCHG.	1 YR	2 YRS	5 YRS	10 YRS	20 YRS	50 YRS	100 YRS	300 YRS	1000 YRS	3000 YRS	10000 YRS
1.500E-02	2.855E+04	2.872E+03	2.518E+03	1.696E+03	8.785E+02	2.358E+02	4.570E+00	1.456E-02	1.823E-03	9.448E-06	8.303E-08	4.243E-08
2.500E-02	2.789E+03	8.272E+02	7.248E+02	4.884E+02	2.530E+02	8.791E+01	1.314E+00	2.859E-03	1.852E-04	9.747E-07	2.090E-08	1.088E-08
3.750E-02	2.593E+03	7.084E+02	6.207E+02	4.183E+02	2.167E+02	5.816E+01	1.125E+00	1.816E-03	5.630E-05	3.078E-07	1.573E-08	8.492E-09
5.000E-02	2.724E+04	1.233E+03	1.075E+03	7.238E+02	3.749E+02	1.008E+02	1.945E+00	2.741E-03	8.775E-08	7.260E-08	2.138E-08	1.263E-08
7.500E-02	1.022E+04	7.126E+02	6.241E+02	4.206E+02	2.179E+02	5.848E+01	1.131E+00	1.571E-03	1.619E-08	1.018E-08	8.263E-09	6.130E-09
1.250E-01	1.233E+04	4.029E+02	3.525E+02	2.378E+02	1.231E+02	3.303E+01	8.388E-01	8.870E-04	6.357E-09	4.370E-09	3.944E-09	3.701E-09
2.250E-01	1.370E+04	2.406E+02	2.088E+02	1.408E+02	7.285E+01	1.955E+01	3.779E-01	5.255E-04	2.702E-07	4.038E-08	5.038E-09	4.902E-09
3.750E-01	8.909E+03	1.120E+02	9.757E+01	6.575E+01	3.406E+01	9.142E+00	1.787E-01	2.474E-04	1.095E-08	1.470E-07	1.248E-09	7.752E-10
5.750E-01	2.742E+05	1.579E+01	8.756E+00	5.789E+00	2.999E+00	8.049E-01	1.558E-02	2.343E-05	1.022E-08	1.365E-07	4.533E-10	1.694E-11
8.500E-01	2.393E+05	3.021E+02	2.217E+02	1.372E+02	7.019E+01	1.883E+01	3.840E-01	5.057E-04	8.208E-09	1.101E-09	4.357E-12	5.210E-16
1.250E+00	1.032E+07	9.024E+06	7.912E+06	5.332E+06	2.762E+06	7.414E+05	1.433E+04	1.991E+01	1.992E-09	2.571E-10	9.873E-13	1.008E-16
1.750E+00	1.213E+05	4.104E+01	1.125E+02	2.331E+07	1.199E+10	3.776E+11	1.189E+12	1.249E+14	7.130E+15	3.380E+15	4.008E+18	2.295E+19
2.250E+00	7.428E+04	8.609E+01	7.548E+01	5.087E+01	2.635E+01	7.073E+00	1.367E+01	1.899E-04	7.141E-18	0.0	0.0	0.0
2.750E+00	1.268E+04	3.258E+01	2.855E+01	1.924E+01	9.887E+02	2.875E+02	5.171E-04	7.184E-07	2.701E-18	0.0	0.0	0.0
3.500E+00	1.383E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.000E+00	1.971E+03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.000E+00	1.969E+11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.500E+00	3.128E+12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	1.115E+07	9.032E+06	7.919E+06	5.337E+06	2.765E+06	7.420E+05	1.434E+04	1.994E+01	2.076E-03	1.114E-05	1.820E-07	8.994E-08
GAM POW	3.423E+01	2.774E+01	2.432E+01	1.639E+01	8.491E+00	2.279E+00	4.406E-02	8.123E-05	6.375E-09	3.422E-11	4.975E-13	2.762E-13

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