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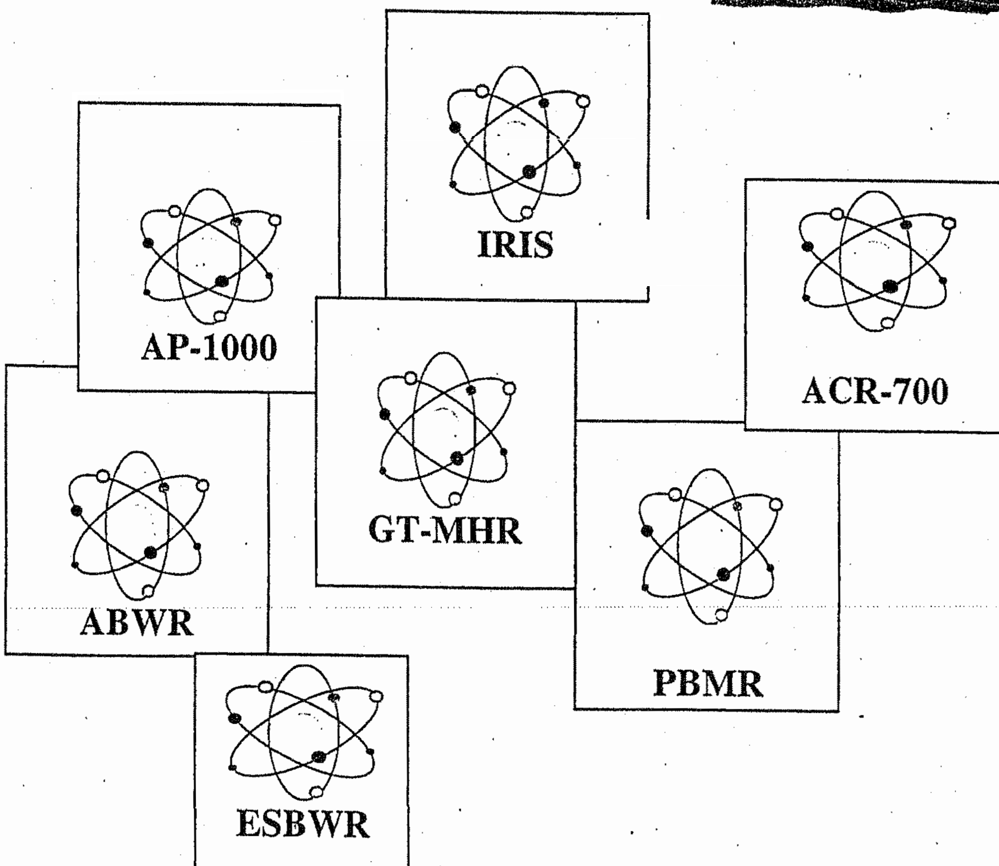
Early Site Permit Environmental Report Sections and Supporting Documentation



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	R/A	Typed Name/Organization	Signature	Date
Performer/ Author	N/A	Robert Nitschke/4664	R L Nitschke	05/05/2003
Technical checker	R			
Independent Peer Reviewer (if applicable)	R	Ken Moor/4643	K Moor	5/11/03
Approver	A	Tom Hill/42A1	T Hill	5/13/03
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7. Distribution: (Name and Mail Stop) R. Nitschke, M/S 2209; Ken Moor, M/S 2213; Jolene Robinson, M/S 1235; B.P. Singh, DOE-HQ; Tom Mundy, Exelon Corp.; ~~Joe Hegner~~ Marvin Smith, Dominion Corp.; George Zinke, Entergy Corp.; Steve Routh, Bechtel; Eddie Grant, Exelon Corp; Mike Bourgeois, Entergy Corp

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Early Site Permit ER Sections and Supporting Documentation
Table of Contents

ER SECTION 3.8
TRANSPORTATION OF RADIOACTIVE MATERIALS

3.8 Transportation of Radioactive Materials

This section addresses the transportation issues associated with siting and operating a new reactor and is divided into two main subsections. The first subsection addresses the light-water-cooled reactor (LWR) designs presently being considered. The second subsection addresses the gas-cooled reactor designs also being considered. This split addresses the regulatory distinction made in 10 CFR 51.52 for light-water-cooled reactors.

3.8.1 Light-Water-cooled Reactors

As required by 10 CFR 51.52, every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor (LWR), and submitted on or after September 4, 1979, is to utilize Table S-4, "Environmental Impact of Transportation of Fuel and Waste To and From One Light-Water-cooled Nuclear Power Reactor," and shall contain a statement concerning transportation of fuel and radioactive wastes to and from the reactor.

Table S-4 (as provided in 10 CFR 51.52(c) and repeated in Table 3.8-3) is a summary impact statement concerning transportation of fuel and radioactive wastes to and from a reactor. The table is divided into two categories of environmental considerations: (1) normal conditions of transport and (2) accidents in transport. The normal conditions of transport consideration are further divided into environmental impact, exposed population, and range of doses to exposed individuals per reactor reference year. The "accidents in transport" consideration is concerned with environmental risk. Under "normal conditions of transport," the environmental impacts of the heat of the fuel cask in transit, weight, and traffic density are described. Also the number and range of radioactive doses to transportation workers and the general public are described. Under "accidents in transport," the environmental risk from radiological effects and common nonradiological causes such as fatal and nonfatal injuries and property damage are described.

To indicate that Table S-4 adequately describes the environmental effects of the transportation of fuel and waste to and from the reactor, the reactor licensee must state that the reactor and this transportation either meet all of the conditions in paragraph (a) of 10 CFR 51.52 or all of the conditions in paragraph (b) of 10 CFR 51.52. Subparagraphs 10 CFR 51.52(a)(1) through (5) delineate specific conditions the reactor must meet to use Table S-4 as part of its environmental report. Subparagraph 10 CFR 51.52(a)(6) states, "The environmental impacts of transportation of fuel and waste to and from the reactor, with respect to normal conditions of transport and possible accidents in transport, are as set forth in Summary Table S-4 in paragraph (c) of this section; and the values in the table represent the contribution of the transportation to the environmental costs of licensing the reactor." Paragraph 10 CFR 51.52(b) states that reactors not meeting the conditions of 10 CFR 51.52(a) shall make a full description and detailed analysis for their reactor equivalent to Table S-4.

The light water cooled reactor technologies being considered have characteristics that fall within the conditions of 10 CFR 51.52, for use of Table S-4, with one minor exception for two of the reactor designs, i.e., rated core thermal power level. The effect of this difference will be discussed later.

The light water cooled technologies being considered are identified in Section 1.1.3. These designs include the ABWR (Advanced Boiling Water Reactor), the ESBWR (Economic Simplified Boiling Water Reactor), the AP-1000 (Advanced Passive PWR), the IRIS (International Reactor Innovative and Secure), and the ACR-700 (Advanced CANDU Reactor). The standard configuration for each of these reactor technologies is as follows. The ABWR is a single unit, 4300 MWt, 1500 MWe reactor. The ESBWR is a similar BWR: single unit, 4000 MWt, 1390 MWe. The AP-1000 is a single unit, 3400 MWt, 1117-1150 MWe pressurized water reactor, The IRIS is a three module pressurized water reactor configuration for a total of 3000 MWt and 1005 MWe. And the ACR-700 is a twin unit, 3964 MWt, 1462 MWe, light-water-cooled reactor with a heavy water moderator.

10 CFR 51.52 lists several conditions that need to be addressed by these reactor' technologies. If all the conditions are satisfied by all of the reactor technologies, then the Table S-4 values are appropriate for use in the Early Site Permit. These conditions are reactor core thermal power; fuel form; fuel enrichment; fuel encapsulation; average fuel irradiation; time after discharge of irradiated fuel before shipment; mode of transport for unirradiated fuel; mode of transport for irradiated fuel; and mode of transport for radioactive waste other than irradiated fuel. There are two other conditions in S-4 that require that all radioactive waste, with the exception of irradiated fuel, be packaged and in solid form. Table 3.8-1, "LWR Transportation Worksheet," was prepared to succinctly show the reference conditions along with the values for the new reactor technologies. The information to complete the table was supplied by the reactor vendors.

10 CFR 51.52(a)(1) requires that the reactor have a core thermal power level not exceeding 3800 megawatts. Of the considered LWR technologies, only the two boiling water reactors, the ABWR and the ESBWR, exceed this value. The ABWR has a core thermal power level of 4300 megawatts thermal (MWt) while the ESBWR reactor power level is 4000 MWt. The higher rated core power level would typically indicate the need for more fuel and therefore more fuel shipments. This is not the case in this instance due to the higher unit capacity and higher burnup for the reactors with the increased power level. The annual fuel loading for the reference reactor was 35 MTU while the annual fuel loading for both the ABWR and ESBWR is only 32.8 MTU. In fact, the annual MTU of fuel normalized to equivalent electrical generation is just slightly more than half of the reference LWR, 18.4 versus 35. This reduced annual MTU of fuel will mean fewer shipments and less environmental impact. Also, WASW-1238 states: "The analysis is based on shipments of fresh fuel to and irradiated fuel and solid waste from a boiling water reactor or a pressurized water reactor with design ratings of 3,000 to 5,000 megawatts thermal (MWt) or 1,000 to 1,500 megawatts electrical (MWe)." Both the ABWR and the ESBWR fall within these bounds.

10 CFR 51.52(a)(2) requires that the reactor fuel be in the form of sintered uranium dioxide (UO_2) pellets. The LWR technologies being considered have a sintered UO_2 pellet fuel form.

10 CFR 51.52(a)(2) requires that the reactor fuel have a uranium-235 enrichment not exceeding 4% by weight. This condition has been modified by "NRC Assessment of the Environmental Effects of Transportation Resulting From Extended Fuel Enrichment and Irradiation" as provided in 53FR30555 and 53FR32322. This reference along with NUREG 1437, *Generic Environmental Impact Statementfor License Renewal of Nuclear Plants,* concluded that *5%* enrichment is also bounded. Based on this modification, the LWR technologies being considered meet this condition. NOT App.

10 CFR 51.52(a)(2) requires that the reactor fuel pellets be encapsulated in Zircaloy rods. This has been modified by 10 CFR 50.44, which allows use of ZIRLO™. Based on this modification, the LWR technologies being considered meet this condition.

10 CFR 51.52(a)(3) requires that the average burnup is not to exceed 33,000 megawatt-days per metric ton of uranium (MWd/MTU). NUREG 1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* concludes that 62,000 MWd/MTU for the peak rod is also bounded by the Table. Based on this modification, the LWR technologies being considered meet this condition. The average discharge burnup in MWd/MTU ranges from a low of 20,500 for the ACR-700 to'a high of 55,200 for the IRIS reactor technology.

10 CFR 51.52(a)(3) requires that no irradiated fuel assemblies be shipped until at least 90 days after it is discharged from the reactor. Table S-4 assumes 150 days of decay time prior to shipment of any irradiated fuel assemblies. For the LWR technologies being considered, five years is the minimum decay time expected before shipment of irradiated fuel assemblies. The five-year minimum time is supported additionally by two current practices. One is per contract with DOE, who has ultimate responsibility for the spent fuel. Five years is the minimum cooling time specified in 10 CFR 961, Appendix E. The other practice is the NRC specifies five years as the minimum cooling period when they issue certificates of compliance for casks used for shipment of power reactor fuel. (NUREG-1437, Addendum 1, pp 26) In all likelihood, the decay time will be at least ten years and probably even longer. In addition to the minimum fuel storage time, NUREG-1555 Environmental Standard Review Plan, Section 3.8 asks for the capacity of the onsite storage facilities to store irradiated fuel. The LWR technologies being considered are designing for on-site storage of spent fuel for up to 60 years through a combination of pool and dry storage.

10 CFR 51.52(a)(5) requires that uninadiated fuel be shipped to the reactor by truck. The LWR technologies being considered are planning to ship their uninadiated fuel by truck.

10 CFR 51.52(a)(5) allows for truck, rail, or barge transport of irradiated fuel. The LWR technologies being considered comply with the transport mode. Three of the reactor vendors identified rail as the shipment mode, two reactor vendors specified truck as the

shipment mode, and the vendor for the ABWR and the ESBWR stated either rail or truck. Of note, the **DOE** is responsible for transport from reactor sites to the repository and DOE will make the decision on transport mode. NUREG-1555, Environmental Standard Review Plan, Section 3.8, also asks for the estimated transportation distance from the plant to the facility to which irradiated fuel will most likely to be sent. Recognizing the uncertainty in predicting the future destination of spent fuel in the United States, 2500 miles is utilized as a bounding distance at this time. This length bounds the approximate average distance from typical reactor sites to potential repository locations in the US.

10 CFR 51.52(a)(5) requires that the mode of transport of low-level radioactive waste is either truck or rail. The LWR technologies being considered plan to ship their radioactive waste by truck.

Finally, 10 CFR 51.52(a)(4) requires that with the exception of spent fuel, radioactive waste shipped from the reactor is to be packaged and in a solid form. The LWR technologies being considered will solidify and package their radioactive waste. Additionally, existing NRC (10 CFR 71) and DOT (49 CFR 173,178) packaging and transportation regulations specify requirements for the shipment of radioactive material. The LWR technologies being considered are also subject to these regulations.

In conclusion, since the LWR technologies being considered satisfy the basis 10 CFR 51.52(a) conditions for use of Table S-4, the environmental impacts of transportation of fuel and radioactive wastes are represented by the values given in 10 CFR 51.52(c), Table S-4. Thus, the radiological and nonradiological environmental impacts of transportation of fuel to and from, and waste from, an LWR are small.

Table 3.8-1

LWR-S4 Transportation Worksheet

Reactor Technology Characteristic	Table S-4 Condition	**ESBWR (Single unit) (4000 MWt) (1390 MWe)**	**ABWR (Single unit) (4300 MWt) (1500 MWe)**	**AP-1000 (Single Unit) (3400 MWt) (1117 - 1150 MWe)**	**IRIS** (3 Reactors) **(3000 MWt total) (1005 MWe total)**	ACR-700 **(Twin Unit) (3964 MWt total) (1462 Mwe total)**
Reactor Power Level MWt	not exceeding 3800 MWt per reactor	4000 MWt	4300 MWt	3400	3000 (1000 MWt per reactor, 3 reactors per plant)	3964 (1982 MWt per reactor, 2 reactors per plant)
Fuel Form	sintered UO_2 pellets	sintered UO_2 pellets	sintered UO_2 pellets	sintered UO_2 pellets	sintered UO_2 pellets	sintered UO_2 pellets
U235 Enrichment	Not exceeding 4%; NUREG 1437 concludes that 5% is bounded	Initial Core < 3.5%; Reload average < 4.5%	Initial Core < 3.5%; Reload average < 4.5%	Initial Core Load Region 1 2.35% Region 2 3.40% Region 3 4.45% Reload Average 4.51%	fuel cycle average ~ 4.85%; maximum assembly 4.95%; reload 4.75 - 4.95%	2%
Fuel Rod Cladding	Zircaloy rods; 10 CFR 50.44 allows use of ZIRLO	Zircaloy	Zircaloy	Zircaloy or ZIRLO™	ZIRLO™	Zircaloy-4
Average burnup MWd/MTU	Not exceeding 33,000; NUREG 1437 concludes 62,000 MWd/MTU for peak rod is bounded	46,000	46,000	48,700	55,200	20,500

LWR-S4 Transportation Worksheet

Reactor Technology	Reference LWR (Single unit) (1100 MWe)	ESBWR (Single unit) (4000 MWt) (1390 MWe)	ABWR (Single unit) (4300 MWt) (1500 MWe)	AP-1000 (Single Unit) (3400 MWt) (1117 - 1150 MWe)	IRIS (3 Reactors) (3000 MWt total) (1005 MWe total)	ACR-700 (Twin Unit) (3964 MWt total) (1462 Mwe total)
Characteristic						
Unirradiated fuel						
transport mode	truck	truck	truck	truck	truck	truck
Irradiated fuel						
transport mode	truck, rail or barge	truck, rail	truck, rail	rail	rail	rail
decay time prior to shipment	Not less than 90 days is a condition for use of Table S-4; 5 years is per contract with DOE	five years	five years	ten years	five years	ten years
radioactive waste						
transport mode	truck or rail	truck	truck	truck	truck	truck
waste form	solid	solid	solid	solid	solid	solid
packaged	yes	yes	yes	yes	yes	yes

Yellow indicates a value larger than or different from Table S-4

3.8.2 Gas-cooled Reactors

3.8.2.1 Introduction and Background

The following assessment of the environmental impacts of the transportation of fresh and spent fuel and low-level waste to and from the reactor for gas-cooled reactor technologies is based on a comparison of the key parameters and conditions that were used to generate the impacts listed in 10 CFR 51.52(c), Table S-4. This comparison can then demonstrate that the environmental impacts of these gas-cooled reactor technologies are no worse than the impacts previously identified in Table S-4 for the light-water-cooled technologies, The premise being that if the values of the major contributors to the health and environmental impacts that were used for the reference LWR are greater than those comparable values for the gas-cooled reactor technologies, then the subsequent impacts would also be greater and therefore bounding. It is important to point out that even though we are looking at the contributors individually, it is the overall cumulative impact that is of concern. That is, for purposes of comparing/evaluating cumulative impacts, there can be increases in select individual contributors if offset by decreases in other contributors.

The parameters that have been chosen for purposes of comparison include not only the major contributors to the health and environmental impacts but also the conditions listed in 10 CFR 51.52. The major contributor to transportation risk is the number of shipments. Basically, the more shipments, the more risk; if there are no shipments, there is no risk. The Table S-4 shipments include fresh fuel for both initial core loading and reloads, irradiated fuel, and low-level waste (LLW) from operations. The second main contributor to the transportation risk would be the mode of shipment. In this case, only trucks and trains are considered. The last important risk factor relates to what kind of material is being shipped. In the category for irradiated fuel, we compared fission product inventory, krypton inventory, actinide inventory, total radioactivity, decay heat, and weight of shipment. For radioactive waste, we used the volume to determine the number of shipments. Radioactivity (Ci) was also estimated to assure that the assumption about the percentage of LLW that might require shielding was reasonable.

The 10 CFR 51.52 conditions are: reactor core thermal power; fuel form; fuel enrichment; fuel encapsulation; average fuel irradiation; time after discharge of irradiated fuel before shipment; mode of transport for unirradiated fuel; mode of transport for irradiated fuel; and mode of transport for radioactive waste other than irradiated fuel. In addition, there are two other conditions that require that all radioactive waste with the exception of irradiated fuel be packaged and in solid form. Since existing packaging and transportation regulations already address those items and would also apply to these new reactor technologies, no further discussion is needed for these two conditions.

Before proceeding with the evaluation, it is important to note that the NRC has an ongoing review of the safety of spent fuel transportation. The latest evaluation is

NUREG/CR-6672, "Reexamination of Spent Fuel Shipment Risk Estimates," published in March 2000. The NRC in their document "An Updated View of Spent Fuel Transportation Risk," concluded that the NUREG/CR-6672 study confirmed that earlier risk estimates (NUREG-0170, "Final Environmental Statement on the Transport of Radioactive Materials by Air and Other Modes") to the public remain conservative by factors of 2 to 10 or more; that existing regulations governing the shipment of spent fuel are adequate; and no unreasonable risk is posed to the public by the continued shipment of spent fuel. The range of conservative risk factors covers differences in mode of transport (rail or truck) and either accident or accident-free scenarios.

These same NRC conclusions support the position that environmental assessments of the transport casks do not have to be done for the Part 71 cask certifications because they meet the categorical exclusion criteria in 10 CFR 51.22(c)(13) that package designs used for the transportation of licensed materials do not require an environmental review. As discussed in 10 CFR 51.22(a), the NRC has determined that certain categories of licensing and regulatory actions have already been determined individually or cumulatively to not have a significant effect on the human environment; thus, a separate environmental assessment is not required. As mentioned in the previous paragraph, a generic assessment of the environmental effects associated with transportation of all radioactive material, including spent fuel, has already been done as provided in NUREG-0170, "Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes," dated December 1977. This environmental impact statement (EIS) provided the regulatory basis for continued issuance of general licenses for transportation of radioactive material under 10 CFR 71. In addition, the NRC has conducted a reexamination of the risks associated with spent fuel shipments as documented in NUREG/CR-6672. This reexamination concluded that the estimated risks for future shipments are well below those in the 1977 study. Thus, NUREG-0170 remains valid as the baseline report on which National Environmental Policy Act (NEPA) analyses of transportation risk are based.

Table 3.8-1 captures the major features of the reference LWR that were used to develop Table S-4 and compares these same features with the gas-cooled reactor technologies being considered. The reference LWR pertains to the typical 1100 MWe light-water-cooled nuclear reactor as described in WASH-1238. The information to construct the worksheet was taken from the "Normal Conditions of Transport" portion of the 10 CFR 51.52 Summary Table S-4 "Environmental Impact of Transportation of Fuel and Waste to and from One Light-Water-cooled Nuclear Power Reactor," WASH-1238 "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants" and Supplement 1 to WASH-1238 (NUREG-751038) for the reference LWR. The information for the reactor technologies was provided by the reactor vendors.

3.8.2.2 Analysis

This section provides a detailed description of the comparison of the individual characteristics supporting Table S-4 against the corresponding parameters for the gas-cooled reactor technologies. The value for the reference reactor is given along with the

corresponding values or range of values for the gas-cooled reactor technologies. As appropriate, additional information and/or observations are provided. Table 3.8-2, the Gas-cooled Reactor Transportation Worksheet, provides additional details regarding the reactor technology specific values.

There are two gas-cooled reactor technologies presently being considered. These reactor technologies are the GT-MHR (Gas Turbine-Modular Helium Reactor), and the PBMR (Pebble Bed Modular Reactor). The standard configuration for each of these reactor technologies is as follows. The GT-MHR is a four module, 2400 MWt, 1140 MWe gas-cooled reactor. The PBMR is an eight module, 3200 MWt, 1320 MWe gas-cooled reactor. The unit capacities for these reactors are as follows: 88% for the GT-MHR; 95% for the PBMR. These values are contrasted with the reference LWR, a single unit, 1100 MWe plant with a unit capacity factor of 80%.

Before beginning direct comparisons, it is important to note that the plants being considered are a different physical size, have a different electrical rating, and have a different capacity factor from the reference LWR. In order to make proper comparisons, we need to evaluate the characteristics based on equivalent criteria. In this case, electrical generation is the metric of choice. Electrical generation is why the plants are being built, and we want to know if these new reactor technologies, for the same electrical output, have a greater or lesser impact on the health and environment. The reference LWR is an 1100 MWe plant with a capacity factor of 80%. Based on this, the reactor technologies should be normalized to 880 MWe using their plant specific electrical rating and capacity factor. For many of the characteristics being examined, this adjustment is not necessary. But in a few cases, specifically those dealing with the number of shipments of fuel and waste, an adjustment is appropriate. The amount of this adjustment ranges from minus 12% for the GT-MHR to minus 30% for the PBMR.

3.8.2.3 Table S-4 Conditions

As discussed previously, Table S-4 lists several conditions that need to be addressed by the new reactor technologies. These conditions are reactor core thermal power; fuel form; fuel enrichment; fuel encapsulation; average fuel irradiation; time after discharge of irradiated fuel before shipment; mode of transport for unirradiated fuel; mode of transport for irradiated fuel; and mode of transport for radioactive waste other than irradiated fuel. Two other conditions in S-4 require that radioactive waste, with the exception of irradiated fuel, be packaged and in solid form.

10 CFR 51.52(a)(1) requires that the reactor have a core thermal power level not exceeding 3800 MWt. The gas-cooled reactors being considered meet this condition. The GT-MHR has a core thermal power level of 600 MWt per module. The PBMR has a core thermal power level of 400 MWt per module.

10 CFR 51.52(a)(1) requires that the reactor fuel be in the form of sintered UO_2 pellets. The fuel form for the gas-cooled reactors being considered is TRISO coated uranium

oxycarbide fuel kernels for the GT-MHR and TRISO coated uranium dioxide fuel kernels for the PBMR.

10 CFR 51.52(a)(2) requires that the reactor fuel have a uranium-235 enrichment not exceeding 4% by weight. This has been modified by NUREG 1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, which concluded that 5% enrichment is also bounded. The PBMR has an equilibrium enrichment of 12.9% while the GT-MHR fissile particle enrichment is 19.8%.

10 CFR 51.52(a)(2) requires that the reactor fuel pellets be encapsulated in Zircaloy rods. This has been modified by 10 CFR 50.44, which allows use of ZIRLO. The gas-cooled reactors being considered have a different configuration. The fuel kernels are coated with layers of pyrolytic carbon and silicone carbide. These coatings are considered the equivalent of the fuel cladding. For the GT-MHR these TRISO fuel particles are blended and bonded together with a carbonaceous binder. These are stacked within a graphite block. For the PBMR, the fuel unit is a 6 cm diameter graphite sphere containing approximately 15000 TRISO fuel particles.

10 CFR 51.52(a)(3) requires that the average burnup is not to exceed 33,000 MWd/MTU. NUREG 1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, concludes that 62,000 MWd/MTU for the peak rod is also bounded by the Table. The gas-cooled reactors have an expected burnup of 133,000 MWd/MTU for the PBMR and 112,742 MWd/MTU for the GT-MHR.

10 CFR 51.52(a)(3) requires that no irradiated fuel assemblies be shipped until at least 90 days after it is discharged from the reactor. Table S-4 assumes 150 days of decay time prior to shipment of any irradiated fuel assemblies with a condition of not less than 90 days. For the gas-cooled reactor technologies being considered, five years is the minimum decay time prior to shipment of irradiated fuel assemblies. This is per contract with DOE, who has ultimate responsibility for the spent fuel. In all likelihood, the decay time will be at least ten years and probably even longer. The gas-cooled reactor technologies being considered are designing for on-site storage of spent fuel for up to 60 years including potential modular storage expansions.

10 CFR 51.52(a)(3) requires that the unirradiated fuel be shipped to the reactor by truck. The gas-cooled reactor technologies being considered are planning to ship their unirradiated fuel by truck.

10 CFR 51.52(a)(3) allows for truck, rail, or barge transport of irradiated fuel. The gas-cooled reactor technologies being considered plan to allow for irradiated fuel shipment by truck. However, the actual mode of shipment will be determined by DOE and may include either rail or truck shipments.

10 CFR 51.52(a)(3) requires that the mode of transport of low-level radioactive waste is either truck or rail. The gas-cooled reactor technologies being considered plan to ship their radioactive waste by truck.

Finally, 10 CFR 51.52(a)(4) requires that that, with the exception of spent fuel, radioactive waste shipped from the reactor is to be packaged and in a solid form. The gas-cooled technologies being considered will solidify and package their radioactive waste, Additionally, existing NRC (10 CFR 71) and DOT (49 CFR 173,178) packaging and transportation regulations specify requirements for the shipment of radioactive material. The gas-cooled technologies being considered are also subject to these regulations.

3.8.2.4 Risk Contributors – Shipments

This section discusses the type and number of shipments for the gas-cooled reactor technologies and the values used for the reference LWR.

The reference LWR assumed an initial core loading of 100 MTU for a PWR and 150 MTU for a BWR. These quantities resulted in 18 truck shipments. For the new gas-cooled reactor technologies, the numbers of shipments were 44 for the PBMR and 51 for the GT-MHR. If normalized to the equivalent electrical output, the number of shipments would be 31 and 45 respectively.

The reference LWR assumed an annual reload of 30 MTU. This quantity resulted in 6 truck shipments. For the new gas-cooled reactor technologies, the numbers of reload shipments ranged from 3 for the PBMR to 20 for the GT-MHR. The number of shipments normalized to the electrical generation changes slightly to 1 for the GT-MHR.

With respect to the number of spent fuel shipments by truck, the reference LWR assumed 60 shipments annually. For the two gas-cooled reactor technologies, the number of shipments is considerably less. The PBMR requires 16 annual shipments while the GT-MHR requires 38 truck shipments annually. Normalizing to the electrical generation lowers these numbers to 12 to 34, respectively.

The reference LWR assumed 10 rail shipments annually of spent fuel. Since the gas-cooled reactor technologies are not planning to ship their spent fuel by rail, no comparison is needed. However, based on the comparison for truck shipments, fewer than 10 rail shipments annually would be expected if DOE decided to use larger and higher capacity rail transport casks for gas-reactor spent fuel.

The reference LWR also considered transporting spent fuel by barge and assumed 5 shipments annually. Since the gas-cooled reactor technologies are not planning to ship their spent fuel by barge, no comparison is needed.

The reference LWR assumes 46 shipments annually of low-level radioactive waste. The gas-cooled reactor technologies will make far fewer shipments. The GT-MHR will need only 6 shipments while the PBMR will require 9 shipments annually. These results assume that 90% of the LLW can be shipped at 1000 ft^3 per truck, and the remaining 10%

can be shipped at 200 ft^3 per truck. If the numbers are normalized to electrical generation, the numbers of shipments range from 6 to 7.

The Table S-4 value, traffic density in trucks per day, for the reference LWR is given as less than one per day. Both the gas-cooled reactor technologies would also have less than one per day. In fact, the new gas-cooled reactor technologies would have far fewer shipments per year. The reference LWR bounding annual value for truck shipments is 110 based on a 40 year period, while the normalized number of truck shipments for the gas-cooled reactor technologies would require as few as 18 for the PBMR and only 41 for the GT-MHR.

The rail density in cars per month for the reference LWR is given as less than 3 per month. Since the gas-cooled reactor technologies are not planning to make my shipments by rail, no comparison is needed. However, as noted above, if DOE decided to use rail transport for spent fuel instead of truck, fewer than 3 shipments per month would be expected based on the expected larger capacity of rail spent fuel casks compared to truck casks.

3.8.2.5 Risk Contributors - Contents

This section addresses the radioactive contents of the shipments and their thermal loading and compares them to the reference LWR. The radioactive and decay heat values are based on the earliest time of shipment. For the gas-cooled reactor technologies, the five-year time was selected because it is the current minimum allowed time before shipment per DOE contract. These values are compared with the reference LWR that used a 90-day decay time. Ninety days was the minimum allowed time before shipment for Table S-4. Since we are evaluating the transportation impacts, it is the inventory and associated decay heat at the time of shipment that is of interest, not the inventory and decay heat at any other particular time.

The fission product inventory at the time of shipment for the reference LWR was 6.19×10^6 Ci per MTU. The values for the fission product inventory at the time of shipment for the gas-cooled reactor technologies were both much lower, from 3.5 to 4 times lower.

The actinide inventory at the time of shipment in Ci per MTU for the reference LWR was 1.42×10^5. Because of the longer burnup times for the new gas-cooled new reactor technologies, both of these reactor technologies have values that exceed the reference LWR. The GT-MHR and the PBMR, exceed the reference LWR by ~ 64% and ~59%, respectively. This comparison changes significantly for the GT-MHR if one considers the Ci per shipment, which is really what is of concern. The reference LWR ships 0.5 MTU per truck cask while the GT-MHR ships about a third less 0.16044 MTU per truck cask. Based on this comparison, the actinide inventory per shipment is about half (53%) for the GT-MHR versus the reference LWR. Since the PBMR plans to ship 0.495 MTU per cask, there is essentially no difference from the comparison per MTU.

The total radioactive inventory in Ci per MTU at the time of shipment for the reference LWR was 6.33 x 10^6. The new gas-cooled reactor technologies have much lower total radioactivity at time of shipment. The differences are from 3 to almost 4 times lower.

The krypton-85 inventory in Ci per MTU at the time of shipment for the reference LWR was 1.13 x 10^4. Both the GT-MHR and the PBMR exceed the reference LWR by about a factor of 2.3, As before, if one considers the Ci per shipment, the Kr-85 inventory for the GT-MHR would be about 71% of the Kr-85 reference LWR inventory. The PBMR comparison remains essentially the same,

The kilowatts per MTU at the time of shipment for the reference LWR were 27.1. This value is considerably higher than for the gas-cooled reactor technologies. At the time of shipment, the decay heat for the gas-cooled reactor technologies being considered ranges from 6.36 kilowatts per MTU for the GT-MHR to 3.91 kilowatts per MTU for the PBMR.

The decay heat (per irradiated fuel truck cask in transit) in kilowatts for the reference LWR was 10. Both the gas-cooled reactor truck casks generate much less heat (5 to 10 times lower) per truck cask than the reference LWR.

The decay heat (per irradiated fuel rail cask in transit) in kilowatts for the reference LWR was 70. Since the gas-cooled reactor technologies are not planning to ship their spent fuel by rail, no comparison is needed. However, should DOE elect to transport by rail, the expected decay heat would be less than 70 based on the comparison for truck shipment.

At the time of the reference LWR evaluation, the road limit was 73,000 lbs. This has changed slightly through the years. 23 CFR 658.17 'Weight" states that for the Interstate and Defense Highways the maximum gross vehicle weight shall be 80,000 pounds. In all cases for the gas-cooled reactor technologies, the road limit is governed by state and federal regulations.

3.8.2.6 Discussion

Of the close to 30 characteristics/conditions that were examined, there are only 8 that were exceeded by the gas-cooled reactor technologies being considered. Three of these characteristics have no direct transportation impact on the health and the environment: fuel form, U_{235} enrichment, and fuel rod cladding. There are operational issues and fuel cycle impact issues associated with these characteristics that are addressed as part of the operating license and as part of the evaluation of Table S-3 "Uranium fuel cycle data," respectively. Two of these characteristics (number of shipments for initial core loading and number of reload shipments) are really a part of the overall truck transportation picture. When one considers the total number of truck shipments (fresh fuel, spent fuel, and radioactive waste), the new reactor technologies have many fewer total shipments. For example, on an average annual basis, the new reactor technologies require 69 to 105 fewer truck shipments. Comparing the total number of shipments is appropriate since the

radiological impacts from fresh fuel are negligible. One characteristic, burnup, manifests its impact through other characteristics, fuel inventory and decay heat at time of shipment, which are addressed separately. In the case of decay heat, both of the gas-cooled reactor technologies will generate fewer watts per MTU at time of shipment, and fewer kW per truck cask at time of shipment. The fuel inventory will be discussed as part of the remaining two characteristics that were exceeded: actinide inventory and krypton-85 inventory.

That the actinide inventory per metric ton of spent fuel is greater for the majority of the new gas-cooled reactor technologies is not surprising, since actinide activity tends to increase with increasing burnup and both of the gas-cooled reactor technologies plan a higher burnup than the reference LWR. The increase in the actinide activity for the new reactor technologies ranges from 59% to 65%. And as discussed in the previous section, if one considers the actinide inventory per shipment, only the PBMR exceeds the reference LWR by 59%. From NUREG/CR-6703 "Environmental Effects of Extending Fuel Burnup Above 60 GWd/MTU," we learn that "none of the actinides contributes more than one percent of the external dose from an iron transportation cask, and as a group, the actinides do not contribute significantly to the dose from transportation accidents. In fact, increasing the activities of Pu-238, Pu-239, Pu-240, Pu-241, Am-241, Cm-242 and Cm-244 by more than a factor of 1000 only increased the cumulative dose for a transportation accident during shipment of 43 GWd/MTU spent fuel from the northeast to Clark County, NV from 0.0358 to 0.0359 person-mSv/shipment (3.58×10^{-3} to 3.59×10^{-3} person-rem/shipment)." There is one other area where the increased actinide activity needs to be considered and that is the corresponding increase in neutron source term. NUREG/CR-6703 states "because neutrons are effectively attenuated by low-density materials such as plastics and water, it is believed that minor modifications can be made to shipping casks to allow them to transport the higher burnup fuel at full load."

Based on the analysis performed and the conclusions drawn in NUREG/CR-6703 which show that actinides are not major contributors to the transportation risk, either incident free or accident, and with the actinide activity only 59% greater, the environmental impacts would still be bounded even for these higher burnups.

This leaves the Kr-85 inventory as the final characteristic to be addressed. The increase of Kr-85, a long-lived noble gas, would suggest an increase of the consequences associated with an accident that resulted in a breach of the fuel cask and fuel rods. The range of increase for the gas-cooled technologies being considered is from 121% to 133%. And as discussed in the previous section, if one considers the Kr-85 inventory per shipment, only the PBMR exceeds the reference LWR. These amounts are based on a 5-year cooling time. If this decay time were increased by about 11 years, slightly greater than the half-life of Kr-85 (10.6 years), not an unlikely scenario by the way, this increase would for the most part decay away. Another factor to consider is that transportation risk is a function of both consequences and likelihood. Because the new reactor technologies require fewer truck shipments, the likelihood would decrease approximately 37% for the reactor with the greatest Kr-85 inventory. Another factor to consider is that the accident

rate for large trucks has steadily declined for more than the past 25 years and is less than half the rate in 1975. Thus, the likelihood has decreased to about 37% (0.63 x 0.5) of the 1975 likelihood. A final and major factor to consider is that the cask regulations are based on allowable releases independent of the inventory. Thus, regardless of the initial source term, if the cask releases more than a specific acceptable amount, it would not be licensed. Based on these considerations, the 5-year Kr-85 quantities would still be bounded by the overall transportation risk profile provided by Table S-4.

3.8.2.7 Conclusion

In conclusion, this detailed comparison of the underpinnings of Table S-4 show that the existing environmental and health effects are still conservative and appropriate for use by the gas-cooled reactor technologies being considered. Of close to 30 characteristics examined, only eight were exceeded by the new technologies. In these instances, either they are independent of any impact or there are mitigating factors and controls to assure that these slight increases are bounded by the impacts specified in Table S-4. This conclusion is also borne out by the observation that these new reactor technologies will be using the same transportation modes and subject to the same NRC and DOT regulations for packaging and transportation as the original analysis that was used to develop Table S-4. Thus, the new reactor technologies under consideration and the transportation of radioactive material associated with them meet the conditions in 10 CFR 51.52(b).

3.8.3 Methodoloav Assessment

As indicated in Section 1.1.3, the selection of a reactor design to be used for the EGC ESP Facility is still under consideration. Selection of a reactor to be used at the EGC ESP Site may not be limited to those considered above. However, the methodology utilized above is appropriate to evaluate the final selected reactor. Further, should the selected design be shown to be bounded by the above evaluation, then the selected design would be considered to be within the acceptable transportation environmental impacts considered for this ESP.

D/() ADDRESS Releases From

References:

10CFR50.44, Standards for combustible gas control system in light-water-cooled power reactors

10CFR51.22, Criterion for categorical exclusion; identification of licensing and regulatory actions eligible for categorical exclusion or otherwise not requiring environmental review

10CFR51.52, Table S-4 Environmental Impact of Transportation of Fuel and Waste

10 CFR 71, Packaging and Transportation of Radioactive Material

49 CFR 173, Shippers – General Requirements for Shipments and Packagings

49 CFR 178, Specifications for Packagings

Docket No, 50-400, 53 FR 30355 NRC Assessment of the Environmental Effects of Transportation Resulting From Extended Fuel Enrichment and Irradiation, August 11, 1988, and 53 FR 32322, August 24,1988

NUREG-0170 Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes, Vols. 1 and 2, December 1977

NUREG-1437 Generic Environmental Impact Statement for License Renewal of Nuclear Plants, Volumes 1 & 2, May 1996

NUREG-1555 Standard Review Plans for Environmental Reviews for Nuclear Power Plants, October 1999

NUREG/CR-6672 Reexamination of Spent Fuel Shipment Risk Estimates, March 2000

NUREG/CR-6703 Environmental Effects of Extending Fuel Burnup Above 60 Gwd/MTU, January 2001

WASH-1238 ENVIRONMENTAL SURVEY OF TRANSPORTATION OF RADIOACTIVE MATERIALS TO AND FROM NUCLEAR POWER PLANTS, December 1972

Supplement 1 to WASH-1238 (NUREG-751038) ENVIRONMENTAL SURVEY OF TRANSPORTATION OF RADIOACTIVE MATERIALS TO AND FROM NUCLEAR POWER PLANTS, April 1975

Table 3.8-2 Gas-cooled Reactor Transportation Worksheet

Reactor Technology Characteristic	Reference LWR (Single unit) (1100 MWe)	GT-MHR (4 Modules) (2400 MWt total) (1140 MWe total)	PBMR (8 Modules) (3200 MWt total) (1320 MWe total)	Comments
Capacity	80%	88%	95%	
Normalization factor	1	0.88	0.7	
Reactor Power Level MWt	3400	2400 (600 MWt per module, 4 modules per plant)	3200 (400 MWt per module, 8 modules per plant)	not exceeding 3800 MWt per reactor is a condition for use of Table S-4
Fuel Form	sintered UO_2 pellets	TRISO coated particle fuel with uranium oxycarbide (UCO) kernal	Sphere of TRISO Coated UO_2 fuel kernels	Sintered UO_2 pellets is a condition for use of Table S-4
U235 Enrichment	1% - 4%	fissile particle 19.8%; fertile particle natural uranium	initial 4.9%; equilibrium 12.9%	Not exceeding **4%** is a condition for use of Table S-4; NUREG 1437 concludes that 5% is bounded
Fuel Rod Cladding	zircaloy	Graphite	Graphite	Zircaloy rods are a condition for use of Table S-4; 10 CFR 50.44 allows use of ZIRLO)

Gas-cooled Reactor Transportation Worksheet cont.

Characteristic	Reference LWR (Single unit) (1100 MWe)	GT-MHR (4 Modules) (2400 MWt total) (1140 MWe total)	PBMR (8 Modules) (3200 MWt total) (1320 MWe total)	Comments
Average burnup MWd/MTU	33,000	112,742	133,000	Not exceeding 33,000 is a condition for use of Table S-4; NUREG 1437 concludes 62,000 MWd/MTU for peak rod is bounded
Unirradiated fuel				
unirradiated fuel transport mode	truck	truck	truck	shipment by truck is a condition for use of Table S-4
# of shipments for initial core loading		1851 shipments (1020 fuel elements per module x 4 modules; 80 elements per truck)	44 shipments (260,000 fuel spheres per module x 8 modules, 48,000 spheres per truck)	100 MTU for PWR; 150 MTU for BWR
# of reload shipmentslyear		620 shipments (520 elements per reload per 1.32 years x 4 modules; 80 elements per truck)	3 shipments (18,000 fuel spheres per module x 8 modules, 48,000 spheres per truck)	30 MTU annual reload

Gas-cooled Reactor Transportation Worksheet cont.

	Reference LWR (Single unit) (1100 MWe)	GT-MHR (4 Modules) (2400 MWt total) (1140 MWe total)	PBMR (8 Modules) (3200 MWt total) (1320 MWe total)	Comments
Irradiated fuel				
irradiated fuel transport mode truck, rail or barge		truck	truck	shipment by truck, rail or barge is a condition for use of Table S-4
decay time prior to shipment	150 days	five years	five years	Not less than 90 days is a condition for use of Table S-4; 5 years is per contract with DOE
fission product inventory in Ci per MTU after 5 year decay	6.19×10^6	1.55×10^6	1.78×10^6	The value for the LWR is for a 90 day decay time.
Actinide inventory in Ci per MTU after 5 year decay	1.42×10^5	2.33×10^5	2.26×10^5	The value for the LWR is for a 90 day decay time.
Total radioactivity inventory in Ci per MTU after 5 year decay	6.33×10^6	1.78×10^6	2.01×10^6	The value for the LWR is for a 90 day decay time.
Krypton-85 inventory in Ci per MTU after 5 year decay	1.13×10^4	2.50×10^4	2.63×10^4	The value for the LWR is for a 90 day decay time.

Gas-cooled Reactor Transportation Worksheet cont.

	Reference LWR (Single unit) (1100 MWe)	GT-MHR (4 Modules) (2400 MWt total) (1140 MWe total)	PBMR (8 Modules) (3200 MWt total) (1320 MWe total)	Comments
Irradiated fuel				
watts per MTU after 5 year decay	2.71×10^4	6.36×10^3	3.91×10^3	The value for the LWR is for a 90 day decay time.
# of spent fuel shipments by truck	6038	shipments (520 elements per module X **4** modules per **1.32** years, **42** elements per truck)	16 shipments (12 shipments for 1000 Mwe)	0.5 MT of irradiated fuel per cask
heat(per irradiated fuel truck cask in transit) kW	10	1.02 (6.356 kW/MTU x 0.16044 MTU/shipment)	1.9 (3.9 kw/MTU x .495 MTU/shipment)	
# of spent fuel shipments by rail	10	0	0	Appendix B, Table 1 says 3.2 MT of irradiated fuel per cask, Appendix B, Table 3 says 3.5
heat(per irradiated fuel rail cask in transit) kW	70	NA	NA	
# of spent fuel shipments by barge	5	0	0	

Gas-cooled Reactor Transportation Worksheet cont.

	Reference LWR (Single unit) (1100 MWe)	GT-MHR (4 Modules) (2400 MWt total) (1140 MWe total)	PBMR (8 Modules) (3200 MWt total) (1320 MWe total)	Comments
radioactive waste				
radioactive waste transport mode	truck or rail	truck	truck	Shipment by truck or rail is a condition for use of Table S-4
# of rad waste shipments by truck	**46**	6 (1100 Ci/yr; 98 ^{3}/yr)	9 (800 drums)	assumed 90% of the waste shipped at 1000 ft^3 per truck, 10% at 200 ft^3 per truck
weight per truck lbs.	73,000	governed by state and federal regulations	governed by state and federal regulations	current interstate gross vehicle limit is 80,000 lbs.(23 CFR 658.17)
# of rad waste shipments by rail	1[redacted]	0	0	
weight per cask per rail car tons	100	100	100	
Transport totals				
traffic density, trucks per day	less than [redacted]	less than 1	less than [redacted]	
rail density, cars per month	less than 3	0	0	

Gas-cooled Reactor Transportation Worksheet cont.

Yellow indicates a value
larger than or different from
the reference LWR

Notes:
The results for the reactor technologies have not been adjusted for their larger electrical generation or increased capacity factor.

References:
10CFR51.52, Table S-4 Environmental Impact of Transportation of Fuel and Waste

Table 3.8-3

Summary Table S-4-Environmental Impact of Transportation of Fuel and Waste To and From One Light-Water-Cooled Nuclear Power Reactor[1]

Normal Conditions of Transport

Condition
Value

Heat (per irradiated fuel cask in transit)
250,000 Btu/hr.

Weight (governed by Federal or State restrictions)
73,000 lbs. Per truck; 100 tons per cask per rail car.

Traffic density:

Truck
Less than 1 per day.

Rail
Less than 3 per month.

Exposed Population
Estimated Number of Persons Exposed
Range of Doses to Exposed individuals[2] (per reactor year)
Cumulative Dose to Exposed Population (per reactor year)[3]

Transportation workers
200

0.01 to 300 millirem
4 man-rem.

General public:

Onlookers
1,100

0.003 to 1.3 millirem
3 man-rem.

Along Route
600,000

0.0001 to 0.06 millirem

Accidents in Transport

Types of Effects
Environmental Risk

Radiological effects

Small[4]

Common (nonradiological) causes
1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

[1]Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972 , and Supp. 1 NUREG-75/038 April 1975. Both documents are available for inspection and copying at the Commission's Public Document Room, 2120 L Street NW., Washington, DC and may be obtained from the National Technical Information Service, Springfield, VA 22161 . WASH-1238 is available form NTIS at a cost of $5.45 (microfiche, $2.25) and NUREG-75-038 is available at a cost of $3.25 (microfiche $2.25).

[2]The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

[3]Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case would be 1 man-rem.

[4]Athough the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being appiled to a single reactor or a multireactor site.

ER SECTION 7.4
TRANSPORTATION ACCIDENTS

7.4 Transportation Accidents

The assessment of transportation accidents is provided in Section 3.8, Transportation of Radioactive Materials.

ER SECTION 5.7
URANIUM FUEL CYCLE IMPACTS

5.7 Uranium Fuel Cycle Impacts

This section addresses the uranium fuel cycle environmental impacts and is divided into two main subsections. The first subsection addresses the light-water-cooled reactor (LWR) designs presently being considered. The second subsection addresses the gas-cooled reactor designs also being considered. This split addresses the regulatory distinction made in 10 CFR 51.51 for light-water-cooled reactors.

5.7.1 Light-water-cooled Reactors

10 CFR 51.51(a) states that "Every environmental report prepared for the construction permit stage of a light-water-cooled nuclear power reactor, and submitted on or after September 4,1979 shall take Table S-3, Table *of* Uranium Fuel Cycle Environmental Data, as the basis for evaluating the contribution of the environmental effects of uranium mining and milling, the production of uranium hexafluoride, isotopic enrichment, fuel fabrication, reprocessing of irradiated fuel, transportation of radioactive materials and management of low level waste and high level wastes related to uranium fuel cycle activities to the environmental costs of licensing the nuclear power plant. Table S-3 shall be included in the environmental report and may be supplemented by a discussion of the environmental significance of the data set forth in the table as weighed in the analysis for the proposed facility."

Table S-3 of 10 CFR 51.51 is reproduced in its entirety herein as Table 5.7-3. Specific categories of natural-resource use included in the table relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in the table for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

Descriptions of the environmental impact assessment of the uranium fuel cycle as related to the operation of light-water-cooled reactors are well documented by the USNRC. The environmental impact of a light-water-cooled reactor on the U.S. population from radioactive gaseous and liquid releases (including radon and technetium) due to the uranium fuel cycle is small when compared with the impact of natural background radiation. In addition, the nonradiological impacts of the uranium fuel cycle are acceptable.

The light-water-cooled reactor technologies being considered are identified in Section 1.1.3. These LWR designs include the ABWR (Advanced Boiling Water Reactor), the ESBWR (Economic Simplified Boiling Water Reactor), the AP-1000 (Advanced Passive PWR), the IRIS (International Reactor Innovative and Secure), and the ACR-700 (Advanced light-water-cooled version of the CANDU Reactor). The standard configuration for each of these reactor technologies is as follows. The ABWR is a single
4 unit, 4300 MWt, 1500 MWe reactor. The ESBWR is a similar BWR: single unit, 4000 MWt, 1390 MWe. The AP-1000 is a single unit, 3400 MWt, 1117-1150 MWe

pressurized water reactor. The IRIS is a three module pressurized water reactor configuration for a total of 3000 MWt and 1005 MWe. And the ACR-700 is a twin unit, 3964 MWt, 1462 MWe, light-water-cooled CANDU reactor.

These reactor technologies are all light-water-cooled nuclear power reactors with uranium dioxide fuel and therefore Table S-3 of paragraph (a) of 10 CFR 51.51 with the current amendment (as given in 49 FR 9381, March 12, 1984 and 49 FR 10922, March 23, 1984) provides the environmental effects from the uranium fuel cycle for these reactor technologies.

5.7.2 Gas-cooled Reactors

5.7.2.1 Introduction and Background

This section provides an assessment of the environmental impacts of the fuel cycle, as related to the operation of the gas-cooled reactor technologies, based on a comparison of the key parameters that were used to generate the impacts listed in 10 CFR 51.51 Table S-3 (and repeated in Table 5.7-3). The key parameters are energy usage, material involved, number of shipments, etc. associated with the major fuel cycle activities. These activities are mining and milling, uranium hexafluoride conversion, enrichment, fuel fabrication, and radioactive waste disposal. Basically, the premise is that if less energy is needed, if fewer shipments are required, and if less material is involved in the process, then with all other things being equal, the overall impacts are less.

There are two gas-cooled reactor technologies being considered at this time. The GT-MHR is a four module, 2400 MWt, 1140 MWe reactor that operates at a unit capacity of 88%. The PBMR is an eight module, 3200 MWt, 1320 MWe reactor operating at a 95% unit capacity.

A key reference is NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* May 1996, which provides a very detailed look at the impacts to the environment from the nuclear fuel cycle. The document also looks at the sensitivity of the changes to the nuclear fuel cycle on the impacts to the environment. As these changes are much more representative of the current and future situation than what was considered in the WASH-1248 *Environmental Survey of the Uranium Fuel Cycle* report, the conclusions of NUREG-1437 will be used in the following discussion.

Table 5.7-1, "The Gas-Cooled Fuel Cycle Worksheet" was prepared to succinctly capture the major features of the reference LWR fuel cycle that were used to develop Table S-3 and compare these same features with the gas-cooled reactor technologies being considered. This comparison can then help to demonstrate that the existing Table S-3 is appropriate for use by these technologies. The premise being that if the values of the major contributors to the health and environmental impacts that were used for the reference LWR fuel cycle are greater than those comparable values for the gas-cooled reactor technologies then the published impacts would also be greater and suitable for use by the new reactor technologies. It is important to point out that even though we are

looking at the contributors individually, it is the overall impact that is of concern. As such, there can be increases in individual contributors, yet the total impacts can still be bounded, if offset by decreases in other contributors,

The information to construct the worksheet was taken from 10 CFR 51.51 Table S-3 "Uranium Fuel Cycle Environmental Data," WASH-1248 *Environmental Survey of the Uranium Fuel Cycle,* and Supplement 1 to WASH-1248 (also known as NUREG-0116) *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle.* The "reference L W R refers to the model 1000 MWe light-water-cooled nuclear reactor used as a basis for studying annual fuel related requirements as described in WASH-1248. For the gas-cooled reactor technologies, information was gathered from the reactor vendors, United States Enrichment Corporation (USEC) and ConverDyn.

5.7.2.2 Analytic Approach

The major activities of the reference LWR fuel cycle that were considered in the WASH-1248 report were uranium mining, uranium milling, uranium hexafluoride production, uranium enrichment, fuel fabrication, irradiated fuel reprocessing, radioactive waste management which includes decontamination and decommissioning, and transportation. Three comments pertinent to this analysis are: 1) the WASH-1248 report and this evaluation only address the uranium fuel cycle (other fuel cycles such as thorium and plutonium are not part of this effort), 2) irradiated fuel reprocessing is not being considered by any of the new reactor technologies and is not included in this analysis, and 3) the transportation impacts are addressed based on the following premise - if the quantity of material required by the new gas-cooled reactor technologies at each major step of the fuel cycle is less than the reference plant, then the transportation impacts are also less. Comparing only the number of shipments of material is appropriate since there is little if any radioactivity in the fuel cycle shipments considered by Table S-3.

The main features of the major activities of the reference LWR fuel cycle that were identified as being the primary contributors to the health and environmental impacts are as follows. For the mining operation, annual ore supply is the major determinant of environmental and health impacts. Less ore will necessitate less energy, fewer emissions, less water usage, and less land disturbed. Secondarily, the mining technique can play a significant role in any impacts. Open pit mining has by far the most environment impact, followed by underground mining, with in *situ* leaching being the most environmentally benign.

For the milling operation, annual yellowcake (U_3O_8) production is the metric of interest. If a plant requires less U_3O_8 than the reference plant, then there will be less energy needed, fewer emissions, and less water usage. This is especially true if *in situ* leaching was used to obtain the ore, because the major milling steps of crushing and grinding are not required.

For the uranium conversion process, annual uranium hexafluoride (UF_6) production is the primary determinant of environmental impacts. If the new technology requires less UF_6

than the reference plant, then there will be less energy required, fewer emissions and less. water used. As with the mining step, the conversion process (wet versus dry) is also a consideration. However, NUREG 1437 states that in either case "the environmental releases are so small that changing from 100 percent use of one process to 100 percent of the other would make no significant difference in the totals given in Tables S-3 or S-4."

For the enrichment operation, there are two quantities of interest. The first quantity is the separative work units (SWU) needed to enrich the fuel, and the second quantity is the amount of enriched UF_6. The SWU is a measure of energy required to enrich the fuel. More SWUs would by itself indicate not only more energy required but also more emissions associated with the production of the energy needed and with that more water usage. However, this assumes the same technology is used to achieve the enrichment. As discussed in NUREG 1437, the centrifuge process uses 90 percent less energy than the gaseous diffusion process. Since the major environmental impacts for the entire fuel cycle are from the emissions from the fossil fueled plants needed to supply the energy demands of the gaseous diffusion plant, this reduction in energy requirements results in a fuel cycle with much less environmental impact. With regard to the mount of enriched UF_6 produced, the major effect would be the number of shipments. More UF_6 would necessitate more shipments, while less UF_6 would require fewer shipments. Slight increases or decreases would probably result in the same number of shipments.

For the fuel fabrication process, the quantity of UO_2 produced is the value of interest. This is really equivalent to the annual fuel loading in MTU, which will also be evaluated. Here again, the production of more UO_2 would require more energy, greater emissions, and increased water usage. New reactor technologies with an annual fuel loading less than the reference LWR plant would have less environmental impact, requiring less energy, fewer emissions and less water usage.

The last activity to be addressed is radioactive waste management. There are two aspects of radioactive waste that are considered as part of Table S-3: operations and reactor decontamination and decommissioning (D&D). For these activities, curies (Ci) of low-level waste (LLW) from annual operations and Ci of LLW from reactor (D&D) are the measures to consider. Curies by themselves are not a direct indicator of the potential environmental impacts. The radionuclide, its half-life and type of emission, and its physical and chemical form are the main contributors to risk. While we recognize this distinction, for this bounding analysis we will use curies as was done in the WASH-1248. More curies generally indicate the potential for greater impacts, while fewer curies indicate lesser impacts.

One of the clearest ways to conduct this comparison between the reference LWR and the gas-cooled reactor technologies is to start with the annual fuel loading in MTU for each of the reactor technologies. The other activities more accurately originate from the need for a certain amount of fuel. Using annual fuel loading as the starting point, the analysis will proceed in the reverse direction for the fuel cycle until the mining has been addressed, then the radioactive waste will be addressed. Before beginning this comparison, it is important to recognize that the plants being considered are a different

size, have a different electrical rating and have a different capacity factor from the reference LWR. The reference LWR is a 1000 MWe plant with a capacity factor of 80%. In order to make a proper comparison, we need to evaluate the activities based on the same criterion. In this case, electrical generation is the metric of choice. Electrical generation is why the plants are being built and we want to know if these new reactor technologies, for the same electrical output, have a greater or lesser impact on human health and environment. Based on this, the reactor technologies will be normalized to 800 MWe using plant specific electrical rating and capacity factor.

5.7.2.3 Analysis and Discussion

5.7.2.3.1 Fuel Fabrication / Operations

The reference LWR required 35 MTU on an annual basis. This is equivalent to 40 MT of enriched UO_2, the annual output needed from the fuel fabrication plant. In comparison, the normalized annual fuel needs for the new gas-cooled reactor technologies ranged from 4.3 MTU to 5.3 MTU, approximately 88% to 85% lower than the reference plant. Similarly, the annual output needed from the fuel fabrication plant range from a low of 4.89 MT of UO_2 to 6.0 MT of UO_2, again approximately 88% to 85% lower than the reference plant. The specific breakdowns are shown on Table 5.7-1. One important distinction is that the fuel form for the gas-cooled reactors is also different. For the GT-MHR, the fuel is a two-phase mixture of enriched UO_2 AND UC_2, usually referred to as UCO. For the PBMR the fuel kernel is UO_2. Both fuels are then TRISO coated. For the GT-MHR these TRISO fuel particles are blended and bonded together with a carbonaceous binder. These fuel compacts are then stacked within a graphite block. For the PMBR, the fuel unit is a 6 cm diameter graphite sphere containing approximately 15000 fuel particles,

Before concluding the potential impacts from the fuel fabrication process are less, the gas-cooled reactors require a different fuel fabrication process altogether. The TRISO coated fuel kernel is quite different from the UO_2 sintered fuel pellet and as such would require a different type of facility, Ideally, to ensure the environmental impacts of this change in fabrication process are bounded by the reference LWR fuel fabrication plant, a comparison of the land use, energy demand, effluents, etc., is in order. However, because there are no planned or currently operating plants in the United States, a direct comparison cannot be made at this time. Therefore, we have provided information on the reference fuel fabrication plant along with conceptual design information for a TRISO fabrication plant that was planned for the New Production Reactor and conceptual design information received from one of the gas-cooled reactor vendors.

From WASH-1248, the reference LWR fuel fabrication plant produced fuel for 26 plants (–910 MTU), was located on a site of about 100 acres, required 5.2 million gallons of water per annual fuel requirement of 35 MTU, and required 1,700 MW-hours of electricity per 35 MTU. The WASH-1248 report also states that nearly all of the airborne chemical effluents resulted from the combustion of fossil fuels to produce electricity to operate the fabrication plant. These numbers represented a very small portion of the

overall fuel cycle. For example, the electrical usage represented less than 0.5% of that needed for the enrichment process, and the water use was less than 2% of the overall fuel cycle.

The fuel fabrication facility for the New Production Reactor was for a modular high temperature gas reactor (MHTGR) design and was sized for just one plant, so any comparisons with the much larger reference LWR fuel fabrication plant are problematic. The dimensions for the fuel fabrication building were 230 A x 150 ft. The annual production was about 2 MTU. The plant required 960 kW of electrical power and 45 liters per minute of water. Effluents consisted of 60 m^3/yr of miscellaneous non-combustible solids and filters; 50 m^3/yr of combustible solids; 50 m^3/yr of process off-gas and HVAC filters; 2.0 m^3/yr of tools and failed equipment; and process off-gases of 900,000 m^3/yr. The process off-gases consisted of 74 % N_2, 12% O_2, 7.2% Ar, 6.4% CO_2, 0.2% CO, and 0.02% CH_3CCl_3. The activity associated with this off-gas: 0.01 pCi alpha/m^3, and 0.01 pCi beta/m^3.

The information gathered from one of the current reactor vendors was for a plant producing 6.3 MTU, about 19% more than the annual reload of 5.31 MTU for its reactor. Again this plant was sized for just one reactor. This plant would require 10 MW of electrical power with an annual electrical usage of 35,000 MW-hr. The gaseous emissions consist of 80 MT of nitrogen, 52 MT of argon, 22.4 MT of CO, 22 MT of hydrogen and 3.7 MT of CO_2. The solid waste totals about 84 m^3 of LLW, 3 m^3 of intermediate level waste, and the remainder sanitary/industrial wastes. The liquid processing system would generate an additional 3.8 m^3 of LLW, would discharge about 3700 m^3 of low activity aqueous effluent, and would discharge about 45,000 m^3 of industrial cooling water.

Because of the differences in scale and the state of design of the facilities, it is not possible or appropriate to make a direct comparison of the impacts. Obviously, there are economies of scale and design improvements that will occur for a plant comparable in size to the reference plant. Regardless, the projected impacts of a TRISO fuel plant based on the two conceptual designs are not inconsistent with the reference plant and would be operated within existing air, water, and solid waste regulations, Further; like the impacts associated with the sintered UO_2 pellet plant, the impacts from a TRISO fuel plant would still be a minor contributor to the overall fuel cycle impacts. By characterizing the impacts as "not inconsistent," we mean that while certain parameters such as electrical usage for fuel fabrication might be higher for the gas-cooled plants on an annual fuel loading basis, the environmental impacts from the TRISO plants as conceptualized would still be bounded by the overall LWR fuel cycle impacts.

5.7.2.3.2 Uranium Enrichment

In order to produce the 40 MT of enriched UO_2 for the reference LWR, the enrichment plant needed to produce 52 MT of UF_6, which required 127 MT of SWU. The normalized enriched UF_6 needs for the new gas-cooled reactor technologies ranged from 6.38 MT of UF_6 to 7.9 MT of UF_6, approximately 88% to 85% lower. To produce these

quantities of UF_6 requires from 124 MT of SWU to 163 MT of SWU, slightly lower to 28% higher. The enrichment SWU calculation for the new reactor technologies was performed using the USEC SWU calculator and assumes a 0.30% tails assay, the same value as for the NUREG-0116 reference plant. Using this calculator for the reference LWR plant yielded 126 MT of SWU versus the NUREG value of 127. This is very close indicating that this latest version of the USEC SWU calculator is appropriate for use in this computation. Table 5.7-2 "Gas-cooled Reactor SWU and Feed Calculation Results" gives the details of the computations.

The 28% increase in the MTU of SWU would by itself indicate greater environmental impacts. However, a close look at the original WASH-1248 analysis shows that the environmental impacts are almost totally from the electrical generation needed for the gaseous diffusion process. These impacts result from the emissions from the electrical generation that is assumed to be from coal plants and from the associated water to cool the plants. Today, and in the future, the enrichment process is and will be different. A significant fraction of the enrichment services to US utilities today is provided from European facilities using centrifuge technology rather than the fifty-year-old gaseous diffusion technology. For the future, two private companies, United States Enrichment Corporation and Louisiana Energy Services, are planning to develop centrifuge technology in the US. In fact, NRC has just recently accepted United States Enrichment Corporation's centrifuge license application for technical review, Centrifuge technology requires less than 10% of the energy needed for the gaseous diffusion process and as such the environmental impacts associated with the electrical generation will be correspondingly less. This tremendous reduction in energy and the associated environmental impacts more than offsets a 28% increase in SWU.

5.7.2.3.3 Uranium Hexafluoride Production

In order to provide the feed needed for the reference LWR to the enrichment plant, the uranium hexafluoride plant needed to produce 360 MT of UF_6. The normalized feed needed for the new gas-cooled reactor technologies, the output from the uranium hexafluoride plant, ranged from 241 to 303 MT of UF_6, well below the reference plant. The feed calculations were performed using the USEC SWU calculator. Using this calculator for the reference LWR yielded 353 MT of UF_6 versus the NUREG value of 360. Again this value is very close (<2%) to the published value.

5.7.2.3.4 Uranium Milling

To produce the 360 MT of UF_6 for the reference LWR, 293 MT of yellowcake (U_3O_8) from the mill was required. The normalized new gas-cooled reactor technologies needs ranged from 193 MT of U_3O_8 to 243 U_3O_8, well below the reference plant. These yellowcake numbers were generated using the relationship 2.61285 lbs of U_3O_8 to 1 kg of UF_6. This conversion factor was obtained from ConverDyn.

5.7.2.3.5 Uranium Mining

The raw ore needed to produce the 293 MT of yellowcake (U_3O_8) for the reference LWR was 272,000 MT. Now assuming a 0.1% ore body and a 90% recovery efficiency, the normalized new gas-cooled reactor technologies ore requirements ranged from 215,000 to 270,000 MT of ore, both below the reference plant. Of note, the NUREG table value of 272,000 should be about 325,600 using the same assumptions. It is not clear why this number is different, but in any case, the gas-cooled reactor technologies are below the published reference plant value.

Uranium mining completes the front end of the fuel cycle. However, there are two areas on the down stream cycle to be considered. These are the LLW generated by operations and the LLW generated as past of the D&D process. As mentioned earlier, spent fuel reprocessing is not germane to this analysis, and therefore, not discussed,

5.7.2.3.6 Solid Low-Level Radioactive Waste - Operations

For the reference LWR, 10 CFR 51.51, Table S-3, Table of Uranium Fuel Cycle Environmental Data, states that there are 9,100 Ci of LLW generated annually from operations. The range of activity of LLW generated annually projected by the new gas-cooled reactor technologies is 65.4 Ci to 1,100 Ci, far below the reference LLW. This decrease would also suggest many fewer shipments to the disposal facility and less worker exposure.

5.7.2.3.7 Solid Low-Level Radioactive Waste – Decontamination and Decornrnissioning

10 CFR 51.51, Table S-3, states 1,500 Ci per Reactor Reference Year (RRY) "comes from reactor decontamination and decommissioning – buried at land burial facilities," Based on this small quantity and the modifying phrase "buried at land burial facilities" it is clear that only waste suitable for shallow land burial is being considered. At this time, only general conclusions can be drawn to indicate these gas-cooled reactor technologies would generate less D&D LLW than the reference plant. The new plants will operate much cleaner than the reference LWR as evidenced by the annual generation of much less LLW. Improvements in fuel integrity and differences in fuel forrn as well as the use of the chemically and radiologically inert helium as the coolant are responsible for this reduction and also should contribute to both a lower level and less overall contamination to be managed during the D&D process. The plants higher thermal efficiency and higher fuel burnup would produce less heavy metal radioactive waste. Lastly, the plants are typically more compact than the reference LWR contributing to less D&D waste. Of note, the entry for the PBMR indicated approximately 15 times the RRY curie quantity of D&D waste. The main radionuclides identified for this waste are Co-60 and Fe-55 with half-lives of 5.26 years and 2.73 years respectively. Based on these half-lives, after about 20 years the activity would be less than the reference LWR.

5.7.2.4 Summary and Conclusion

To recap, there are only two instances where any part of the uranium fuel cycle is/might be exceeded by the new gas-cooled reactor technologies. These fuel cycle steps are

enrichment, a 28% increase and possibly D&D. As discussed above, the enrichment requirement for SWU, while slightly larger, can be conducted in a much more environmentally benign manner, centrifuge versus gaseous diffusion, from current overseas sources or expected new domestic facilities. The net effect will be that the environmental and health impacts will be less than those identified in Table S-3. The second area, decontamination and decommissioning, is a minor contributor to the fuel cycle impacts. A slight increase in the D&D step is more than offset by the significant decreases in the impacts due to reduction in fuel needs and changes in the enrichment process and mining technique.

In conclusion, this detailed comparison of the underpinnings of Table S-3 show qualitatively that the existing WASH-1248 environmental and health effects are still conservative and appropriate for use by these new gas-cooled reactor technologies. Collectively, improvements in both past practices as well as changes in technology have resulted in a fuel cycle with lower environmental impact,

5.7.3 Methodology Assessment

As indicated in Section 1.1.3, the selection of a reactor design to be used for the ESP Facility is still under consideration. Selection of a reactor to be used at the ESP Site may not be limited to those considered above. However, the methodology utilized above is appropriate to evaluate the final selected reactor. Further, should the selected design be shown to be bounded by the above evaluation, then the selected design would be considered to be within the acceptable fuel cycle environmental impacts considered for this ESP.

References:

10 CFR 51.51, Table S-3, Table of Uranium Fuel Cycle Environmental Data
NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants,* May 1996
WASM-1248 *Environmental Survey of the Uranium Fuel Cycle,* April 1974
Supplement 1 to WASH-1248 also known as NUREG-0116 *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle,* October *1976*
EGG-NPR-8522, Rev. B *NPR-MHTGR Generic Reactor Plant Description and Source Terms,* March 1991

Table 5.7-1 Gas-cooled Fuel Cycle Worksheet

Reactor Technology Facility/Activity	Reference LWR (Single unit) (1000 MWe) 80% Capacity	GT-MHR (4 Modules) (2400 MWt total) (1140 MWe total) 88% Capacity	PBMR (8 Modules) (3200 MWt total) (1320 MWe total) 95% Capacity
Mining Operations			
Annual ore supply MT	272,000	337140	337140
Normalized annual ore supply MT	272,000	269712	214739
fraction of reference LWR	1	0.99	0.79
Calculated number	314,011	269712	214739
Milling Operations			
Annual yellowcake MT	293	303	303
Normalized annual yellowcake MT	293	243	193
fraction of reference LWR	1	0.83	0.66
Calculated number	283	243	193
UF_6 Production			
Annual UF_6 MT	360	379	379
Normalized annual UF_6 MT	360	303	241
fraction of reference LWR	1	0.84	0.67
Calculated number	353	303	241

Table 5.7-1 Gas-cooled Fuel Cycle Worksheet cont.

Facility/Activity — Reactor Technology	Reference LWR (Single unit) (1000 MWe) 80% Capacity	GT-MHR (4 Modules) (2400 MWt total) (1140 MWe total) 88% Capacity	PBMR (8 Modules) (3200 MWt total) (1320 MWe total) 95% Capacity
Enrichment Operations			
Enriched UF_6 MT	52	8.0	12.3
Normalized enriched UF_6 MT	52	6.38	7.9
fraction of reference LWR	1	0.12	0.15
Calculated number	52	6.38	7.9
Annual SWU MT	127	204	194
Normalized annual SWU MT	127	163	124
fraction of reference LWR	1	1.29	0.97
Calculated number	126	163	124
Fuel Fabrication Plant Operations			
Enriched UO_2 MT	40	6.11	9.5
Normalized enriched UO_2 MT	40	4.89	6.0
fraction of reference LWR	1	0.12	0.15
Calculated number	40	4.89	6.0
Annual Fuel Loading MTU	35	5.39	8.34
Normalized annual fuel loading MTU	35	4.3	5.31
fraction of reference LWR	1	0.12	0.15

Table 5.7-1 Gas-cooled Fuel Cycle Worksheet cont.

Facility/Activity — Reactor Technology	Reference LWR (Single unit) (1000 MWe) 80% Capacity	GT-MHR (4 Modules) (2400 MWt total) (1140 MWe total) 88% Capacity	PBMR (8 Modules) (3200 MWt total) (1320 MWe total) 95% Capacity
Reprocessing Plant Operations			
Annual spent fuel reprocessing MTU	35	0	0
Solid Radioactive Waste			
Annual LLW from reactor operations Ci	9,100	1100 Ci; 98 m^3	65.4 Ci; 800 drums
fraction of reference LWR	1	0.12	0.01
LLW from Reactor Decontamination & Decommissioning Ci per RRY	1,500	[redacted]	2.2×10^4 (5.30×10^5 Ci after 24 years operation and 2 years decay)
TRU and HLW Ci	1.1×10^7	NA	NA

Table 5.7-1 Gas-cooled Fuel Cycle Worksheet cont.

Yellow indicates a value larger than Table S-3

Blue indicates data missing or incomplete

References:
10CFR51.51, Table S-3 Table of Uranium Fuel Cycle Environmental Data

Notes:
The enrichment SWU calculation was performed using the USEC SWU calculator and assumes a 0.30% tails assay.
The information on the reference reactor (mining, milling, UF6, enrichment, fuel fabrication vaiues) taken from NUREG-0116, Table 3.2, no recycling
The information on the reference reactor (solid radioactive waste) taken from 10CFR51.51, Table S-3
The calculated information on the reference reactor uses the same methodology as for the reactor technologies.
The normalized information is based on 1000 MWe and the reactor vendor supplied unit capacity factor.
For the new reactor technologies, the annual fuel loading was provided by the reactor vendor.
The USEC SWU calculator also calculated the kgs of U feed. This number was multiplied by 1.48 to get the necessary amount of UF_6.
The annual yellowcake number was generated using the relationship 2.61285 lbs of U_3O_8 to 1 kg U of UF_6; 1.185 kgs of U308 to 1.48 kg of UF6
The annual ore supply was generated assuming an 0.1% ore body and a 90% recovery efficiency.
Co-60 with a 5.26 year half-life and Fe-55 with a 2.73 year half-life are the main nuclides listed for the PBMR D&D waste.

Table 5.7-2 Gas-cooled Reactor SWU and Feed Calculation Results

Reactor Technology	Kgs Uranium Product	Weight Percent U235	SWU Quantity	Kgs of U Feed Required	Tails Assay
GT-MHR	5,394	19.80%	204373	255918	0.30%
PBMR	8,340	12.90%	194414	255679	0.30%
NUREG 0116	35,000	3.10%	126,175	238,455	0.30%
WASH 1248	35,000	3.20%	-147,280	223,965	0.25%

Notes:
The reactor vendor supplied the Kgs uranium product and weight percent U235.
The tails assay was assumed to be 0.3% to match NUREG-0116 with the exception of WASH 1248 which used a tail assay of 0.25%
The SWU Quantity and Kgs Feed Required were calculated using the USEC SWU Calculator
The results have not been normalized to equivalent electrical generation.

Table 5.7-3, 10 CFR 51.51 Table S-3- of Uranium Fuel Cycle Environmental Data[1]

[Normalized to model LWR annual fuel requirement WASH-12481 or reference reactor year [NUREG-0116]]

[See Footnotes at end of this table]

Environmental Considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
Natural Resource Use		
Land (acres)		
Temporarily committed[2]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 110 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons)		
Discharged to air	160	=2 percent of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000 MWe LWR with once through cooling.
Fossil Fuel:		
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1,000 MWe output
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of scf)	135	<0.4 percent of model 1,000 MWe energy output.
Effluents-Chemical (MT)		
Gases (including entrainment):[3]		
SO_x	4,400	
NO_x[4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases		
F	.67	Principally from UF_6, production, enrichment, and reprocessing. Concentration within range of state standards- below level that has effects on human health.
HCl	.014	
Liquids:		
SO_4^-	9.9	From enrichment, fuel fabrication, and reprocessing

NO_3^-	25.8	steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are: NH_3-600cfs., NO_3-20cfs., Fluoride-70cfs.
Fluoride	12.9	
CA^{++}	5.4	
$C1^-$	8.5	
Na^+	12.1	
NH_3	10.0	
Fe	.4	
Tailings Solutions (thousands of MT)	240	From mills only-- no significant effluents to environment.
Solids	91,000	Principally from mills-- no significant effluents to environment.
Effluents-- Radiological (curies)		
Gases (including entrainment):		
Rn-222		Presently under reconsideration by the Commission.
Ra-226	.02	
Th-230	.02	
Uranium	.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85(thousands)	400	
Ru-106	.14	Principally from fuel reprocessing plants.
I-129	1.3	
I-131	.83	
Tc-99		Presently under consideration by the Commission
Fission products and transuranics	.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling-- included tailings liquor and returned to ground -- no effluents; therefore, no effect on the environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication lants concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low level reactor wastes and 1,5000 Ci comes from reactor decontamination and decommissioning -- buried at land burial facilities. 600 Ci comes from mills -- included in tailing returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.

TRU and HLW (deep)	1.1 x 10^7	Buried at Federal Repository
Effluents-- thermal (billions of British thermal units)	4,063	<5 percent of model 1,000 MWe LWR.
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure	22.6	From reprocessing and waste management.

[49 FR 9381, Mar. 12, 1984; 49 FR 10922, Mar. 23, 1984]

[1] in some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table, should be read as if a specific zero entry had been made. However there are other areas that are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle or estimates of Technetium89 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.

Data supporting this table are given in the Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974; the "Environmental Survey of Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp.2 to WASH-1248): and in the record of final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the two fuel cycles (uranium only and fuel recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of §51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

[2] The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.

[3] Estimated effluents based upon combustion of equivalent coal for power generation.

[4] 1.2 percent from natural gas use and process.

ACRONYMS

The following list gives the major acronyms and abbreviations that were used in the ER sections and supporting documentation.

Acronyms

ABWR	Advanced Boiling Water Reactor
ACR-700	Advanced CANDU Reactor
AECL	Atomic Energy of Canada, Limited
AP-1000	Advanced Passive Pressurized Water Reactor
BWR	Boiling Water Reactor
CANDU	Canada Deuterium Uranium
CFR	Code of Federal Regulations
D&D	Decontamination and Decommissioning
DOE	U. S. Department of Energy
DOE-NE	DOE Office of Nuclear Energy, Science and Technology
DOT	U. S. Department of Transportation
ESBWR	Economic Simplified Boiling Water Reactor
ESP	Early Site Permit
FR	Federal Register
GT-MHR	Gas Turbine-Modular Helium Reactor
INEEL	Idaho National Engineering and Environmental Laboratory
IRIS	International Reactor Innovative and Secure
ISL	in *situ* leaching
kW	kilowatt
LEU	Low Enriched Uranium
LLW	Low-level Radioactive Waste
LWR	Light Water Reactor
MT	Metric Ton
MTU	Metric Ton Uranium
MWd	Megawatt days
MWe	Megawatt electric
MWt	Megawatt thermal
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
NUREG	Nuclear Regulatory Commission Regulation
PBMR	Pebble Bed Modular Reactor
PWR	Pressurized Water Reactor
RRY	Reactor Reference Year
SECY	NRC Office of the Secretary
SWU	Separative Work Unit
TRISO	Fuel kemal coating – three layers of pyrolytic carbon, one layer of silicon carbide
UCO	uranium oxycarbide
USEC	United States Enrichment Corporation

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This bibliography is by no means a complete record of all the works and sources that were consulted. The list is provided to identify the major documents and to facilitate referencing them in the future.

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Code of Federal Regulations

10CFR50.44, Standards for combustible gas control system in light-water-cooled power reactors

10CFR51. Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions, 02/04/2002

10CFR51.22, Criterion for categorical exclusion; identification of licensing and regulatory actions eligible for categorical exclusion or otherwise not requiring environmental review

10CFR51.51, Table S-3 Uranium Fuel Cycle Environmental Data

10CFR51.52, Table S-4 Environmental Impact of Transportation of Fuel and Waste

10CFR52, Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants; Subpart A – Early Site Permits

10CFR61, Licensing Requirements for Land Disposal of Radioactive Waste, Subpart D – Technical Requirements for Land Disposal Facilities

10CFR71, Packaging and Transportation of Radioactive Material

49CFR173, Shippers – General Requirements for Shipments and Packagings

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NUREG-1714 <u>Final Environmental Impact Statement for the Construction and Operation of an Independent Spent Fuel Storage Installation on the Reservation of the Skull Valley Band of Goshute Indians and the Related Transportation Facility in Tooele County, Utah</u>, December 2001

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FORT ST. VRAIN NUCLEAR GENERATING STATION APPLICANT'S ENVIRONMENTAL REPORT OPERATING LICENSE STAGE

Yucca Mountain Information

Spent Nuclear Fuel Transportation, http://www.ymp.gov/new/snf_trans.pdf

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Chapter 6 Environmental Impacts of Transportation describes potential impacts of transportation activities nationally and in Nevada on the transportation-related affected environment
Appendix J Transportation provides the basis for potential impacts related to national and Nevada transportation, as discussed in Chapter 6.
Appendix M Supplemental Transportation Information in response to public comments, this appendix provides general information not specifically related to the transportation analysis considered in Chapter 6 and Appendix J.

Early Site Permit Task Force Documents

Renulatorv Issues Related to the Pebble Bed Modular Reactor (PBMR), letter to Mr. Thomas L. King NRR from James A. Muntz, Exelon dated May 10,2001

Whether Tables S-3 and S-4 Apply to Non-Light Water Reactors (In Particular, to the PBMR)?, letter from E. Neil Jensen, Senior Attorney, Rulemaking & Fuel Cycle Division to Joseph Gray, Associate General Counsel for Licensing & Regulation dated August 29, 2001

Pebble Bed Modular Reactor Preapplication Review – Outcomes Expected, letter from Thomas L. King, Director, Division of Systems Analysis and Regulatory Effectiveness, Office of Nuclear Regulatory Research to James Muntz, Vice President Nuclear Products, Exelon Generation dated September 26,2001

Response to NRC letter date September 26,2001 Regarding the Pebble Bed Modular Reactor Technical Information Availability, letter from James A. Muntz, Vice President, Nuclear Projects, Exelon Generation, to U.S. Nuclear Regulatory Commission dated November 15,2001

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Uranium Industry Annual 2001, DOE/EIA-0478 (2001), May 2002

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CONTACT LIST

This list identifies the contact information for the major people that were contacted or who participated in some capacity for this project.

EARLY SITE PERMIT CONTACT LIST

Ellen Anderson, NEI, 292 739-8117; epa@nei.org

Tony Banks, Dominion, 804.273-2170; tony_banks@dom.com

J. Alan Beard, ABWR
GE Nuclear Energy
13113 Chestnut Oak Drive
Darnestown, MD 20878
James.beard(ii),,eene.Ge.com
Work Phone (301) 208-1460 or (408) 925-3524
Cell Phone (301) 461-3497

George Beck, Parsons (for Exelon); 610 855-2243; George.Beck@,parsons.com

Russ Bell, NET, 202 739-8087; cell phone 301 661-8203; rib@nei.org

Mike Bourgeois
Entergy Nuclear Potomac, Inc.
1340 Echelon Parkway ..
Jackson, MS. 39213
mail unit M-ECH-683
mbourge@entergy.com

Mike Cambria, Parsons; 610 855-2049; michael.cambria@parsons.com

Mario D. Carelli, IRIS
Chief Scientist & Manager of Energy Systems
Science & Technology Department
Westinghouse Electric Company
401 Building
1344 Beulah Road
Pittsburgh, PA 15235-5083
carellmd@westinghouse.com

Guy Gesare, Enercon Services, Inc; gcesare@,enercon.com

Roy Challberg, ESBWR
GE Nuclear Energy
Advanced Reactor Projects
(408) 925-3317
rov.chaIlberg@gene.ge.com

Larry Conway, Westinghouse, IRIS 412 256-1189; conwavle@,,westinPhouse.com

Stefan S. Doerffer
Senior Project Engineer
Atomic Energy of Canada Limited
Advanced Reactor Technology Development
Phone (905) 823-9060 **ext.** 4806
fax (905) 403-7337
e-mail doerffers@aecl.ca
office **SP4F1 41-006**

Carol English, **INEEL** PCE, 526-9234; cci@,inel.gov

R. W. (Bob) Evans, Enercon Services, Inc.; 301 972-5221; bevans@,enercon.com

Eddie Grant
Exelon Generation Company, LLC
M/S KSA 3-E
200 **Exelon** Way
Kennett Square, PA 19348
610-765-5001
eddie.grant@,exeloncora.com

Excel Services
11921 Rockville Pike, Suite 100
Rockville, MD 20852
Phone 301 984-4400

Exelon Generation
200 **Exelon** Way
KSA3-N
Kennett Square, PA 19348
Telephone 610 765-5661
Website http://www.exeloncorp.com

Joe Hegner, Dominion, 804 273-2770 Joseph Hegner(i?),dom.com

Wayne Hickerson
Bechtel Power Corporation
5275 **Westview** Drive
Frederick, MD 21703-8306
BP4-1B11
301-228-6505
301-360-0237 (fax)
wthicker@bechtel.com

Kristie Hicks

CH2M HILL/IDF
1020 Landbank Street
Idaho Falls, ID 83402
208.552.7310 main
208.472.7905 facsys
Khicks1@ch2m.com

Tom Hill, INEEL PI, 526-1711; tjh@inel.gov

Scott Hyman, Dominion, Fuel Group 804 273-3200

Ronaldo Jenkins, NRC, NRR; 301 415-2985; rvj@nrc.gov

Amy Lientz, CH2M Hill, alientz@ch2m.com

Joan Baldwin Lowber, Bechtel - Frederick
North Anna ESP Project Administrator phone 301-228-6211; jlowber@bechtel.com
7215 Corporate Court
F6 1A7
Frederick, MD 21703

Maurice Magugumela
Licensing Manager, U.S. Liaison
PBMR (pty) Ltd
P.O. Box 9396
Lake Buena Vista Building
Centurion 0046 South Africa
Office: 4-27 12 677 9429
Cell: +27 82 551 1674
Maurice.Magugumela@pbmr.co.za

William D. Maher, Exelon Corp., William.Maher@.exeloncorp.com

Travis Mitchell, INEEL PCE, 526-3864; mitctr@inel.gov

Ken Moor, INEEL, 526-8810; ksm@.inel.gov

Marvin Morris, Omega Technical Services; 479 967-2307; otsi@cox-internet.com

Thomas P. Mundy
Exelon Generation Company, LLC
M/S KSA 3-E
200 Exelon Way
Kennett Square, PA 19348
610 765-5662
thomas.mundy@exeloncorp.com

Robert L. Nitschke, INEEL
P.O. Box 1625
Idaho Falls, ID 83415-2209
Phone 208 526-1463
e-mail rln@inel.gov

Nuclear Energy Institute (NEI)
1776 I Street, NW, Suite 400
Washington, D.C. 20006-3708
202 739-8000

Nuclear Regulatory Commission
One White Flint North
11545 Rockville Pike
Rockville, MD 20852

Laurence L. Parme
Manager: GT-MHR Safety and Licensing
General Atomics Co.
P.O. Box 85608
San Diego, CA 92186-560.8
858 455-2518 fax 858 455-2469
Laurence.parme@gat.com

Parsons Energy and Chemicals
2675 Morgantown Road
Reading, PA 19607

Atambir Rao
GE Nuclear Energy
ESBWR Project Manager
(408) 925-1885
atambir.rao@gene.GE.com

Jolene Robinson, DOE-ID Project Manager, 526-2176; robinsik@,id.doe.gov

Stephen Routh
Bechtel Power Corporation
5275 Westview Drive
Frederick, MD 21703
301 228-6245
sdrouth@,bechtkl.com

Wayne Schofield, CH2M Hill, 406-276-3282; 208 521-2669 cell phone;
wschofie@ch2m.com

Waynedog@3rivers.net

Spencer W. Semmes, P.E.
Lead Engineer, Technology
Early Site Permitting Project
Dominion Resources Services, Inc.
5000 Dominion Boulevard
Glen Allen, VA **23060**
804 273-4182
Spencer_Semmes@dom.com

Ron Simard, NEI, **202 739-8128;** rls@nei.org

B. P. Singh, DOE HQ, **NE-20; 301 903-3741;** Bhupinder.singh@hq.doe.gov

Marvin Smith
Dominion
5000 Dominion Blvd.
Glen Allen, VA **23060**
804 **273-2244**
Marvin_Smith@dom.com

Mike **Soulard**
Manager, Customer Studies
Advanced Reactor Technology Department
Atomic Energy Canada, Ltd.
2251 Speakman Drive
Mississaugua, Ontario **L5K 1B2** Canada
ACR-700
soulardm@aecl.ca

Finis Southworth **526-8150; 208 390-9877** cell phone; fin@,inel.gov

Kyle Turner **303 670-8797;** kvieturn@,att.net

John **Vinson,** NEI, transportation guru

James W. Winters
Manager, Passive Plant Projects
Westinghouse Electric Corporation
P.O. Box **355**
Pittsburgh, **PA 15230-0355**
AP-1000
winterjw@westinghouse.com

George Alan Zinke
Project Manager
Nuclear Business Development
Entergy Nuclear Potomac, Inc.
1340 Echelon Parkway
Jackson, MS 39213
mail unit M-ECH-683
601.368.5381 OFFICE
601.368.5323 FAX
gzinke@entergy.com

PRESENTATIONS

This section provides copies of the three slide presentations that were given to the NRC on September 25,2002; December 5,2002; and January 29, 2003.

Background

- Tables S-3 & S-4 used to assess environmental impacts for model LWR
- S-3 - impacts from uranium fuel cycle
- S-4 - impacts from transportation of new and spent fuel and waste
- Use of tables required for use in preparing an Early Site Permit
- Basis documents for S-3 and S-4 are WASH 248/NUREG 0116 and WASH 1238/NUREG-75-038

Characteristics of the advanced reactor designs that are consistent with Tables S-3 and S-4

- Use of NRC and DOT licensed casks
- Acceptable risk levels
- Modes of transportation

Characteristics of the advanced reactor designs that affect the comparison with Tables S-3 and S-4

- Reprocessing
- Enrichment
- Burn-up
- Fuel types
- Cooling time prior to shipment
- Demographics
- Current accident statistics
- Waste disposal

Proposed Approach

- Understand the critical assumptions, parameter values and basis used to develop the current values in Tables S-3 and S-4

  Update assumptions and data sources
- Gather comparable parameter values from the reactor types under consideration
- Develop environmental impacts from advanced reactor types

Proposed Approach (cont.)

- For those impacts bounded by the existing table, document the results
- For those impacts that are not bounded, revisit the assumptions and data used, and prepare alternative values for use by advanced reactor types
- Above all, the environmental impacts should be equivalently protective

Schedule

- Support the existing Early Site Permit plans
- Interim Status meeting with NRC in December
- Draft evaluation by the end of January
- Final report by end of April
- Repond to NRC questions as needed

Summary

- Proposed approach for verifying the use of Tables S-3 & S-4 for advanced reactor designs being considered under the DOE Near Term Deployment initiative

ESP-8

Methodology for Estimating Fuel Cycle and Transportation Environmental Impacts for Early Site Permit Applications

December 5, 2002

NEI

ESP-8 Objectives

- Update NRC staff on industry's Tables S-3/ S-4 initiative
- Original update intended to provide preliminary results
- Due to revised (earlier) meeting date, this briefing provides additional details regarding methodology
- This briefing also describes approach if certain assumptions in existing tables do not initially bound new technologies

NEI

Proposed Methodology for Determining Fuel Cycle Environmental Impacts

- Determine fuel cycle requirements [uranium, enrichment, transportation] for range of technologies considered by ESP applications
- Compare fuel cycle requirements to those used to develop Tables S3 and S4
- Where the fuel cycle requirements are lower than the conditions assumed to develop Tables S3 and S4, use the current table impacts for the environmental evaluation
- Where any fuel cycle requirements are higher than the conditions assumed to develop Tables S3 and S4, evaluate potential impacts along with other fuel cycle technology changes that may have reduced environmental impacts

NEI

10 CFR 51.51, Table S-3

- Table S-3 developed based on fuel requirements for a model 1000 MWe LWR
- Uranium, SWU, and transport requirements will be compared with the values used as basis of current Table S-3 for the same energy output
- Technology improvements that have tended to reduce environmental impacts may offset any increase in fuel cycle and transportation requirements

NEI

Fuel Cycle Technology Changes

- Higher fuel burnup
  - Reduces average annual fuel loading [lower number of fuel assemblies at higher enrichment]
  - Generally reduces average annual uranium ore requirements, but may slightly increase SWU
- Higher Operating Plant Capacity Factor
  - Increases both energy production and fuel requirements
- Improved enrichment processes
  - Lower emissions from electric generation
  - Improved energy efficiency [especially for centrifuge enrichment technology]
- No spent fuel reprocessing expected

NEI

10 CFR 51.52, Table S-4

- Current Table S-4 is based on the transportation of fuel and waste to and from a 1100 MWe LWR subject to the following conditions
  - Core power not to exceed 3,800 MWt
  - Uranium dioxide pellets of less than 4% enrichment encapsulated in zircaloy rods
  - Average irradiation of no more than 33,000 megawatt-days per metric ton, and no assembly shipped until at least 90 days after discharge

NEI

10 CFR 51.52, Table S-4 (cont.)

- The number, modes, types and radioactive inventories of shipments of spent fuel and wastes will be determined for a range of reactor technologies and compared to the values used as a basis of current Table S-4 for the same energy output
- Any increases of these values will be evaluated
- Technology improvements have tended to reduce transportation environmental impacts and may off set any changes in transportation conditions

NEI

Changes in Fuel Cycle Transportation Technology

- Higher fuel burnup reduces spent fuel generation and reduces quantity of spent fuel to be shipped
- New fuel types do not all use zircaloy rods
- Longer cooling time after discharge [minimum of 5 years - average of over 10 years] reduces source term at transport
- Transport casks for new fuel types and higher burnup fuel must meet same normal and accident dose limits

NEI

ESP-8, Tables S-3 & S-4

Fuel Cycle and Transportation Evaluation of New Reactor Technologies

January 29, 2003

NEI

ESP-8 Task History

- September 25th - presented an approach to Tables S-3 & S-4
- Gathered background information, vendor data, other supporting materials
- December 5th - presented refined methodology
- January 29th – discussion of preliminary findings

NEI

Key Points of the Methodology

- As in the WASH reports, use conservative but reasonable assumptions
- Compare ESP fuel cycle and transportation requirements with those assumed to calculate the environmental impacts shown in Tables S-3 & S-4
- Evaluate any potential increases in fuel cycle requirements [e.g., enrichment]
- Demonstrate that Tables S3 & S4 are suitable for determining the expected fuel cycle environmental impacts in ESP applications

NEI

General Observations

- Stricter environmental regulations are in effect for all operations
- Mining and milling operations are considerably different
- UF_6 conversion similar
- Enrichment process potentially much different

NEI

Matter before the ESP Task Force

- Are the existing Tables S-3 and S-4 bounding and appropriate for advanced reactor types?
- If not, what would be equivalent environmental effects
- Six reactor types currently being considered: 3 advanced LWRs, 2 gas-cooled reactors and 1 advanced heavy water

Early Site Permit Approach to Tables S-3 & S-4

Nuclear Energy Institute
Early Site Permit Task Force

Presentation to the

U. S. Nuclear Regulatory Commission

September 25, 2002

General Observations (cont.)

- Fuel fabrication similar for light water reactors, different for gas-cooled reactors
- Low-level waste generation from operations much less
- Transportation regulations similar
- Recent evaluations still support conclusion that transportation impacts are minimal

NEI

Preliminary Fuel Cycle Results

- Generally the new reactor technologies require less uranium ore, yellowcake, and UF_6 so the mining, milling, and conversion impacts should be bounded
- Slightly higher SWU in some cases, up to 20% in one case, but due to changes in enrichment technology, stricter environmental regulations and method of electrical generation the fuel cycle environmental impacts shown in Table S3 are still appropriate for the ESP applications

NEI

Preliminary Fuel Cycle Results (cont.)

- Annual fuel loading exceeded in one case but the planned number of shipments is 2 fewer than the reference LWR so the impacts are expected to be bounded
- Much less LLW from operations so radwaste impacts would be bounded
- Still evaluating D&D and gas-cooled fuel fabrication

NEI

Preliminary Transportation Results

- Thermal power exceeded in one case; potential impacts addressed as part of the overall fuel cycle
- Fuel form, cladding different in two cases; potential impacts addressed as part of the packaging requirements
- Enrichment and burnup exceeded in one case; potential impacts addressed as part of the packaging requirements

NEI

Preliminary Transportation Results (cont.)

- Initial core loading shipments exceeded in two cases; potential impacts bounded since the total number of shipments (initial and annual reload) are less than the reference LWR
- Fuel inventory is greater in some cases; potential impacts addressed as part of the packaging requirements

NEI

ESP-8 Summary

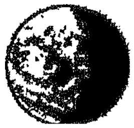
- Preliminary results indicate that fuel cycle and transportation impacts for a range of new reactor technologies are consistent with Tables S3 and S4
- Preparing to send ESP-8 resolution letter
- NRC staff feedback desired on industry-proposed approach

NEI

VENDOR DATA SUBMITTALS

The following section is divided into seven subsections for the seven reactor technologies that were considered. The seven sections are the ABWR, ESBWR, AP-1000, IRIS, ACR-700, GT-MHR and the PBMR. Along with the vendor data submittals are subsequent e-mail discussions that modified some of the original supplied data.

ABWR



"Beard, James A. (PS, NE)" <james.beard@gene.GE.com>

02/13/2003 09:46 AM

To: "Beard, James A. (PS, NE)" <james.beard@gene.GE.com>, rln@inel.gov
cc: "Carnbria, Michael (Parsons)" <Michael.Cambria@parsons.com>, "Smith, Marvin (Dominion)" <Marvin_Smith@dom.com>, "Semmes, Spencer (Dominion)" <Spencer_Semmes@dom.com>, "Atambir S. Rao (PS, NE) (E-mail)" <atambir.rao@gene.GE.com>
Fax to:
Subject: RE: ABWR Decay Heat Loads for 5 year Old Fuel

All:

Let me try again with the information in an attached file and not as an ernbeeded object.

Alan

<<5 year decay heat.doc>>

> -----Original Message-----
> From: Beard, James A. (PS, NE)
> Sent: Thursday, February 13, 2003 8:27 AM
> To: 'rln@inel.gov'
> **Cc:** 'Cambria, Michael (Parsons)'; 'Smith, Marvin (Dominion)'; 'Semmes,
> Spencer (Dominion)'
> Subject: ABWR Decay Heat Loads for 5 year Old Fuel
>
> Robert:
>
> Please revise the information regarding decay heat of 5 year old fuel that
> we provided previously with the information below.
>
> Let me know if you have any furhter questions.
>
> g GE NUCLEAR ENERGY
>
> J. Alan Beard
>
> Program Manager
> James.Beard@gene.ge.com
> Work Phone **(301)** 208-1460 or (408) 925-3524
> Cell Phone **(301)** 461-3497
>
>
>
> << OLE Object: Device Independent Bitmap >>

5 year decay heat.d

Table 5-2, Decay Heat after Five Years Cooling (no uncertainty allowance)

	Initial Core Discharge	Reload Core Discharge
Relative Decay Heat after 5 yrs	7.800×10^{-5}	9.886×10^{-5}
Decay Heat (MW/MTU)	2.14×10^{-3}	2.71×10^{-3}

Table 5-3, Decay Heat after Five Years Cooling (two sigma uncertainty allowance)

	Initial Core Discharge	Reload Core Discharge
Relative Decay Heat after 5 yrs	8.398×10^{-5}	1.060×10^{-4}
Decay Heat (MW/MTU)	2.30×10^{-3}	2.90×10^{-3}

"Beard, James A. (PS, NE)" <james.beard@gene.GE.com> on 02/12/2003 08:56:50 AM

To: rln@inel.gov
cc:

Subject: FW: Spent Fuel Radioactivity

> Bob:
>
> Attached is a table with the radioactive inventory of the ABWR spent fuel
> 5 years after discharge from the reactor. Let me know if you have any
> questions or concerns.
>
> Alan
>
>
>
> <<CoreInventory.doc>>
>
> Provide estimates of the spent fuel inventories and radioactivity, in Ci
> per MTU, after 5 years of decay
> Fission product inventory
> Actinide inventory
> Total radioactivity
> krypton-85 inventory
>
> The reactor type is an ABWR at a power level of 4300 MWt
> The fuel type is GE 14 with the following characteristics.
>

	Initial Core	Reload 1	Reload 2 to Eq.
Core Size, number of bundles	872	872	872
Core Thermal Power, MWth	4300	4300	4300
Operating Cycle Length, days	605	605	605
Operating Capacity Factor, %	100	100	100
Refueling Outage Duration, days	30	30	30
Refueling Interval, months	21	21	21
Loaded Batch Size	872	240	316
Batch Average Enrichment, w/o U235	3.5	4.5	4.5
Average Bundle Mass, KgU	180	180	180
Batch Average Burnup, GWd/MT	36	46	46

>
>

CoreInventory.d

Five Year Decay Inventory, GE Fuel

Activation Products		Actinides + Daughters		Fission Products	
Isotope	Curie/MTU	Isotope	Curie/MTU	Isotope	Curie/MTU
Ag-109m	7.76E-04	Am-241	1.34E+03	Ag-108	3.44E-06
Ar-37	5.48E-16	Am-242	3.32E+01	Ag-109m	1.36E-04
Ar-39	3.42E-04	Am-242m	3.34E+01	Ag-110	4.44E-01
C-14	7.70E-01	Am-243	3.24E-t-01	Ag-110m	3.34E+01
Ca-41	1.18E-03	Am-245	2.50E-09	Ba-137m	1.18E+05
Ca-45	8.65E-04	Bi-212	4.49E-02	Cd-113m	6.13E+01
Cd-109	7.76E-04	Bk-249	1.72E-04	Cd-115m	6.79E-10
Cd-115m	1.12E-13	Cm-241	1.01E-17	Ce-141	1.49E-11
Cl-36	1.86E-02	Cm-242	5.51E+01	Ce-144	1.14E+04
Co-58	7.49E-05	Cm-243	3.69E+01	(3-134	4.81E+04
Co-60	2.73E+03	Cm-244	4.86E+03	Cs-135	8.22E-01
Cr-51	5.28E-16	Cm-245	6.56E-01	(3-137	1.24E+05
Eu-152	1.08E-03	Cm-246	1.41E-01	ELI-152	1.09E+01
Eu-154	1.53E+02	Np-235	5.01E-04	Eu-154	1.01E+04
Eu-155	7.14E+01	Np-237	6.16E-01	Eu-155	5.22E+03
Fe-55	3.35E+03	Np-238	1.67E-01	Gd-153	1.41E-01
Fe-59	4.32E-10	Np-239	3.24E+01	H-3	5.34E-I-02
Gd-153	2.26E+01	Np-240m	9.23E-07	I-129	4.20E-02
H-3	5.24E-04	Pa-233	6.16E-01	In-114	4.21E-11
Hf-175	3.05E-07	Pa-234m	3.13E-01	In-114m	4.39E-11
Hf-181	1.08E-10	Pb-212	4.49E-02	In-115m	4.77E-14
Ho-166m	2.39E-02	Po-212	2.88E-02	Kr-85	8.90E+03
In-113m	1.95E-02	Po-216	4.49E-02	Nb-93m	7.54E-01
In-114	1.63E-09	Pu-236	3.56E-01	Nb-95	6.78E-03
In-114m	1.70E-09	Pu-237	4.37E-12	Nb-95m	2.27E-05
Ir-192	8.59E-08	Pu-238	6.14E+03	Pd-107	1.46E-01
K-42	1.63E-12	Pu-239	3.87E+02	Pm-146	1.84E+00
Lu-177	9.04E-07	Pu-240	6.15E+02	Pm-147	3.37E+04
LLI-177m	3.93E-06	Pu-241	1.22E+05	Pm-148	8.59E-11
Mn-54	3.46E+01	Pu-242	2.24E+00	Pm-148m	1.52E-09
Mo-93	1.95E-02	Pu-243	5.85E-07	Pr-144	1.14E+04
Nb-93m	1.98E-01	Ra-224	4.49E-02	Pr-144m	1.37E+02
Nb-94	1.76E-01	Rn-220	4.49E-02	Rh-102	4.67E-01
Nb-95	4.55E-04	Th-228	4.49E-02	Rh-103m	1.09E-08
Nb-95m	1.52E-06	Th-231	2.20E-02	Rh-106	1.64E+04
Ni-59	2.59E+00	Th-234	3.13E-01	Ru-103	1.21E-08
Ni-63	4.20E+02	Tl-208	1.61E-02	Ru-106	1.64E+04
P-32	2.89E-08	U-232	6.00E-02	Sb-124	1.17E-06
Re-188	9.56E-08	U-234	1.47E+00	Sb-125	4.45E+03
Ru-103	8.38E-16	U-235	2.20E-02	Sb-126	1.43E-01
S-35	1.84E-05	U-236	3.77E-01	Sb-126m	1.02E+00
Sb-124	2.93E-08	U-237	3.00E+00	Se-79	5.61E-01
Sb-125	9.16E+02	U-238	3.13E-01	Srn-151	5.60E+02

Five Year Decay Inventory, GE Fuel

Activation Products

Isotope	Curie/MTU
Sc-46	7.04E-07
Sn-113	1.95E-02
Sn-119m	5.20E+01
Sn-121m	1.12E+00
Sn-123	2.40E-02
Sr-89	8.94E-10
Sr-90	6.68E-03
Ta-182	1.74E-01
Tb-160	1.49E-03
Tc-99	4.80E-03
Te-123m	2.45E-04
Te-125m	2.24E+02
Te-127	7.52E-07
Te-127m	7.67E-07
Tm-170	2.43E-07
W-181	1.82E-04
W-185	1.08E-05
W-188	9.46E-08
Y-90	6.68E-03
Y-91	6.98E-08
Zn-65	2.39E-03
Zr-93	6.86E-01
Zr-95	2.05E-04
Total	7.98E+03

Actinides + Daughters

Isotope	Curie/MTU
U-240	9.23E-07
Total	1.36E+05

Fission Products

Isotope	Curie/MTU
Sn-119m	1.24E+00
Sn-121m	2.46E-01
Sn-123	1.60E-01
Sn-126	1.02E+00
Sr-89	8.33E-06
Sr-90	8.85E+04
Tb-160	3.14E-05
Tc-99	1.74E+01
Te-123m	6.79E-04
Te-125m	1.09E+03
Te-127	1.02E-01
Te-127m	1.04E-01
Te-129	1.02E-12
Te-129m	1.57E-12
Y-90	8.85E+04
Y-91	3.38E-04
Zr-93	2.50E+00
Zr-95	3.05E-03
Total	5.87E+05

128

TOTAL - 171

Five Year Decay Inventory, GE Fuel

Activation Products

Isotope	Curie/MTU
Ag	7.78E-04
Ar	3.42E-04
Be	2.12E-06
C	7.70E-01
Ca	2.05E-03
Cd	7.76E-04
Cl	1.86E-02
Co	2.73E+03
Cr	5.28E-16
Eu	2.24E+02
Fe	3.35E+03
Gd	2.26E+01
H	5.24E-04
Hf	1.01E-06
Ho	2.39E-02
I	1.75E-13
In	1.95E-02
Ir	1.70E-07
K	3.20E-08
Lu	4.84E-06
Mn	3.46E+01
Mo	1.95E-02
Nb	3.75E-01
Ni	4.23E+02
Os	7.29E-10
P	2.89E-08
Pb	8.97E-08
Re	2.45E-07
Ru	2.66E-14
S	1.84E-05
Sb	9.16E+02
Sc	7.04E-07
Si	2.88E-08
Sm	4.19E-06
Sn	5.32E+01
Sr	6.68E-03
Ta	1.74E-01
Tb	1.49E-03
Tc	4.80E-03
Te	2.24E+02
Tm	7.28E-06
V	2.01E-14

Actinides + Daughters

Isotope	Curie/MIIU
Am	1.44E+03
Bi	4.49E-02
Bk	1.72E-04
Cm	4.95E+03
Np	3.32E-t-01
Pa	9.30E-01
Pb	4.49E-02
Po	7.36E-02
Pu	1.29E+05
Ra	4.49E-02
Rn	4.49E-02
Th	3.80E-01
Tl	1.61E-02
U	5.24E-i-00
Total	1.36E+05

Fission Products

Isotope	Curie/MTU
Ag	3.38E+01
Ba	1.18E+05
Cd	6.13E+01
Ce	1.14E+04
Cs	1.72E+05
Eu	1.53E+04
Gd	1.41E-01
H	5.34E+02
Ho	4.51E-03
I	4.20E-02
In	9.98E-11
Kr	8.90E+03
La	1.47E-10
Nb	7.61E-01
Nd	2.17E-09
Pd	1.46E-01
Pm	3.37E-i-04
Pr	1.15E+04
Rb	2.99E-05
Rh	1.64E+04
Ru	1.64E+04
Sb	4.45E+03
Se	5.61E-01
Sm	5.60E+02
Sn	2.66E+00
Sr	8.85E+04
Tb	3.14E-05
Tc	1.74E+01
Te	1.09E+03
Xe	6.58E-17
Y	8.85E+04
Zr	2.50E+00
Total	5.87E+05

Five Year Decay Inventory, GE Fuel

Activation Products

Isotope	Curie/MTU
W	1.93E-04
Y	6.68E-03
Zn	2.39E-03
Zr	6.86E-01
Total	7.98E+03

Actinides + Daughters

Isotope	Curie/MTU

Fission Products

Isotope	Curie/MTU

"Beard, James A. (PS, NE)" <james.beard@gene.GE.com>

02/04/2003 06:21 PM

To: "Cambria, Michael (Parsons)" <Michael.Cambria@parsons.com>, eddie.grant@exeloncorp.com, rln@inel.gov
cc:
Fax to:
Subject: ABWR **S-3** and *4* Information

Mike, Eddie and Robert:

Here at long last is the S-3 and S-4 information. I hope that we have provided the information that you need to complete your assessment. If you should require any additional information please let me know right away.

Thanks

Alan

g GE NUCLEAR ENERGY

J. Alan Beard

Program Manager
James.Beard@gene.ge.com
Work Phone (301) 208-1460 or (408) 925-3524
Cell Phone (301) 461-3497

<<S3_S4 Questions-ABWR.doc>>

S3_S4 Questions-ABWR

ESP 8: Reactor Vendor Questionnaire

Information on Annual Fuel Requirements

1. Define Standard Technical Configuration.
   - Provide expected reactor power, MW_t and MW_e for each reactor

     For the GE ABWR and ESBWR the uprated thermal power of the ABWR of 4300 MWt is used to bound both reactors. For reference the currently certified power level of the ABWR is 3926 MWt and the ESBWR design value is 4000 MWt

   - Number of modules or reactors expected for a typical unit configuration for small modular systems

     The ABWR and ESBWR are both designed as single unit plants.

2. Expected Fuel Loading
   - Provide Initial Core Fuel Loading in MTU

     The initial core load for the ABWR and ESBWR are approximately equal. For the ABWR the initial core-load is 156.96 MT of Uranium.

   - Provide Annual Average Fuel Loading in MTU based on 40 years of operation

     The average annual fuel loading in MTU is 32.76. This is based on an average capacity factor of 95%. This capacity factor is subject to variation by the operating practices of the utility but in GE's view represents a reasonably achievable measure. This figure includes allowances for refueling and maintenance outages but does not include any provision for extended outages.

   [Note: Provide the basis for the above estimates, i.e. estimated unit capacity factor, refueling/maintenance outage frequencies and durations, and average expected energy produced per year.]

3. Average Fuel Enrichment in % U-235
   [Note: Provide table of MTU and enrichment if multiple fuel enrichments are normally used for the initial core or fuel reloads]

   The batch average enrichment of the core is less than 3.5% for the initial core and less than 4.5% for the subsequent reloads.

4. Fuel form
   - Provide Fuel Assembly (or Basic Fuel Unit) Drawing

     See Figure at back of information

- Provide a Table giving the following for each fuel unit:

Total Mass	Bundle average mass is 266 kg (without channel) Bundle average mass is 298 kg (with channel)
Uranium Mass	Bundle Average Uranium mass 180 kg
Volume	
Outside Dimensions	14.2 cm x 14.2 cm x 447.0 cm (with channel)

An estimate of the typical number of fuel assemblies or units required for the initial core and the average expected number of fuel assemblies or units per year for core reloads

For the ABWR the core holds 872 fuel assemblies. The information provided in response to this request is based on the GE-14 fuel type, which is the latest offering of the GE fuels group. The basic design of the GE-14 is the same as earlier BWR fuels offered by GE as far as overall dimensions. However, improvements in the design have been made to optimize the fuel utilization.

The ESBWR core will hold a total of 1020 bundles. The cross sectional area of these bundles will be the same as the ABWR. However they are approximately 15% shorter so the net effect is that the same amount of Uranium is held in the core as for the ABWR.

5. Fuel materials
- Provide a table of fuel material types and mass for a typical fuel unit including a description of fuel, structural, and cladding materials

The channel, fuel rods (cladding), water rods, spacers and end plugs are all fabricated fiom Zircalloy, of which there is approximately 85 kg used in each bundle.

The upper and lower tie plates and assorted fasteners are fabricated fiom stainless steel of which there is approximately 6.8 kg used in each bundle

There are a number of small components that are fabricated from inconel of which there is a approximately 0.5 kg used per bundle.

467
44
/13
/22
8
/2003

ESP 8 Reactor Vendor Questionnaire (cont'd)

Information on Annual Fuel Requirements (cont'd)

6. Define the expected typical transport mode (i.e. truck, rail, etc.) for delivery of the unirradiated fuel from the fabrication facility or port of entry to the reactor site

   Typical shipment of new fuel from the GE fuel facility in Wilmington, NC is by flat bed tractor trailer.

7. Provide a general description of the transport containers expected to be used for delivery of unirradiated fuel
   - Capacity of each container, i.e. number of fuel units per container

     The transport containers consist of a dual packaging system. Two fuel assemblies are first packed in a padded steel box. The steel box is then packaged inside a padded . wooden crate. The dimensions of a typical wooden crate are 30" x 30" X 15'6"

   - Number of containers that can be transported on one legal weight truck shipment

     The number of bundles that typically can be shipped on a single truck is either 28 or 30 and is limited by weight.

   [Note: This data is intended to allow for a determination of the number of shipments and MTU for the initial core loading and the average number of shipments and MTU per year for core reloads.]

Information on Expected Low Level Waste Production

1. Estimated annual average LLW production expected from reactor operations
   - Provide an estimate of the expected volumes and curies of LLW

     The production of LLW is in large part controlled by the practices of the owner. GE in the design certification chose not to establish unreasonable expectations for future owners and as such followed the maximum target values. In this case the volume of LLW is 100 cubic meters per year with an estimated curie content of 2700 Ci.

2. LLW expected from reactor decontamination and decommissioning
   - Provide an estimate of the expected volumes and curies of LLW produced due to reactor decontamination and decommissioning

The process for decontamination and decommissioning of an ABWR is outside the control of GE and subject to a great deal of variation depending on the timing and the methods chosen. As such, GE is unable to provide a reasonable estimate for these values!

ESP 8 Reactor Vendor Questionnaire (cont'd)

Information on Spent Fuel Production/Transport

1. Spent Fuel Shipments
   - Provide an estimate of the quantity (MTU) of irradiated fuel that can be transported in one legal weight truck cask **[25** ton cask] or typical rail cask [100 ton cask], assuming 5 year cooling after discharge.
     [Note: Estimate should be in MTU (based on unirradiated MTU) and number of fuel units to allow for a determination of the average number of spent fuel shipments expected per year of reactor operation.]

     GE is not familiar with the constraints of fuel assemblies that can be transported in the commercially available casks. What we can tell you is the GE-14 fuel type is nearly identical to the other GE fuel types and the number of BWR fuel assemblies that can be shipped should not be different for the ABWR.

     Assume 7 BWRs

2. Provide the average fuel burnup in MWd/MTU

   After achieving an equilibrium core, the batch average burnup is 46 GWd/MT

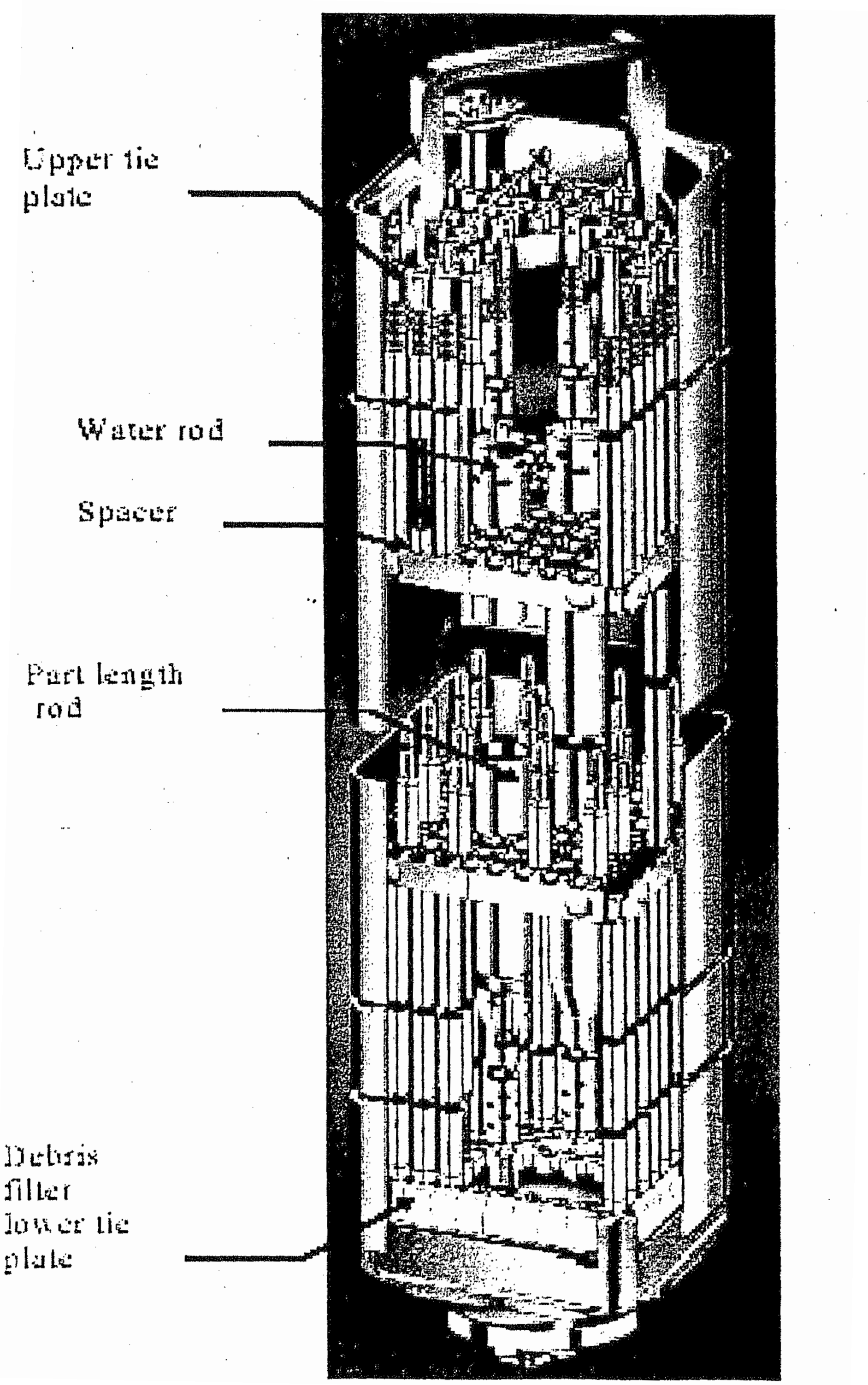
3. Provide an estimate of the decay heat in watts per MTU after 5 years of decay from fuel discharge

   The estimated decay heat per MTU **5** years after discharge from the core is between **18-22** kilowatts.

4. Provide estimates of the spent fuel inventories and radioactivity, in Ci per MTU, after 5 years of decay
   - Fission product inventory
   - Actinide inventory
   - Total radioactivity
   - Krypton-85 inventory

   GE is still trying to gather these numbers and will provide this information as soon as possible.

   [Note: If available, please provide a complete set of the ORIGEN run results (or other applicable code for the appropriate reactor type) detailing the spent fuel inventories at **5** years decay to answer questions 3 and 4.]


Upper tie
plate
Water rod
Spacer
Part length
rod
Debris
filter
lower tie
plate

ESBWR

"Challberg, Roy C. (PS, NE)" <roy.challberg@gene.GE.com> on 03/17/2003 01:29:04 PM

To: RLNQ inel.gov
cc:

Subject: RE: ESP-8 Information for the ESBWR

We originally developed the design for the European market but now are in the pre-certification phase with the NRC for US certification. The "E" officially stands for "Economic". And yes, the "S" is simplified.

Sorry for the long winded answer.
Roy

-----Original Message-----
From: RLN@inel.gov [mailto:RLN@inel.gov]
Sent: Monday, March 17, 2003 12:31 PM
To: Challberg, Roy C. (PS, NE)
Subject: RE: ESP-8 Information for the ESBWR

Thanks for the confirmation Roy. One more little item. What do the letters ES of the initials ESBWR represent? I have seen European Simplified and Economic Simplified but most of the time it escapes definition. Thanks for your help.

Bob

"Challberg, Roy C. (PS, NE)" <roy.challberg@gene.GE.com> 03/17/2003 12:39 PM

To: RLN@inel.gov
cc:
Fax to:
Subject: RE: ESP-8 Information for the ESBWR

Bob-
You're exactly right. The bounding decay heat value for one of the reload cores for ABWR (4300 MWt) was 2.9 kW. That was the decay heat after 5 years
(with a 2 sigma uncertainty). This will bound the 4000 MWt ESBWR fuel.
Roy

-----Original Message-----
From: RLN@inel.gov [mailto:RLN@inel.gov]
Sent: Monday, March 17, 2003 9:09 AM
To: Challberg, Roy C. (PS, NE)
Subject: RE: ESP-8 Information for the ESBWR

Thanks much Roy. I understand the potential variability of the numbers. For this effort, we just need some justification for the value we select, so thanks again.

In looking closer at the data, one other item has arisen: the decay heat value. I know for the ABWR they originally gave the same 18 -22 kW per MTU value. Later, upon questioning , it was modified to 2.9. This was the two sigma uncertainty value for the reload core discharge after five years cooling.

If you would please check into this for the ESBWR.

Thank you.

Bob

"Challberg, Roy C. (PS, NE)" <roy.challberg@gene.GE.com>
03/17/2003 09:43 AM

To: RLN@inel.gov
cc:
Fax to:
Subject: RE: ESP-8 Information for the ESBWR

Bob-
Our recent heat balance of our total plant design for a typical site gives us 1390 MWe, which of course is highly dependent upon site conditions and type of heat sink.
Let me know if you need anything else.
Roy

GE Nuclear Energy
Advanced Reactor Projects
(408) 925-3317

-----Original Message-----
From: RLN@inel.gov [mailto:RLN@inel.gov]
Sent: Friday, March 14, 2003 3:19 PM

To: Challberg, Roy C. (PS, NE)
Subject: Re: ESP-8 Information for the ESBWR

Hi Roy,

Thanks for the ESBWR information. I'll look at it Monday and see if I have any questions. One item I do need, is what is the MWe for the ESBWR? I use it and the capacity factor to normalize to the reference LWR which was 1000 MWe and 80%.

Have a **good** weekend.

Bob

Robert L. Nitschke
Science Fellow
INEEL, IRC 602/242
P.O. Box 1625
Idaho Falls, ID 83415-2209
Phone 208 526-1463 Fax 208 526-0690

"Challberg, Roy C.(PS, NE)" <roy.challberg@gene.GE.com> on 03/17/2003 12:39:38 PM

To: RLN@inel.gov
cc:

Subject: RE: ESP-8 Information for the ESBWR

Bob-
You're exactly right. The bounding decay heat value for one of the reload cores for ABWR (4300 MWt) was 2.9 kW. That was the decay heat after 5 years (with a 2 sigma uncertainty). This will bound the 4000 MWt ESBWR fuel.
Roy

-----Original Message-----
From: RLNQinel.gov [mailto:RLN@inel.gov]
Sent: Monday, March 17, 2003 9:09 AM
To: Challberg, Roy C. (PS, NE)
Subject: RE: ESP-8 Information for the ESBWR

Thanks much Roy. I understand the potential variability of the numbers. For this effort, we just need some justification for the value we select, so thanks again.

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Thank you.

Bob

"Challberg, Roy C. (PS, NE)" <roy.challberg@gene.GE.com>
03/17/2003 09:43 AM

To: RLN@inel.gov
cc:
Fax to:
Subject: RE: ESP-8 Information for the ESBWR

Bob-
Our recent heat balance of our total plant design for a typical site gives us 1390 MWe, which of course is highly dependent upon site conditions and type of heat sink.
Let me know if you need anything else.
Roy

GE Nuclear Energy
Advanced Reactor Projects
(408) 925-3317

-----Original Message-----
From: RLN@inel.gov [mailto:RLN@inel.gov]
Sent: Friday, March 14, 2003 3:19 PM
To: Challberg, Roy C. (PS, NE)
Subject: Re: ESP-8 Information for the ESBWR

Hi Roy,

Thanks for the ESBWR information. I'll look at it Monday and see if I have any questions. One item I do need, is what is the MWe for the ESBWR? I use it and the capacity factor to normalize to the reference LWR which was 1000 MWe and 80%.

Have a good weekend.

Bob

Robert L. Nitschke
Science Fellow
INEEL, IRC 602/242
P.O. Box 1625
Idaho Falls, ID 83415-2209
Phone 208 526-1463 Fax 208 526-0690

"Challberg, Roy C. (PS, NE)" <roy.challberg@gene.GE.com> on 03/17/2003 09:43:07 AM

To: RLNQinel.gov
cc:

Subject: RE: ESP-8 Information for the **ESBWR**

Bob-
Our recent heat balance of our total plant design for a typical site gives us 1390 MWe, which of course is highly dependent upon site conditions and type **of** heat sink.
Let me know if you need anything else.
Roy

GE Nuclear Energy
Advanced Reactor Projects
(408) 925-3317

-----Original Message-----
From: RLN@inel.gov [mailto:RLN@inel.gov]
Sent: Friday, March 14, 2003 3:19 PM
To: Challberg, Roy **C.** (PS, NE)
Subject: Re: ESP-8 Information for the ESBWR

Hi Roy,

Thanks for the ESBWR information. I'll look at it Monday and see if I have any questions. One item I do need, is what is the MWe for the ESBWR? I use it and the capacity factor to normalize to the reference LWR which was 1000 MWe and 80%.

Have **a** good weekend.

Bob

Robert L. Nitschke
Science Fellow
INEEL, IRC 602/242
P.O. Box 1625
Idaho Falls, ID 83415-2209
Phone 208 526-1463 Fax 208 526-0690

"Challberg,Roy C.(PS, NE)" <roy.challberg@gene.GE.com> on 03/14/2003 02:55:12 PM

To: "Nitschke,Robert (INEEL)" crlnQinel.gov,
cc: "Cambria, Michael(Parsons)" <Michael.Cambria@parsons.com>, "Mundy,Thomas(Exelon)" <thomas.mundy@exeloncorp.com>, "Rao, Atambir" <atambir.rao@gene.GE.com>

Subject: ESP-8 *Information* for the ESBWR

Robert-
Attached is a file describing the GE ESBWR fuel and core, in response to the ESP-8 questionaire (S-3/4 information).

If you need further information, please don't hesitate to contact me directly.

Roy Challberg
GE Nuclear Energy
Advanced Reactor Projects
(408) 925-3317
<mailto:roy.challberg@gene.ge.com>

<<S3_S4 Questions-ESBWR.doc>>

S3_S4 Questions-ESBWR.do

ESP 8: Reactor Vendor Questionnaire

Information on Annual Fuel Requirements

1. Define Standard Technical Configuration.
   - Provide expected reactor power, MW_t and MW_e for each reactor

     For the GE ABWR and ESBWR the uprated thermal power of the <u>ABWR</u> of <u>4300 MWt</u> is used to bound both reactors. For reference the currently certified power level of the ABWR is 3926 MWt and the <u>ESBWR design value is 4000 MWt</u>

   - Number of modules or reactors expected for a typical unit configuration for small modular systems

     The ABWR and ESBWR are both designed as **<u>single unit plants</u>.**

2. Expected Fuel Loading
   - Provide Initial Core Fuel Loading in MTU

     <u>The initial core load for the ABWR and ESBWR are approximately equal.</u> For the ABWR the initial core load is 156.96 MT of Uranium.
     ABWR ~ 157 MTU
     ESBWR ~ 157 MTU

   - Provide Annual Average Fuel Loading in MTU based on 40 years of operation

     The average annual fuel loading in MTU is 32.76. This is based on an average capacity factor of 95%. This capacity factor is subject to variation by the operating practices of the utility but in GE's view represents a reasonably achievable measure. This figure includes allowances for refueling and maintenance outages but does not include any provision for extended outages.

   [Note: Provide the basis for the above estimates, i.e. estimated unit capacity factor, refueling/maintenance outage frequencies and durations, and average expected energy produced per year.]

3. Average Fuel Enrichment in % U-235
   [Note: Provide table of MTU and enrichment if multiple fuel enrichments are normally used for the initial core or fuel reloads]

   The batch average enrichment of the core is less than 3.5% for the initial core and less than 4.5% for the subsequent reloads.

4. Fuel form
   - Provide Fuel Assembly (or Basic Fuel Unit) Drawing - See Figure 1

- Provide a Table giving the following for each fuel unit:
- An estimate of the typical number of fuel assemblies or units required for the initial core and the average expected number of fuel assemblies or units per year for core reloads

Table 1

Parameter	ABWR	ESBWR
Number of bundles in core	872	1020
Active fuel length	381 cm	305 cm
Fuel bundle average mass (with channel)	298 kg	238 kg
Fuel bundle average mass (w/o channel)	266 kg	213 kg
Bundle average Uranium mass	180 kg	144 kg
Bundle outside dimensions	14.2 cm X 14.2 cm	14.2 cm X 14.2 cm
Bundle overall length	447 cm	378 cm
Mass of Zircaloy (per bundle)	~85 kg	~68 kg
Mass of Stainless Steel (per bundle)	~6.8 kg	~6.8 kg
Mass of Inconel (per bundle)	~0.5 kg	~0.5 kg

See Table 1 above. The information provided in response to this request is based on the GE-14 fuel type, which is the latest offering of the GE fuels group. The basic design of the GE-14 is the same as earlier BWR fuels offered by GE as far as overall dimensions. However, improvements in the design have been made to optimize the fuel utilization.

The cross sectional area of the ESBWR bundles will be the same as the ABWR. However they are approximately 15% shorter, but with more bundles in the core, so the net effect is that approximately the same amount of Uranium is held in the core as for the ABWR.

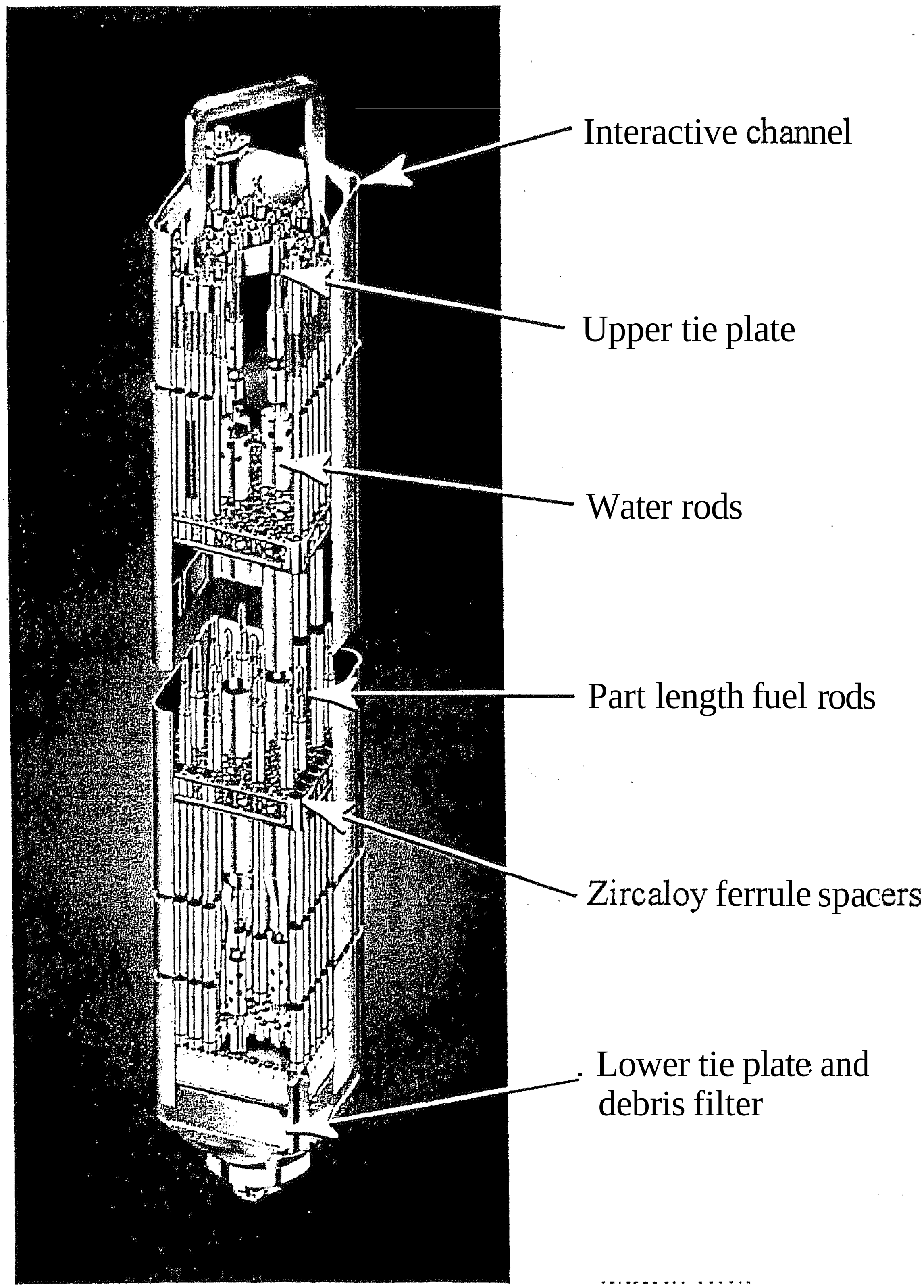
5, Fuel materials

- Provide a table of fuel material types and mass for a typical fuel unit including a description of fuel, structural, and cladding materials

See Table 1 above. The channel, fuel rods (cladding), water rods, spacers and end plugs are all fabricated from Zircaloy,

The upper and lower tie plates and assorted fasteners are fabricated from stainless steel.

There are a number of small components that are fabricated from inconel.



GE 14 Fuel Bundle
Figure 1

6. Define the expected typical transport mode (i.e. truck, rail, etc.) for delivery of the unirradiated fuel from the fabrication facility or port of entry to the reactor site

   Typical shipment of new fuel from the GE fuel facility in Wilmington, NC is by flat bed tractor trailer.

7. Provide a general description of the transport containers expected to be used for delivery of unirradiated fuel
   - Capacity of each container, i.e. number of fuel units per container

     The transport containers consist of a dual packaging system. Two fuel assemblies are first packed in a padded steel box. The steel box is then packaged inside a padded wooden crate. The dimensions of a typical wooden crate are 30" x 30" x 15'6" (ESBWR fuel assemblies crate would be ~ 13'6" long)

   - Number of containers that can be transported on one legal weight truck shipment

     The number of ABWR bundles that typically can be shipped on a single truck is either 28 or 30 and is limited by weight. The single truck could carry up to 36 ESBWR bundles based on the lighter weight.

   [Note: This data is intended to allow for a determination of the number of shipments and MTU for the initial core loading and the average number of shipments and MTU per year for core reloads.]

Information on Expected Low Level Waste Production

1. Estimated annual average LLW production expected from reactor operations
   - Provide an estimate of the expected volumes and curies of LLW

     The production of LLW is in large past controlled by the practices of the owner. GE in the design certification chose not to establish unreasonable expectations for future owners and as such followed the maximum target values. In this case the volume of LLW is 100 cubic meters per year with an estimated curie content of 2700 Ci.

2. LLW expected from reactor decontamination and decommissioning
   - Provide an estimate of the expected volumes and curies of LLW produced due to reactor decontamination and decommissioning

     The process for decontamination and decommissioning of an ABWR is outside the control of GE and subject to a great deal of variation depending on the timing and the methods chosen. As such, GE is unable to provide a reasonable estimate for these values.

ESP 8 Reactor Vendor Questionnaire (cont'd)

Information on Spent Fuel Production/Transport

1. Spent Fuel Shipments
   - Provide an estimate of the quantity (MTU) of irradiated fuel that can be transported in one legal weight truck cask [25 ton cask] or typical rail cask [100 ton cask], assuming 5 year cooling after discharge.
     [Note: Estimate should be in MTU (based on unirradiated MTU) and number of fuel units 'to allow for a determination of the average number of spent fuel shipments expected per year of reactor operation.]

     GE is not familiar with the constraints of fuel assemblies that can be transported in the commercially available casks. What we can tell you is the GE-14 fuel type is nearly identical to the other GE fuel types and the number of BWR fuel assemblies that can be shipped should not be different for the ABWR.

     If a "standard" size BWR spent fuel cask were used for spent ESBWR fuel, less fuel per cask shipment would result. With the shorter fuel assemblies it would be reasonable to expect a new cask design would be possible. Assuming the cask load or quantity based on either curie content.or total decay heat, a larger cask could be conceived and therefore more ESBWR spent fuel bundles could be shipped per cask.

2, Provide the average fuel burnup in MWd/MTU

   After achieving an equilibrium core, the batch average burnup is 46 GWd/MT

3. Provide an estimate of the decay heat in watts per MTU after 5 years of decay from fuel discharge

   The estimated decay heat per MTU, 5 years after discharge from the core is between 18-22 kilowatts.

4. Provide estimates of the spent fuel inventories and radioactivity, in Ci per MTU, after 5 years of decay
   - Fission product inventory

   - Actinide inventory

   - Total radioactivity

     Krypton-85 inventory

   See Table 2 for ABWR determination. This table is based on 4300 MWt ABWR (power uprated).

The fuel type is GE 14 with the following characteristics,

	Initial Core	Reload 1	Reload 2 to Eq.
Core Size, number of bundles	872	872	872
Core Thermal Power, MWth	4300	4300	4300
Operating Cycle Length, days	605	605	605
Operating Capacity Factor, %	100	100	100
Refueling Outage Duration, days	30	30	30
Refueling Interval, months	21	21	21
Loaded Batch Size	872	240	316
Batch Average Enrichment, w/o U235	3.5	4.5	4.5
Average Bundle Mass, KgU	180	180	180
Batch Average Burnup, GWd/MT	36	46	46

This particular analysis should bound the 4000 MWt ESBWR core.

[Note: If available, please provide a complete set of the ORIGEN *run* results (or other applicable code for the appropriate reactor type) detailing the spent fuel inventories at 5 years decay to answer questions 3 and 4.]

Table 2

Activation Products		Actinides + Daughters		Fission Products	
Isotope	Curie/MTU	Isotope	Curie/MTU	Isotope	Curie/MTU
Ag-109m	7.76E-04	Am-241	1.34E+03	Ag-108	3.44E-06
Ar-37	5.48E-16	Am-242	3.32E+01	Ag-109m	1.36E-04
Ar-39	3.42E-04	Am-242m	3.34E+01	Ag-110	4.44E-01
C-14	7.70E-01	Am-243	3.24E+01	Ag-110m	3.34E+01
Ca-41	1.18E-03	Am-245	2.50E-09	Ba-137m	1.18E+05
Ca-45	8.65E-04	Bi-212	4.49E-02	Cd-113m	6.13E+01
Cd-109	7.76E-04	Bk-249	1.72E-04	Cd-115m	6.79E-10
Cd-115m	1.12E-13	Cm-241	1.01E-17	Ce-141	1.49E-11
Cl-36	1.86E-02	Cm-242	5.51E+01	Ce-144	1.14E+04
Co-58	7.49E-05	Cm-243	3.69E+01	Cs-134	4.81E+04
Co-60	2.73E+03	Cm-244	4.86E+03	Cs-135	8.22E-01
Cr-51	5.28E-16	Cm-245	6.56E-01	Cs-137	1.24E+05
Eu-152	1.08E-03	Cm-246	1.41E-01	Eu-152	1.09E+01
Eu-154	1.53E+02	Np-235	5.01E-04	Eu-154	1.01E+04
Eu-155	7.14E+01	Np-237	6.16E-01	Eu-155	5.22E+03
Fe-55	3.35E+03	Np-238	1.67E-01	Gd-153	1.41E-01
Fe-59	4.32E-10	Np-239	3.24E+01	H-3	5.34E+02
Gd-153	2.26E+01	Np-240m	9.23E-07	I-129	4.20E-02
H-3	5.24E-04	Pa-233	6.16E-01	In-114	4.21E-11
Hf-175	3.05E-07	Pa-234m	3.13E-01	In-114m	4.39E-11
Hf-181	1.08E-10	Pb-212	4.49E-02	In-115m	4.77E-14
Ho-166m	2.39E-02	Po-212	2.88E-02	Kr-85	8.90E+03
In-113m	1.95E-02	Po-216	4.49E-02	Nb-93m	7.54E-01

Activation Products

Isotope	Curie/MTU
In-114	1.63E-09
In-114m	1.70E-09
Ir-192	8.59E-08
K-42	1.63E-12
Lu-177	9.04E-07
Lu-177m	3.93E-06
Mn-54	3.46E+01
Mo-93	1.95E-02
Nb-93m	1.98E-01
Nb-94	1.76E-01
Nb-95	4.55E-04
Nb-95m	1.52E-06
Ni-59	2.59E+00
Ni-63	4.20E+02
P-32	2.89E-08
Re-188	9.56E-08
Ru-103	8.38E-16
S-35	1.84E-05
Sb-124	2.93E-08
Sb-125	9.16E+02
Sc-46	7.04E-07
Sn-113	1.95E-02
Sn-119m	5.20E+01
Sn-121m	1.12E+00
Sn-123	2.40E-02
9-89	8.94E-10
Sr-90	6.68E-03
Ta-182	1.74E-01
Tb-160	1.49E-03
Tc-99	4.80E-03
Te-123m	2.45E-04
Te-125m	2.24E+02
Te-127	7.52E-07
Te-127m	7.67E-07
Tm-170	2.43E-07
W-181	1.82E-04
W-185	1.08E-05
W-188	9.46E-08
Y-90	6.68E-03
Y-91	6.98E-08
Zn-65	2.39E-03
Zr-93	6.86E-01
Zr-95	2.05E-04
Total	7.98E+03

Actinides + Daughters

Isotope	Curie/MTU
Pu-236	3.56E-01
Pu-237	4.37E-12
Pu-238	6.14E+03
Pu-239	3.87E+02
Pu-240	6.15E+02
Pu-241	1.22E+05
Pu-242	2.24E+00
Pu-243	5.85E-07
Ra-224	4.49E-02
Rn-220	4.49E-02
Th-228	4.49E-02
Th-231	2.20E-02
Th-234	3.13E-01
Tl-208	1.61E-02
U-232	6.00E-02
U-234	1.47E+00
U-235	2.20E-02
U-236	3.77E-01
U-237	3.00E+00
U-238	3.13E-01
U-240	9.23E-07
Total	1.36E+05

Fission Products

Isotope	Curie/MTU
Nb-95	6.78E-03
Nb-95m	2.27E-05
Pd-107	1.46E-01
Pm-146	1.84E+00
Pm-147	3.37E+04
Pm-148	8.59E-11
Pm-148m	1.52E-09
Pr-144	1.14E+04
Pr-144m	1.37E+02
Rh-102	4.67E-01
Rh-103m	1.09E-08
Rh-106	1.64E+04
Ru-103	1.21E-08
Ru-106	1.64E+04
Sb-124	1.17E-06
Sb-125	4.45E+03
Sb-126	1.43E-01
Sb-126m	1.02E+00
Se-79	5.61E-01
Sm-151	5.60E+02
Sn-119m	1.24E+00
Sn-121m	2.46E-01
Sn-123	1.60E-01
Sn-126	1.02E+00
Sr-89	8.33E-06
Sr-90	8.85E+04
Tb-160	3.14E-05
Tc-99	1.74E+01
Te-123m	6.79E-04
Te-125m	1.09E+03
Te-127	1.02E-01
Te-127m	1.04E-01
Te-129	1.02E-12
Te-129m	1.57E-12
Y-90	8.85E+04
Y-91	3.38E-04
Zr-93	2.50E+00
Zr-95	3.05E-03
Total	5.87E+05

Activation Products	
Isotope	Curie/MTU
Ag	7.78E-04
Ar	3.42E-04
Be	2.12E-06
C	7.70E-01
Ca	2.05E-03
Cd	7.76E-04
Cl	1.86E-02
Co	2.73E+03
Cr	5.28E-16
Eu	2.24E+02
Fe	3.35E+03
Gd	2.26E+01
H	5.24E-04
Hf	1.01E-06
Ho	2.39E-02
I	1.75E-13
In	1.95E-02
Ir	1.70E-07
K	3.20E-08
Lu	4.84E-06
Mn	3.46E+01
Mo	1.95E-02
Nb	3.75E-01
Ni	4.23E+02
Os	7.29E-10
P	2.89E-08
Pb	8.97E-08
Re	2.45E-07
Ru	2.66E-14
S	1.84E-05
Sb	9.16E+02
Sc	7.04E-07
Si	2.88E-08
Sm	4.19E-06
Sn	5.32E+01
Sr	6.68E-03
Ta	1.74E-01
Tb	1.49E-03
Tc	4.80E-03
Te	2.24E+02
Tm	7.28E-06
V	2.01E-14
W	1.93E-04

Actinides + Daughters	
Isotope	Curie/MTU
Am	1.44E+03
Bi	4.49E-02
Bk	1.72E-04
Cm	4.95E+03
Np	3.32E+01
Pa	9.30E-01
Pb	4.49E-02
Po	7.36E-02
Pu	1.29E+05
Ra	4.49E-02
Rn	4.49E-02
Th	3.80E-01
Tl	1.61E-02
U	5.24E+00
Total	1.36E+05

Fission Products	
Isotope	Curie/MTU
Ag	3.38E+01
Ba	1.18E+05
Cd	6.13E+01
Ce	1.14E+04
Cs	1.72E+05
Eu	1.53E+04
Gd	1.41E-01
H	5.34E+02
Ho	4.51E-03
I	4.20E-02
In	9.98E-11
Kr	8.90E+03
La	1.47E-10
Nb	7.61E-01
Nd	2.17E-09
Pd	1.46E-01
Pm	3.37E+04
Pr	1.15E+04
Rb	2.99E-05
Rh	1.64E+04
Ru	1.64E+04
Sb	4.45E+03
Se	5.61E-01
Sm	5.60E+02
Sn	2.66E+00
Sr	8.85E+04
Tb	3.14E-05
Tc	1.74E+01
Te	1.09E+03
Xe	6.58E-17
Y	8.85E+04
Zr	2.50E+00
Total	5.87E+05

Activation Products		Actinides + Daughters		Fission Products	
Isotope	Curie/MTU	Isotope	Curie/MTU	Isotope	Curie/MTU
Y	6.68E-03				
Zn	2.39E-03				
Zr	6.86E-01				
Total	7.98E+03				

AP-1000

'Winters, James W."
<winterjw@westinghouse.com>

02106120530 01:26 PM

To: "Winters, James W." <winterjw@westinghouse.com>, "'Cambria, Michael'" <Michael.Cambria@parsons.com>
cc: 'Tom Mundy (Email)" <thomas.mundy@exeloncorp.com>, "Robert L. Nitschke (E-mail)" <rln@inel.gov>, "Wayne Schofield (E-mail)" <Wschofie@ch2m.com>
Fax to:
Subject: RE: Data request for early site permit applications

Item #1:

Sizewell's decommissioning plan says they will generate about 13,000 TBq (350,000 Ci) from decommissioning. We estimate on the order of 50% of that for AP1000, or about 200,000 Ci.

We will include this in the siting guide with a note something like "Estimated based upon Sizewell B's estimate of 13,000 TBq."

Item #2:

60000 MWD/MTU is the current peak rod burnup limit (actually it is 62000 MWD/MTU).

21000 MWD/MTU is the approximate cycle burnup for an 18 Month (520 EFPD) Equilibrium Cycle.

48700 MWD/MTU is the approximate region average discharge burnup for each feed region (68 Assemblies) assuming continuous 18 Month (520 EFPD) Equilibrium Cycles.

Jim

> ----------
> From: Cambria, Michael[SMTP:Michael.Cambria@parsons.com]
> Sent: Friday, January 24, 2003 2:52 PM
> To: 'Winters, James W.'
> **Cc**: Tom Mundy (E-mail); Robert L. Nitschke (E-mail); Wayne Schofield
> (E-mail)
> Subject: RE: Data request for early site permit applications
>
> Jim:
>
> Just a note to inquire on how you are making out with generating the
> requested info. If you could let me know if and when we might expect it,
> it
> would be helpful.
>
> Thank you
>
> Mike
>
> -----Original Message-----
> From: Winters, James W. [mailto:winterjw@westinghouse.com]
> Sent: Friday, January 17, 2003 12:48 PM
> To: 'Winters, James W.'; 'Cambria, Michael'
> Cc: 'Cummins, Ed'; 'Demetri, Kathryn J.'; 'Grant, Eddie R.'; 'George Zinke (E-mail)'; 'Marvin Smith (E-mail)'; 'Meneely, Timothy K.'; 'Steve Routh (E-mail)'; 'Spencer Semmes (E-mail)'; 'Mundy, Thomas P.'; 'Vijuk, Ronald P.'; 'Wayne Schofield (E-mail)'; 'RLN(a)inel.gov'; Ioannidi, John
Subject: RE: Data request for early site permit applications

>
> Kathy,
>
> Please take the lead on this and then send me the information. I will get
> it to Michael and include it in our siting guide.
>
> Jim
>
> > ----------
> > From: Cambria, Michael[SMTP:Michael.Cambria@parsons.com]
> > Sent: Thursday, January 16, 2003 1:11 PM
> > To: 'Winters, James W.'
> > Cc: 'Cummins, Ed'; 'Demetri, Kathryn J.'; 'Grant, Eddie R.';
> 'George
> > Zinke (E-mail)'; 'Marvin Smith (E-mail)'; 'Meneely, Timothy K.'; 'Steve
> > Routh (E-mail)'; 'Spencer Semmes (E-mail)'; 'Mundy, Thomas P.'; 'Vijuk,
> > Ronald P.'; 'Wayne Schofield (E-mail)'; 'RLN(a)inel.gov'; Ioannidi, John
> > Subject: RE: Data request for early site permit applications
> >
> > Jim:
> >
> > After reviewing your input the following is some outstanding data needs
> > and/or questions:
> >
> > 1) Need your curie estimate for the D&D; and
> >
> > 2) Please clarify the burnup #? Presently it is stated the design
> burnup
> > is
> > 60,000 MWd/MTU while-the expected is 21,000. What is the average fuel
> > burnup over the 40 year
> > operational period?
> >
> > If you have any questions on the above please contact Bob Nitschke of
> > INEEL
> > at (208) 526-1463 or by email at rln@inel.gov.
> >
> > Thanks
> >
> > Mike
> >
> >
> > -----Original Message-----
> > From: Winters, James W.
> > Sent: Thursday, December 19, 2002 3:58 PM
> > To: Winters, James W.; 'RLN(a)inel.gov'
> > Cc: Cumins, Ed; Demetri, Kathryn J.; 'Grant, Eddie R.'; George Zinke
> > (E-mail); Marvin Smith (E-mail); Meneely, Timothy K.; Steve Routh
> > (E-mail); Spencer Semmes (E-mail); 'Mundy, Thomas P.'; Vijuk, Ronald P.;
> > Winters, James W.; Wayne Schofield (E-mail); Meneely, Timothy K.;
> > Cambria, Michael
> > Subject: RE: Data request for early site permit applications
> >
> >
> > Here are our revised responses to the ESP-8 questions. We have included
> > the
> > page 3 items as Items 10 through 13 in the fuel information section.
> This
> >'information will also be added to Revision 3 of our siting guide. The
> > information requested for spent fuel shipments is not available right
> now

> > since the cognizant engineer is on holiday. We will send it as soon as
> he
> > is back (1/2). The proper radwaste value is 1830 curies per year
> > corresponding to the DCD. This will also be corrected in Revision 3 of
> > the
> > Siting Guide.
> >
> > <<Responses to ESP 8 R2.doc>>
> >
> > Item 13 references an AP1000 calculation note for the ORIGEN data
> related
> > to
> > fuel inventories and radioactivity. Attached below are the relevant
> > tables
> > associated with that calculation.
> >
> > <<AP1000 SF Curie.pdf>>
> >
> > Jim
> >
> > > ----------
> > > From: RLN@inel.gov[SMTP:RLN@inel.gov]
> > > Sent: Monday, December 16, 2002 1:17 PM
> > > To: Winters, James W.
> > > Cc: Cummins, Ed; Demetri, Kathryn J.; 'Grant, Eddie R.'; George
> > Zinke
> > > (E-mail); Marvin Smith (E-mail); Meneely, Timothy K.; 'Michael
> Cambria';
> > > Steve Routh (E-mail); Spencer Semmes (E-mail); 'Mundy, Thomas P.';
> > Vijuk,
> > > Ronald P.; Winters, James W.; Wayne Schofield (E-mail)
> > > Subject: RE: Data request for early site permit applications
> > >
> > > <<File: Responses to ESP 8 R1.doc>>
> > >
> > > Hi Jim,
> > >
> > > Thanks for your response. I am not sure why you did not receive a
> page
> > 3.
> > > It should have looked something like this:
> > >
> > > Information on Spent Fuel Production/Transport
> > >
> > > 1. Spent Fuel Shipments
> > > * Provide an estimate of the quantity (MTU) of irradiated fuel
> that
> > > can
> > > be transported in one legal weight truck cask [25 ton cask] or typical
> > > rail
> > > cask [100 ton cask], assuming 5 year cooling after discharge.
> > > [Note: Estimate should be in MTU (based on unirradiated MTU) and
> > > number of fuel units to allow for a determination of average number of
> > > spent fuel shipments per year of reactor operation.]
> > > 2. Provide the average fuel burnup in MWd/MTU
> > > 3. Provide an estimate of the decay heat in watts per MTU after 5
> years
> > > of
> > > decay from fuel discharge
> > > 4. Provide estimates of the spent fuel inventories and radioactivity,
> > in

> > > Ci per MTU, after 5 years of decay
> > > * Fission product inventory
> > > * Actinide inventory
> > > * Total radioactivity
> > > * Krypton-85 inventory
> > > [Note: If available, please provide a complete set of ORIGEN run
> results
> > > (or other applicable code for the applicable reactor type) detailing
> the
> > > spent fuel inventories at 5 years decay to answer questions 3 and 4.]
> > >
> > > ------
> > >
> > > As such, we will still need information on the number and types of
> spent
> > > fuel shipment, average burnup, decay heat, etc.
> > >
> > >
> > > Also if I may, one question on your latest submittal. In the
> attachment
> > > "Responses to ESP 8 R1", it states 1830 curies per year of solid
> waste.
> > > The AP1000 Siting Guide document on pages 33 and 36 show 1100 curies
> per
> > > year.
> > >
> > > Thank you.
> > >
> > > **Bob**
> > >
> > > phone 208 526-1463
> > >
> > >
> > >
> > >
> > > "Winters, James
> > >
> > > W." To: "Winters,
> James
> > > W."
> > > <winterjw@westing
> > > <winterjw@westinghouse.com>, "'Michael Cambria'"
> > > house.com>
> > > <Michael.Cambria@parsons.com>
> > > cc: "'Mundy,
> Thomas
> > > P.'"
> > > 12/13/2002 09:35
> > > <thomas.mundy@exeloncorp.com>, "Cummins, Ed"
> > > AM
> > > <cumminwe@westinghouse.com>, "Vijuk, Ronald P."
> > >
> > > <vijukrp@westinghouse.com>, "'Grant, Eddie R.'"
> > >
> > > <eddie.grant@exeloncorp.com>, "Marvin Smith (E-mail)"
> > >
> <Marvin_Smith@dom.com>,
> > > "Robert L. Nitschke (E-mail)"
> > > <rln@inel.gov>,
> "Spencer
> > > Semmes (E-mail)"

> > >
> > <Spencer_Semmes@dom.com>,
> > > "Steve Routh (E-mail)"
> > > <sdrouth@bechtel.com>,
> > > "Wayne Schofield (E-mail)"
> > > <Wschofie@ch2m.com>,
> > > "George Zinke (E-mail)"
> > > <GZINKE@entergy.com>,
> > > "Vijuk, Ronald P."
> > >
> > > <vijukrp@westinghouse.com>, "Demetri, Kathryn J."
> > >
> > > <demetrkj@westinghouse.com>, "Meneely, Timothy K."
> > >
> > > <meneeltk@westinghouse.com>
> > > Fax to:
> > >
> > > Subject: RE: Data
> > request
> > > for early site permit
> > > applications
> > >
> > >
> > >
> > >
> > >
> > >
> > >
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> > > * Cycle Length - 18 months - 520 EFPD @ 3400 MWT
> > > * Capacity Factor - 95% including refueling outage
> > > * Reload fuel requirement - 68 Fuel Assemblies
> > > * Average Enrichment - 4.51 w/o U235
> > >
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> > > > * At 5 years decay, the average spent fuel assembly curie
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> > > > Fission Products 4.450E+05 curies
> > > > Total 5.301E+05
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> > > LLW from Decommissioning:
> > > * No AP1000 specific estimate has been made. Information
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> > > design differences.
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> > >
> > > <<Responses to ESP 8 R1.doc>>
> > >
> > > This information is also being added to our Siting parameters
> document.
> > > Thanks for your interest.
> > >
> > > Jim
> > > 413-374-5290
> > >
> > > > ----------
> > > > From: Michael Cambria[SMTP:Michael.Cambria@parsons.com]
> > > > Sent: Monday, December 09, 2002 **12:14** PM
> > > > To: 'Winters, James W.'
> > > > Cc: 'Mundy, Thomas P.'; 'Cummins, Ed'; 'Vijuk, Ronald
> > P.';
> > > 'Grant, Eddie
> > > > R.'; Marvin Smith (E-mail); Robert L. Nitschke (E-mail); Spencer
> > Semmes
> > > > (E-mail); Steve Routh (E-mail); Wayne Schofield (E-mail); George
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> > > > (E-mail)
> > > > Subject: RE: Data request for early site permit applications
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> > be
> > > > greatly appreciated. Thank you for your cooperation.
> > > >
> > > > Regards,
> > > >
> > > > Mike
> > > >
> > > > -----Original Message-----
> > > > From: Winters, James W.
> > > > Sent: Tuesday, December 03, 2002 4:52 PM
> > > > To: Winters, James W.; 'Grant, Eddie R.'
> > > > Cc: Mundy, Thomas P.; Cummins, Ed; Winters, James W.; Vijuk, Ronald
> > P.;
> > > > Cambria, Michael
> > > > Subject: RE: Data request for early site permit applications
> > > >

> > > >
> > > > Here is our response table. Formal letter will be FEDEXed today.
> > > >
> > > > <<Responses to ESP 8.doc>>
> > > >
> > > > Jim
> > > >
> > > > > ----------
> > > > > From:	Grant, Eddie R.[SMTP:eddie.grant@exeloncorp.com]
> > > > > Sent:	Monday, November 11, 2002 2:37 PM
> > > > > To:	James W. Winters (E-mail)
> > > > > Cc:	Michael Cambria (E-mail); Mundy, Thomas P.
> > > > > Subject:	Data request for early site permit
> applications
> > > > >
> > > > > <<File: ESP-08, info request, AP1K.pdf>>
> > > > > As you are aware, Exelon Corporation, Dominion Resources Services,
> > and
> > > > > Entergy Nuclear Potomac are currently developing Early Site Permit
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> > > > > applications to facilitate the future deployment of advance
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> > > > design
> > > > > concepts. The attached letter requests some additional information
> > > > > necessary
> > > > > to complete the environmental assessment for this effort.
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> > > > >
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> > > > > Your response is requested by November 27, 2002.
> > > > >
> > > > > Thank you in advance for your cooperation in this matter,
> > > > >
> > > > > Please direct your responses to the attention of Michael J.
> Cambria
> > > at:
> > > > >
> > > > > Parsons Energy and Chemicals
> > > > > 2675 Morgantown Road
> > > > > Reading, PA 19607
> > > > > Email: michael.cambria@parsons.com
> > > <mailto:michael.cambria@parsons.com>
> > >
> > > > > (610) 855-2049
> > > > >
> > > > > Should you have any questions or require additional clarification
> > > > > regarding
> > > > > the information requested by the attached questionnaire, please
> > > contact
> > > > > Robert L. Nitschke of INEEL at (208) 526-3463 or by email at
> > > > rln@inel.gov
> > > > > <mailto:rln@inel.gov>.
> > > > >
> > > > >
> > > > > Eddie R Grant

> > > > > Exelon ESP Project
> > > > > 610-765-5001 Office
> > > > > 610-765-5545 Fax
> > > > > 850-598-9801 Cell
> > > > >
> > > > >
> > > > >
> > > > >
> > >
> **
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> > > > > to copyright belonging to the Exelon Corporation family of
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> immediately
> > > and
> > >
> > > > > permanently delete the original and any copy of this e-mail and
> any
> > > > > printout. Thank You.
> > > > >
> > >
> **
> > > > >
> > > > >
> > > >
> > > (See attached file: Responses to ESP 8 R1.doc)
> > >
> > >
> > >
> >
>

'**Winters, James W." <winterjw@westinghouse.com> on *0110212003* 08:00:20 AM**

To: '"RLN@inel.gov"' <RLN@inel.gov>
CC: '"spencer_semmes@dom.com"' <spencer_semmes@dom.com>, '"edward.b.toll@parsons.com"' <edward.b.toll@parsons.com>, '"michael.cambria@parsons.com"' <michael.cambria@parsons.com>, '"eddie.grant@exeloncorp.com"' <eddie.grant@exeloncorp.com>, "Cummins, Ed" <cumminwe@westinghouse.com>, "Winters, James W." <winterjw@westinghouse.com>

Subject: Spent Fuel Shipping

This completes our responses to the ESP-8 questions. Currently operating plants ship spent Westinghouse fuel after 10 years after removal from the reactor. This is usually 5 years in pool and 5 years dry storage. There can be 21-28 fuel assemblies n a shipping cask and one cask per rail car. None are shipped by truck.

Jim

'Winters, James W." <winterjw@westinghouse.com>

12/19/2002 01:57 PM

To: "Winters, James W." <winterjw@westinghouse.com>, "'RLN@inel.gov'" <RLN@inel.gov>
cc: "Cummins, Ed" <cumminwe@westinghouse.com>, "Demetri, Kathryn J." <demetrkj@westinghouse.com>, "'Grant, Eddie R.'" <eddie.grant@exeloncorp.com>, "George Zinke (E-mail)" <GZINKE@entergy.com>, "Marvin Smith (E-mail)" <Marvin_Smith@dom.com>, "Meneely, Timothy K." <meneeltk@westinghouse.com>, "'Michael Cambria'" <Michael.Cambria@parsons.com>, "Steve Routh (E-mail)" <sdrouth@bechtel.com>, "Spencer Semmes (E-mail)" <Spencer_Semmes@dom.com>, "'Mundy, Thomas P.'" <thomas.mundy@exeloncorp.com>, "Vijuk, Ronald P." <vijukrp@westinghouse.com>, "Winters, James W." <winterjw@westinghouse.com>, "Wayne Schofield (E-mail)" <Wschofie@ch2m.com>, "Meneely, Timothy K." <meneeltk@westinghouse.com>
Fax to:
Subject: RE: Data request for early site permit applications

Here are our revised responses to the ESP-8 questions. We have included the page 3 items as Items 10 through 13 in the fuel information section. This information will also be added to Revision 3 of our siting guide. The information requested for spent fuel shipments is not available right now since the cognizant engineer is on holiday. We will send it as soon as he is back (1/2). The proper radwaste value is 1830 curies per year corresponding to the DCD. This will also be corrected in Revision 3 of the Siting Guide.

<<Responses to ESP 8 R2.doc>>

Item 13 references an AP1000 calculation note for the ORIGEN data related to fuel inventories and radioactivity. Attached below are the relevant tables associated with that calculation.

<<AP1000 SF Curie.pdf>>

Jim

\> ----------
\> From: RLN@inel.gov[SMTP:RLN@inel.gov]
\> Sent: Monday, December 16, 2002 1:17 PM
\> To: Winters, James W.
\> Cc: Cummins, Ed; Demetri, Kathryn J.; 'Grant, Eddie R.'; George Zinke
\> (E-mail); Marvin Smith (E-mail); Meneely, Timothy K.; 'Michael Cambria';
\> Steve Routh (E-mail); Spencer Semmes (E-mail); 'Mundy, Thomas P.'; Vijuk,
\> Ronald P.; Winters, James W.; Wayne Schofield (E-mail)
\> Subject: RE: Data request for early site permit applications
\>
\> <<File: Responses to ESP 8 R1.doc>>
\>
\> Hi Jim,
\>
\> Thanks for your response. I am not sure why you did not receive a page 3.
\> It should have Looked something like this:
\>
\> Information on Spent Fuel Production/Transport
\>
\> 1. Spent Fuel Shipments
\> * Provide an estimate of the quantity (MTU) of irradiated fuel that
\> can

> be transported in one legal weight truck cask [25 ton cask] or typical
> rail
> cask [100 ton cask], assuming 5 year cooling after discharge.
> [Note: Estimate should be in MTU (based on unirradiated MTU) and
> number of fuel units to allow for a determination of average number of
> spent fuel shipments per year of reactor operation.]
> 2. Provide the average fuel burnup in MWd/MTU
> 3, Provide an estimate of the decay heat in watts per MTU after 5 years
> of
> decay from fuel discharge
> 4. Provide estimates of the spent fuel inventories and radioactivity, in
> Ci per MTU, after 5 years of decay
> * Fission product inventory
> * Actinide inventory
> * Total radioactivity
* Krypton-85 inventory
> [Note: If available, please provide a complete set of ORIGEN run results
> (or other applicable code for the applicable reactor type) detailing the
> spent fuel inventories at 5 years decay to answer questions 3 and 4.]
>
> ------
>
> As such, we will still need information on the number and types of spent
> fuel shipment, average burnup, decay heat, etc.
>
>
> Also if I may, one question on your latest submittal. In the attachment
> "Responses to ESP 8 R1", it states 1830 curies per year of solid waste.
> The AP1000 Siting Guide document on pages 33 and 36 show 1100 curies per
> year.
>
> Thank you.
>
> Bob
>
> phone 208 526-1463
>
>
>
>
> "Winters, James
>
> W." To: "Winters, James
> W."
> <winterjw@westing
> <winterjw@westinghouse.com>, "'Michael Cambria'"
> house.com>
> <Michael.Cambria@parsons.com>
> cc: "'Mundy, Thomas
> P.'"
> 12/13/2002 09:35
> <thomas.mundy@exeloncorp.com>, "Cummins, Ed"
> <cumminwe@westinghouse AM
> .com>, "Vijuk, Ronald P."
>
> <vijukrp@westinghouse.com>, "'Grant, Eddie R.'"
>
> <eddie.grant@exeloncorp.com>, "Marvin Smith (E-mail)"
> <Marvin_Smith@dom.com>,
> "Robert L. Nitschke (E-mail)"
> <rln@inel.gov>, "Spencer

> Semmes (E-mail)" <Spencer_Semmes@dom.com>,
>
> "Steve Routh (E-mail)" <sdrouth@bechtel.com>,
>
> "Wayne Schofield (E-mail)" <Wschofie@ch2m.com>,
>
> "George Zinke (E-mail)" <GZINKE@entergy.com>,
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> <vijukrp@westinghouse.com>, "Demetri, Kathryn J."
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> Fax to:
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> Subject: RE: Data request for early site permit applications
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> * Cycle Length - 18 months - 520 EFPD @ 3400 MWT
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> * Reload fuel requirement - 68 Fuel Assemblies
> * Average Enrichment - 4.51 w/o U235
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> * No AP1000 specific estimate has been made. Information from
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>
> <<Responses to ESP 8 R1.doc>>
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> 413-374-5290
>
> > ----------
> > From: Michael Cambria[SMTP:Michael.Cambria@parsons.com]
> > Sent: Monday, December 09, 2002 12:14 PM
> > To: 'Winters, James W.'
> > Cc: 'Mundy, Thomas P.'; 'Cummins, Ed'; 'Vijuk, Ronald P.';
> 'Grant, Eddie
> > R.'; Marvin Smith (E-mail); Robert L. Nitschke (E-mail); Spencer Semmes
> > (E-mail); Steve Routh (E-mail); Wayne Schofield (E-mail); George Zinke
> > (E-mail)
> > Subject: RE: Data request for early site permit applications
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> > greatly appreciated. Thank you for your cooperation.
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> > Regards,
> >
> > Mike
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> > -----Original Message-----
> > From: Winters, James W.
> > Sent: Tuesday, December 03, 2002 4:52 PM
> > To: Winters, James W.; 'Grant, Eddie R.'
> > Cc: Mundy, Thomas P.; Cummins, Ed; Winters, James W.; Vijuk, Ronald P.;
> > Cambria, Michael
> > Subject: RE: Data request for early site permit applications
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> > <<Responses to ESP 8.doc>>
> >
> > Jim
> >
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> > > Sent: Monday, November 11, 2002 2:37 PM
> > > To: James W. Winters (E-mail)
> > > Cc: Michael Cambria (E-mail); Mundy, Thomas P.
> > > Subject: Data request for early site permit applications
> > >
> > > <<File: ESP-08, info request, AP1K.pdf>>
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> > >
> > > Parsons Energy and Chemicals
> > > 2675 Morgantown Road
> > > Reading, PA 19607
> > > Email: michael.cambria@parsons.com
> <mailto:michael.cambria@parsons.com>
>
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> > >
> > >
> > > Eddie R Grant
> > > Exelon ESP Project
> > > 610-765-5001 Office
> > > 610-765-5545 Fax
> > > 850-598-9801 Cell
> > >
> > >
> > >
> > >
> ***

> > > received this e-mail in error, please notify the sender immediately
> and
>
> > > permanently delete the original and any copy of this e-mail and any
> > > printout. Thank **You**.
> > >
> **
> > >
> > >
> >
> (See attached file: Responses to ESP 8 R1.doc)
>
>
>

Responses to ESP 8 R2AP1000 SF Curie.

Responses to ESP 8: Reactor Vendor Questionnaire
Revision 2

Information on Annual Fuel Requirements

1. Standard Technical Configuration

Reactor Power	3400 MW_t
Plant Power	1117 – 1150 MW_e
Number of Plants per Unit	1

2. Expected Fuel Loading

Initial Core Fuel Loading	84.5 MTU
Annual Average Fuel Loading	24.4 MTU

3. Average Fuel Enrichment (initial load)

Region 1	2.35 weight % U-235
Region 2	3.40 weight % U-235
Region 3	4.45 weight % U-235

4. Fuel Form

Fuel Assembly Drawing	See attached figure
Total mass	1730 lb/assembly
Uranium mass	0.5383 MTU/assembly
Volume (FA envelope)	13404.3 in^3
Outside Dimensions	8.426x8.426x188.8 in
Number of Assemblies (Initial)	157
Number of Assemblies (Reload)	68 on 18 month cycle

5. Fuel Materials

Fuel	211,588 lb UO_2
Structure and Cladding	43,105 lb Zircaloy or ZIRLO™ 270 lb Alloy 718 (top & bottom Grids for 157 assemblies)

6. Expected Typical Transport Truck

7. New Fuel Transport Containers

Capacity	2 assemblies per container
Shipping	6 containers per truck

8. Fuel reload data:

Cycle Length	18 months - 520 EFPD @ 3400 MWT

Capacity Factor	95% including refueling outage
Reload fuel requirement	68 Fuel Assemblies
Average Enrichment	4.51 w/o U235

9. Spent fuel data:

At 5 years decay, the average spent fuel assembly curie content:

Actinides	8.506E+04 curies
Fission Products	4.450E+05 curies
Total	5.301E+05 curies

10. Spent Fuel Shipping Information

Quantity of spent fuel (MTU):

Truck Cask	To be provided later
Rail Car Cask	To be provided later

11. Average Fuel Burnup

Expected	21000 MWD/MTU (3400 MWt x 520 efpd / 84.5 MTU)
Design	60000 MWD/MTU

12. Estimate of Decay Heat in watts per MTU after 5 years of decay

While we use ORIGEN, we have not used it for decay heat calculation for AP1000. We therefore have estimated decay heat based on ANS 1979 standards, with 0 sigma margin, at five years to be 1.127E-4 watts/watt. With core power of 3400 MW and core loading of 84.5 MTU, the estimated specific decay heat for AP1000 is 4530 watts/MTU.

13. Estimates of spent fuel inventories and radioactivity

ORIGEN results for spent fuel inventories and radioactivity are addressed by AP1000 document APP-SSAR-GS2-496. This is based on one burned AP1000 assembly, decayed to 5 years. (Note that ORIGEN was run assuming a core loading of 83.6 MTU.) The 5 year decay data is in the last column (as label indicates). Also note that the inventory units are total Curies (based on 532337.6 grams for an assembly).

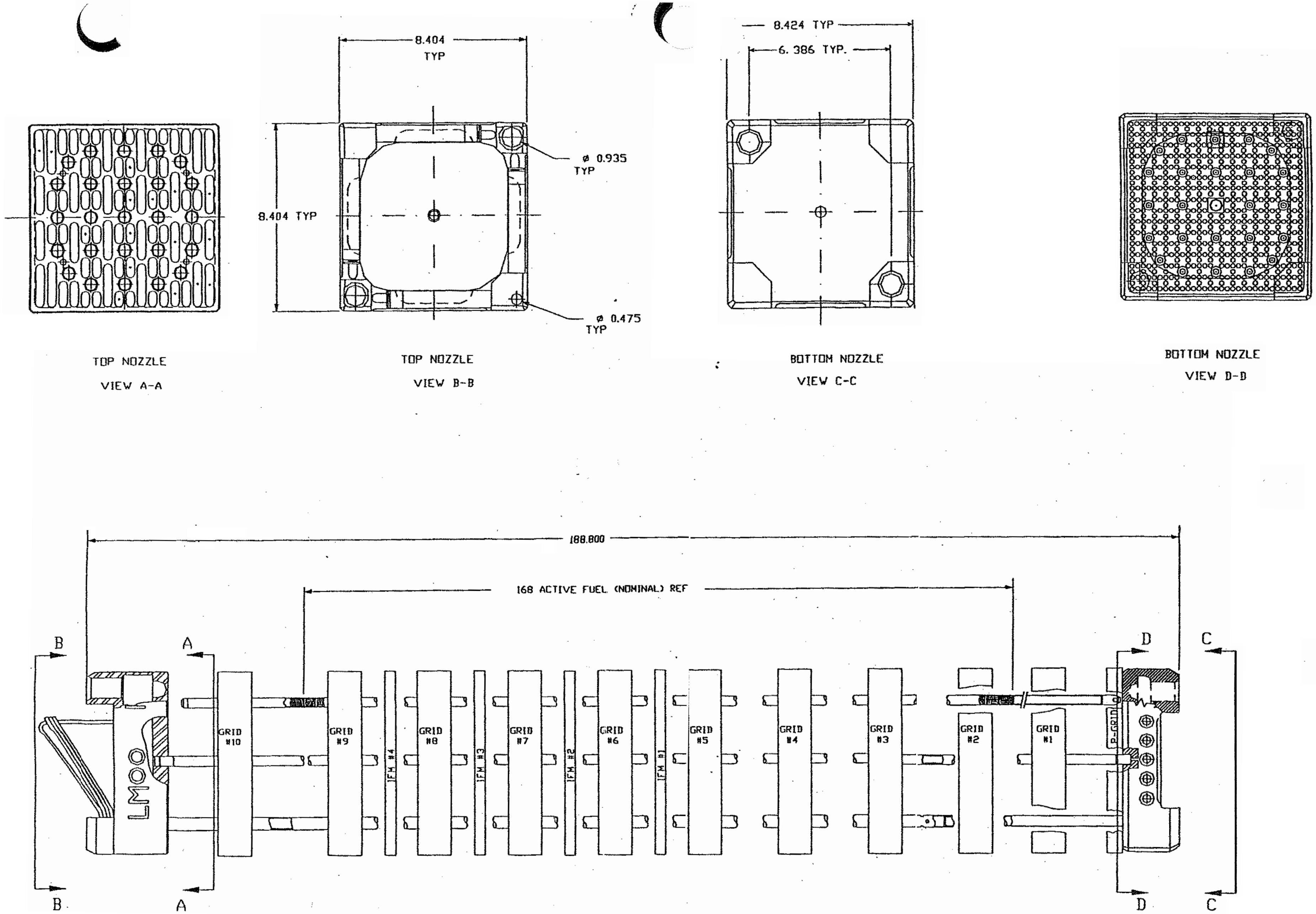
Information on Expected Low Level Waste Production

1. LLW Production

Volume	1964 cubic feet per year (average, as shipped)
Activity	1830 curies per year (average, as shipped)

2. LLW from Decommissioning

No AP1000 specific estimate has been made. Information from Sizewell indicates 6200 cubic meters of LLW from decommissioning. The AP1000 value should be significantly less (maybe half) considering the design differences.



Dimensions are in inchės (nominal)

```
==================================================
|        WESTINGHOUSE CONFIGURATION CONTROL        |
|      Internal Reference CN-REA-01-62 R0          |
|                                                  |
|            Code: ORIGEN2                         |
|         Version: 2.1.1                           |
|   Configuration: February  3, 1995               |
|       Execution: November 30, 2001   16:51:38.57 |
|  Control Number: 5342983194974                   |
|                                                  |
|  A record of configured versions exists in the   |
|       Westinghouse Engineering Technology        |
|        Configuration Control Department.         |
==================================================
```

1 OUTPUT UNIT = 6

PAGE 231

ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities

\+ ACTINIDES+DAUGHTERS

POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC

0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES

One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
HE 4	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TL206	4.043E-18	4.0433-18	4.0433-18	4.043E-18	4.043E-18	4.0433-18	4.0433-18	4.0433-18	4.043E-18	4.043E-18
TL207	3.447E-08	3.4403-08	3.4403-08	3.4393-08	3.4373-08	3.3903-08	3.409E-08	3.684E-08	4.436E-08	1.2543-07
TL208	9.191E-04	9.635E-04	9.6413-04	9.2793-04	9.3633-04	1.014E-03	1.267E-03	1.660E-03	2.6173-03	1.1543-02
TL209	1.439E-08	1.441E-08	1.441E-08	1.428E-08	1.397E-08	9.592E-09	4.8933-09	4.468E-09	4.469E-09	4.541E-09
PB206	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PB207	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PB208	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PB209	6.676E-07	6.234E-07	6.2023-07	6.6113-07	6.466E-07	4.4413-07	2.2653-07	2.0693-07	2.069E-07	2.1023-07
PB210	3.794E-09	3.800E-09	3.805E-09	3.838E-09	3.864E-09	4.0053-09	4.0953-09	4.0823-09	4.0223-09	3.693E-09
PB211	3.4573-08	3.449E-08	3.449E-08	3.448E-08	3.446E-08	3.4003-08	3.418E-08	3.695E-08	4.449E-08	1.258E-07
PB212	2.558E-03	2.5583-03	2.5603-03	2.581E-03	2.6033-03	2.8233-03	3.5253-03	4.620E-03	7.283E-03	3.212E-02
PB214	9.932E-11	9.9473-11	9.956E-11	1.002E-10	1.008E-10	1.060E-10	1.2293-10	1.512E-10	2.316E-10	2.893E-09
BI208	5.361E-18	5.361E-18	5.3613-18	5.361E-18	5.361E-18	5.3613-18	5.3613-18	5.361E-18	5.361E-18	5.360E-18
BI209	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BI210M	4.0593-18	4.0593-18	4.0593-18	4.059E-18	4.059E-18	4.059E-18	4.0593-18	4.0593-18	4.059E-18	4.059E-18
BI210	3.750E-09	3.7533-09	3.7573-09	3.780E-09	3.804E-09	3.9673-09	4.0993-09	4.0843-09	4.024E-09	3.695E-09
BI211	3.457E-08	3.4493-08	3.4493-08	3.448E-08	3.446E-08	3.4003-08	3.4183-08	3.695E-08	4.449E-08	1.2583-07
BI212	2.558E-03	2.6823-03	2.6833-03	2.5833-03	2.606E-03	2.8233-03	3.525E-03	4.6203-03	7.283E-03	3.212E-02
BI213	6.6623-07	6.6713-07	6.674E-07	6.611E-07	6.466E-07	4.4413-07	2.2653-07	2.069E-07	2.069E-07	2.102E-07
BI214	9.932E-11	9.9473-11	9.956E-11	1.002E-10	1.008E-10	1.060E-10	1.229E-10	1.512E-10	2.316E-10	2.893E-09
PO210	2.262E-09	2.2663-09	2.2703-09	2.2933-09	2.314E-09	2.486E-09	2.880E-09	3.299E-09	3.717E-09	3.697E-09

PO211M	7.287E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PO211	9.683E-11	9.658E-11	9.658E-11	9.655E-11	9.650E-11	9.519E-11	9.571E-11	1.034E-10	1.246E-10	3.522E-10
PO212	1.639E-03	1.718E-03	1.719E-03	1.655E-03	1.670E-03	1.808E-03	2.258E-03	2.960E-03	4.666E-03	2.058E-02
PO213	6.518E-07	6.527E-07	6.529E-07	6.468E-07	6.326E-07	4.345E-07	2.217E-07	2.024E-07	2.024E-07	2.057E-07
PO214	1.366E-07	1.344E-07	1.322E-07	1.190E-07	1.082E-07	5.036E-08	6.927E-09	4.902E-10	2.322E-10	2.892E-09
PO215	3.449E-08	3.449E-08	3.449E-08	3.448E-08	3.446E-08	3.400E-08	3.418E-08	3.695E-08	4.449E-08	1.258E-07
PO216	2.558E-03	2.561E-03	2.564E-03	2.586E-03	2.609E-03	2.823E-03	3.525E-03	4.620E-03	7.283E-03	3.212E-02
PO218	9.934E-11	9.949E-11	9.958E-11	1.002E-10	1.008E-10	1.060E-10	1.230E-10	1.512E-10	2.316E-10	2.893E-09
AT217	6.662E-07	6.671E-07	6.673E-07	6.611E-07	6.466E-07	4.441E-07	2.265E-07	2.069E-07	2.069E-07	2.102E-07
RN218	1.365E-07	1.343E-07	1.321E-07	1.189E-07	1.081E-07	5.025E-08	6.804E-09	3.390E-10	7.067E-13	0.000E+00
RN219	3.449E-08	3.449E-08	3.449E-08	3.448E-08	3.446E-08	3.400E-08	3.418E-08	3.695E-08	4.449E-08	1.258E-07
RN220	2.558E-03	2.561E-03	2.564E-03	2.586E-03	2.609E-03	2.823E-03	3.525E-03	4.620E-03	7.283E-03	3.212E-02
RN222	9.934E-11	9.944E-11	9.953E-11	1.002E-10	1.008E-10	1.060E-10	1.230E-10	1.512E-10	2.316E-10	2.893E-09
FR221	6.662E-07	6.671E-07	6.673E-07	6.611E-07	6.466E-07	4.441E-07	2.265E-07	2.069E-07	2.069E-07	2.102E-07
FR223	4.465E-10	4.467E-10	4.469E-10	4.483E-10	4.495E-10	4.598E-10	4.873E-10	5.306E-10	6.276E-10	1.735E-09
RA222	1.365E-07	1.343E-07	1.321E-07	1.189E-07	1.081E-07	5.025E-08	6.804E-09	3.390E-10	7.067E-13	0.000E+00
RA223	3.449E-08	3.449E-08	3.449E-08	3.448E-08	3.446E-08	3.400E-08	3.418E-08	3.695E-08	4.449E-08	1.258E-07
RA224	2.558E-03	2.561E-03	2.564E-03	2.586E-03	2.608E-03	2.823E-03	3.525E-03	4.620E-03	7.283E-03	3.212E-02
RA225	6.917E-07	6.805E-07	6.695E-07	6.057E-07	5.561E-07	3.255E-07	2.136E-07	2.066E-07	2.068E-07	2.102E-07
RA226	1.004E-10	1.005E-10	1.006E-10	1.013E-10	1.020E-10	1.074E-10	1.230E-10	1.512E-10	2.316E-10	2.893E-09
RA228	4.438E-12	4.441E-12	4.445E-12	4.468E-12	4.488E-12	4.656E-12	5.109E-12	5.827E-12	7.453E-12	2.615E-11
AC225	6.662E-07	6.669E-07	6.671E-07	6.609E-07	6.464E-07	4.440E-07	2.265E-07	2.069E-07	2.069E-07	2.102E-07
AC227	3.235E-08	3.237E-08	3.238E-08	3.248E-08	3.257E-08	3.332E-08	3.531E-08	3.845E-08	4.547E-08	1.257E-07
AC228	6.169E-07	1.588E-07	4.090E-08	1.205E-11	4.494E-12	4.656E-12	5.109E-12	5.828E-12	7.454E-12	2.615E-11
TH226	1.365E-07	1.343E-07	1.321E-07	1.189E-07	1.081E-07	5.025E-08	6.804E-09	3.390E-10	7.067E-13	0.000E+00
TH227	3.402E-08	3.402E-08	3.402E-08	3.396E-08	3.386E-08	3.319E-08	3.406E-08	3.698E-08	4.380E-08	1.241E-07
TH228	2.587E-03	2.592E-03	2.597E-03	2.626E-03	2.652E-03	2.874E-03	3.511E-03	4.603E-03	7.263E-03	3.211E-02
TH229	2.064E-07	2.064E-07	2.064E-07	2.064E-07	2.064E-07	2.064E-07	2.065E-07	2.066E-07	2.068E-07	2.102E-07
TH230	1.878E-07	1.881E-07	1.883E-07	1.899E-07	1.913E-07	2.030E-07	2.364E-07	2.946E-07	4.444E-07	3.049E-06

1 OUTPUT UNIT = 6
PAGE 232
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities
+ ACTINIDES+DAUGHTERS
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
TH231	1.3293-02	1.0963-02	9.281E-03	5.4753-03	5.0093-03	4.9213-03	4.922E-03	4.922E-03	4.922E-03	4.9233-03
TH232	2.980E-11	2.981E-11	2.983E-11	2.992E-11	3.000E-11	3.0663-11	3.238E-11	3.495E-11	4.026E-11	8.2123-11
TH233	2.9713-02	4.6313-12	7.2173-22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TH234	1.626E-01	1.626E-01	1.626E-01	1.6263-01	1.626E-01	1.6253-01	1.624E-01	1.624E-01	1.624E-01	1.6243-01
PA231	3.967E-07	3.971E-07	3.974E-07	3.9863-07	3.9953-07	4.0653-07	4.2403-07	4.5013-07	5.0343-07	9.2023-07
PA232	1.986E-02	1.525E-02	1.170E-02	2.1913-03	4.8953-04	2.5423-09	4.1643-23	0.000E+00	0.000E+00	0.000E+00
PA233	4.661E-01	4.661E-01	4.662E-01	4.666E-01	4.6703-01	4.7153-01	4.770E-01	4.784E-01	4.786E-01	4.7933-01
PA234M	1.729E-01	1.626E-01	1.626E-01	1.626E-01	1.6263-01	1.6253-01	1.624E-01	1.6243-01	1.6243-01	1.624E-01
PA234	1.047E-02	3.177E-03	1.0683-03	2.118E-04	2.115E-04	2.112E-04	2.111E-04	2.111E-04	2.111E-04	2.111E-04
PA235	1.965E-07	1.9953-16	2.025E-25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U230	1.3643-07	1.342E-07	1.319E-07	1.1873-07	1.080E-07	5.0203-08	6.7973-09	3.387E-10	7.0583-13	0.000E+00
U231	4.113E-05	3.787E-05	3.487E-05	2.068E-05	1.296E-05	2.911E-07	1.458E-11	5.1713-18	2.738E-31	0.000E+00
U232	1.186E-02	1.1883-02	1.189E-02	1.200E-02	1.210E-02	1.2883-02	1.486E-02	1.768E-02	2.294E-02	4.694E-02
U233	2.939E-06	2.942E-06	2.945E-06	2.963E-06	2.978E-06	3.1083-06	3.4493-06	3.964E-06	5.0253-06	1.3403-05
U234	1.9773-02	1.9803-02	1.982E-02	1.997E-02	2.0103-02	2.1193-02	2.405E-02	2.836E-02	3.728E-02	1.071E-01
U235	4.921E-03	4.921E-03	4.9213-03	4.9213-03	4.9213-03	4.921E-03	4.922E-03	4.922E-03	4.922E-03	4.923E-03
U236	2.121E-01	2.121E-01	2.121E-01	2.121E-01	2.121E-01	2.121E-01	2.121E-01	2.121E-01	2.121E-01	2.122E-01
U237	1.113E+06	1.057E+06	1.004E+06	7.253E+05	5.422E+05	5.110E+04	1.098E+02	2.130E+00	2.069E+00	1.706E+00
U238	1.6243-01	1.6243-01	1.624E-01	1.624E-01	1.6243-01	1.6243-01	1.624E-01	1.624E-01	1.624E-01	1.624E-01
U239	1.564E+07	9.6423-03	5.946E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
U240	2.615E+01	1.450E+01	8.038E+00	1.917E-01	6.775E-03	1.7043-06	1.7043-06	1.704E-06	1.704E-06	1.7043-06
U241	7.150E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP235	1.127E-02	1.1263-02	1.125E-02	1.119E-02	1.113E-02	1.070E-02	9.6293-03	8.226E-03	5.948E-03	4.6133-04
NP236M	1.467E+01	1.013E+01	7.002E+00	6.736E-01	8.2913-02	3.4153-09	1.851E-28	0.000E+00	0.000E+00	0.000E+00
NP236	9.4863-06	9.4863-06	9.486E-06	9.486E-06	9.4863-06	9.4863-06	9.486E-06	9.4863-06	9.486E-06	9.486E-06
NP237	4.690E-01	4.6943-01	4.6993-01	4.7233-01	4.7393-01	4.7813-01	4.786E-01	4.7863-01	4.7863-01	4.7933-01
NP238	7.555E+05	6.414E+05	5.445E+05	1.931E+05	7.635E+04	4.101E+01	6.7013-02	6.693E-02	6.678E-02	6.5573-02
NP239	1.561E+07	1.357E+07	1.171E+07	4.613E+06	2.004E+06	2.347E+03	3.343E+01	3.343E+01	3.343E+01	3.342E+01
NP240M	5.331E+03	1.463E+01	8.109E+00	1.9343-01	6.8353-03	1.7043-06	1.704E-06	1.704E-06	1.704E-06	1.7043-06
NP240	2.590E+04	1.199E+01	5.551E-03	4.2263-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NP241	7.1503-05	2.0343-18	6.8453-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU236	1.310E+00	1.312E+00	1.313E+00	1.313E+00	1.310E+00	1.291E+00	1.240E+00	1.168E+00	1.032E+00	3.904E-01
PU237	7.525E+00	7.468E+00	7.411E+00	7.063E+00	6.765E+00	4.769E+00	1.916E+00	4.8783-01	2.9203-02	6.6143-12
PU238	6.050E+03	6.058E+03	6.064E+03	6.090E+03	6.100E+03	6.121E+03	6.154E+03	6.187E+03	6.215E+03	6.065E+03
PU239	2.508E+02	2.514E+02	2.519E+02	2.538E+02	2.5453302	2.550E+02	2.550E+02	2.550E+02	2.550E+02	2.550E+02
PU240	5.383E+02	5.383E+02	5.383E+02	5.383E+02	5.383E+02	5.384E+02	5.385E+02	5.388E+02	5.392E+02	5.425E+02
PU241	8.848E+04	8.848E+04	8.847E+04	8.843E+04	8.840E+04	8.813E+04	8.744E+04	8.641E+04	8.432E+04	6.956E+04

PU242	1.815E+00	1.815E+00	1.815E+00	1.815E+00	1.815E+00	1.815E+00	1.815E+00	1.815E+00	1.815E+00	1.815E+00
PU243	4.917E+05	9.178E+04	1.713E+04	4.141E-01	3.342E-05	2.773E-06	2.773E-06	2.773E-06	2.773E-06	2.773E-06
PU244	1.706E-06	1.706E-06	1.706E-06	1.706E-06	1.706E-06	1.706E-06	1.706E-06	1.706E-06	1.706E-06	1.706E-06
PU245	3.805E+00	1.736E+00	7.922E-01	5.502E-03	6.446E-05	1.358E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PU246	1.484E-03	1.437E-03	1.392E-03	1.137E-03	9.488E-04	2.183E-04	4.725E-06	1.506E-08	1.087E-12	9.781E-13
AM239	1.229E-03	6.108E-04	3.036E-04	3.629E-06	6.913E-08	7.515E-22	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM240	3.564E-01	3.026E-01	2.569E-01	9.109E-02	3.602E-02	1.931E-05	5.671E-14	9.024E-27	0.000E+00	0.000E+00
AM241	1.002E+02	1.004E+02	1.006E+02	1.018E+02	1.029E+02	1.118E+02	1.349E+02	1.692E+02	2.385E+02	7.273E+02
AM242M	1.342E+01	1.342E+01	1.342E+01	1.342E+01	1.342E+01	1.341E+01	1.340E+01	1.339E+01	1.336E+01	1.311E+01
AM242	6.012E+04	3.578E+04	2.129E+04	8.073E+02	5.522E+01	1.334E+01	1.333E+01	1.332E+01	1.329E+01	1.305E+01
AM243	3.339E+01	3.342E+01	3.343E+01	3.343E+01	3.343E+01	3.343E+01	3.343E+01	3.343E+01	3.343E+01	3.342E+01
AM244M	2.875E+05	1.326E-03	6.112E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM244	1.508E+04	6.619E+03	2.905E+03	1.577E+01	1.483E-01	5.235E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AM245	3.805E+00	2.141E+00	9.841E-01	6.838E-03	8.129E-05	1.120E-06	9.841E-07	8.099E-07	5.422E-07	2.290E-08

1 OUTPUT UNIT = 6
PAGE 233
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities
\+ ACTINIDES+DAUGHTERS
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0WR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
AM246	1.4843-03	1.4403-03	1.394E-03	1.1393-03	9.5043-04	2.187E-04	4.7323-06	1.508E-08	1.087E-12	9.781E-13
CM241	2.3403-02	2.3183-02	2.2963-02	2.1603-02	2.0453-02	1.314E-02	4.1373-03	7.314E-04	2.0663-05	1.2543-17
CM242	4.066E+04	4.066E+04	4.062E+04	4.015E+04	3.967E+04	3.598E+04	2.789E+04	1.903E+04	8.671E+03	2.829E+01
CM243	3.462E+01	3.462E+01	3.462E+01	3.461E+01	3.461E+01	3.455E+01	3.441E+01	3.421E+01	3.379E+01	3.066E+01
CM244	9.388E+03	9.389E+03	9.388E+03	9.385E+03	9.383E+03	9.360E+03	9.301E+03	9.214E+03	9.037E+03	7.754E+03
CM245	1.206E+00	1.206E+00	1.206E+00	1.206E+00	1.206E+00	1.206E+00	1.206E+00	1.206E+00	1.206E+00	1.205E+00
CM246	4.8143-01	4.814E-01	4.8143-01	4.814E-01	4.8143-01	4.8143-01	4.8143-01	4.8143-01	4.814E-01	4.811E-01
CM247	2.773E-06	2.773E-06	2.7733-06	2.773E-06	2.773E-06	2.7733-06	2.7733-06	2.7733-06	2.7733-06	2.773E-06
CM248	1.448E-05	1.448E-05	1.448E-05	1.448E-05	1.448E-05	1.448E-05	1.448E-05	1.449E-05	1.449E-05	1.4503-05
CM249	7.5023-01	3.1493-04	1.354E-06	1.080E-06	9.676E-07	3.954E-07	3.828E-08	1.153E-09	8.537E-13	0.000E+00
CM250	3.681E-12	3.682E-12	3.683E-12	3.691E-12	3.699E-12	3.7483-12	3.830E-12	3.884E-12	3.909E-12	3.912E-12
CM251	2.177E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BK249	8.231E-02	8.233E-02	8.224E-02	8.168E-02	8.118E-02	7.7253-02	6.785E-02	5.584E-02	3.738E-02	1.579E-03
BK250	3.538E-01	2.678E-02	2.0313-03	4.657E-06	4.624E-06	4.3643-06	3.7533-06	2.993E-06	1.879E-06	4.771E-08
BK251	2.122E-04	3.344E-08	5.2693-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CF249	2.954E-05	2.9763-05	2.9993-05	3.139E-05	3.2643-05	4.2503-05	6.602E-05	9.6023-05	1.420E-04	2.299E-04
CF250	1.3293-03	1.3393-03	1.3393-03	1.3393-03	1.338E-03	1.3343-03	1.3223-03	1.305E-03	1.270E-03	1.028E-03
CF251	1.030E-05	1.030E-05	1.030E-05	1.030E-05	1.030E-05	1.030E-05	1.030E-05	1.030E-05	1.0293-05	1.0263-05
CF252	3.451E-03	3.4493-03	3.448E-03	3.4403-03	3.4333-03	3.3773-03	3.2343-03	3.031E-03	2.6533-03	9.2753-04
CF253	4.0883-04	4.0093-04	3.9323-04	3.476E-04	3.113E-04	1.2723-04	1.2323-05	3.712E-07	2.7473-10	0.000E+00
CF254	7.880E-06	7.835E-06	7.7913-06	7.5133-06	7.2743-06	5.5893-06	2.8103-06	1.002E-06	1.200E-07	6.452E-15
CF255	1.325E-06	5.1733-09	2.021E-11	1.1313-26	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ES253	2.6523-04	2.675E-04	2.697E-04	2.797E-04	2.841E-04	2.3513-04	5.9973-05	4.275E-06	1.0923-08	4.176E-30
ES254M	2.9733-05	2.4063-05	1.947E-05	5.095E-06	1.536E-06	9.080E-11	8.472E-22	0.000E+00	0.000E+00	0.000E+00
ES254	4.704E-06	4.698E-06	4.6923-06	4.6553-06	4.6223-06	4.362E-06	3.751E-06	2.992E-06	1.878E-06	4.769E-08
ES255	9.9493-07	9.882E-07	9.7943-07	9.2583-07	8.804E-07	5.850E-07	2.0143-07	4.067E-08	1.512E-09	7.987E-21
SF250	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL	3.415E+07	1.555E+07	1.345E+07	5.677E+06	2.767E+06	1.941E+05	1.320E+05	1.219E+05	1.094E+05	8.506E+04

0 CUMULATIVE TABLE TOTALS

AP+FP	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ACT+FP	3.415E+07	1.555E+07	1.345E+07	5.677E+06	2.767E+06	1.941E+05	1.320E+05	1.219E+05	1.094E+05	8.506E+04
AP+ACT+FP	3.415E+07	1.555E+07	1.345E+07	5.677E+06	2.767E+06	1.941E+05	1.320E+05	1.219E+05	1.094E+05	8.506E+04

1 OUTPUT UNIT = 6
PAGE 234
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities
\+ FISSION PRODUCTS
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
H 3	5.519E+02	5.519E+02	5.518E+02	5.515E+02	5.513E+02	5.494E+02	5.443E+02	5.368E+02	5.218E+02	4.168E+02
LI 6	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LI 7	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BE 9	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BE 10	2.966E-06	2.966E-06	2.966E-06	2.966E-06	2.966E-06	2.966E-06	2.966E-06	2.966E-06	2.966E-06	2.966E-06
C 14	1.196E-04	1.196E-04	1.196E-04	1.196E-04	1.196E-04	1.196E-04	1.196E-04	1.196E-04	1.196E-04	1.195E-04
NI 66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 66	3.736E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 66	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 67	8.318E-11	7.272E-11	6.357E-11	2.713E-11	1.266E-11	2.608E-14	2.564E-21	6.845E-32	0.000E+00	0.000E+00
ZN 67	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 68	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 69	2.633E-02	1.042E-03	5.675E-04	1.234E-05	4.016E-07	3.377E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 69M	1.7703-03	9.669E-04	5.283E-04	1.149E-05	3.740E-07	3.145E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 69	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 70	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 70	3.176E-04	1.697E-14	9.070E-25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 70	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 71	3.749E-03	2.379E-08	2.850E-09	4.155E-15	2.492E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 71M	3.9313-04	4.709E-05	5.642E-06	8.225E-12	4.934E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 71	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 71	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 71M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 72	1.159E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 72	2.166E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 72	4.223E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 72	4.988E+01	4.172E+01	3.488E+01	1.124E+01	4.077E+00	1.089E-03	5.184E-13	5.387E-27	0.000E+00	0.000E+00
GA 72	5.006E+01	4.793E+01	4.344E+01	1.597E+01	5.846E+00	1.562E-03	7.4403-13	7.731E-27	0.000E+00	0.000E+00
GE 72	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 73	3.813E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 73	1.836E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 73	5.424E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 73	8.834E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 73	9.328E+01	1.699E+01	3.091E+00	6.345E-05	4.057E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 73	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 73M	9.336E+01	1.699E+01	3.091E+00	6.346E-05	4.058E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 74	7.192E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

NI 74	1.050E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 74	6.793E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 74	1.590E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 74	1.710E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 74	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CO 75	9.499E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 75	4.227E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 75	6.560E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 75	2.806E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 75	3.422E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 75	3.475E+02	8.598E-01	2.070E-03	5.463E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 75M	1.614E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 75	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 76	1.058E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = *6*
PAGE 235
ORIGEN2 **V2.1** (8-1-91), **Run on** 11/30/01 **at** 16:51:51

* AP1000 **U02 Case - Decayed Average Assembly Activities**
\+ **FISSION PRODUCTS**
POWER= 2.16543E+01 **MW**, BURNUP= 3.38110E+04 **MWD**, **FLUX=** 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
CU 76	4.640E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 76	4.354E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 76	6.781E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 76	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 76	5.061E+01	3.690E+01	2.690E+01	3.635E+00	6.064E-01	2.946E-07	9.980E-24	0.000E+00	0.000E+00	0.000E+00
SE 76	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NI 77	1.844E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 77	2.172E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 77	4.698E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 77	1.172E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 77	5.589E+02	2.679E+02	1.283E+02	1.213E+00	1.871E-02	3.690E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 77M	1.191E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 77	1.507E+03	1.292E+03	1.079E+03	2.906E+02	8.640E+01	4.513E-03	3.047E-14	5.248E-31	0.000E+00	0.000E+00
SE 77	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 77M	5.659E+00	3.204E+00	2.675E+00	7.208E-01	2.143E-01	1.119E-05	7.556E-17	0.000E+00	0.000E+00	0.000E+00
NI 78	2.147E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 78	7.645E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 78	4.286E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 78	1.910E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 78	3.440E+03	1.111E+01	3.585E-02	5.976E-18	4.563E-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 78	3.560E+03	8.338E+01	5.621E-01	8.905E-16	2.882E-29	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 78	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 79	2.573E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 79	3.297E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 79	2.330E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 79	7.140E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 79	8.292E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 79	4.112E-01	4.112E-01	4.112E-01	4.112E-01	4.112E-01	4.112E-01	4.112E-01	4.112E-01	4.112E-01	4.112E-01
SE 79M	8.339E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 79	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 79M	1.418E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 79	1.230E-06	9.693E-07	7.638E-07	1.688E-07	4.374E-08	7.579E-13	2.877E-25	0.000E+00	0.000E+00	0.000E+00
CU 80	2.642E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 80	1.113E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 80	2.065E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 80	1.272E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 80	1.737E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

SE 80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 80	6.848E-01	6.958E-02	1.060E-02	7.053E-03	1.647E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 80M	4.270E-01	6.502E-02	9.900E-03	6.591E-03	1.539E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 80	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CU 81	2.015E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 81	2.736E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 81	1.261E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 81	1.445E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 81	2.673E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 81	2.912E+04	1.816E-01	2.995E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 81M	7.452E+02	1.229E-01	2.028E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 81	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 81	7.645E-07	7.645E-07	7.645E-07	7.645E-07	7.645E-07	7.645E-07	7.645E-07	7.645E-07	7.645E-07	7.645E-07
KR 81M	3.544E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6
PAGE 236
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 UO2 Case - Decayed Average Assembly Activities

\+ FISSION PRODUCTS

POWER= 2.16543E+01 MW, BURNUP= 3 38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC

0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES

One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
ZN 72	3.742E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 72	4.896E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 72	1.195E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 72	2.120E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 72M	9.228E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 72	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 72	7.151E+03	5.656E+03	4.469E+03	1.005E+03	2.645E+02	5.198E-03	2.740E-15	0.000E+00	0.000E+00	0.000E+00
BR 72M	2.790E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 72	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZN 73	3.591E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 73	1.401E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 73	8.478E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 73	3.562E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 73	2.498E+04	5.846E-06	1.361E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 73M	3.539E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 73	6.215E+04	2.068E+03	6.370E+01	1.705E-08	4.643E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 73	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 73M	6.275E+04	6.448E+03	2.466E+02	7.272E-08	1.981E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 74	2.104E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 74	3.265E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 74	2.987E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 74	9.739E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 74	1.020E+05	1.734E-02	2.649E-09	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 74M	4.791E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 74	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GA 75	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 75	7.362E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 75	1.635E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 75	5.330E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 75M	3.990E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 75	1.201E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 75	8.813E+03	8.813E+03	8.812E+03	8.807E+03	8.803E+03	8.767E+03	8.675E+03	8.537E+03	8.262E+03	6.379E+03
KR 75M	1.222E+05	1.932E+04	3.018E+03	2.363E-02	6.381E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 75	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 76	1.429E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 76	8.487E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 76	9.911E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

BR 86	8.274E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 86M	8.292E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 86	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 86	2.839E+03	2.787E+03	2.735E+03	2.432E+03	2.189E+03	9.314E+02	1.002E+02	3.539E+00	3.665E-03	0.000E+00
RB 86M	2.674E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 86	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GE 87	1.865E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 87	3.785E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 87	8.456E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 87	1.886E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 87	2.242E+05	3.270E+02	4.701E-01	4.802E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 87	2.088E-05	2.088E-05	2.088E-05	2.088E-05	2.088E-05	2.088E-05	2.088E-05	2.088E-05	2.088E-05	2.088E-05
SR 87	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 87M	1.374E+01	7.086E-01	3.655E-02	2.560E-10	1.294E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

OUTPUT UNIT = 6

1
PAGE 237
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 UO2 Case - Decayed Average Assembly Activities FISSION PRODUCTS

\+
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
0
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
GE 88	9.634E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 88	4.320E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 88	3.235E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 88	1.888E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 88	3.142E+05	1.679E+04	8.967E+02	7.830E-06	4.822E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 88	3.220E+05	1.875E+04	1.001E+03	8.744E-06	5.384E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 88	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 89	4.885E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 89	9.797E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 89	1.222E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 89	3.696E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 89	4.056E+05	2.772E-09	1.526E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 89	4.241E+05	4.213E+05	4.184E+05	4.006E+05	3.853E+05	2.810E+05	1.233E+05	3.585E+04	2.820E+03	5.506E-06
Y 89	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 89M	3.884E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AS 90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 90	2.774E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 90	7.360E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 90	3.633E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 90	3.860E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 90M	9.950E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 90	6.968E+04	6.968E+04	6.967E+04	6.966E+04	6.965E+04	6.954E+04	6.927E+04	6.886E+04	6.804E+04	6.186E+04
Y 90	7.418E+04	7.363E+04	7.315E+04	7.119E+04	7.039E+04	6.956E+04	6.929E+04	6.888E+04	6.806E+04	6.187E+04
Y 90M	1.394E+01	9.531E-01	6.514E-02	2.715E-09	6.769E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 90	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 90M	3.599E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 91	4.838E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 91	2.788E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 91	2.711E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 91	5.022E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 91	5.523E+05	2.305E+05	9.603E+04	3.751E+02	2.626E+00	8.470E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 91	5.741E+05	5.730E+05	5.705E+05	5.502E+05	5.320E+05	4.051E+05	1.990E+05	6.852E+04	7.633E+03	2.320E-04
Y 91M	3.207E+05	1.465E+05	6.103E+04	2.384E+02	1.669E+00	5.382E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 91	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SE 92	3.224E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 92	4.304E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

KR 92	1.440E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 92	4.496E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 92	6.229E+05	2.895E+04	1.345E+03	4.8583-06	1.358E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 92	6.269E+05	1.593E+05	1.982E+04	8.287E-03	1.364E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 92	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 92	3.154E-06	3.048E-06	2.946E-06	2.3743-06	1.956E-06	4.074E-07	6.796E-09	1.465E-11	4.754E-17	0.000E+00
SE 93	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 93	6.996E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 93	5.526E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 93	3.475E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 93	7.368E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 93	7.598E+05	3.376E+05	1.481E+05	8.042E+02	7.562E+00	2.669E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 93	1.771E+00	1.771E+00	1.771E+00	1.771E+00	1.771E+00	1.771E+00	1.771E+00	1.771E+00	1.771E+00	1.771E+00
NB 93	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6

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ORIGEN2 V2.1 (8-1-91), Run **on** 11/30/01 at 16:51:51

* AP1000 U02 **Case - Decayed Average Assembly** Activities

\+ FISSION PRODUCTS

POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC

0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES

One Asy at 4.728 w/o; Region-wise Power **to** 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
NB 93M	1.870E-01	1.871E-01	1.872E-01	1.879E-01	1.885E-01	1.933E-01	2.057E-01	2.241E-01	2.613E-01	5.235E-01
BR 94	6.213E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 94	1.704E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 94	1.878E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 94	7.052E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 94	7.869E+05	3.759E-06	1.688E-17	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 94	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 94	1.467E-04	1.467E-04	1.4673-04	1.467E-04	1.467E-04	1.467E-04	1.467E-04	1.467E-04	1.467E-04	1.466E-04
NB 94M	8.754E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 95	5.959E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 95	3.287E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 95	9.182E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 95	6.562E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 95	8.698E+05	2.048E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 95	9.019E+05	8.971E+05	8.922E+05	8.621E+05	8.361E+05	6.517E+05	3.402E+05	1.283E+05	1.725E+04	2.305E-03
NB 95	9.067E+05	9.066E+05	9.065E+05	9.047E+05	9.017E+05	8.403E+05	5.694E+05	2.533E+05	3.746E+04	5.1183-03
NB 95M	6.390E+03	6.381E+03	6.371E+03	6.261E+03	6.124E+03	4.834E+03	2.524E+03	9.519E+02	1.279E+02	1.710E-05
MO 95	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BR 96	3.168E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 96	5.020E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 96	2.968E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 96	4.551E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 96	8.297E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 96	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 96	2.658E+03	1.862E+03	1.304E+03	1.366E+02	1.814E+01	1.388E-06	3.782E-25	0.000E+00	0.000E+00	0.000E+00
MO 96	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 97	3.277E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 97	5.823E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 97	2.437E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 97	7.227E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 97	9.525E+05	5.822E+05	3.559E+05	1.576E+04	9.691E+02	1.425E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97	9.628E+05	5.861E+05	3.583E+05	1.584E+04	9.740E+02	1.536E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 97M	9.036E+05	5.515E+05	3.371E+05	1.493E+04	9.180E+02	1.3503-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 97	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR 98	3.801E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB 98	1.425E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 98	9.912E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Y 98	5.117E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 98	9.644E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98	9.846E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 98M	1.166E+04	7.210E-01	4.461E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 98	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC 98	8.723E-06	8.723E-06	8.723E-06	8.723E-06	8.723E-06	8.723E-06	8.723E-06	8.723E-06	8.723E-06	8.723E-06
RB 99	1.474E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR 99	2.915E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y 99	2.951E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR 99	9.558E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 99	1.001E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB 99M	4.601E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO 99	1.147E+06	1.012E+06	8.918E+05	4.015E+05	1.966E+05	5.969E+02	[illegible].614E-04	2.270E-14	0.000E+00	0.000E+00
TC 99	1.199E+01	1.199E+01	1.200E+01	1.202E+01	1.202E+01	1.203E+01	1.203E+01	1.203E+01	1.203E+01	1.203E+01

1 **OUTPUT UNIT** = 6
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ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed **Average Assembly Activities**
\+ **FISSION** PRODUCTS
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, **FLUX=** 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
TC 99M	1.005E+06	9.492E+05	8.528E+05	3.869E+05	1.895E+05	5.750E+02	1.555E-04	2.187E-14	0.000E+00	0.000E+00
RU 99	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB100	1.370E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR100	6.025E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y100	1.334E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR100	8.763E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB100	5.648E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB100M	5.648E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO100	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC100	5.795E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU100	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RB101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR101	8.695E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y101	4.397E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR101	5.568E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB101	9.434E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO101	1.029E+06	1.554E-09	2.326E-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC101	1.029E+06	3.495E-08	7.051E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU101	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR102	8.344E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y102	1.148E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR102	3.233E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB102	8.203E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO102	1.007E+06	3.052E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102	1.008E+06	3.076E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC102M	1.397E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH102	1.549E+00	1.548E+00	1.548E+00	1.545E+00	1.542E+00	1.519E+00	1.460E+00	1.377E+00	1.220E+00	4.688E-01
PD102	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SR103	2.874E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y103	1.778E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR103	1.256E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB103	5.917E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO103	1.021E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC103	1.039E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU103	1.041E+06	1.032E+06	1.023E+06	9.672E+05	9.200E+05	6.131E+05	2.127E+05	4.346E+04	1.654E+03	1.053E-08
RH103	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

RH103M	9.381E+05	9.303E+05	9.222E+05	8.719E+05	8.294E+05	5.527E+05	1.917E+05	3.918E+04	1.491E+03	9.494E-09
SR104	1.236E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y104	1.705E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR104	3.171E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB104	2.960E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO104	8.516E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC104	9.150E+05	1.230E-06	1.518E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU104	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH104	9.749E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH104M	6.379E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD104	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y105	8.252E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR105	4.322E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB105	1.031E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6
PAGE 240
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities
+ **FISSION PRODUCTS**
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
MO105	6.227E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC105	7.758E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU105	7.974E+05	1.265E+05	1.941E+04	1.362E-01	3.331E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH105	7.113E+05	6.376E+05	5.155E+05	1.168E+05	3.081E+04	6.159E-01	3.394E-13	1.369E-31	0.000E+00	0.000E+00
RH105M	2.233E+05	3.551E+04	5.452E+03	3.824E-02	9.353E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD105	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Y106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR106	4.374E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB106	2.652E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO106	3.416E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC106	5.617E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU106	4.814E+05	4.809E+05	4.805E+05	4.776E+05	4.751E+05	4.549E+05	4.064E+05	3.430E+05	2.420E+05	1.546E+04
RH106	5.407E+05	4.809E+05	4.805E+05	4.776E+05	4.751E+05	4.549E+05	4.064E+05	3.430E+05	2.420E+05	1.546E+04
RH106M	2.712E+04	6.184E+02	1.410E+01	5.624E-10	2.789E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD106	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG106	1.074E-06	1.031E-06	9.896E-07	7.644E-07	6.067E-07	9.298E-08	6.973E-10	4.529E-13	1.246E-19	0.000E+00
Y107	3.872E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR107	1.962E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB107	4.053E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO107	1.249E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC107	3.124E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU107	4.828E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH107	4.853E+05	6.278E-05	6.453E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD107	1.252E-01	1.252E-01	1.252E-01	1.252E-01	1.252E-01	1.252E-01	1.252E-01	1.252E-01	1.252E-01	1.252E-01
PD107M	1.508E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG107	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ZR108	7.060E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB108	9.151E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO108	3.578E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC108	1.829E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU108	3.351E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH108	3.384E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH108M	3.229E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD108	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG108	2.081E+00	3.262E-06	3.262E-06	3.2613-06	3.261E-06	3.260E-06	3.257E-06	3.2533-06	3.244E-06	3.174E-06
AG108M	3.665E-05	3.665E-05	3.665E-05	3.6653-05	3.664E-05	3.663E-05	3.660E-05	3.655E-05	3.645E-05	3.566E-05
CD108	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

ZR109	5.262E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB109	1.837E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO109	1.157E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC109	8.491E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU109	2.071E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH109	2.158E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH109M	1.079E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD109	3.137E+05	1.699E+05	9.157E+04	1.829E+03	5.514E+01	2.496E-11	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD109M	1.094E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG109	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG109M	3.136E+05	1.699E+05	9.160E+04	1.829E+03	5.517E+01	3.159E-03	2.888E-03	2.525E-03	1.915E-03	2.159E-04
CD109	3.304E-03	3.302E-03	3.299E-03	3.284E-03	3.270E-03	3.159E-03	2.888E-03	2.525E-03	1.915E-03	2.159E-04
NB110	2.083E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO110	2.296E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6
PAGE 241
ORIGEN2 V2.1 (8-1-91), **Run** on 11/30/01 **at** 16:51:51

* AP1000 U02 Case - **Decayed Average Assembly Activities**
\+ **FISSION PRODUCTS**
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
TC110	2.088E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU110	8.992E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH110	9.696E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH110M	7.050E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD110	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG110	2.168E+05	8.416E+01	8.404E+01	8.331E+01	8.266E+01	7.755E+01	6.566E+01	5.115E+01	3.060E+01	5.317E-01
AG110M	6.337E+03	6.328E+03	6.319E+03	6.264E+03	6.215E+03	5.831E+03	4.937E+03	3.846E+03	2.301E+03	3.998E+01
CD110	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB111	1.773E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO111	4.727E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC111	6.715E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU111	3.899E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH111	5.322E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD111	5.542E+04	1.481E+02	3.264E+01	2.259E-03	4.287E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD111M	9.214E+02	2.032E+02	4.479E+01	3.101E-03	5.884E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG111	5.674E+04	5.430E+04	5.184E+04	3.861E+04	2.966E+04	3.490E+03	1.312E+01	3.031E-03	9.918E-11	0.000E+00
AG111M	5.588E+04	2.121E+02	4.676E+01	3.244E-03	6.156E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD111	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD111M	7.869E+01	2.789E-03	9.882E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
NB112	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO112	8.639E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC112	2.253E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU112	1.660E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH112	2.642E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD112	2.831E+04	1.872E+04	1.237E+04	9.000E+02	8.627E+01	4.664E-07	1.266E-28	0.000E+00	0.000E+00	0.000E+00
AG112	2.843E+04	2.181E+04	1.463E+04	1.066E+03	1.022E+02	5.524E-07	1.500E-28	0.000E+00	0.000E+00	0.000E+00
CD112	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO113	6.141E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC113	5.957E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU113	8.816E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH113	1.834E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD113	2.209E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG113	1.991E+04	4.165E+03	8.671E+02	4.182E-02	5.743E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG113M	2.240E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD113M	7.447E+01	7.447E+01	7.447E+01	7.444E+01	7.441E+01	7.419E+01	7.361E+01	7.275E+01	7.102E+01	5.873E+01
IN113	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

IN113M	3.4013-06	2.254E-08	1.494E-10	2.377E-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO114	6.278E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC114	1.339E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU114	3.957E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH114	1.040E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD114	1.493E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG114	1.514E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD114	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN114	1.781E+01	6.436E+00	6.391E+00	6.114E+00	5.876E+00	4.258E+00	1.839E+00	5.215E-01	3.9003-02	5.112E-11
IN114M	6.772E+00	6.725E+00	6.678E+00	6.388E+00	6.140E+00	4.450E+00	1.921E+00	5.4503-01	4.075E-02	5.341E-11
SN114	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
MO115	4.2053-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC115	2.827E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU115	1.869E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

OUTPUT UNIT = 6

1
PAGE 242
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 UO2 Case - Decayed Average Assembly Activities

FISSION PRODUCTS

\+
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
RH115	7.914E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD115	1.425E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG115	1.068E+04	1.607E-07	2.339E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG115M	4.114E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD115	1.475E+04	1.268E+04	1.085E+04	4.052E+03	1.678E+03	1.310E+00	1.025E-08	7.089E-21	0.000E+00	0.000E+00
CD115M	1.372E+03	1.361E+03	1.351E+03	1.286E+03	1.230E+03	8.605E+02	3.386E+02	8.360E+01	4.696E+00	[illegible].449E-10
IN115	7.708E-12	7.736E-12	7.762E-12	7.865E-12	7.909E-12	8.021E-12	8.148E-12	8.210E-12	8.230E-12	[illegible].231E-12
IN115M	1.477E+04	1.360E+04	1.177E+04	4.407E+03	1.825E+03	1.485E+00	2.380E-02	5.875E-03	3.300E-04	[illegible].532E-14
SN115	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC116	1.753E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU116	4.179E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH116	3.756E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD116	1.060E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG116	5.910E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG116M	5.910E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD116	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN116	8.945E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN116M	6.516E+03	6.477E-01	6.438E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN116	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TC117	7.416E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU117	6.058E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH117	1.863E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD117	9.223E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG117	5.796E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG117M	5.794E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD117	7.732E+03	3.171E+02	1.294E+01	2.054E-08	2.751E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD117M	4.183E+03	3.631E+02	3.144E+01	5.870E-06	5.598E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN117	7.129E+03	8.933E+02	6.378E+01	7.847E-06	7.435E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN117M	9.032E+03	1.208E+03	7.514E+01	6.090E-06	5.737E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN117	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN117M	1.709E+02	1.667E+02	1.626E+02	1.390E+02	1.208E+02	3.871E+01	1.987E+00	2.310E-02	2.408E-06	0.000E+00
TC118	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU118	4.131E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH118	3.217E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD118	7.902E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG118	7.615E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG118M	5.331E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

CD118	1.162E+04	5.714E-01	2.805E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN118	1.162E+04	5.724E-01	2.810E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN118M	5.083E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN118	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RU119	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH119	2.592E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD119	5.851E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG119	1.076E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD119	5.809E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD119M	5.809E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN119	3.343E+03	8.337E-10	7.583E-22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN119M	8.716E+03	1.436E-08	1.306E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN119M	2.195E+02	2.192E+02	2.189E+02	2.169E+02	2.152E+02	2.017E+02	1.702E+02	1.319E+02	7.811E+01	1.253E+00

1 OUTPUT UNIT = 6

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ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 UO2 Case - Decayed Average Assembly Activities

FISSION PRODUCTS

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POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC

0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES

One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
RU120	8.636E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH120	3.914E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD120	2.194E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG120	7.384E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD120	1.141E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN120	5.823E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN120M	5.823E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN120	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH121	6.195E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD121	8.636E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG121	5.170E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD121	1.128E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN121	9.599E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN121M	2.378E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN121	1.202E+04	8.823E+03	6.469E+03	9.061E+02	1.561E+02	9.841E-05	6.581E-21	0.000E+00	0.000E+00	0.000E+00
SN121M	2.204E-01	2.204E-01	2.204E-01	2.203E-01	2.203E-01	2.201E-01	2.196E-01	2.189E-01	2.173E-01	2.056E-01
SB121	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH122	7.504E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD122	2.656E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG122	3.223E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD122	1.078E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN122	1.160E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN122M	8.238E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN122	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB122	3.266E+03	2.873E+03	2.527E+03	1.121E+03	5.416E+02	1.478E+00	3.026E-07	2.801E-17	0.000E+00	0.000E+00
SB122M	2.568E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE122	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
RH123	6.400E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD123	6.004E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG123	1.686E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD123	1.026E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN123	9.550E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN123M	4.007E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN123	2.616E+03	2.609E+03	2.602E+03	2.558E+03	2.520E+03	2.227E+03	1.614E+03	9.958E+02	3.685E+02	1.451E-01
SN123M	1.126E+04	4.447E-02	[illegible]	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB123	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE123	5.058E-12	5.063E-12	5.087E-12	5.096E-12	5.120E-12	5.307E-12	5.691E-12	6.067E-12	6.428E-12	6.616E-12

TE123M	4.755E+01	4.741E+01	4.727E+01	4.641E+01	4.566E+01	3.996E+01	2.823E+01	1.676E+01	5.733E+00	1.212E-03
PD124	1.121E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG124	7.684E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD124	9.313E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN124	1.518E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN124	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB124	2.157E+03	2.144E+03	2.132E+03	2.056E+03	1.990E+03	1.527E+03	7.650E+02	2.714E+02	3.215E+01	1.589E-06
SB124M	1.128E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE124	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PD125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG125	2.409E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD125	6.818E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN125	9.946E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN125M	7.266E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6
PAGE 244
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities
\+ FISSION PRODUCTS
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
SN125	9.861E+03	9.513E+03	9.177E+03	7.308E+03	5.961E+03	1.141E+03	1.526E+01	2.363E-02	3.879E-08	0.000E+00
SN125M	1.613E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB125	1.329E+04	1.328E+04	1.328E+04	1.327E+04	1.326E+04	1.310E+04	1.258E+04	1.183E+04	1.042E+04	3.829E+03
TE125	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE125M	2.897E+03	2.898E+03	2.899E+03	2.905E+03	2.910E+03	2.939E+03	2.943E+03	2.843E+03	2.537E+03	9.342E+02
PD126	1.675E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG126	7.431E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD126	4.947E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN126	2.130E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN126	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01
SB126	1.127E+03	1.096E+03	1.066E+03	8.928E+02	7.620E+02	2.107E+02	7.464E+00	1.624E-01	1.145E-01	1.145E-01
SB126M	3.835E+02	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01	8.178E-01
TE126	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
AG127	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE126	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD127	2.813E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN127	1.265E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN127M	1.265E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN127	4.852E+04	9.244E+02	1.761E+01	2.245E-10	4.014E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN127M	2.308E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB127	7.650E+04	7.094E+04	6.485E+04	3.667E+04	2.201E+04	3.500E+02	7.115E-03	6.520E-10	2.1283-24	0.000E+00
TE127	7.586E+04	7.426E+04	7.049E+04	4.490E+04	3.077E+04	8.800E+03	5.781E+03	3.262E+03	1.004E+03	9.272E-02
TE127M	1.007E+04	1.007E+04	1.006E+04	1.000E+04	9.894E+03	8.643E+03	5.902E+03	3.330E+03	1.025E+03	9.466E-02
I127	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE127	1.530E-01	1.516E-01	1.501E-01	1.414E-01	1.339E-01	8.644E-02	2.759E-02	4.973E-03	1.463E-04	1.221E-16
AG128	3.146E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD128	1.058E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN128	1.961E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN128	1.071E+05	2.271E+01	4.815E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB128	1.078E+04	4.281E+03	1.701E+03	4.927E+00	2.636E-02	9.563E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB128M	1.177E+05	2.757E+01	5.845E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE128	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I128	1.845E+04	3.895E-05	8.224E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE128	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD129	4.527E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN129	1.701E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN129	7.325E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

SN129M	7.763E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB129	2.136E+05	3.157E+04	4.602E+03	2.325E-02	4.239E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE129	2.105E+05	5.785E+04	2.549E+04	1.871E+04	1.765E+04	1.098E+04	3.185E+03	4.975E+02	1.089E+01	8.861E-13
TE129M	3.118E+04	3.099E+04	3.069E+04	2.875E+04	2.712E+04	1.687E+04	4.893E+03	7.643E+02	1.673E+01	1.361E-12
I129	3.120E-02	3.121E-02	3.121E-02	3.122E-02	3.123E-02	3.129E-02	3.136E-02	3.139E-02	3.139E-02	3.139E-02
XE129	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE129M	1.796E+01	1.720E+01	1.647E+01	1.252E+01	9.795E+00	1.335E+00	7.374E-03	3.028E-06	3.239E-13	0.000E+00
CD130	3.708E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN130	1.663E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN130	2.206E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB130	7.005E+04	2.672E-01	1.019E-06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB130M	2.934E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE130	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I130	4.944E+04	2.533E+04	1.292E+04	1.822E+02	4.023E+00	1.451E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00

OUTPUT UNIT = 6

1
PAGE 245
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 UO2 Case - Decayed Average Assembly Activities

FISSION PRODUCTS

+

POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC

0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES

One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
I130M	1.956E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE130	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CD131	6.167E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN131	6.134E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN131	1.836E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB131	4.972E+05	1.908E-04	7.195E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE131	5.382E+05	1.580E+04	1.198E+04	2.069E+03	4.299E+02	1.243E-03	4.415E-18	0.000E+00	0.000E+00	0.000E+00
TE131M	9.217E+04	7.019E+04	5.319E+04	9.189E+03	1.909E+03	5.520E-03	1.961E-17	0.000E+00	0.000E+00	0.000E+00
I131	6.086E+05	5.883E+05	5.661E+05	4.366E+05	3.430E+05	4.727E+04	2.680E+02	1.145E-01	1.328E-08	0.000E+00
XE131	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE131M	6.851E+03	6.846E+03	6.833E+03	6.612E+03	6.259E+03	2.625E+03	1.066E+02	5.935E-01	1.226E-05	0.000E+00
CD132	5.638E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN132	1.525E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN132	9.402E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB132	2.842E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB132M	1.898E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE132	8.509E+05	7.654E+05	6.881E+05	3.508E+05	1.920E+05	1.439E+03	4.116E-03	1.991E-11	1.524E-28	0.000E+00
I132	8.680E+05	7.883E+05	7.090E+05	3.615E+05	1.978E+05	1.483E+03	4.241E-03	2.051E-11	1.570E-28	0.000E+00
XE132	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS132	2.953E+02	2.799E+02	2.653E+02	1.890E+02	1.396E+02	1.190E+01	1.928E-02	1.261E-06	3.072E-15	0.000E+00
BA132	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN133	1.894E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN133	2.853E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB133	3.108E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133	6.957E+05	8.175E+00	1.000E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE133M	3.981E+05	4.875E+01	5.966E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I133	1.181E+06	8.091E+05	5.424E+05	4.309E+04	4.470E+03	4.585E-05	6.620E-26	0.000E+00	0.000E+00	0.000E+00
I133M	4.125E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE133	1.139E+06	1.130E+06	1.102E+06	7.934E+05	5.536E+05	2.676E+04	9.643E+00	6.594E-05	1.541E-15	0.000E+00
XE133M	3.802E+04	3.663E+04	3.407E+04	1.545E+04	6.548E+03	4.570E+00	2.581E-08	1.096E-20	0.000E+00	0.000E+00
CS133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA133	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
IN134	1.154E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN134	4.554E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB134	5.772E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB134M	5.317E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE134	8.922E+05	5.828E+00	3.804E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

I134	1.280E+06	3.370E+02	2.709E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I134M	1.452E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE134M	1.057E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS134	2.578E+05	2.577E+05	2.576E+05	2.569E+05	2.562E+05	2.508E+05	2.374E+05	2.185E+05	1.842E+05	4.802E+04
CS134M	6.292E+04	3.574E+03	2.030E+02	2.621E-06	2.290E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA134	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SN135	5.139E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB135	2.930E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE135	4.832E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I135	1.106E+06	3.145E+05	8.938E+04	3.095E+01	2.480E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE135	2.341E+05	4.391E+05	2.738E+05	1.479E+03	8.668E+00	4.557E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE135M	2.454E+05	5.038E+04	1.432E+04	4.958E+00	3.972E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS135	4.466E-01	4.468E-01	4.469E-01	4.471E-01	4.471E-01	4.471E-01	4.471E-01	4.471E-01	4.471E-01	4.471E-01

1 OUTPUT UNIT = 6
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ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities
\+ **FISSION PRODUCTS**
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.OHR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.OYR	5.OYR
CS135M	6.179E+04	5.028E+00	4.092E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA135	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA135M	3.360E+02	2.514E+02	1.882E+02	3.001E+01	5.805E+00	9.394E-06	7.345E-21	0.000E+00	0.000E+00	0.000E+00
SN136	4.767E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SB136	6.170E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE136	2.449E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136	5.174E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I136M	2.984E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS136	7.090E+04	6.905E+04	6.725E+04	5.687E+04	4.896E+04	1.450E+04	6.065E+02	5.188E+00	2.8753-04	0.000E+00
BA136	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA136M	1.168E+04	1.138E+04	1.108E+04	9.373E+03	8.068E+03	2.390E+03	9.994E+01	8.550E-01	4.738E-05	0.000E+00
SB137	1.028E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE137	7.399E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I137	4.868E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE137	1.024E+06	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS137	1.045E+05	1.045E+05	1.045E+05	1.045E+05	1.044E+05	1.043E+05	1.039E+05	1.033E+05	1.021E+05	9.308E+04
BA137	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA137M	9.900E+04	9.884E+04	9.884E+04	9.882E+04	9.880E+04	9.865E+04	9.828E+04	9.772E+04	9.658E+04	8.806E+04
SB138	1.343E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE138	1.910E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I138	2.378E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE138	9.230E+05	4.6803-10	2.368E-25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138	1.038E+06	3.2863-01	6.102E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS138M	5.405E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA138	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA138	8.045E-11	8.045E-11	8.045E-11	8.045E-11	8.045E-11	8.045E-11	8.045E-11	8.045E-11	8.045E-11	8.0453-11
SB139	1.008E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE139	3.892E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I139	1.050E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE139	7.074E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS139	9.813E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA139	1.023E+06	2.770E+03	6.629E+00	1.671E-16	2.282E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR139	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE140	4.956E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

I140	2.874E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE140	4.450E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS140	8.812E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA140	9.865E+05	9.602E+05	9.345E+05	7.872E+05	6.751E+05	1.941E+05	7.512E+03	5.721E+01	2.496E-03	0.000E+00
LA140	1.092E+06	1.070E+06	1.047E+06	8.981E+05	7.745E+05	2.234E+05	8.645E+03	6.584E+01	2.872E-03	0.000E+00
CE140	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR140	2.934E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE141	2.307E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I141	4.977E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE141	1.587E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS141	6.454E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA141	9.252E+05	1.282E-06	1.748E-18	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA141	9.303E+05	1.216E+05	1.465E+04	2.214E-02	1.372E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE141	9.347E+05	9.293E+05	9.199E+05	8.599E+05	8.095E+05	4.958E+05	1.380E+03	2.025E+04	3.901E+02	1.158E-11

1 OUTPUT UNIT = 6
PAGE 247
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities

+ **FISSION PRODUCTS**

POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC

0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES

One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
PR141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND141	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TE142	2.642E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I142	8.280E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE142	5.551E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS142	3.797E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA142	8.632E+05	4.791E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA142	8.865E+05	4.589E+03	2.105E+01	3.276E-14	1.845E-27	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE142	2.732E-05	2.732E-05	2.732E-05	2.732E-05	2.732E-05	2.732E-05	2.732E-05	2.732E-05	2.732E-05	2.732E-05
PR142	1.085E+05	7.039E+04	4.557E+04	2.903E+03	2.471E+02	5.091E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR142M	2.125E+04	3.034E-11	4.333E-26	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND142	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I143	5.727E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE143	9.947E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS143	1.776E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA143	7.401E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA143	8.262E+05	2.768E-10	9.132E-26	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE143	8.346E+05	6.533E+05	5.078E+05	1.029E+05	2.466E+04	2.273E-01	1.663E-14	0.000E+00	0.000E+00	0.000E+00
PR143	8.061E+05	8.045E+05	7.988E+05	7.165E+05	6.272E+05	1.945E+05	9.066E+03	9.123E+01	7.064E-03	0.000E+00
ND143	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
I144	4.844E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE144	1.861E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS144	5.749E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA144	5.410E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA144	7.182E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE144	7.621E+05	7.611E+05	7.602E+05	7.544E+05	7.492E+05	7.083E+05	6.119E+05	4.913E+05	3.127E+05	8.871E+03
PR144	7.698E+05	7.612E+05	7.602E+05	7.544E+05	7.492E+05	7.083E+05	6.119E+05	4.913E+05	3.128E+05	8.872E+03
PR144M	9.155E+03	9.134E+03	9.123E+03	9.052E+03	8.990E+03	8.500E+03	7.343E+03	5.896E+03	3.753E+03	1.065E+02
ND144	1.477E-09	1.478E-09	1.478E-09	1.480E-09	1.482E-09	1.497E-09	1.5333-09	1.578E-09	1.644E-09	1.757E-09
I145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE145	2.297E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS145	1.481E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA145	2.883E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA145	5.313E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE145	5.751E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR145	5.754E+05	1.446E+05	3.599E+04	5.379E+00	2.032E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

PM145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM145	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
XE146	1.455E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS146	2.276E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA146	1.097E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA146	3.528E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE146	4.688E+05	2.576E-10	1.404E-25	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR146	4.709E+05	1.263E-03	1.397E-12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND146	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM146	3.036E+00	3.035E+00	3.035E+00	3.032E+00	3.029E+00	3.005E+00	2.943E+00	2.853E+00	2.676E+00	1.617E+00
SM146	3.069E-07	3.069E-07	3.070E-07	3.071E-07	3.071E-07	3.078E-07	3.096E-07	3.122E-07	3.174E-07	3.482E-07
XE147	1.331E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS147	4.088E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA147	2.652E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6
PAGE 248
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities
+ FISSION PRODUCTS
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
LA147	1.749E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE147	3.666E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR147	3.773E+05	3.640E-13	3.1943-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND147	3.839E+05	3.724E+05	3.609E+05	2.959E+05	2.478E+05	5.862E+04	1.365E+03	4.848E+00	4.400E-05	0.000E+00
PM147	6.156E+04	6.167E+04	6.178E+04	6.239E+04	6.282E+04	6.394E+04	6.187E+04	5.798E+04	5.071E+04	1.762E+04
SM147	1.016E-06	1.016E-06	1.017E-06	1.021E-06	1.024E-06	1.050E-06	1.117E-06	1.212E-06	1.391E-06	2.202E-06
CS148	2.736E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA148	5.043E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA148	6.785E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE148	2.741E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR148	3.064E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND148	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM148	1.689E+05	1.584E+05	1.486E+05	9.897E+04	6.887E+04	4.035E+03	1.981E+02	4.335E+01	1.935E+00	4.331E-11
PM148M	1.579E+04	1.566E+04	1.553E+04	1.472E+04	1.404E+04	9.544E+03	3.486E+03	7.696E+02	3.435E+01	7.690E-10
SM148	6.625E-11	6.627E-11	6.629E-11	6.639E-11	6.646E-11	6.664E-11	6.673E-11	6.6773-11	6.678E-11	6.678E-11
CS149	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA149	6.095E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA149	1.775E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE149	1.558E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR149	2.207E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND149	2.441E+05	2.034E+03	1.661E+01	9.907E-13	1.457E-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM149	4.154E+05	3.622E+05	3.098E+05	1.148E+05	4.725E+04	3.500E+01	2.388E-07	1.345E-19	0.000E+00	0.000E+00
SM149	3.155E-13	3.526E-13	3.845E-13	5.026E-13	5.435E-13	5.7213-13	5.721E-13	5.721E-13	5.721E-13	5.721E-13
EU149	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CS150	2.631E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA150	4.687E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA150	3.571E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE150	7.545E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR150	1.543E+05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND150	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM150	6.587E+03	2.957E+02	1.327E+01	3.8573-08	8.8753-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM150	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU150	1.969E-05	1.969E-05	1.969E-05	1.969E-05	1.968E-05	1.966E-05	1.960E-05	1.951E-05	1.932E-05	1.788E-05
BA151	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA151	4.723E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE151	2.320E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR151	8.761E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

ND151	1.349E+05	4.492E-13	1.483E-30	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM151	1.348E+05	1.013E+05	7.557E+04	1.181E+04	2.246E+03	3.148E-03	1.693E-18	0.000E+00	0.000E+00	0.000E+00
SM151	3.303E+02	3.316E+02	3.325E+02	3.348E+02	3.351E+02	3.350E+02	3.346E+02	3.340E+02	3.327E+02	3.226E+02
EU151	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
BA152	1.287E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA152	5.530E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE152	5.244E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR152	3.944E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND152	9.263E+04	1.326E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM152	9.544E+04	2.060E-14	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM152M	1.853E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM152	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU152	4.474E+00	4.474E+00	4.474E+00	4.472E+00	4.470E+00	4.456E+00	4.419E+00	4.364E+00	4.252E+00	3.468E+00
EU152M	8.888E+01	3.641E+01	1.491E+01	5.227E-02	3.325E-04	4.914E-22	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6
PAGE 249
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 UO2 Case - Decayed Average Assembly Activities
+ FISSION PRODUCTS
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
GD152	9.599E-13	9.603E-13	9.605E-13	9.607E-13	9.607E-13	9.612E-13	9.625E-13	9.645E-13	9.684E-13	9.959E-13
LA153	5.886E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE153	9.672E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR153	1.284E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND153	5.516E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM153	6.292E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM153	4.937E+05	4.133E+05	3.458E+05	1.119E+05	4.079E+04	1.127E+01	5.868E-09	6.973E-23	0.000E+00	0.000E+00
EU153	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD153	2.127E+01	2.123E+01	2.120E+01	2.101E+01	2.084E+01	1.951E+01	1.643E+01	1.270E+01	7.471E+00	1.138E-01
LA154	2.739E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE154	1.150E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR154	3.197E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND154	2.996E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM154	3.704E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM154M	6.436E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM154	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU154	1.366E+04	1.366E+04	1.366E+04	1.365E+04	1.364E+04	1.357E+04	1.339E+04	1.313E+04	1.260E+04	9.128E+03
GD154	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
LA155	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE155	1.344E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR155	6.562E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND155	1.183E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM155	2.400E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM155	3.037E+04	5.398E-06	9.313E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU155	9.289E+03	9.287E+03	9.285E+03	9.274E+03	9.264E+03	9.183E+03	8.975E+03	8.671E+03	8.077E+03	4.618E+03
GD155M	1.678E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD155	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE156	1.277E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR156	1.262E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND156	4.411E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM156	1.380E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM156	1.846E+04	7.626E+03	3.148E+03	1.158E+01	7.695E-02	1.617E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU156	3.088E+05	3.021E+05	2.954E+05	2.557E+05	2.247E+05	7.863E+04	5.084E+03	8.356E+01	1.777E-02	0.000E+00
GD156	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
CE157	9.925E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR157	1.931E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND157	1.257E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

PM157	6.784E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM157	1.233E+04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU157	3.309E+04	1.921E+04	1.111E+04	3.473E+02	1.563E+01	1.828E-10	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD157	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR158	1.411E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND158	1.918E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM158	2.224E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM158	6.757E+03	7.983E-02	9.427E-07	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU158	7.275E+03	1.248E+00	3.679E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD158	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PR159	5.490E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND159	1.886E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM159	5.110E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM159	3.225E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1 OUTPUT UNIT = 6
PAGE 250
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 UO2 Case - Decayed Average Assembly Activities FISSION PRODUCTS
+
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One Asy at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
EU159	3.909E+03	4.746E-09	5.031E-21	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD159	7.207E+03	4.655E+03	2.976E+03	1.753E+02	1.390E+01	1.619E-08	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB159	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND160	1.372E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM160	8.252E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM160	1.168E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU160	1.791E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD160	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB160	1.746E+03	1.738E+03	1.729E+03	1.678E+03	1.633E+03	1.310E+03	7.368E+02	3.109E+02	5.265E+01	4.351E-05
DY160	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ND161	9.821E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM161	9.771E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM161	3.211E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU161	7.800E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD161	9.253E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB161	1.412E+03	1.344E+03	1.278E+03	9.306E+02	7.006E+02	6.998E+01	1.716E-01	2.087E-05	1.824E-13	0.000E+00
DY161	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
PM162	4.178E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM162	4.064E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU162	2.265E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD162	4.149E+02	1.276E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB162	4.109E+02	4.942E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB162M	1.261E+01	3.227E-01	7.743E-03	4.262E-13	2.820E-22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY162	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM163	4.508E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU163	5.245E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD163	1.656E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB163	1.789E+02	1.488E-09	1.142E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB163M	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY163	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM164	3.880E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU164	1.042E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
GD164	6.515E+01	6.580E-09	6.645E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB164	8.093E+01	7.637E-09	7.712E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY164	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
SM165	2.392E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
EU165	1.617E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

GD165	2.172E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TB165	3.550E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY165	1.006E+03	2.937E+01	8.526E-01	1.568E-10	3.052E-19	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY165M	6.297E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
HO165	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
DY166	2.805E+01	2.533E+01	2.287E+01	1.198E+01	6.720E+00	6.146E-02	2.950E-07	3.101E-15	1.141E-31	0.000E+00
HO166	3.211E+02	2.425E+02	1.842E+02	3.888E+01	1.363E+01	9.157E-02	4.395E-07	4.621E-15	1.597E-31	0.000E+00
HO166M	8.586E-03	8.586E-03	8.586E-03	8.586E-03	8.586E-03	8.585E-03	8.585E-03	8.583E-03	8.581E-03	8.561E-03
ER166	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ER167	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ER167M	9.993E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ER168	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
YB168	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ER169	5.107E-01	4.922E-01	4.744E-01	3.756E-01	3.048E-01	5.590E-02	6.698E-04	8.792E-07	1.027E-12	0.000E+00

1 OUTPUT UNIT = 6
PAGE 251
ORIGEN2 V2.1 (8-1-91), Run on 11/30/01 at 16:51:51

* AP1000 U02 Case - Decayed Average Assembly Activities
+ FISSION PRODUCTS
POWER= 2.16543E+01 MW, BURNUP= 3.38110E+04 MWD, FLUX= 3.82E+14 N/CM**2-SEC
0 7 NUCLIDE TABLE: RADIOACTIVITY, CURIES
One *Asy* at 4.728 w/o; Region-wise Power to 54 GWD/MTU

	2xBurned	12.0HR	1.0D	100.0HR	7.0D	30.0D	90.0D	180.0D	1.0YR	5.0YR
TM169	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
YB169	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ER170	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TM170	1.4493-01	1.4453-01	1.441E-01	1.417E-01	1.3953-01	1.2323-01	8.919E-02	5.491E-02	2.023E-02	7.686E-06
TM170M	1.629E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
YB170	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ER171	2.2363-06	7.3983-07	2.448E-07	2.219E-10	4.198E-13	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TM171	4.1073-03	4.1053-03	4.103E-03	4.0903-03	4.079E-03	3.9873-03	3.758E-03	3.4383-03	2.863E-03	6.755E-04
YB171	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ER172	9.132E-10	7.706E-10	6.503E-10	2.219E-10	8.481E-11	3.4463-14	4.905E-23	0.000E+00	0.000E+00	0.000E+00
TM172	5.744E-04	5.0403-04	4.422E-04	1.931E-04	9.205E-05	2.249E-07	3.437E-14	2.054E-24	0.000E+00	0.000E+00
YB172	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
TOTAL	1.033E+08	2.587E+07	2.221E+07	1.528E+07	1.308E+07	7.809E+06	4.573E+06	2.940E+06	1.800E+06	4.450E+05

0 CUMULATIVE TABLE TOTALS

AP+FP	1.033E+08	2.587E+07	2.221E+07	1.528E+07	1.308E+07	7.809E+06	4.573E+06	2.940E+06	1.800E+06	4.450E+05
ACT+FP	1.374E+08	4.142E+07	3.566E+07	2.096E+07	1.585E+07	8.003E+06	4.705E+06	3.062E+06	1.909E+06	5.301E+05
AP+ACT+FP	1.374E+08	4.142E+07	3.566E+07	2.096E+07	1.585E+07	8.003E+06	4.705E+06	3.062E+06	1.909E+06	5.301E+05

D1