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SPENT FUEL RECEIPT SCENARIOS STUDY

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SUMMARY

This study supports an OCRWM investigation of the options available to the DOE and the nuclear utilities for selection of spent fuel for acceptance into the Federal Waste Management System for disposal. It identifies several possible spent fuel receipt scenarios and analyzes the near-field thermal effects in a simulated Yucca Mt. repository that would result from emplacement of spent fuel and DHLW on schedules that are determined by the scenarios.

Three receipt scenarios are developed. They are designed to accept different portions of the spent fuel inventory, consistent with the acceptance schedule in the 1988 Mission Plan Amendment (DOE, 1988a). They specify the spent fuel discharge year (age) and burnup (GWD/MTU) characteristics by reactor type (BWR and PWR) as a function of receipt year. The first scenario implements the Oldest Fuel First concept that is the primary basis for allocation of acceptance priority in the standard contracts between DOE and the spent fuel generators (10 CFR 961, 1983). The other two scenarios employ a strategy that results in receipts with the characteristic of uniform integrated energy deposition of the spent fuel and co-emplaced DHLW over the repository operational period.

The study is constrained by a specific set of assumptions, including disposal of intact fuel assemblies, emplaced in vertical holes, in a repository modeled after the basic design and operating concept as detailed in the SCP-CDR. It focuses on the near-field thermal effects during the first 300 years following repository closure, the minimum period during which the NRC requires that the waste packages provide "substantially complete containment." The study evaluates the potential for enhancing performance during this period, by maintaining the emplacement hole wall temperatures above the boiling point of water, thus minimizing the effects of aqueous corrosion by liquid water contacting the waste package containers. The study does NOT purport to optimize any of the other elements of the DOE Waste Management System, or even all elements of the repository subsystem.

In general, the effect of emplacing spent fuel and DHLW as scheduled by the receipt scenarios falls short of fulfilling the objective of maintaining all emplacement holes above the unconfined boiling point of water for at least 300 yrs after repository closure. However, when combined with one or both of the other possible "heat-tailoring" options, i.e., package-scale adjustment of the spent fuel characteristics and/or geometric modifications to the repository disposal panels, this objective appears to be achievable when the levelized energy receipt scenarios are employed.

The study recommends additional analyses and sensitivity studies to evaluate further these basic concepts. Continuing interaction with other system elements is also recommended, with the objective of developing a receipt scenario that is optimized over all elements of the DOE system and that can be accepted by the nuclear utilities.

CONTENTS

SUMMARY.	ii
KEY TO ACRONYMS.	iv
1.0 INTRODUCTION.	1
1.1 OBJECTIVE OF THE STUDY.	1
1.2 SUMMARY OF ASSUMPTIONS.	2
1.2.1 Acceptance Rate and Inventory Assumptions	
1.2.2 Waste Package Configuration Assumptions	
1.2.3 Repository Assumptions	
1.3 QUALIFICATIONS.	5
2.0 DISCUSSION.	6
2.1 SCOPE OF THE STUDY.	6
2.1.1 Inventory Considerations	
2.1.2 Scenarios Investigated	
2.2 SELECTION METHODOLOGY.	7
2.2.1 "Optimization Parameter"	
2.2.2 Development of the Selection Algorithm	
2.2.3 Output Description	
2.3 THERMAL ANALYSIS PARAMETERS AND METHODOLOGY.	10
2.3.1 Repository and Panel Geometry	
2.3.2 Waste Package Distributions	
2.3.3 Waste Characteristics	
2.3.4 Analysis Methodology	
2.3.5 Limitations of the Analyses	
3.0 RESULTS AND CONCLUSIONS.	15
3.1 RESULTS OF THE STUDY.	15
3.1.1 Oldest Fuel First Scenario	
3.1.2 Levelized Energy Scenarios	
3.1.3 Thermal Analyses of the Scenarios	
3.2 CONCLUSIONS.	22
3.2.1 Conclusions on Receipt Scenarios	
3.2.2 Conclusions on Thermal Analyses	
3.3 RECOMMENDATIONS.	23
4.0 REFERENCES.	25

FIGURES

APPENDICES

- A - Waste Acceptance Schedule
- B - Historical and Projected Inventory Tables
- C - Flowchart and Listing of Scheduling Program
- D - Oldest Fuel First Receipt Schedule from Oldest Fuel Inventory
- E - Levelized Energy Receipt Schedule from Oldest Fuel Inventory
- F - Levelized Energy Receipt Schedule from "Hi-Graded" Inventory
- G - Reference Information/Technical Data Base Summary

KEY TO ACRONYMS

ASG	Automated Sciences Group, Inc. (ORNL contractor)
BWR	boiling water reactor (type of nuclear power plant)
CDC	Control Data Corporation
CFR	Code of Federal Regulations
CPU	central processing unit
DHLW	defense high level waste (DOE Defense Program HLW)
DOE	Department of Energy
DOE-HQ	Department of Energy - Headquarters (Washington, DC)
DWPF	Defense Waste Processing Facility (Savannah River, GA)
EIA	Energy Information Administration (DOE)
FIFO	first in-first out (an inventory management strategy)
GWD	gigawatt-days (a unit of energy - spent fuel burnup)
HLW	high level waste (often solidified reprocessing wastes)
HWVP	Hanford Waste Vitrification Plant (at the Hanford site)
INEL	Idaho National Engineering Laboratory (Westinghouse)
LIFO	last in first out (an inventory management strategy)
LLNL	Lawrence Livermore National Laboratory (Univ. of Calif.)
MRS	Monitored Retrievable Storage
MTU	metric tons of uranium (mass of UO_2 in reactor fuel)
NRC	Nuclear Regulatory Commission (Washington, DC)
NTS	Nevada Test Site (DOE facility in southern Nevada)
OCRWM	Office of Civilian Radioactive Waste Management (DOE)
OFF	Oldest Fuel First (a spent fuel allocation scenario)
ORNL	Oak Ridge National Laboratory (Martin-Marietta)
PNL	Pacific Northwest Laboratories (Battelle)
PRS	Preferred Receipt Scheduler (computer program)
PWR	pressurized water reactor (type of nuclear power plant)
QAL	Quality Assurance Level (establishes QA requirements)
SCP-CDR	Site Characterization Plan - Conceptual Design Report
WBS	Work Breakdown Structure (a program activity hierarchy)
WVDP	West Valley (New York) Demonstration Project
YMP	Yucca Mountain Project
YMPO	Yucca Mountain (Nevada) Project Office (DOE)

1.0 - INTRODUCTION

This study reports on the results of an assignment from the DOE Office of Civilian Radioactive Waste Management to evaluate the effects of different scenarios for receipt of spent fuel on the potential performance of the waste packages in the proposed Yucca Mountain high-level waste repository. The initial evaluations were performed and an interim letter report was prepared during the fall of 1988. Subsequently, the scope of work was expanded and additional analyses were conducted in 1989. This report combines the results of the two phases of the activity.

This study is a part of a broader effort to investigate the options available to the DOE and the nuclear utilities for selection of spent fuel for acceptance into the Federal Waste Management System for disposal. Each major element of the system has evaluated the effects of various options on its own operations, with the objective of providing the basis for performing system-wide trade-offs and determining an optimum acceptance scenario.

Therefore, this study considers different scenarios for receipt of spent fuel by the repository only from the narrow perspective of their effect on the very-near-field temperatures in the repository following permanent closure. The study disregards impacts on other elements of the DOE Waste Management System. Even the local impacts on other aspects of the repository are not considered, although some comments on possible implications are contained in the conclusions.

This report is organized into three main sections. The balance of this section is devoted to a statement of the study objective, a summary of the assumptions used to guide and define the study, and some qualifications that address the sources of information and quality assurance issues.

The second section of the report contains a discussion of the major elements of the study, including the scope of the study, a description of the methodology that was developed and used to select the receipt schedules, and a discussion of the parameters and analyses that were used to evaluate the thermal effects in the repository.

The third section summarizes the results of the study and draws some conclusions from them. It also recommends some specific additional work, primarily sensitivity studies, that would complement the study and provide added insight to guide future activities related to this topic.

The appendices include copies of the waste acceptance schedule and the existing and projected spent fuel inventory that were used in the study, a flowchart and source listing of the software that was developed and used to generate the receipt scenarios, and the annual receipt schedules for the scenarios that were analyzed.

1.1 - OBJECTIVE OF THE STUDY

The objective of the Spent Fuel Receipt Scenarios Study is to evaluate several scenarios for receipt of spent fuel at the proposed Yucca Mountain high-level waste repository and to select one or more preferred receipt schedules that would, if implemented, enhance the postclosure performance of the waste packages and the engineered barrier system. This enhancement is derived from the judgment that the assurance of integrity of the waste packages can be substantially improved if the emplacement borehole walls can be maintained at a temperature in excess of the local unconfined boiling point, calculated to be 97°C at the repository elevation, for the minimum containment period of 300 years following closure. In the unsaturated zone of Yucca Mountain,

this condition is expected to prevent liquid water from contacting the container surfaces and thus preclude aqueous corrosion processes.

Implicit in this objective are two separate but closely interactive elements:

- Scenario evaluation and selection of receipt schedules for use in the thermal analyses, and
- Analysis of the effects on the waste package thermal environment in the repository that would result from emplacement of spent fuel on these schedules.

It is important to emphasize that the objective of the study does not consider optimization of any other elements of the DOE Waste Management System or even any other aspects of the repository element.

1.2 - SUMMARY OF ASSUMPTIONS

A series of assumptions were needed in order to establish a basis for proceeding with the development of receipt scenarios and analysis of the thermal effects in the repository. These assumptions have been used in all aspects of the study with no significant deviation. They fall into three broad categories:

- Spent fuel acceptance rates and inventory information.
- Waste package contents and configurations.
- Repository design concepts and rock properties.

1.2.1 - Acceptance Rate and Inventory Assumptions

Three assumptions were made relating to spent fuel acceptance rates and inventory. First, it was assumed that the waste acceptance schedule is as tabulated in the 1988 OCRWM Draft Mission Plan Amendment, Table 2-2 (DOE, 1988a). That schedule specifies acceptance in the first repository of a total of 70,000 MTU (metric tons of uranium), of which 63,020 MTU is spent fuel and 6980 MTU is high-level waste. Waste is to be accepted at the repository over a 25-year period from 2003 through 2027. During the first five years, only spent fuel is accepted at rates from 400 to 1800 MTU/yr. During the following 17 years, the acceptance rate is a "steady-state" 3000 MTU spent fuel and 400 MTU (equivalent) high-level waste. During the final three years, the acceptance rate declines. The Mission Plan waste acceptance schedule is reproduced in Appendix A. This assumption was adequate to allow the spent fuel receipt schedules to be developed, but we found it necessary to make some additional assumptions about the receipt sequencing for high-level waste in order to perform the repository thermal analyses. These are discussed in Section 2.3.3.

Second, it was necessary to assume a spent fuel inventory, including historical data and annual projections, for use in the study. This information is in the form of tables, arranged by year, containing each year's discharges identified by reactor type and segregated into burnup ranges of 5 GWD/MTU for each type. The tables typically are expressed in units of both MTU and intact assemblies.

During the study, DOE-HQ determined that the inventory information to be released in the OCRWM database managed by Oak Ridge National Laboratory should be used. Two sets of information were provided to us from different DOE contractors. One came from Address & Associates, who maintain the Energy Information Administration database and make the long-term projections. The other came from ASG, who maintain the OCRWM database for ORNL. Slight differences were found between the two in the historical data; however, these differences are not significant at the level of detail of this study. We elected to use the Address tables (Address, 1988); they are the basis of the receipt schedules and analyses in this report and are reproduced in Appendix B. Both sets of inventory information represent the EIA historical data through 1987 and the "No New Orders - Extended Burnup" projection case.

The third acceptance assumption is that all fuel will have a minimum age of five years after discharge at the time of acceptance. We have interpreted this assumption to mean that the minimum age constraint applies to the time of receipt at the repository. This difference would be significant only late in the operational period if there is a substantial delay between acceptance into the DOE system and receipt at the repository.

1.2.2 - Waste Package Configuration Assumptions

This category of assumptions relates to the design concepts for, and constraints on, the waste packages. Again, there are three basic assumptions. The first of these addresses the physical form of the spent fuel as installed in waste packages for disposal in the repository. We assume the form to be intact fuel assemblies for two reasons. First, this form results in less energy available for release as heat following emplacement on a per-package basis than consolidated fuel; this assumption is conservative with respect to the study objectives. The second reason is that inventory allocation is simplified because the inventory is expressed in terms of intact assemblies, without regard to any modification made to the physical form by the owners prior to acceptance into the DOE system or modifications by the DOE system prior to emplacement.

The second assumption in this category is that the fuel assemblies will be packaged for emplacement in the "hybrid" waste package configuration. This configuration concept (DOE, 1988b) is designed to provide an efficient packing of intact fuel assemblies in a circular envelope with a 27 $\frac{1}{4}$ inch inside diameter. This configuration, shown in Figure 1, is designed to accommodate three PWR assemblies spaced 120 degrees apart on the outside perimeter, with three BWR assemblies similarly positioned. An additional BWR assembly fits in the center of the package. This 3 PWR - 4 BWR configuration is in almost exactly the same ratio as the aggregate ratio of the inventory on an assembly basis. Therefore, all spent-fuel packages will be assumed to have this internal configuration. Given the average weights, in MTU, of the fuel assemblies, all spent-fuel packages are assumed to contain 2.015 MTU. For example, during the "steady-state" receipt years 2008-2024, the repository will emplace 3000/2.015, or 1489 spent-fuel packages per year.

The third waste-package assumption is that the peak cladding temperature in all spent-fuel packages will be limited to 350°C in an inert gas environment. This constraint is required to ensure that gas pressure in the fuel rods will not cause stress rupture failure of the fuel cladding, which could result in rapid release of the radionuclides that would be available for transport in the event of container breach. Cladding failure exposes the UO₂ fuel pellets for oxidation by repository air in a breached container, from which the inert cover gas has escaped. This assumption leads to a maximum emplacement hole wall temperature design limit of 275°C for spent-fuel packages.

1.2.3 - Repository Assumptions

The last category of assumptions is related to aspects of the repository design and the hydrologic and thermal properties of the rock in the repository horizon. These assumptions provide a basis for analyzing the thermal response of the waste-package emplacement holes to emplacing spent fuel that is received on the selected schedules.

The repository design and operating concepts established in the SCP CDR (Sandia, 1987) have been assumed. The basic design concept is that the repository layout will consist of a set of excavated panels comprised of access drifts and emplacement drifts. These panels will be served by a set of centrally located main drifts that will provide haulage routes for excavated rock, waste package transporters, and other service functions. The emplacement panels will be developed sequentially, with their excavation, emplacement hole construction, and outfitting proceeding in parallel with waste emplacement operations in previously constructed panels. For this study we assumed that, during the "steady-state" operational period, all waste receipts for a given year will be emplaced in a single panel. We recognized that this is a simplification of the conceptual design, in which the panels are of irregular size; but we felt that our assumptions were consistent with the design concepts, and that the level of detail of the study did not warrant any more detailed treatment of the design. For our analysis, we modeled a set of emplacement panels that are sized and arranged in a lay out that approximates the conceptual design. The details of this simulated repository layout are described in Section 2.3.1. The limitations of these analyses, in terms of the physical repository parameters, are discussed in Section 2.3.5.

The SCP-CDR describes two alternatives for waste package emplacement orientation. The first is emplacement of a single waste package vertically in a hole in the floor of the emplacement drift. Each emplacement drift contains a single row of emplacement holes. The second alternative is emplacement of multiple waste packages placed end to end in long near-horizontal holes drilled in the ribs of the drifts. It is acknowledged that this concept is beyond presently available technology and would require some development. The YMP is presently evaluating these concepts, together with a third concept that involves a variant of the SCP-CDR horizontal scheme, in which one to three packages are placed in short horizontal holes. A decision on the emplacement orientation will be made prior to initiating the next design phase.

For this study, we assumed that the waste packages are emplaced vertically, with a spacing between holes of 7.5 ft, the minimum separation that is operationally feasible. Section 2.3.1 discusses the details of the assumed panel geometry. The SCP-CDR design specifies an emplacement hole diameter of 29 in. for a 26-in. diameter container. However, we have assumed a hole diameter of 31 in. to be consistent with a 28-in. diameter thin-walled container containing the hybrid spent-fuel configuration described in Section 1.2.2.

The final assumptions we made are values for host rock parameters that are needed for the thermal analyses. These physical properties of the rock are used in the calculations and are limited to the thermal diffusivity, conductivity, and ambient temperature. The thermal diffusivity has not been reported explicitly, and is therefore computed to be $31.34 \text{ m}^2/\text{yr}$ using reported values for conductivity, density, and heat capacity. The mean values for density and heat capacity from the Yucca Mountain Project Reference Information Base (DOE, 1987b) were used. The conductivity used in these analyses (2.15 W/m-K) was determined by linear interpolation at a saturation of 65% between the mean values for "dry" and fully saturated conditions, also taken from the Reference Information Base for the Topopah Spring welded tuff (TSw2) repository host rock. The analyses are most sensitive to conductivity and the limitation of a constant conductivity is discussed further in Section 2.3.5. The ambient rock temperature was assumed to be 25°C .

1.3 - QUALIFICATIONS

Two topics must be addressed under the general heading of qualifying statements or conditions with respect to this study. The first involves the information that was provided to us by others for which we have no formal mechanism for independent validation. If it contains errors, those errors will be propagated in the results of this study. As indicated in the summary of assumptions, this information includes the fuel acceptance schedule, the inventory history and projections, the high-level waste production schedules, the waste-form thermal characteristics, the repository design concepts, and the rock properties. This information has been compiled from several sources, as referenced throughout this document.

The second qualifier relates to the formal establishment of the scope and direction of the study. This study was initiated at the direction of the Yucca Mountain Project Office by letter to LLNL (Skousen, 1988) as an assigned Action Item under WBS 1.2.2. The initial work that was done in 1988 was performed under WBS 1.2.1.2 as a Systems Engineering activity. The additional analyses that were done in 1989 were performed under WBS 1.2.2.4 as a Waste Package Design activity. These activities were not assigned a formal Quality Assurance Level (QAL), but were conducted under the principle of "good scientific and engineering practice." Periodic reviews of the progress of the study have been performed by LLNL, YMPO, and DOE-HQ. The study is QAL III.

2.0 - DISCUSSION

This section discusses the scope of the study, the development and application of the fuel selection scheduling algorithm, and the parameters and methodology employed in the repository thermal analyses.

2.1 - SCOPE OF THE STUDY

Adequate information was not available to us at the initiation of the study to provide even conjectural guidance as to the constraints, preferences, or latitude that could be expected from other elements of the overall spent-fuel management system. In retrospect, that is probably just as well; we were neither influenced nor constrained in the study by these factors and have therefore developed our "preferred" scenarios from only the perspective of the repository engineered barrier system.

We clearly recognize that there are many, often conflicting, agendas that will need to be considered in deciding the ultimate approach to be taken to schedule spent-fuel acceptance into the DOE disposal system. Our scope is therefore confined to expressing a preliminary preference, and assessing the effect on the near field repository temperatures that would result from the emplacement of the selected spent fuel receipts.

2.1.1 - Inventory Considerations

At the outset of the study, we were faced with an immediate question of what part of the inventory we should consider for acceptance in the repository. While the DOE has contracted ultimately to accept all commercially generated spent fuel into the system, the acceptance schedule for the first repository is limited to 63,020 MTU over a 25-yr period ending in 2027. The projected discharges through that year total 85,500 MTU. Considering that, in general, only fuel that is five or more years old will be accepted into the DOE system, we were still faced with an eligible inventory of 80,300 MTU discharged through 2022. Several approaches were considered for allocating the inventory to be accepted. For example, one could decide to accept 79% (63/80) of each year's discharge. Lacking any firm guidance or other basis for this allocation, we have considered two cases that, from our viewpoint, seem reasonable.

The first case assumes that the first 63,020 MTU discharged will be accepted. This approach results in acceptance of all fuel discharged through 2011 and one-third of the discharge from 2012. In this case, the only age constraint is the five-year minimum, so it would be allowable, for example, to accept 2005 discharges in any year after 2010.

The second case we considered takes a different approach. Remembering that our overall objective is to limit liquid water contacting waste packages in the repository, we decided to consider an inventory allocation consistent with that objective. It assumes that we are free to select the portion of the inventory with the highest decay energy content that is otherwise eligible for acceptance. This is achieved with the fuel that has the highest burnup in each discharge year. We are further constrained by the assumptions of the study to maintain a 4:3 ratio of BWR to PWR fuel, on an assembly count basis, in each year, to fill the "intact hybrid" container configuration. This would, for example, result in acceptance of all BWR fuel discharged through 2022 with burnups in excess of 25 GWD/MTU, and all PWR fuel through the same time with burnups in excess of 30 GWD/MTU. In effect, this approach amounts to "hi-grading" the inventory to further our objective. In the scenario we used, some variations were incorporated in the receipt schedules, but the approach was maintained.

2.1.2 - Scenarios Investigated

To select our receipt schedules, a total of about 100 possible schedule cases were generated and evaluated. Most of these were variations on only two basic scenarios, including various combinations of the two.

The first basic scenario that was considered was a simple "oldest fuel first" approach. In inventory management terms, this strategy is also known as "First In - First Out," or simply "FIFO." Based on previous work, we expected that the result would not be very satisfactory, and it is not. In this scenario, the resulting waste stream exhibits the characteristic of monotonically decreasing age at emplacement and a corresponding increase of the average burnup of the fuel received, due to the historical pattern of discharges and the increasing burnup levels projected by the nuclear utilities. The net effect of these two factors is a very non-uniform integrated energy content in the annual receipts, which translates to a very unbalanced temperature distribution in the repository. The average age and burnup as a function of receipt year for this scenario are shown in Figure 2 as solid lines. The "+" marks in Figures 2, 3, and 4 indicate the ages of the fuel that are present in the stream in the year of receipt.

The other basic scenario we investigated was the "Last In - First Out," or "LIFO," approach, subject only to the five-year minimum time since discharge limitation. As expected, this results in a waste stream that is effectively the inverse of the FIFO approach. The average age slowly increases from 5 to about 10 years during the first 17 operating years, then rapidly increases to almost 25 years in the final years of operation. The average burnup declines over time as the older, low-burnup fuel is phased into the receipt stream. Figure 3 shows the average age and burnup for the LIFO scenario, with a five-year minimum age. This scenario results in a waste stream with two age components, as shown by the "+" marks; one is the fuel that becomes eligible for acceptance by reaching the five-year minimum age, and the other is a progressively older component that is needed to fill the acceptance quota for a given year.

Several other LIFO scenarios were considered, with different fixed or time-varied minimum ages. An example of this approach, using a fixed minimum age of 16 years, is shown in Figure 4. Note that the oldest fuel, when finally accepted into the system, was discharged more than 55 years prior to receipt. The acceptability of this situation to the other elements of the waste management system remains to be determined.

As we considered the implications of these simple scenarios, it became obvious that an approach that would most likely result in a preferred receipt schedule would be a combination of the two basic scenarios, FIFO and LIFO, with the option to adjust the fraction from each that is accepted in each year. At this point, we recognized the need for incorporating additional capabilities into the selection algorithm to allow for this option and the need for an optimization parameter. These aspects are discussed in more detail in the next section.

2.2 - SELECTION METHODOLOGY

This section is devoted to a discussion of the approach and methodology that have been used in the study. We describe the basis for the approach used, the "optimization parameter" employed, the development and implementation of the selection algorithm (including its variables), and the format and content of the output of the selection program.

2.2.1 - "Optimization Parameter"

Early in the planning of this study, we found that, with several different receipt scenarios to examine and emplacement schemes to analyze, we would need a single "optimization parameter" that could be employed to judge the relative merits of different approaches.

In the context of this limited study, the term "optimization" is used advisedly; i.e., it does not imply anything about the efficiency of the overall nuclear waste system, the DOE-OCRWM Waste Management Program, or the Yucca Mountain Project. It is used only in the very narrow sense of a relative standard for evaluating the effectiveness of different receipt scenario options at controlling the thermal response of the engineered barrier system during the period 300 to 1000 years following repository closure. It is during this period that the NRC regulations establish a performance objective of "substantially complete containment." In the unsaturated zone of Yucca Mountain, we believe the case can be made that liquid water cannot contact the container surfaces, and aqueous corrosion modes will not be operable, if the walls of the emplacement boreholes can be maintained at a temperature in excess of the local unconfined boiling point.

Several possible parameters were considered as the measure of effectiveness for the various spent-fuel selection scenarios. Among those parameters considered were waste age at emplacement, burnup (GWD/MTU), initial power (decay heat) generation rates, and integrated energy deposition. Recognizing that the long-term effectiveness is most closely related to the energy deposited in the host rock per unit area, we decided to use the integrated energy contained in each year's fuel receipts as the "optimization parameter" for this study. Fuel receipt scenarios were then developed, by fuel type, age and burnup range, to achieve a uniform integrated energy content in the fuel received during each year. The method for calculating this parameter is described in Section 2.2.2. We recognize that these receipt schedules are by no means unique solutions. With over 200,000 fuel assemblies from which to select, a nearly infinite number of possible combinations will satisfy the criteria. We further acknowledge that some modification to these "optimized" schedules may be needed to compensate for repository geometry and waste package distribution effects, as discussed later in this report. The limitations on this study did not allow for detailed evaluation of these aspects.

2.2.2 - Development of the Selection Algorithm

The initial assessment of the scope of this study revealed that no computer program was readily available that was suitable for the task at hand; i.e., sufficiently flexible to allow investigation of alternative strategies for selection of fuel from the projected inventory and compatible with the available LLNL computer resources. Therefore, we decided to develop a new program, incorporating as much flexibility as possible to allow changes as the study developed.

This computer program, written in FORTRAN, is very flexible and allows selection from the spent fuel inventory to meet the objectives of the study. It is named "Preferred Receipt Scheduler" or "PRS." It reads a fuel inventory file developed from the OCRWM database and a set of user-supplied parameters for the allocation algorithms. The inventory input file contains the actual and projected numbers of fuel assemblies discharged annually, by reactor type, subdivided into twelve burnup ranges of 5-GWD/MTU for each type. PRS then generates an allocation using these parameters and algorithms; and outputs a summary of the allocation results, individual annual acceptance tables, and a listing of the original and unallocated inventory.

PRS is sequenced to accept a set of user-supplied parameters and option selections which are read from an input file. The program then executes a series of nested "do loops" in which all of the allocations are made, with periodic calls to a subroutine that generates the output files for plotting or listing. The sequence of instructions is specifically tailored to this study; i.e., it considers a 60-yr period from 1968 (the date of the earliest discharges in the inventory) to 2027 (the last year of waste acceptance to the first repository). With minor revisions, the program could be modified to evaluate other time periods.

The sequence of instructions includes an exterior loop that is indexed over the 60-yr period. This loop performs a series of initialization steps prior to invoking the two principal "do loops." These principal loops, each of which is itself a nested loop that is indexed over both time and burnup range, have time-dependent variables that are supplied in the input file that is read at the beginning of the program. The major difference between these two loops is that they are designed to allocate the available inventory according to two opposing strategies. The first sequence to be invoked is the LIFO (Last In-First Out) loop that has several user-selected parameters including minimum age, number of years to be considered, and fraction of available inventory of a particular discharge year that may be accepted. The second sequence is the FIFO (First In-First Out) loop that also has a user-selected parameter of the fraction of the total fuel required for a receipt year that is to be allocated from the inventory on an "oldest first" basis. The allocations to a receipt year from these two algorithms are compared with the total fuel required, by fuel type, for that year. The available inventory is then appropriately decremented, and the number of assemblies allocated from the inventory, by discharge year, burnup range, and fuel type, are written to an output file. In both of the allocation loops, the allocation from a particular discharge year's available inventory is made by decrementing from the highest burnup range first and proceeding to lower burnup ranges as necessary to fill the allocation.

To evaluate the effectiveness of selected variables in each run, it is necessary to compute the contribution of each allocation of fuel assemblies from each burnup range from each discharge year to the integrated energy that will be deposited in the repository. This calculation is made within the allocation loops at each index and accumulated for the total allocation for each receipt year. The calculation is made by reference to two three-dimensional arrays that contain the integrated energy for each fuel type by burnup range for each discharge year and receipt year. These arrays are loaded at run time from an auxiliary file. That file was generated using the thermal power values from the ORNL database of ORIGEN2 calculations, integrated appropriately from the year of receipt to year 2353, or approximately 300 yr following repository closure.

The software described here was developed on an "ad hoc" basis for this study. It does not conform to formal quality assurance requirements, other than "good scientific practice," and must therefore be considered as a Quality Assurance Level III item. It has not been verified or validated by any formal and documented protocol; however, we have carefully examined the results for consistency. The initial and final inventory printouts have been compared to ensure that all of the inventory has either been allocated or remains for future allocation. This is more an accountability check than a verification of the software, but is a valid check that the program is performing as designed.

A total of 13 versions of this program evolved during the study, all of which have been archived for future reference. All of the calculations that support the conclusions of this report were made with the last version of the program. A listing of the source code for that version, with a list of the key variables and their functions, is included as Appendix C. This source code is configured to run on the Livermore Computer Center Cray 1 system, but could be easily modified for other computers, including a personal computer with sufficient memory and a FORTRAN compiler. Typically, the time required for execution on the Cray system is about 3 seconds per run.

2.2.3 - Output Description

As briefly mentioned in Section 2.2.2, each run of the selection program produces several different types of output. This section describes these output products, including the format of those for which only brief headers or labels are supplied. These outputs, for the receipt scenarios that have been used in the thermal effects analyses, are included in Section 3.1, and Appendices D, E, and F.

The first table in the output is a summary, by emplacement year, of the user-supplied input parameters; quantities and average age, burnup and energy characteristics, by individual reactor type and the combined averages, of the fuel selected for each year; followed by the overall totals or averages, as appropriate, for the 25-yr operating period.

This summary is followed by 25 pages that detail the fuel assembly receipt schedule for each repository operating year from 2003 to 2027. Each page identifies the emplacement year, the discharge years from which the allocation has been drawn, the age at emplacement, and the number of assemblies, by reactor type, in each of the 12 burnup ranges, reading left to right from low to high burnup. This array is also totaled both down and across.

After the annual receipt schedules, the initial inventory and the remaining unallocated inventory are listed. These pages are labeled with only a first-page header for each listing, but the columns follow the same format as the annual receipt schedules.

In addition to the tabular information, the program also generates files for use in graphically plotting the results. Each run's output contains a single plot, on which four sets of information appear. Three of these, shown as connected points labeled "A", "B", and "E", are the average age at acceptance, average burnup, and integrated energy per MTU, respectively, for each repository acceptance year. The fourth set of information, shown as "+" signs on the plot, are the ages at receipt of the fuel from the specific discharge years that contribute to that year's allocation.

2.3 - THERMAL ANALYSIS PARAMETERS AND METHODOLOGY

Repository panel-scale thermal analyses were performed to assess the effectiveness of the waste receipt scenarios in terms of establishing and maintaining a temperature distribution that will enhance the performance of the engineered barrier system. These analyses, while subject to several limitations, provide a basis for comparing the thermal effects resulting from the emplacement of the waste, as received in the various scenarios, in selected repository panels. These effects were investigated in four panels within the repository, and two different emplacement schemes for distribution of the waste forms within the panels were compared. The interactive effects of all waste packages in these panels, as well as the effects from packages emplaced in adjacent panels, were included. A discussion of the analytical technique and its limitations concludes this section.

2.3.1 - Repository and Panel Geometry

In order to perform these thermal analyses, a simplified repository layout that is consistent with the study assumption of using the SCP-CDR design and operating concepts has been developed. It consists of a total of 20 panels, 10 on each side of a central area that would contain the main access drifts. The total area occupied by this repository simulation is about 1270 acres. This layout is shown in Figure 5. The panels selected for detailed analyses are identified in the figure as Panels "A", "H", "J", and "T".

Eighteen of the panels are identical and are sized to accommodate the "steady-state" receipt of 3000 MTU of spent fuel and 400 MTU equivalent DHLW during the years 2008-2025. This simulation panel geometry has been developed to approximate the configuration in the conceptual design. These panels are rectangular, with an active emplacement area that consists of 17 emplacement drifts spaced 125 ft on centers. Each drift is 1005 ft long, and accommodates 135 vertical emplacement holes spaced 7.5 ft on centers. Thus each panel contains a total of 2295 holes. This is essentially the number of packages (2289) to be emplaced in each of the "steady-state" years of repository operation. The closest emplacement drift is located 250 ft from the center of the main access drifts, and the end emplacement hole in each drift is located 125 ft from the center of the barrier pillar that separates adjacent panels. Thus, the overall area that is associated with each panel

is a rectangle 1255 ft by 2250 ft and comprises 64.8 acres. This panel is shown in both Figures 6 and 7; they differ only in the arrangement of waste-form types, as discussed in Section 2.3.2.

The remaining two panels, designated as Panels "A" and "T", are configured to emplace the spent fuel that is scheduled for receipt during the startup operations in the years 2003-2007 and the final operations in 2026-2027, respectively. The details of Panel "A" are shown in Figure 8; Panel "T" is very similar. With the exception of these two panels, it is assumed that the repository operating concept is emplacement of each year's receipts into a single panel, with development of panels for future years' receipts proceeding in parallel with emplacement operations. As a further indication of consistency with the SCP-CDR, a comparison was made of the areal power density in a "typical" panel with the conceptual design. The average spent-fuel package in the oldest inventory scenarios has a thermal output of 1765 W and an average age of about 21 yr at emplacement. The DHLW, assuming it is from the Savannah River DWPF in the midrange of the vitrification campaign, has a thermal output of 440 W per package and an age of about 12 yr at emplacement (DOE, 1987a). The total initial thermal output of the packages to be emplaced in the panel is 2.98 MW, or 46.0 kW/acre. This is consistent with the allowable initial power density guideline from Appendix G of the SCP-CDR, which indicates a value of about 45 kW/acre for waste in this age range.

2.3.2 - Waste Package Distributions

A wide variety of possibilities exists for ways to distribute the waste packages within a panel. As indicated in Section 2.3.1, we have elected to analyze the first and last panels, which contain only spent fuel, with the packages distributed within those panels such that each year's receipts are grouped together and emplaced sequentially from the outer rows toward the center of the repository.

For the remaining panels, which contain both waste forms, we have selected for our analyses two of the simpler schemes that could be easily realized in actual repository operations. These two schemes implement two quite different approaches to the treatment of the waste forms with respect to the resulting temperature distributions and possible radionuclide release consequences resulting from breached containers.

The first package-distribution scheme we analyzed assumes that, for the purpose of enhancing the integrity of the containment barrier during the 300-yr period following repository closure, the consequence of a container breach is the same, regardless of the waste form within it. This leads to a goal of the emplacement scheme to maintain the temperatures of all emplacement boreholes above the local unconfined boiling point for as long as possible, without regard for the type of waste package emplaced. Recognizing that those packages that contain DHLW will contribute only a fraction as much energy to this goal as spent-fuel packages, it follows that the package distribution should involve combining the two types to take advantage of the higher energy output of the spent-fuel packages to raise the temperature of the adjacent DHLW packages.

Recalling that our typical panel is dimensioned to accommodate 2295 packages in 17 rows of 135 packages each, we compensated for the "edge effects" on all four sides of the panel by filling the outermost two rows on each end of the panel and the outermost six holes on each end of the other 13 rows with spent-fuel packages. The remainder of the 13 inner rows are commingled, with each row containing 62 DHLW packages alternated with 61 spent-fuel packages. This distribution, shown schematically in Figure 6, accommodates a total of 1489 spent-fuel and 806 DHLW packages within the panel.

The second package-distribution scheme we analyzed takes the approach that the consequences, in terms of radionuclide release from a breached container, are less significant in the case of a DHLW package. Because the waste form is enclosed by a stainless steel pour canister

within the disposal container, additional resistance to direct contact of the glass waste form by liquid water is provided. Furthermore, there is little or no concern for releases of gaseous radionuclides directly from the glass matrix. Therefore, it may be less important to maintain the temperature of the emplacement holes containing DHLW packages above boiling, so the packages could be emplaced in a configuration where they are used as "guard heaters" around the perimeter of the panel. The spent-fuel packages could then be clustered in the central region of the panel so that, by virtue of their higher energy content, they will remain at temperatures above boiling for a substantially longer period than in the commingled arrangement.

Our implementation of this concept, for the purpose of these analyses, is to fill the outermost two rows of the panel and the outermost 10 holes on each end of the remaining 13 rows with DHLW packages. The remaining 115 holes in these 13 rows all contain spent-fuel packages. This arrangement accommodates a total of 1495 spent-fuel packages and 800 DHLW packages in the panel and is shown schematically in Figure 7.

2.3.3 - Waste Characteristics

We did not consider "tailoring" of the contents of the individual spent-fuel packages within a panel, although the analytical method is specifically designed to allow this, down to the level of specifying the contents of each package in terms of the age and burnup of its contents. This is a very time-consuming process, and, in our judgement, this level of detail was not warranted for the purpose of the preliminary assessments in this study.

We have, however, examined the characteristics and quantities of fuel in the annual receipt schedules that are designed to "level" the integrated energy. We are convinced that a sufficient spectrum of ages and burnups is available to allow additional tailoring of annual receipts to improve further the temperature distributions. Additional specification of the order of receipt, or sufficient lag storage capacity, at the repository or elsewhere in the system, would be needed to allow more detailed selection at the time of filling each package.

The analyses presented are for panels representing the receipts for the years 2003-2007, 2014, 2016, and 2026-2027. These are designated as Panels "A", "H", "J" and "T", respectively. Panels "H" and "J" are representative of the middle of the projected repository operating period and are well into the "steady-state" operations, with annual receipts of 3000 MTU spent fuel and 400 "MTU equivalent" of DHLW. We have attributed to each spent-fuel package the mass-weighted average age and burnup characteristics of the fuel scheduled to be emplaced in the panel selected for analysis. The characteristics of the waste forms in adjacent panels in the simulation are representative of the receipts in prior and subsequent years.

To arrive at a suitable set of characteristics for the DHLW to use in the analyses, we have made some assumptions about the sequencing of this waste form into the disposal system. While the analysis is not highly sensitive to these characteristics, the assumptions are stated here. We assumed that the "MTU equivalence" for the glass (or other) wastes is 2 MTU/canister for the WVDP waste and 0.5 MTU/canister for the Savannah River DWPF product. Further, we assume that the initial HLW accepted at the repository in the years 2008-2009 will consist of 300 MTU (150 canisters) of WVDP and 100 MTU (200 canisters) of DWPF waste each year. This will be followed by 400 MTU (800 canisters) per year of DWPF glass for the next several years, with a phase-in of HWVP and INEL product as the backlog of DWPF waste is accepted and the DWPF production rate is reduced. Assuming disposal of the oldest production first, the DWPF product to be received in 2014 would be the 4400th to 5200th canisters produced. These canisters represent production during the years 2001-2005, with an average "age" following vitrification of 12 yr. This or a similar set of assumptions is needed in order to use the ORNL database information, as tabulated in DOE/RW-0184, for establishing the decay energy following emplacement. Lacking

any other basis or guidance for the analyses, we used this set of characteristics for DHLW in all of the panels that contain both waste forms.

2.3.4 - Thermal Analysis Methodology

The analyses for this study were made with an LLNL implementation of the temporal and spatial superposition of the analytic solution of the diffusion equation for conductive dissipation of thermal energy from a point source. This implementation is more fully described and documented elsewhere (Montan, 1986). This software was originally written to support the design and analysis of an in-situ heater test in the Climax granite at NTS in 1977. These programs have evolved and been used extensively in a variety of applications, including most recently a preliminary thermal analysis of the SCP-CDR design in 1987. Various specialized post-processors have been developed and employed to plot temperature vs time for selected points within an array of thermal sources; to display temperatures in very large spatial arrays, such as those reported here; and to count the number of points in such arrays that are at a given temperature at a particular time. The number of individual thermal sources and the heat-generation characteristics and geometries that can be simulated in these codes is limited only by the core memory of the computing hardware and the patience and ingenuity of the individual preparing the input. The innermost iteration loop in the calculation, which consumes the majority of the computing time, performs multiple evaluations of the complementary error function. A typical analysis of the type reported here involves about 90 million evaluations of this function. This software was originally written to run on CDC 7600 machines, but has since been modified for the Cray 1 computers in the Livermore Computer Center, where a typical analysis requires about 12 minutes of CPU time.

The arrays of sources used in these analyses have been configured to represent spatially the simulation panels. Depending on the location within the repository simulation, i.e., a corner or interior panel being analyzed, a total of six to ten panels are included in the source array. This is an adequate number to introduce negligible error ($<0.1^{\circ}\text{C}$) over simulation times up to 1000 yr. These arrays, shown schematically in Figures 9, 10, and 11, represent the equivalent of about 14,000 to 23,000 waste packages, or about one third to one half of the total in the repository.

In the array for the panel being analyzed, each waste package is individually represented by a row of equally spaced point sources along a vertical line whose length corresponds to a fuel assembly or HLW canister, with the appropriate decay energy distributed among the points. The number of points on this line is sufficient to result in a negligible error in the calculated temperature. In these analyses, for example, 39 points are used to represent a spent-fuel waste package.

The other panels in the array are the two panels (if present) on each side of the panel to be analyzed and the panels opposite them on the other side of the main access drifts. In each of these panels, each emplacement row is simulated by point sources along a horizontal line whose length corresponds to the length of the emplacement drift, with distributed thermal energy equivalent to the row of waste packages they represent.

The thermal output of each of these sources is computed from a decay curve that is based on the ORNL ORIGEN2 calculations for the appropriate waste forms (Johnson and Montan, 1990). To simulate the repository operation in the calculation, each panel is assigned the appropriate source characteristics of the waste forms (MTU/package, age at emplacement, average burnup, and emplacement year). Each panel array is activated during the calculation at the time that the panel is loaded during the simulated repository operation.

The simulation calculates the temperature of the wall of each borehole in the panel to be analyzed at the prescribed time, superposing the contribution of each source to the temperature at each point of interest, subject to a threshold based on the Fourier number to minimize the number of evaluations of the error function without degrading the result.

2.3.5 - Limitations of the Analyses

In exchange for using the method of superposition of the analytic solution to the diffusion equation to simulate very large thermal source arrays, we had to accept several limitations implicit in the method. These limitations affect two significant aspects of the repository thermal analyses.

Potentially the most severe limitation is that the only heat transport mechanism simulated is conduction. Thus, no other mechanisms that we expect to be operative in the repository (i.e., vaporization, vapor flow in fractures and subsequent condensation of pore water, radiative and convective transport in mined openings, and heat removal by the ventilation system prior to closure) are modeled. We do not yet have good comparisons with the more sophisticated hydrothermal codes that are being developed to simulate complex heat transfer and fluid flow in fractured and partially saturated rock.

The other acknowledged limitation of this analysis method is the implicit assumption of heat dissipation in an infinite homogeneous medium whose physical properties - including density, heat capacity, and thermal conductivity - are constant. No mined openings exist in the simulation. In partially saturated rock at temperatures above the unconfined boiling point, the limitation of a constant conductivity is a source of error because the conductivity decreases as the rock is dehydrated at elevated temperatures. Also, the differing physical properties of the underlying and overburden rock units are not taken into account.

It should be noted that if the thermal conductivity value we used is too high for the dehydrated portion of the repository, then the emplacement-hole wall temperatures predicted by these analyses will be correspondingly too low. Conversely, if the effect of the other heat transfer mechanisms that are neglected in these analyses are significant, the temperatures that are predicted at the borehole walls will be too high. There are some preliminary indications, based on finite difference calculations that include other heat transfer mechanisms and saturation-dependent thermal conductivity, that the effects are offsetting and of similar magnitude.

3.0 - RESULTS AND CONCLUSIONS

This section is a summary of the results of the study and the conclusions we have drawn based on those results. In addition, we make some recommendations for activities that we believe would be useful in providing further insight into this subject.

3.1 - RESULTS OF THE STUDY

The results of the study are divided into two categories. The first contains a description of the three spent-fuel receipt scenarios that were selected for analysis and a summary of the process for arriving at the selected scenarios that invoke the "levelized" integrated energy parameter. The second category of results contains the thermal analyses that were performed utilizing the scenarios, including the effects of using the two different schemes for arranging the waste types within a panel.

3.1.1 - Oldest Fuel First Scenario

As indicated in Section 2.1.2, the first receipt scenario considered is the simple "oldest fuel first" or OFF approach. This scenario parallels the primary methodology established by DOE in the standard contracts for allocation of priority for delivery of spent fuel from the utilities to the Federal Waste Management System. This scenario, by definition, selects fuel for receipt in the order in which it was permanently discharged from the power reactors, and is totally indifferent to any intrinsic characteristics of the fuel such as age at receipt or burnup. The only constraint that we have placed on the receipts is that they preserve the 4:3 ratio, on an assembly basis, between BWR and PWR fuel so that the correct number of assemblies will be accepted each year to fill the spent fuel packages consistent with the study assumptions. This constraint introduces minor deviations from an exact OFF scenario in every year. These deviations are on the order of a few percent and are not significant to the thermal analyses.

The OFF scenario accepts the first 63,020 MTU to be discharged. This includes all discharges from the earliest, in 1968, through 2011, with a portion of the higher burnup fuel from 2012 included to make up the full 63,020 MTU. The average age at emplacement of this fuel receipt stream monotonically decreases with time. The fuel received in the first year (2003) includes discharges from the years 1968-1973 and is therefore 30-35 yr old, with an average age of 31.5 yr. At the end of the repository emplacement operations in 2027, the average age has decreased to 15.8 yr. The average burnup increases from about 15 to 40 GWD/MTU over the first 15 yr, and then remains nearly constant for the last 10 yr. The combination of these two characteristics results in a range of more than a factor of three for the integrated energy over the repository operating period. The average age, burnup, and energy characteristics, together with the age groupings for this scenario, are plotted in Figure 12. The annual characteristics, detailed receipt schedules, and inventories for this scenario are tabulated in Appendix D.

3.1.2 - Levelized Energy Scenarios

Before describing the details of the fuel receipt scenarios that we have selected to satisfy the levelized energy characteristic, we should recall that there are a near-infinite number of possibilities from which to choose. With about 280,000 fuel assemblies in the projected available inventory and possible ages at receipt ranging from 5 to 60 yr, the possible permutations for accepting about 10,000 of these in any year is mind-boggling. To make our selections both comprehensible to the other elements of the DOE system (and the utilities who will be providing the fuel) and flexible (to allow for some intra-panel "fine-tuning" in the emplacement configurations), we have elected to recommend receipt scenarios that have a common characteristic. Using the variable parameters associated with the FIFO and LIFO loops in the scheduling algorithm, we have forced the selection process to produce receipt schedules that draw from the available inventory in two distinct age

groups. The groups are tightly clustered and quite different, providing latitude for other parts of the system to accommodate their own "optimization" factors in developing their preferences, while still allowing us to achieve our objectives.

It should be emphasized that there are many instances in the annual receipts where small numbers of assemblies are specified in a burnup range for a particular fuel type and discharge year. These numbers are artifacts of the scheduling algorithm and should not be considered significant. The approach we have used was selected to be very tolerant of variations in the receipts, within reasonable bounds.

With that preface, we will describe the characteristics of the two levelized energy scenarios we have selected. As discussed in Section 2.1.1, we were faced with making a choice of which portion of the available inventory would be accepted in the first repository, because the projected inventory exceeds the design capacity of the repository. The two scenarios reported here correspond to the two inventory options we selected.

Levelized Energy - Oldest Inventory Scenario

This scenario accepts the first 63,020 MTU to be discharged. This includes all discharges from the earliest, in 1968, through 2011, with a portion of the higher burnup fuel from 2012 included to make up the full 63,020 MTU. This fuel is accepted in two narrow age ranges, the younger being 15-18 yr, and the older 32-36 yr after discharge at the time of acceptance. In all but the final receipt year, fuel is accepted from both age groups, thus providing some flexibility in the arrangement within each repository panel to compensate for local geometric effects. To preserve this flexibility, we were forced to allow the annual average integrated energy to increase somewhat in the last three receipt years, because the amount of older fuel remaining in the inventory was rapidly dwindling. In the final year, there was none left, so the entire allocation was from the younger age group. However, during the first 22 yr, the average integrated energy for the receipts for each year was held constant at $84.7 \text{ kW-yr/MTU} \pm 3.3\%$. The average age, burnup, and energy characteristics, together with the age groupings for this scenario, are plotted in Figure 13. The annual characteristics, detailed receipt schedules, and inventories and for this scenario are tabulated in Appendix E.

Levelized Energy - "Hi-Graded" Inventory Scenario

This receipt scenario is very similar to the previous one, but is designed to "hi-grade" the available inventory by selecting the highest burnup fuel of each type. To fill this set of receipt schedules, all PWR fuel with burnups $\geq 30 \text{ GWD/MTU}$ discharged between 1972 (the first year with this burnup) and 2017, plus a portion of the 2018 discharges, were selected for receipt. For BWR fuel, all available discharges with burnups $\geq 20 \text{ GWD/MTU}$, covering the period from 1969 to 2016, plus a portion of the 2017 discharges, were selected. Again, the fuel is accepted in two narrow age ranges, the younger being 10-12 yr, and the older 27-32 yr after discharge at the time of acceptance. These ranges have two exceptions: the age range for the first acceptance year is wider (26-34 yr) due to the very limited number of assemblies in the higher burnup ranges during the early discharge years, and a few nine-year-old PWR assemblies were needed in the final acceptance year to fill out the selection. These deviations from the general ranges are not significant. Again, in all but the final year, fuel is accepted from both age groups, thus retaining the flexibility to make intra-panel compensations. In the final receipt year, the older inventory was exhausted and the average integrated energy is therefore somewhat higher. The average energy during the first 24 yr was held constant at a value of $97.2 \text{ kW-yr/MTU} \pm 3.3\%$. This increase of $>15\%$ over the energy deposition from the previous scenario should be expected to produce a corresponding increase in the temperature rise at the emplacement hole surfaces in the repository, everything else being equal. The characteristics for this scenario are plotted in Figure 14, and the annual receipt schedule data are tabulated in Appendix F.

Selecting the leveled energy receipt schedules was straightforward once we had determined that a combined FIFO-LIFO scenario with a minimum age approach would yield a suitable result. With a clearly defined target, i.e., the realization of our "optimization parameter," the selection process consisted of a series of "cut and try" executions of the scheduling program. The early runs were devoted to verifying the correct operation of the variable parameters in the program, as they were added, and qualitatively determining the sensitivity of the result to their use.

The scheduling program was run and evaluated about 100 times to determine the selected receipt schedules. We established a tentative goal of achieving a $\pm 10\%$ range for uniformity of the integrated energy parameter. This was so easily reached that we set a second goal of $\pm 5\%$. As noted above, the results we are reporting for these selected scenarios are both less than $\pm 4\%$ for this parameter. We could further improve the results, but the validity of the inventory projections and other variables in the system do not warrant any further refinement at this time.

We have not fully evaluated the effects of all of the options available for adjusting the scheduling parameters. We are convinced, however, that the scenarios we have selected are reasonable in terms of their implementation, and sufficiently flexible to accommodate at least some of the preferences and constraints of other elements of the DOE system.

3.1.3 - Thermal Analyses of the Scenarios

A total of 12 panel-scale thermal analysis calculations have been done to assess the effects of the deposition of radioactive decay energy on the temperatures of the emplacement borehole walls at a time that corresponds to the minimum period during which "substantially complete containment" is to be achieved by the waste packages. The year 2353, selected for these analyses, is 350 yr after the initiation of emplacement operations, or approximately 300 yr following permanent closure of the repository. The points at which the temperatures are evaluated are on the borehole walls midway between the top and bottom of the waste packages.

As stated, in Section 2.3.3, we have attributed the mass-weighted average age and burnup characteristics to each of the spent fuel or DHLW packages, as appropriate, in the modeled regions of the repository. We have not attempted any geometric or package-scale "heat-tailoring" to compensate for locally hot or cold regions in any panel.

The analyses have been performed for four different panels in the simulated repository. The most extensively studied location is Panel "H", selected because it is representative of those panels that would receive the waste packages during the "steady-state" operations when 3000 MTU, or 1489 packages of spent fuel and 400 MTU equivalent, or 800 packages of DHLW are to be received and emplaced each year. The characteristics of receipts for the year 2014, near the middle of the repository emplacement operations period, are used as the thermal sources in the panel for the analyses. This panel was also chosen for its geometric position in the repository as an interior panel that has at least two adjoining panels on each side. The energy contribution from these adjoining panels is accounted for in the analyses. The properties of the receipts used in the adjacent panels were selected for the years preceding and following 2014 as appropriate. The modeled region is shown in Figure 9.

Six different analyses of Panel "H" are reported. Three of these represent the temperature distributions resulting from the emplacement of the receipts from each of the three scenarios described in Sections 3.1.1 and 3.1.2, employing the commingled waste package distribution scheme. The second set of three analyses are the same as the first, except that the receipts from the three scenarios are emplaced in the alternative non-commingled configuration described in Section 2.3.2.

The second panel investigated, Panel "J", was selected to evaluate the geometric effects on the temperatures that result from the panel location at the end of the repository, where there are adjacent panels on only one side. In all other respects, this panel is the same as Panel "H". The modeled region for these analyses is shown in Figure 10. The characteristics of the receipts for the year 2016 are used for Panel "J", with the contents of the other panels in the model appropriately selected. The two analyses done on this panel use the commingled package distribution, and investigate only the effects of the differences between the Oldest Fuel First and Levelized Energy - Oldest Inventory receipt scenarios.

The third panel we analyzed is different from the "steady state" panels. It is modeled receiving only spent fuel, as planned in the acceptance schedule, during the first five years of repository operations. The panel, designated Panel "A", is configured with the same number of emplacement drifts as the steady-state panels, but the drifts are truncated such that the receipts for each year will be accommodated within two to seven full drifts. The details of this panel layout are shown in Figure 8, and the modeled region for the analyses is shown in Figure 11. The spent fuel characteristics for the years 2003 to 2007 receipts are used in the analyses, with the contents of the adjacent panels appropriately adjusted. As with Panel "J", these analyses investigate only the effects of the Oldest Fuel First and Levelized Energy - Oldest Inventory scenarios.

Panel "T", the last panel we analyzed, is also different from the "steady-state" panels in our simulated repository. This panel, similar to Panel "A", is configured to emplace the spent fuel that is to be accepted during the last two years of repository operation, 2026 and 2027. The same modeled region was used for these analyses as for Panel "A" (Figure 11), and the effects of the same two receipt scenarios were investigated.

The results of each of these analyses are discussed briefly in the following sections and are shown graphically in the accompanying figures. These figures are of two types. The first, type A, are pseudo-isotherms of the analyzed panel. These are not true isotherms of the rock temperatures in the panel, but rather delineate regions of uniform borehole wall temperatures, at the midpoint of the spent fuel waste packages, at 350 years following the start of emplacement, or about 300 years after repository closure. The interval between "isotherms" is 5°C. For reference, type A figures also contain rows of "+" marks that correspond to the locations of the emplaced packages.

The files from which the "isotherm" figures are made have been processed to produce histograms. This second type of figures, type B, display the number of holes, by waste type, that are at a given temperature, in 1°C increments. With the aid of the "isotherms" and the histograms, one can quickly gain considerable insight into the results of the various analyses.

Panel "H" Analyses

The following sections describe briefly the results of the six different panel-scale thermal analyses that were done for various receipt scenarios and package configurations in Panel "H". The three cases that employ the SCP-CDR emplacement scheme of commingling the spent fuel and DHLW packages are discussed first, followed by the discussion of the three cases that investigate the non-commingled emplacement arrangement.

Oldest Fuel First - Commingled Waste [Figures 15A and B]

For this case, the borehole wall temperatures (at the midpoint of the container length, 300 yr following closure) range from 78° to 109°C. The median temperature of all holes is 92°C. The temperatures in spent-fuel holes range from 78° to 109°C, with a median of 94°C. The coolest holes are along the perimeter of the panel, and the hottest are in the second row in from the interior end. That row contains only spent fuel. Nearly all of the spent fuel holes in the commingled center section of the panel are at temperatures between 90° and 95°C. The DHLW holes range from 83° to

92°C, with a median temperature of 87°C. These temperatures are highest in the center of the commingled region, and fall off gradually toward the outer portions of the region. The large percentage of holes (76%) that are below 95°C appears to preclude the possibility of local "heat tailoring" to significantly increase the fraction of holes that will remain above the unconfined boiling point for the full 300 yr.

Levelized Energy - Oldest Inventory - Commingled Waste [Figures 16A and B]

For this case, the borehole wall temperatures range from 80° to 112°C. The median temperature of all holes is 94°C. The temperatures in spent-fuel holes range from 80° to 112°C, with a median temperature of 96°C. The temperature distribution within the panel is very similar to the previous case, but slightly higher, reflecting the somewhat greater integrated energy content of the emplaced fuel. Nearly all of the spent-fuel holes in the commingled center section of the panel are at temperatures between 95° and 100°C. The DHLW holes range from 85° to 95°C, with a median of 90°C. These temperatures are highest in the center of the commingled region, and fall off gradually toward the outer portions of the region. There appears to be a sufficient number (about 350) of spent-fuel holes above 100°C to allow local "heat tailoring" within the panel, by varying the age and burnup of the package contents, to bring nearly all of the spent-fuel holes up to the boiling point.

Levelized Energy - Hi-Graded Inventory - Commingled Waste [Figures 17A and B]

The results for this case are also similar to the previous cases. This is to be expected, because the only significant difference is the higher integrated energy of the selected spent fuel inventory. In this case, the borehole temperatures range from 86° to 121°C, with a median temperature of 102°C. These values are 6-8°C higher than the levelized energy - oldest inventory case. This is an increase of about 9% in the temperature rise above ambient, somewhat less than the approximate 15% increase in the average integrated energy obtained by "hi-grading" the inventory. This difference is explained by the constant energy contribution in the panel from the 800 DHLW packages (about one-third of the total number) in both cases.

For this case, the spent-fuel hole temperatures range from 86° to 121°C, with a median temperature of 104°C. Less than 2% of the spent-fuel holes are below the boiling point, so a very limited amount of package-scale heat-tailoring would be needed to reach the objective. The DHLW holes are also somewhat hotter in this case than in the previous inventory cases. They range from 92° to 102°C, with a median temperature of 97°C. By extensive spent fuel package-tailoring to take advantage of the higher energy available, it may be possible to adjust the temperature of all holes in this panel configuration to remain above boiling for 300 yr.

Oldest Fuel First - Non-Commingled [Figures 18A and B]

As we expected, this configuration creates a very wide distribution of borehole wall temperatures in the panel. The borehole temperatures range from 42° to 134°C, with a median temperature of 107°C. The spent-fuel holes, which are all located in the central region of the panel, are well-guarded by the DHLW packages on the perimeter. The spent-fuel hole temperatures range from 81° to 134°C, with a median temperature of 119°C. About 95% of these holes are above the boiling point, so very little package-scale tailoring would be needed to bring all of their temperatures well above 100°C at 300-yr postclosure. The DHLW holes, on the other hand, are all below the boiling point, with temperatures ranging from 42° to 95°C, with a median temperature of only 57°C. Recall that this effect was the intent of this emplacement scheme. It is quite effective at achieving the design intent. Little variation in the energy output of the DHLW receipts in a given year is expected, so there is no significant package-scale tailoring potential to improve the situation for the DHLW holes in this panel configuration.

Levelized Energy - Oldest Inventory - Non-Commingle [Figures 19A and B]

The effect of changing the receipt scenario produces only minor changes in the temperature distribution in this panel. The borehole temperatures range from 42° to 139°C, with a median temperature of 111°C. The spent-fuel hole temperatures range from 83° to 139°C, with a median temperature of 123°C. About 96% of the spent-fuel holes are above the boiling point, so very little package-scale tailoring would be needed to bring all of their temperatures well above 100°C at 300-yr postclosure. The DHLW holes, on the other hand, are below the boiling point, with temperatures ranging from 42° to 97°C, with a median temperature of only 59°C. As in the previous case, there is no significant package-scale tailoring potential to improve the situation for the DHLW holes in this panel configuration.

Levelized Energy - Hi-Graded Inventory - Non Commingle [Figures 20A and B]

This case is also very similar in character to the parallel case for the oldest inventory. All temperatures are slightly higher, but the overall distributions are nearly identical. The overall range of temperatures is somewhat wider; they range from 45° to 151°C, with a median temperature of 121°C. The spent-fuel hole temperatures range from 90° to 151°C, with a median temperature of 135°C. Less than 1% of the spent-fuel holes are calculated to be below the boiling point, and this could be easily remedied by slight package tailoring. The DHLW holes range from 45° to 106°C, with a median temperature of 63°C. As in the other non-commingled cases, little potential exists for significant improvement in the DHLW temperature distribution within this panel configuration.

Panel "J" Analyses

Two thermal analyses of Panel "J" were done to evaluate the geometric effects associated with its location at the end of the simulated repository. These cases were both done with the commingled waste package configuration; only the receipt scenarios were varied.

Oldest Fuel First - Commingle [Figures 21A and B]

The borehole temperatures in the panel are approximately the same as those seen in the interior panel, except that there is a significant asymmetry across the width of this exterior panel. The temperatures of the spent-fuel holes on the interior edge of the panel are about 15°C higher than those on the outer edge. The temperatures range from 75° to 120°C, with a median temperature of 98°C. The spent-fuel holes have the wider range, varying from 75° to 120°C, with a median temperature of 102°C, while the DHLW holes range from 79° to 100°C, with a median temperature of 88°C. About 60% of the spent-fuel holes are above the boiling point, so it would be possible to "tailor" the package contents to compensate for the boundary effects and significantly increase the number of holes above boiling. However, this would generally lower the temperatures of the commingled DHLW holes, as they would lose some of the benefit of hotter spent fuel neighbors.

Levelized Energy - Oldest Inventory - Commingle [Figures 22A and B]

This case, as expected is similar to the previous one, except that the temperatures are reduced a few degrees because the integrated energy content of the fuel for the year 2016 is a little less than the oldest first scenario. The same asymmetry occurs, and it is of the same magnitude. The hole temperatures range from 70° to 111°C, with a median temperature of 92°C. The spent-fuel holes vary from 70° to 111°C, with a median temperature of 95°C, while the DHLW holes vary from 74° to 93°C, with a median temperature of 88°C. As above, package tailoring would permit some compensation for the geometric asymmetry, but with the same effect on the DHLW holes.

Panel "A" Analyses

The most dramatic effects on the temperatures in a panel produced by the Oldest Fuel First and Levelized Energy receipt scenarios is seen in the analyses for Panel "A". The receipts for this panel, which contains only spent fuel, exhibit the greatest difference in the integrated energy for the two scenarios. These two analyses are discussed in the following sections.

Oldest Fuel First - All Spent Fuel [Figures 23A and B]

In this analysis, no holes remain above the boiling point temperature at 300 yr following closure. This is the only case among those we analyzed for which that is true. The location of this panel at a corner of the simulated repository, the very low average burnup, and the advanced age of the fuel combine to produce this adverse result. The hole temperatures range from 50° to 96°C, with a median temperature of 83°C. Because the receipts from this scenario have such low energy content, there is little package tailoring that could be done to improve the situation. One other alternative, not investigated in this study, would be to substantially reduce the spacing between the emplacement drifts to increase the energy density in the panel. Recall that we have already used the minimum spacing between holes that is acceptable for construction and operations.

Levelized Energy - Oldest Inventory - All Spent Fuel [Figures 24A and B]

In contrast to the preceding case, the use of the levelized energy scenario receipts for the early years very significantly increases the borehole temperatures throughout this panel. The temperatures range from 73° to 139°C, but the median temperature is 123°C, and only about 5% of the holes are at less than the boiling point at 300 yr. Therefore, only very minimal package tailoring would be needed to ensure that all holes would satisfy the objective. This case, and the preceding one, both contain the same type of asymmetry observed in Panel "J" due to the corner location of this panel. The asymmetry in Panel "A" is less pronounced, due to the absence of the very low energy DHLW in this panel. It should be noted that, by continuing to use the 7.5-ft hole spacing, even though the panel contains only spent fuel, this case and the following Panel "T" cases have raised the effective areal power density (APD) in the panel well above the SCP-CDR design basis of 57 kW/acre. As discussed in the following section, entitled "Other Thermal Analyses Results", these cases are very near the power density that would exceed the allowable peak temperature for the waste form. Some further observations and inferences from this analysis are included in the conclusions in Section 3.2.

Panel "T" Analyses

Two analyses were performed in the other panel that contains only spent fuel, Panel "T". These cases parallel the Panel "A" cases, and are included to show the effect of a significantly higher integrated energy density on the temperature distributions, irrespective of the receipt scenario that is employed.

Oldest Fuel First - All Spent Fuel [Figures 25A and B]

This case results in the highest temperatures that were calculated for any of those analyzed. The borehole temperatures range from 83° to 162°C, with a median temperature of 143°C. More than 99% of the holes are above boiling at 300 yr, and about half of them would be expected to still be above boiling temperature at the end of 1000 yr. There is an asymmetry in the distributions similar to that observed in the Panels "J" and "A" cases due to the geometric location in the repository simulation.

Levelized Energy - Oldest Inventory - All Spent Fuel [Figures 26A and B]

This case is virtually identical to the previous one and is included only to complete the study matrix. A very slight difference in the area within the 160°C "isotherm" is observed but is not significant at the resolution of the analysis. A cursory examination of the fuel receipt characteristics resulting from these two scenarios for the final two years of operations shows that this similarity was to be expected.

Other Thermal Analyses Results

Two other aspects of the thermal effects were investigated in the course of the study. We made a calculation of the borehole wall temperature distributions at points located opposite the ends of the waste packages to see how the end effects influenced the temperatures. At 300 yr after closure, the temperature differences between the midplane of the package length and the end of the package were small. They ranged from a difference of 4.4°C in a hole located in the extreme corner of the panel to 5.1°C in the hottest hole in the center of the panel. When expressed as a fraction of the temperature increase above the pre-emplacement ambient, these differences are the same. In the actual repository situation, other local effects, such as a convective cell within the waste package-borehole annulus, will probably dominate the thermal field within the borehole, and the real distribution would be somewhat different than the one we calculated.

We also calculated a borehole-wall time history for the emplacement hole in Panel "H" with the highest 300-yr temperature to determine what the peak temperature was that it reached and when that peak occurred. This calculation was done to assure ourselves that the peak temperature was below the design limit of 275°C established in the SCP-CDR. The calculated peak was 242°C and it occurs 22 yr after emplacement. This time history for the period from emplacement to 300 yr following repository closure is shown in Figure 27A. This time history calculation was extended to show the rate of continued cooling out to 1000 yr; this is plotted in Figure 27B.

This peak borehole-wall temperature value was also compared with the results of package-scale finite difference and finite element calculations that have been done, using the "hybrid" package configuration, to infer a peak spent-fuel cladding temperature. From this comparison, the peak cladding temperature corresponding to this peak borehole temperature would be 335°C. This compares with a design basis limit on the peak fuel cladding temperature of 350°C. The peak cladding temperature would be expected to occur about 4 yr after emplacement.

3.2 - CONCLUSIONS

Based on the results of the receipt scenario investigations and the thermal analyses described in the preceding sections, we conclude that it is feasible to specify age, burnup, and fuel type characteristics of the spent-fuel waste stream to be delivered to the repository for disposal, and to tailor that stream to distribute its energy output in the repository to balance the temperature distributions within the disposal panels. However, it is beyond the scope of this limited study to assess the feasibility of delivering a spent-fuel waste stream with tailored characteristics to the repository because there are many other elements of the waste management system that have constraints on, or preferences for, these characteristics.

3.2.1 - Conclusions on Receipt Scenarios

There are a near-infinite number of possible scenarios for scheduling spent-fuel receipts. Most of them would be based on one or another of the common inventory management strategies, such as "first in-first out," "last in-first out," or some combination of these. Because the spent fuel inventory will have been discharged over a long period of time prior to the initial shipments to the repository and because the discharges will continue during the receipt period, the selection scenarios

are complex. During the "steady-state" repository operational period, the annual discharges are less than the receipt rate. This allows us to receive a blended mix of fuel ages as the older backlog is "worked off." The extreme case of this approach is shown in Figure 3, where a mix of 5-yr-old and older fuel is received. The older fuel fraction of the fuel stream gets progressively older, and flexibility to tailor the energy characteristics is lost.

We conclude, after examining a wide variety of possible scenarios, that the approach we selected using fuel in two fairly narrow age ranges to equalize the energy contained in each year's receipts is a reasonable choice. Many other scenarios using this general approach are certainly possible.

The major conclusion to be drawn from a comparison of the Oldest Fuel First and the Levelized Energy scenarios is that the principal effect occurs during the first 10-12 yr of operations. During this period the largest annual variations in the OFF integrated energy values are observed, and, therefore, the largest benefits accrue by leveling this characteristic. This, of course, is accomplished at the expense of a somewhat lower integrated energy in the levelized case in the later years. If this leveling can be achieved, other options exist for increasing the hole temperatures for extended periods, such as reducing the spacing between emplacement drifts, effectively increasing the areal energy density.

3.2.2 - Conclusions on Thermal Analyses

We conclude from the preliminary thermal analyses of the effectiveness of emplacing the spent fuel and high-level waste that there is a strong potential for reaching the objective of keeping a very large fraction of the emplacement holes hotter than the unconfined boiling point of water for time periods in excess of 300 yr following repository closure.

Though the analyses reported here fall short of the objective of maintaining all emplacement hole temperatures above boiling for 300 yr, they are based solely on uniform emplacement of the "as-received" waste stream. In the results section, we have alluded to some package-scale tailoring of the spent fuel to substantially improve the wall-temperature distribution. In addition, it is possible to vary the emplacement drift and hole spacings within the panels to further enhance the distributions. This "geometric heat tailoring" could be very effective, but in order for it to be viable, with the present repository construction and operating concepts, it would require fairly detailed knowledge of the characteristics of the spent fuel and high-level waste about two years in advance of receipts.

This lead time could be achieved by advance agreement with the utilities. Alternatively, a capability to modulate the character of the waste stream utilizing a lag storage facility within the control of the DOE system, such as an MRS, could serve this function.

3.3 - RECOMMENDATIONS

As we reached the completion of the study reported here, there were several additional tasks that we realized ought to be undertaken. We therefore recommend that consideration be given to authorizing this additional effort, in the interests of bringing the study to a logical completion, for this level of detail. These tasks are almost entirely in the category of sensitivity studies, which will bring insight to the effect of varying parameters that we did not adequately investigate.

From the thermal analyses, it is clear that the effects of tailoring the contents of selected individual packages and panel-scale geometric tailoring will have significant effects on the thermal distributions. A few additional analyses will provide a basic understanding of these effects, and should be done. Coordination with the repository design team will be needed to establish the details of the parameters to be varied for these proposed analyses.

Comparative analyses of the effects of OTH and Levelized Energy scenario receipts in a few of the other panels, especially those between "A" and "H", should be performed to get a better perspective on the temperature distributions in that region.

Finally, we recommend a continuation, on a periodic basis, of the discussions that were initiated in conjunction with this study among the members of the OCRWM and the contractor community with a specific interest in the various aspects of spent-fuel receipt scheduling implications. Consideration should also be given to adding to this group representation from the HLW element, so that the overall scheduling of the DOE system waste stream can be discussed.

4.0 - REFERENCES

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Figure 1. Hybrid spent fuel waste package configuration

Figure 2. Age and Burnup characteristics of spent fuel received in the "First In - First Out" receipt scenario

Figure 3. Age and Burnup characteristics of spent fuel received in the "Last In - First Out" receipt scenario with a 5 - year minimum age

Figure 4. Age and Burnup characteristics of spent fuel received in the "Last In - First Out" receipt scenario with a 16 - year minimum age

Figure 5. Schematic layout of the assumed repository geometry

ES-04/10/00-1 R-03

Figure 6. Commingled waste emplacement layout within a typical panel (H,J)

Figure 7. Non-commingled waste emplacement layout within a typical panel (H, J)

Figure 8. All Spent Fuel emplacement layout within Panel A

Figure 9. Modeled region of the repository for the thermal analysis of Panel H

Figure 10. Modeled region of the repository for the thermal analysis of Panel J

Figure 11. Modeled region of the repository for the thermal analyses of Panels A and T

Figure 12. Age, Burnup and Integrated Energy characteristics of spent fuel received in the "Oldest Fuel First" receipt scenario

Figure 13. Age, Burnup and Integrated Energy characteristics of spent fuel received in the "Levelized" receipt scenario

Figure 14. Age, Burnup and Integrated Energy characteristics of spent fuel received in the "Levelized Hi-Graded" receipt scenario

(A)

(B)

Figure 15. Panel H borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Oldest Fuel First, Commingled Waste case

(A)

(B)

Figure 16. Panel H borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Levelized Energy - Oldest Inventory, Commingled Waste case

(A)

(B)

Figure 17. Panel H borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Levelized Energy - "Hi-Graded" Inventory, Commingled Waste case

(A)

(B)

Figure 18. Panel H borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Oldest Fuel First, Non-Commingle Waste case

(A)

(B)

Figure 19. Panel H borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Levelized Energy - Oldest Inventory, Non-Commingled Waste case

(A)

(B)

Figure 20. Panel H borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Levelized Energy - "Hi-Graded" Inventory, Non-Commingle Waste case

(A)

(B)

Figure 21. Panel J borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Oldest Fuel First, Commingled Waste case

(A)

(B)

Figure 22. Panel J borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Levelized Energy - Oldest Inventory, Commingled Waste case

Figure 23. Panel A borehole wall temperature Isotherms (A) and histograms (B) at about 300 years after closure for the Oldest Fuel First, All Spent Fuel case

(A)

(B)

Figure 24. Panel A borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Levelized Energy - Oldest Inventory, All Spent Fuel case

(A)

(B)

Figure 25. Panel T borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Oldest Fuel First, All Spent Fuel case

(A)

(B)

Figure 26. Panel T borehole wall temperature isotherms (A) and histograms (B) at about 300 years after closure for the Levelized Energy - Oldest Inventory, All Spent Fuel case

(A)

(B)

Figure 27. Temperature history for the hottest emplacement hole in the "Hi-Graded" Inventory case analysis of Panel H: (A) for 300 years, (B) for 1,000 years

Appendix A

Waste Acceptance Schedule

WASTE ACCEPTANCE SCHEDULE

ALL QUANTITIES IN METRIC TONS OF HEAVY METAL

Year	MRS facility			First repository			Total acceptance by the system	
	Spent fuel received	In storage	Spent fuel shipped	Spent fuel	High-level waste	Inventory	Annual	Cumulative
2003 ^A	1200	800	400	400		400	1200	1,200
2004	1200	1600	400	400		800	1200	2,400
2005	2000	3200	400	400		1,200	2000	4,400
2006	2000	4300	900	900		2,100	2000	6,400
2007	2700	5200	1800	1800		3,900	2700	9,100
2008	2700	5200	2700	3000 ^B	400	7,300	3400	12,500
2009	2700	5200	2700	3000	400	10,700	3400	15,900
2010	2700	5200	2700	3000	400	14,100	3400	19,300
2011	2700	5200	2700	3000	400	17,500	3400	22,700
2012	2700	5200	2700	3000	400	20,900	3400	26,100
2013	2700	5200	2700	3000	400	24,300	3400	29,500
2014	2700	5200	2700	3000	400	27,700	3400	32,900
2015	2700	5200	2700	3000	400	31,100	3400	36,300
2016	2700	5200	2700	3000	400	34,500	3400	39,700
2017	2700	5200	2700	3000	400	37,900	3400	43,100
2018	2700	5200	2700	3000	400	41,300	3400	46,500
2019	2700	5200	2700	3000	400	44,700	3400	49,900
2020	2700	5200	2700	3000	400	48,100	3400	53,300
2021	2700	5200	2700	3000	400	51,500	3400	56,700
2022	2700	5200	2700	3000	400	54,900	3400	60,100
2023	2700	5200	2700	3000	400	58,300	3400	63,500
2024	2700	5200	2700	3000	400	61,700	3400	66,900
2025	2620	5120	2700	3000	180	64,880	3100	68,000
2026		2420	2700	2700		67,580		70,000
2027			2420	2420		70,000		70,000
Total	57,620		57,620	63,020	6980 ^B	70,000		70,000

^AIt may be possible to start limited waste acceptance at the MRS facility before the year 2003. This cannot be determined until engineering studies have been completed and additional siting information is available.

^BIn years when waste acceptance at the repository does not match shipments from the MRS facility, the difference is attributable to shipments from nearby reactors directly to the repository.

Appendix B

Historical and Projected Inventory Tables

8:29 THURSDAY, OCTOBER 6, 1988

EIA HISTORICAL DISCHARGES 1987

BURNUP (GWD/MTU) VS. YEAR IN ASSEMBLIES

	0-5		5-10		10-15		15-20		20-25		25-30		30-35		35-40		40-45		45-50		50-55		55-60		60-65		TOTAL		CUMULATIVE	
	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	TOTAL	IVE		
1968	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	5	
1969	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95	100	
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	95	199	
1971	244	0	48	12	19	0	113	0	19	6	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	443	54	706
1972	373	0	197	0	174	31	54	74	4	90	0	83	0	53	0	0	0	0	0	0	0	0	0	0	0	0	0	802	331	1133
1973	51	0	88	0	165	0	230	59	24	0	5	85	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	563	165	1639
1974	0	41	405	4	630	225	247	33	33	118	4	148	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1319	573	4455
1975	2	7	107	242	231	665	131	134	181	17	82	0	58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1071	797	8928
1976	5	0	340	0	495	8	826	436	15	195	0	145	0	142	0	0	0	0	0	0	0	0	0	0	0	0	0	1661	920	12057
1977	0	0	239	0	220	6	1049	210	335	291	4	330	0	205	0	40	0	0	0	0	0	0	0	0	0	0	0	2047	1062	17057
1978	17	0	208	4	155	120	424	210	1348	82	66	793	0	284	0	145	0	1	0	0	0	0	0	0	0	0	0	2238	1649	15944
1979	0	0	0	0	108	66	587	233	614	152	799	562	2	534	0	105	0	5	0	0	0	0	0	0	0	0	0	2110	1653	19707
1980	76	0	2	0	3	2	515	4	1202	59	882	540	56	894	4	82	0	3	0	0	0	0	0	0	0	0	0	3330	1480	24508
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2460	1622	28590
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1963	1521	3484
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2567	1769	4503
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2567	1974	4541
1985	92	0	232	0	100	48	211	58	369	45	1587	525	60	765	0	261	2	9	0	0	0	0	0	0	0	0	0	2652	2081	4733
1986	276	0	212	1	232	64	376	321	237	27	856	486	388	842	0	586	0	85	0	3	0	0	0	0	0	0	0	2596	2392	4991
1987	284	0	264	0	401	65	232	242	418	204	1547	296	68	973	114	796	0	115	0	0	0	0	0	0	0	0	0	3322	2691	56661

8:29 THURSDAY, OCTOBER 6, 1988

EIA HISTORICAL DISCHARGES 1987

BURNUP (GWD/MTU) VS. YEAR IN MTU

	0-5		5-10		10-15		15-20		20-25		25-30		30-35		35-40		40-45		45-50		50-55		55-60		60-65		TOTAL		CUMULATIVE	
	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR	BWR	PMR		
1968	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	
1969	0	0	1	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	10	10	
1970	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	39	49	146	
1971	47	0	9	5	2	0	11	0	2	3	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	70	26	97	146	
1972	72	0	38	0	31	12	4	29	1	31	0	23	0	22	0	0	0	0	0	0	0	0	0	0	0	146	118	264	410	
1973	10	0	17	0	28	0	36	26	2	0	1	33	0	8	0	0	0	0	0	0	0	0	0	0	0	93	67	160	570	
1974	0	7	78	2	121	86	44	13	3	40	0	57	0	1	0	0	0	0	0	0	0	0	0	0	0	247	207	454	1024	
1975	0	3	1	43	45	95	124	54	24	79	2	25	0	23	0	0	0	0	0	0	0	0	0	0	0	318	397	715	1542	
1976	1	0	66	0	94	4	154	182	3	83	0	62	0	55	0	15	0	0	0	0	0	0	0	0	0	363	455	839	3095	
1977	0	0	45	0	43	3	197	87	97	133	1	131	0	87	0	61	0	0	0	0	0	0	0	0	0	396	692	1075	4171	
1978	2	0	33	2	18	48	76	90	235	37	15	335	0	116	0	47	0	0	0	0	0	0	0	0	0	353	652	1075	5264	
1979	0	0	0	0	0	0	31	109	107	115	64	153	232	10	286	0	26	0	0	0	0	0	0	0	0	0	520	625	1245	5529
1980	14	0	0	0	0	1	1	95	0	377	73	123	237	10	377	1	34	0	0	0	0	0	0	0	0	0	457	692	1149	7676
1981	0	0	0	0	0	5	1	19	58	2	224	27	164	233	10	377	1	34	0	0	0	0	0	0	0	0	359	654	1013	8891
1982	0	0	0	0	0	5	1	19	83	137	84	184	57	13	301	1	117	0	0	0	0	0	0	0	0	0	495	767	1265	9556
1983	0	0	0	0	0	5	1	6	3	72	91	51	358	170	45	318	0	5	0	0	0	0	0	0	0	452	858	1310	11266	
1984	0	0	5	0	10	54	0	72	124	53	190	215	123	319	0	107	0	4	0	0	0	0	0	0	0	461	882	1363	12628	
1985	17	0	43	0	18	20	37	26	68	20	287	223	11	334	0	234	0	24	0	0	0	0	0	0	0	467	1042	1509	14138	
1986	51	0	39	0	43	27	67	144	46	12	153	193	69	381	0	247	0	35	0	1	0	0	0	0	0	601	1154	1755	15893	
1987	51	0	49	0	72	28	41	105	76	88	280	130	12	419	20	339	0	45	0	0	0	0	0	0	0	601	1154	1755	15893	

BURNUP (GWD/MTU) VS. YEAR IN ASSEMBLIES																														
0-5		5-10		10-15		15-20		20-25		25-30		30-35		35-40		40-45		45-50		50-55		55-60		60-65		TOTAL		CUMULATIVE		
BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR	BWR	PWR		TOTAL	
1988	400	0	0	0	192	52	64	1043	97	1226	334	703	1010	0	1146	0	192	0	5	0	1	0	53	0	16	3628	3110	6738	6738	
1989	92	0	0	0	216	56	380	149	687	24	935	213	180	643	176	860	0	275	0	8	0	1	0	0	0	2686	2229	4915	11653	
1990	92	0	0	0	304	0	644	9	684	174	1796	262	1228	773	108	1151	0	484	0	27	0	21	0	0	0	2558	2851	7407	19060	
1991	0	0	0	0	0	0	56	160	360	4	1304	215	626	624	342	1380	0	480	0	150	0	0	0	0	0	0	0	6001	25061	
1992	0	0	0	0	0	0	44	0	372	9	1361	265	1751	677	592	1269	0	689	0	164	0	0	0	0	0	0	0	7193	32254	
1993	0	0	0	0	0	0	128	128	64	172	0	1348	80	1398	394	975	0	1087	0	197	0	0	0	0	0	0	0	6414	38668	
1994	0	0	0	0	0	0	0	0	0	0	175	264	1051	567	1276	434	919	0	154	0	42	0	1	0	0	0	0	5952	44620	
1995	0	0	0	0	0	0	0	0	0	0	270	26	2539	330	1152	534	0	426	0	426	0	64	0	0	0	0	0	6818	51438	
1996	0	0	0	0	0	0	0	0	0	0	361	5	1536	541	1324	685	0	499	0	499	0	132	0	0	0	0	0	57796	63975	
1997	0	0	0	0	0	0	0	0	0	0	325	4	1427	338	1400	555	43	1239	0	858	0	169	0	8	0	0	0	7341	71316	
1998	0	0	0	0	0	0	0	0	0	0	195	1	2450	190	1897	471	34	1220	0	674	0	138	0	7	0	0	0	4876	76192	
1999	0	0	0	0	0	0	0	0	0	0	215	3	727	257	877	509	327	895	0	847	0	138	0	15	0	0	0	7837	84029	
2000	0	0	0	0	0	0	0	0	0	0	41	0	2436	417	2046	562	33	1037	0	774	0	138	0	7	0	0	0	5842	89871	
2001	0	0	0	0	0	0	0	0	0	0	121	4	1538	193	918	416	455	1131	0	808	0	106	0	8	0	0	0	6643	96514	
2002	0	0	0	0	0	0	0	0	0	0	75	4	1600	301	1637	620	140	952	0	978	0	135	0	8	0	0	0	6562	103076	
2003	0	0	0	0	0	0	0	0	0	0	240	4	1497	301	1823	397	243	1052	0	837	0	245	0	15	0	0	0	6975	110051	
2004	0	0	0	0	0	0	0	0	0	0	35	4	2221	192	1586	512	163	1308	0	703	0	210	0	8	0	0	0	7711	116364	
2005	0	0	0	0	0	0	0	0	0	0	276	1	889	378	1517	582	332	1129	0	1061	0	124	0	30	0	0	0	6812	123176	
2006	0	0	0	0	0	0	0	0	0	0	182	4	1750	229	1676	300	609	1077	0	798	0	278	0	31	0	0	0	6035	129211	
2007	0	0	0	0	0	0	0	0	0	0	216	105	994	267	961	548	334	1248	0	924	0	82	0	15	0	0	0	7051	136262	
2008	0	0	0	0	0	0	0	0	0	0	197	4	1742	260	2204	357	346	1158	0	1008	0	200	0	7	0	0	0	8202	144464	
2009	0	0	0	0	0	0	0	0	0	0	226	1	1700	366	1690	660	464	1096	0	921	0	168	0	7	0	0	0	7711	152175	
2010	0	0	0	0	0	0	0	0	0	0	390	35	1954	337	1375	351	335	1192	0	1008	0	200	0	8	0	0	0	7501	159776	
2011	0	0	0	0	0	0	0	0	0	0	369	36	1495	240	2135	510	152	1332	0	820	0	200	0	8	0	0	0	7680	167366	
2012	0	0	0	0	0	0	0	0	0	0	117	369	36	1495	240	2135	510	152	1332	0	820	0	200	0	8	0	0	0	7501	167366
2013	0	0	0	0	0	0	0	0	0	0	43	112	368	137	1863	605	553	910	0	655	0	188	0	6	0	0	0	7663	175029	
2014	0	0	0	0	0	0	0	0	0	0	224	216	122	449	137	959	440	1512	0	458	0	168	0	0	0	0	0	9332	184361	
2015	0	0	0	0	0	0	0	0	0	0	159	882	181	514	121	1944	379	894	0	458	0	127	0	0	0	0	0	5200	189561	
2016	0	0	0	0	0	0	0	0	0	0	108	0	0	0	127	49	1114	376	869	0	488	0	14	0	0	0	0	5326	194887	
2017	0	0	0	0	0	0	0	0	0	0	112	262	173	180	100	709	123	356	580	528	0	175	0	24	0	0	0	4446	199333	
2018	0	0	0	0	0	0	0	0	0	0	126	20	112	126	40	736	266	151	443	384	0	190	0	0	0	0	0	4345	203678	
2019	0	0	0	0	0	0	0	0	0	0	41	196	27	128	18	849	315	552	601	601	0	32	0	0	0	0	0	27237	207237	
2020	0	0	0	0	0	0	0	0	0	0	153	129	9	538	127	92	425	312	760	0	411	0	16	0	0	0	0	3559	210399	
2021	0	0	0	0	0	0	0	0	0	0	45	0	45	346	130	1009	139	1878	248	352	0	87	0	30	0	0	0	4941	214440	
2022	0	0	0	0	0	0	0	0	0	0	115	0	0	0	48	766	232	188	261	334	0	30	0	1	0	0	0	3841	224213	
2023	0	0	0	0	0	0	0	0	0	0	84	144	0	0	47	759	245	395	476	334	0	30	0	0	0	0	0	3779	227982	
2024	0	0	0	0	0	0	0	0	0	0	195	0	203	447	75	479	245	395	476	216	0	51	0	25	0	0	0	4612	232604	
2025	0	0	0	0	0	0	0	0	0	0	44	572	48	248	167	1089	104	541	209	198	0	53	0	0	0	0	0	2909	235513	
2026	0	0	0	0	0	0	0	0	0	0	744	84	52	45	67	428	128	132	41	198	0	54	0	0	0	0	0	3175	236688	
2027	0	0	0	0	0	0	0	0	0	0	458	42	28	67	258	88	206	414	53	286	0	54	0	0	0	0	0	560	239248	
2028	0	0	0	0	0	0	0	0	0	0	172	0	0	0	0	145	0	111	0	64	0	14	0	0	0	0	0	3175	236688	
2029	0	0	0	0	0	0	0	0	0	0	52	0	0	0	0	83	0	56	0	59	0	0	0	0	0	0	0	560	240207	
2030	0	0	0	0	0	0	0	0	0	0	52	0	0	0	0	87	0	116	0	59	0	0	0	0	0	0	0	959	240329	
2031	0	0	0	0	0	0	0	0	0	0	127	0	0	0	0	37	0	82	0	0	0	0	0	0	0	0	0	122	240329	
2032	0	0	0	0	0	0	0	0	0	0	332	0	0	0	0	143	0	66	0	33	0	0	0	0	0	0	0	61	241671	
2033	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	0	0	0	0	0	0	0	0	0	58	241671	
2034	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	55	0	0	0	0	0	0	0	0	0	59	241649	
2035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	60	241905	
2036	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	0	0	0	0	0	0	0	0	0	59	241968	
2037	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	224	242192	

[illegible]

Appendix C

Flowchart and Listing of Scheduling Program

"Flowchart" Description of Program PRS - Version 13.0 -----

Program PRS contains two parts, the MAIN program and subroutine SPIT. SPIT has three entry points other than itself: SPA1, SPUT, and SPOT. In the description that follows, these four entry points are addressed individually.

Initial input comes from three files:

- PRS1? An input file containing, on a yearly basis, the parameters needed to define the problem.
- PRS2INV A 3-D file containing the initial inventory by AGE, BURNUP and TYPE.
- PRS3EDF A 4-D file containing the energy factors by BURNUP, RECEIPT YEAR, AGE and TYPE.

Output is written to six files:

- PRS4? A plotable file for age, burnup & integrated energy.
- PRS5? A readable/plotable file which contains all of the receipt year, age & assembly allocation data.
- PRS6? A readable file which contains on a line per year basis scheduled allocations and average annual characteristics, by fuel type.
- PRS7? A readable file which contains the initial and final unallocated inventory.
- PRS8? A readable file which contains on a one page per year basis what was taken from inventory.
- ERRRPT A readable file that reports errors found.

Program PRS has the usual four phases:
Conception, Birth, Life & Death.

CONCEIVE

At compile time, PRS is conceived with a set of PARAMETER's, to establish the size of various arrays, a COMMON block for access by the subroutine SPIT and its entry points, and a DATA statement defining some variables.

BIRTH

---Input from PRS1?---

NYEAR(60)	The calander receipt year.
NEED(60)	Receipt schedule for a given year expressed as number of packages.
TAKE(60)	The fraction of inventory that can be taken from the first LDEEP (see below) years in the LIFO loop.
LAGE(60)	Minimum age in LIFO loop.
LRANG(60)	The number of years in the LIFO loop.
LDEEP(60)	The number of years, starting with LAGE (see above) when TAKE (see above) is applied.
SAVE(60)	The fraction of the needed assemblies that will be saved for the FIFO loop.
MAGE(60)	The minimum age in the FIFO loop.
JI(60)	Initial BWR burnup range.
JF(60)	Final BWR burnup range.
KI(60)	Initial PWR burnup range.
KF(60)	Final PWR burnup range.

---Input from file PRS2INV---

IYRB(60)	Discharge year.
MBW(60,12)	BWR inventory by discharge year and burnup.
MPW(60,12)	PWR inventory by discharge year and burnup.

---Input from file PRS3EDF---

EEB(12,60,60) BWR energy deposition factors by burnup, receipt year and age.

EEP(12,60,60) PWR energy deposition factors by burnup, receipt year and age.

After input is completed, a CALL is made to SPIT:

---SPIT writes to PRS77---

IYRB, MBW, MPW (see above) Initial Inventory

LIFE

In its operational life, PRS has five DO loops. The outer loop (Index N) is over the years available. Inside this loop are two pairs of doubly-nested DO loops, one for LIFO and one for FIFO. In each pair, with the receipt year Index (N) available, the outer loop of the pair (Index LI) loops over the inventory, and the inner loops (Indices J or K) loop over the burnup.

At the end of each iteration of the outer loop, if receipts are allocated, a CALL is made to SPAT.

---SPAT writes to PRS87---

NYEAR(NAP) Receipt year.

NAG Age at receipt.

NBW(61,13) BWR Inventory allocated.

NPW(61,13) PWR Inventory allocated.

ITA Total inventory allocated.

---SPAT writes to PR6Y7---

NYEAR, NEED, LAGE, LRUNG, LDEEP, TAKE, SAVE (see above) for this year.

IBN BWR assemblies requested.

AGEB BWR average age.

BURB BWR average burnup.

DEDB PWR average integrated energy.

IPN	PWR assemblies requested.
AGEP	PWR average age.
BURP	PWR average burnup.
DEDP	PWR average integrated energy.
AGE	Total mass-weighted average age.
BUR	Total mass-weighted average burnup.
DED	Total mass weighted average integrated energy.
FIB	Fraction of BWR allocated from FIFO loop.
FIP	Fraction of PWR allocated from FIFO loop.

---SPAT writes to PRS4?---

NYEAR, AGE, BUR, DED, AGEB, BURB, DEDB, AGEP, BURP, DEDP,
FIB, FIP (see above)

---SPAT writes to PRS5?---

NYEAR(NAP)	Receipt year (see above).
NAG	Age at receipt (see above).
LBB	Number of BWR assemblies allocated.
LPP	Number of PWR assemblies allocated.
LTI	Total number of assemblies allocated.

DEATH

In its terminal phase, PRS, having completed its range of scheduling actions, CALL's SPIT, SPUT, SPOT, and EXIT.

---SPIT writes to PRS7?---

NYEAR, MBW, MPW (see above) Unallocated inventory.

---SPUT writes to PRS6?---

INEED	Total number of packages.
ITB	Total BWR assemblies allocated.
AGEB	BWR mass-weighted average age (all years).

BURB	BWR mass-weighted average burnup (all years).
DEDB	BWR mass-weighted average integrated energy (all years).
ITP	Total PWR assemblies allocated.
AGEP	PWR mass-weighted average age (all years).
BURP	PWR mass-weighted average burnup (all years).
DEDP	PWR mass-weighted average integrated energy (all years).
AGE	Overall mass-weighted average age (all years).
BUR	Overall mass-weighted average burnup (all years).
DED	Overall mass-weighted average integrated energy (all years).
ITT	Total of all assemblies allocated.
IC	CPU time used (us).
IO	Input-output time used (us).
IS	Operating system time used (us).

---SPOT writes to ERRRPT---

ERRSUM	Number of errors found
--------	------------------------

NOTE

The "?" used in output file names may be changed to a symbol as the run designator.

The files PRS6?, PRS7?, PRS8?, and ERRRPT contain an entry on line 1 of some or all pages that contains:

TD(3)	Clock time, Date, Computer used.
AA	PRSXIII? The program version and run designator.

```
1 *cft i=%me
2 *ldr x=prxiii
```

Program PRS MARK XIII - MCD 0 28Oct1988

Written by D. N. Montan
Guidance by L. B. Ballou
& M. A. Revelli

Program PRS has the usual four phases:
Conception, Birth, Life & Death.

one is conceived with parameter's. common & data.

```
parameter ( nmax = 60.  jmax = 12.  kmax = 12.
x          nmap = 61.  jmap = 13.  kmap = 13.
x          errm = 10 )
```

[illegible]

data aa / "PRSXIII" /. noc / 27b /. mabell / 07b /

```

61 C      *****  

62 C      *          *          *          *          *  

63 C      *          *          *          *          *  

64 C      *          *          *          *          *  

65 C      *          *          *          *          *  

66 C      *          *          *          *          *  

67 C      *          *          *          *          *  

68 C      *          *          *          *          *  

69 C      *          *          *          *          *  

70 C      *          *          *          *          *  

71 C      *          *          *          *          *  

72 C      *          *          *          *          *  

73 C  

    PRS at birth gets files, and from some of them  

74 C      call link ( "  

75 C          u1 = prs1?       , unit1   = ( u1, open ) .  

76 C          u2 = prs2inv     , unit2   = ( u2, open ) .  

77 C          u3 = prs3edf     , unit3   = ( u3, open ) .  

78 C          u4 = prs4?       , unit4   = ( u4, create, text ) .  

79 C          u5 = prs5?       , unit5   = ( u5, create, text ) .  

80 C          u6 = prs6?       , unit6   = ( u6, create, hc ) .  

81 C          u7 = prs7?       , unit7   = ( u7, create, hc ) .  

82 C          u8 = prs8?       , unit8   = ( u8, create, hc ) .  

83 C          u9 = prsrpt      , unit9   = ( u9, create, hc ) .  

84 C          x                , unit59 = tty // .. )  

85 C  

86 C      call fileinfo ( 1, i1, u1, 1, 1 )  

87 C      call fileinfo ( 2, i2, u2, 1, 1 )  

88 C      call fileinfo ( 3, i3, u3, 1, 1 )  

89 C      call fileinfo ( 4, i4, u4, 1, 1 )  

90 C      call fileinfo ( 5, i5, u5, 1, 1 )  

91 C      call fileinfo ( 6, i6, u6, 1, 1 )  

92 C      call fileinfo ( 7, i7, u7, 1, 1 )  

93 C      call fileinfo ( 8, i8, u8, 1, 1 )  

94 C      call fileinfo ( 9, i9, u9, 1, 1 )  

95 C  

96 C      run = shiftl( u1, 32 )  

97 C  

98 C      do 10 n = 1, nmax  

99 C          read ( 1, 1001 ) nyep(n), need(n), take(n), lage(n)  

100 C          x         ideep(n), save(n), page(n), ji(n), jf(n).  

101 C  

102 C      10 continue  

103 C          read ( 1, 1002 ) nb, wb, np, wp  

104 C  

105 C      do 20 i = 1, imax  

106 C          read ( 2, 2001 ) iyrb, ( mbw(i,j), j = 1, jmax )  

107 C          if ( iyrb.ne.nyear(i) ) err(i,1) = 1  

108 C  

109 C      20 continue  

110 C          dc 30 i = 1, kmax  

111 C              read ( 2, 2001 ) iyrp, ( mpw(i,k), k = 1, kmax )  

112 C              if ( iyrp.ne.nyear(i) ) err(i,2) = 1  

113 C  

114 C      30 continue  

115 C          read ( 3, 3001 ) eeb  

116 C          read ( 3, 3001 ) eep  

117 C  

118 C      call split  

119 C  

120 C
```

```

121 c
122 c
123 c
124 c
125 c
126 c
127 c
128 c
129 c
130 c
131 c
132 do 999 n = 1, nmax
133 if ( need(n).eq.0 ) go to 999
134 c
135 nap = n
136 c
137 j11 = labs( j1(n) )
138 if ( j11.gt.jmax ) err(n.3) = 1
139 if ( j11.gt.jmax ) j11 = jmax
140 j12 = labs( jf(n) )
141 if ( j12.gt.jmax ) err(n.4) = 1
142 if ( j12.gt.jmax ) j12 = jmax
143 j13 = 1
144 if ( j11.gt.j12 ) j13 = -1
145 c
146 if ( j1(n).gt.0 ) then
147 jf1 = j11
148 jf2 = j12
149 jf3 = j13
150 else
151 jf1 = j12
152 jf2 = j11
153 jf3 = -j13
154 endif
155 c
156 k1 = labs( ki(n) )
157 if ( k11.gt.kmax ) err(n.5) = 1
158 if ( k11.gt.kmax ) k11 = kmax
159 k12 = labs( kf(n) )
160 if ( k12.gt.kmax ) err(n.6) = 1
161 if ( k12.gt.kmax ) k12 = kmax
162 k13 = 1
163 if ( k11.gt.k12 ) k13 = -1
164 c
165 if ( ki(n).gt.0 ) then
166 kf1 = k11
167 kf2 = k12
168 kf3 = k13
169 else
170 kf1 = k12
171 kf2 = k11
172 kf3 = -k13
173 endif
174 c
175 ibw = nb*need(n)
176 ipw = np*need(n)
177 ibn = ibw
178 ipn = ipw
179 ib1 = ibw*save(n)
180 ip1 = ipw*save(n)

```



```

181  ibw = ibw - ibl
182  ipw = ipw - ipi
183  ibg = 0
184  ipg = 0
185  ibi = 0
186  ipi = 0
187  ibj = 0
188  ipk = 0
189  deb = 0.0
190  dep = 0.0
191  do 100 i = 1, imap
192    nip(n) = 0
193    do 190 j = 1, jmap
194      nbw(i,j) = 0
195 90 continue
196    do 100 k = 1, kmap
197      npw(i,k) = 0
198 100 continue
199 c
200 c      LIFO loop
201 c
202  m = n - iage(n)
203  irp = ideep(n) + 1
204  irung(n) = irang(n)
205    if ( irung(n).gt.m ) err(n,7) = 1
206  if ( irung(n).gt.m ) irung(n) = m
207  if = irung(n)
208  do 200 ii = 1, ii
209    i = m - ii + 1
210    nag = nmap - i
211 c
212 c      inner loop on j (SWR)
213 c
214  do 150 j = j11, j12, j13
215    iba = nbw(i,j)
216    if ( iba.lt.irp ) iba = iba+take(n)
217    if ( iba.gt.ibw ) iba = ibw
218    nbw(i,j) = nbw(i,j) - iba
219    nbw(i,j) = nbw(i,j) + iba
220    nbw(imap,j) = nbw(imap,j) + iba
221    nbw(i,jmap) = nbw(i,jmap) + iba
222    nbw(jmap,jmap) = nbw(jmap,jmap) + iba
223    ibg = ibg + iba
224    ibi = ibi + i-iba
225    ibj = ibj + j-iba
226    ip = j - 1
227    if ( j.lt.1 ) jm = 1
228    deb = deb + ( j - 0.5 ) * iba * (exp(j,nag,i) + exp(jm,nag,i))
229    ibw = ibw - iba
230    if ( iba.gt.0 ) nip(i) = 1
231 150 continue
232 c
233 c      inner loop on k (PWR)
234 c
235  do 200 k = k11, k12, k13
236    ipa = mpw(i,k)
237    if ( ipa.lt.irp ) ipa = ipa+take(n)
238    if ( ipa.gt.ipw ) ipa = ipw
239    mpw(i,k) = mpw(i,k) - ipa
240    npw(i,k) = npw(i,k) + ipa

```

```

241 npw(imap,k) = npw(imap,k) + ipa
242 npw(i,kmap) = npw(i,kmap) + ipa
243 npw(imap,kmap) = npw(imap,kmap) + ipa
244 ipg = ipg + ipa
245 ipi = ipi + i*ipa
246 ipk = ipk + k*ipa
247 km = k - 1
248 if ( km.lt.1 ) km = 1
249 dep = dep + ( k - 0.5 ) * ipa * ( eep(k,nag,i) + eep(k,nag,i) )
250 ipw = ipw - ipa
251 if ( ipa.gt.0 ) nip(i) = 1
252
253 200 continue
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RISC loop

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inner loop on j (BWR)

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inner loop on k (PWR)

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301 ipw = ipw - ipa
302 if ( ipa.gt.0 ) nip(i) = 1
303 continue
304 ageb = n - float(ibj)/float(ibg)
305 agep = n - float(ipj)/float(ipg)
306 burb = 5.0 - float(ibj)/float(ibg) - 2.5
307 burp = 5.0 - float(ipj)/float(ipg) - 2.5
308 dedb = 2.5 - deb/ibg
309 dedp = 2.5 - dep/ipg
310 if ( ipb.ne.ibg ) err(n,8) = 1
311 if ( ipb.ne.ipg ) err(n,9) = 1
312 call spat
313 continue
314 c
315 c
316 c
317 c
318 c
319 c
320 c
321 c
322 c
323 c
324 c
325 call spit
326 call spout
327 call spot
328 c
329 call exit
330 c
331 1001 format ( 2i6, f6.0, 3i6, f6.0, 5i6 )
332 1002 format ( 1i0, f10.0, 1i0, f10.0 )
333 2001 format ( 13i6 )
334 3001 format ( 12i6 )
335 end

```



```

455 c .....
456 c .....
457 c .....
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entry sput
ageb = cagp/itb
burp = cbub/itb
decb = cdeb/itb
agep = cagp/itp
burp = cbup/itp
dedp = cdep/itp
age = cage/ineed
bur = cbur/ineed
ded = cced/ineed

want = ineed*( nb + np )

write ( 6, 6002 ) ineed, itb, ageb, burp, decb, itp, agep, burp,
x dedp, age, bur, ded
call timedate( td(1), td(2), td(3) )
write ( 6, 6000 ) td, aa, run
call timeused ( io, io, is )
write ( 6, 6004 ) ineed, age, bur, ded, itb, itp, it, io, io, is
if ( itt.ne.want ) err(n=30,10) = 1

return

entry spot
do 40 n = 1, nmap
do 30 i = 1, errm
err(n) = errs(n) + err(n,i)
30 continue
if ( errs(n).gt.0 ) write ( 9, 9001 ) nyear(n),
x ( err(n,i), i = 1 errm ), errs(n)
errsum = errsum + errs(n)
40 continue
if ( errsum.gt.0 ) write ( 59, 9002 ) errsum, mabell, mabell, mabell
if ( errsum.gt.0 ) write ( 9, 9000 ) td, aa, run

return

```


Appendix D

Oldest Fuel First Receipt Schedule

From

Oldest Fuel Inventory

12:08:57 06/26/89c PRSXIII a

Empl Yr	Pkgs	LIFO		age	range	mod	FIFO		age	BWR	engy	assy	PWR		age	engy	TOTAL	
		age	take		save		age	take		age			age	burn			burn	engy
2003	200	15	0	1 0.000	1.000	1	31.9	10.7	22.3	600	31.3	23.2	31.5	18.8	40.7	31.5	18.8	40.7
2004	200	15	0	1 0.000	1.000	1	31.7	8.6	17.5	600	30.1	18.9	30.7	15.2	32.1	30.7	15.2	32.1
2005	200	15	0	1 0.000	1.000	1	31.4	13.4	28.2	600	30.1	20.1	30.5	17.7	38.0	30.5	17.7	38.0
2006	447	15	0	1 0.000	1.000	1	31.5	14.1	29.9	1341	30.0	21.9	30.5	19.1	41.3	30.5	19.1	41.3
2007	894	15	0	1 0.000	1.000	1	30.5	16.2	35.6	2682	29.3	26.1	29.7	22.6	50.4	29.7	22.6	50.4
2008	1489	15	0	1 0.000	1.000	1	29.2	21.4	48.9	4467	28.0	29.1	26.4	26.3	60.4	26.4	26.3	60.4
2009	1489	15	0	1 0.000	1.000	1	28.1	23.4	54.3	4467	26.2	30.6	26.8	28.0	65.3	26.8	28.0	65.3
2010	1489	15	0	1 0.000	1.000	1	26.6	26.3	60.8	4467	24.9	31.3	25.5	29.5	69.3	25.5	29.5	69.3
2011	1489	15	0	1 0.000	1.000	1	25.3	22.7	52.5	4467	24.0	31.3	24.5	28.2	66.5	24.5	28.2	66.5
2012	1489	15	0	1 0.000	1.000	1	24.4	21.5	50.1	4467	23.5	32.4	23.8	28.5	67.6	23.8	28.5	67.6
2013	1489	15	0	1 0.000	1.000	1	23.5	26.5	62.3	4467	22.7	36.9	22.9	33.2	80.0	22.9	33.2	80.0
2014	1489	15	0	1 0.000	1.000	1	23.0	27.3	64.3	4467	22.3	35.4	22.6	32.5	78.3	22.6	32.5	78.3
2015	1489	15	0	1 0.000	1.000	1	22.4	29.4	69.4	4467	21.7	39.1	21.9	35.7	86.5	21.9	35.7	86.5
2016	1489	15	0	1 0.000	1.000	1	21.5	33.8	80.1	4467	21.3	39.3	21.4	37.4	90.8	21.4	37.4	90.8
2017	1489	15	0	1 0.000	1.000	1	20.9	34.2	81.6	4467	20.6	42.3	20.7	39.4	96.5	20.7	39.4	96.5
2018	1489	15	0	1 0.000	1.000	1	20.3	33.8	80.6	4467	20.2	41.9	20.2	39.0	95.8	20.2	39.0	95.8
2019	1489	15	0	1 0.000	1.000	1	19.5	35.1	84.8	4467	19.5	43.2	19.5	40.3	99.7	19.5	40.3	99.7
2020	1489	15	0	1 0.000	1.000	1	19.0	35.0	84.9	4467	19.0	42.2	19.0	39.7	98.4	19.0	39.7	98.4
2021	1489	15	0	1 0.000	1.000	1	18.3	34.3	83.3	4467	18.5	42.7	18.4	40.4	101.3	18.4	40.4	101.3
2022	1489	15	0	1 0.000	1.000	1	17.7	35.7	87.4	4467	17.9	43.1	17.8	39.8	100.1	17.8	39.8	100.1
2023	1489	15	0	1 0.000	1.000	1	17.0	35.3	87.0	4467	17.5	42.3	17.3	39.6	99.8	17.3	39.6	99.8
2024	1489	15	0	1 0.000	1.000	1	16.3	35.2	87.0	4467	17.0	42.0	16.7	39.4	99.8	16.7	39.4	99.8
2025	1489	15	0	1 0.000	1.000	1	15.9	32.9	81.7	4467	16.4	43.0	16.3	39.4	99.8	16.3	39.4	99.8
2026	1340	15	0	1 0.000	1.000	1	15.7	33.2	82.3	4020	16.2	40.4	16.0	37.8	95.6	16.0	37.8	95.6
2027	1200	15	0	1 0.000	1.000	1	15.6	33.7	83.6	3600	15.6	41.4	15.6	38.7	98.1	15.6	38.7	98.1

Tot/Ave 31283

125132 21.7 29.5 70.5 93849

21.4 34.6 84.60 125132 93849 218981 3942684 819895 59429

12:08:58 06/26/89c PRSXIII a

12.08.57 06/26/89c PRSxIII a

Employment year 2003

Dis yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1968	35	SWR	5	0	0	0	0	0	0	0	0	0	5
		PWR	0	0	0	0	0	0	0	0	0	0	0
1969	34	SWR	0	5	14	73	2	0	0	0	0	0	95
		PWR	0	0	0	0	0	0	0	0	0	0	0
1970	33	SWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	4	95	0	0	0	0	0	0	99
1971	32	SWR	244	48	19	113	19	0	0	0	0	0	443
		PWR	0	12	0	0	6	46	0	0	0	0	64
1972	31	SWR	0	25	174	54	4	0	0	0	0	0	257
		PWR	0	0	31	74	90	33	53	0	0	0	331
1973	30	SWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	85	21	0	0	0	106
Totals		SWR	249	78	207	240	25	1	0	0	0	0	509
		PWR	0	12	35	169	95	74	74	0	0	0	500
													1400

Emplacement Year 2004

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals	
1972	32	BWR	373	172	0	0	0	0	0	0	0	0	0	545
		PWR	0	0	0	0	0	0	0	0	0	0	0	0
1973	31	BWR	0	0	0	226	24	5	0	0	0	0	0	255
		PWR	0	0	0	59	0	0	0	0	0	0	0	59
1974	30	BWR	0	0	0	0	0	0	0	0	0	0	0	0
		PWR	9	4	225	33	118	148	4	0	0	0	0	541
Totals		BWR	373	172	0	226	24	5	0	0	0	0	0	800
		PWR	9	4	225	92	118	148	4	0	0	0	0	600
													1400	

12:08:57 06/26/89c PRSXIII a

Emplacement Year 2005

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1973	32	BWR	51	88	165	4	0	0	0	0	0	0	308
		PWR	0	0	0	0	0	0	0	0	0	0	0
1974	31	BWR	0	0	208	247	33	4	0	0	0	0	492
		PWR	32	0	0	0	0	0	0	0	0	0	32
1975	30	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	116	131	181	82	58	0	0	0	568
Totals		BWR	51	88	373	251	33	4	0	0	0	0	800
		PWR	32	0	116	131	181	82	58	0	0	0	600
													1400

Emplacement Year 2006

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1974	32	BWR PWR	0 0	405 0	422 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	827 0
1975	31	BWR PWR	0 7	0 107	141 115	669 0	134 0	17 0	0 0	0 0	0 0	0 0	961 229
1976	30	BWR PWR	0 0	0 0	0 8	0 430	0 195	0 145	0 142	0 0	0 0	0 0	0 920
1977	29	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 152	0 40	0 0	0 0	0 192
Totals		BWR PWR	0 7	405 107	563 123	669 430	134 195	17 145	0 294	0 40	0 0	0 0	1788 1341 3129

[illegible]

Emplacement Year 2009

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1980	29	BWR PWR	76 0	2 0	3 0	515 0	1388 0	0 0	0 0	0 0	0 0	0 0	1983 0
1981	28	BWR PWR	0 0	1 0	1 40	314 4	1202 59	882 33	56 0	4 0	0 0	0 0	2460 135
1982	27	BWR PWR	0 0	0 11	0 3	0 181	435 188	1001 153	71 697	3 276	2 6	0 5	1512 1521
1983	26	BWR PWR	0 0	0 12	0 16	0 156	0 112	0 386	0 737	0 337	0 12	0 1	0 1769
1984	25	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 771	0 261	0 9	0 0	0 1041
Totals		BWR PWR	76 0	3 23	4 59	829 341	3025 359	1883 572	127 2205	7 874	2 27	0 6	5956 4467 10423

Emplacement Year 2010

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1982	28	BWR	0	1	26	118	306	0	0	0	0	0	451
		PWR	0	0	0	0	0	0	0	0	0	0	0
1983	27	BWR	0	0	5	25	496	1964	244	0	0	0	2734
		PWR	0	0	0	0	0	0	0	0	0	0	0
1984	26	BWR	0	4	92	3	675	1044	677	0	2	0	2567
		PWR	0	0	133	100	115	486	99	0	0	0	933
1985	25	BWR	0	0	0	0	0	143	60	0	1	0	204
		PWR	0	0	48	58	45	525	766	575	63	1	2081
1986	24	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	776	586	85	3	1453
Totals		BWR	0	75	123	146	1477	3151	981	0	3	0	5956
		PWR	0	0	181	158	160	1011	1641	1161	148	4	4467
													10423

Emplacement Year 2011

Dis yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
			92	232	100	211	369	1444	0	0	0	0	
1985	26	BWR	92	232	100	211	369	1444	0	0	0	0	2448
		PWR	0	0	0	0	0	0	0	0	0	0	0
1986	25	BWR	276	212	232	378	257	856	388	0	0	0	2599
		PWR	0	1	64	321	27	456	70	0	0	0	939
1987	24	BWR	0	0	0	0	0	727	68	114	0	0	909
		PWR	0	0	65	242	204	296	973	796	115	0	2691
1988	23	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	0	570	192	5	837
Totals		BWR	368	444	332	589	626	3027	456	114	0	0	5956
		PWR	0	1	129	563	231	752	1043	1366	307	5	4467
													10423

Emplacement Year 2012

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1987	25	BWR	284	264	401	232	418	820	0	0	0	0	249
		PWR	0	0	0	0	0	0	0	0	0	0	0
1988	24	BWR	0	0	192	64	1043	1226	703	0	0	0	3537
		PWR	0	0	52	204	97	334	1010	576	0	0	2273
1989	23	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	21	149	24	213	643	860	275	8	2194
Totals		BWR	593	264	593	296	1461	2046	703	0	0	0	5956
		PWR	0	0	73	353	121	547	1653	1436	275	8	4467
													10423

12:08:58 06/26/89c PRSXIII a

Emplacement Year 2013

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1988	25	BWR	91	0	0	0	0	0	0	0	0	0	91
		PWR	0	0	0	0	0	0	0	0	0	0	0
1989	24	BWR	92	20	216	380	687	935	180	176	0	0	2686
		PWR	0	0	35	0	0	0	0	0	0	0	35
1990	23	BWR	0	0	0	0	47	1796	1228	108	0	0	3179
		PWR	0	0	0	9	124	252	773	1151	484	27	2851
1991	22	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	951	480	150	0	1581
Totals		BWR	183	20	216	380	734	2731	1408	284	0	0	5956
		PWR	0	0	35	9	124	262	773	2102	964	21	4467
													10423

Emplacement Year 2014

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1990	24	BWR	92	0	304	644	337	0	0	0	0	0	1377
		PWR	0	0	0	0	0	0	0	0	0	0	0
1991	23	BWR	0	0	0	56	660	1304	626	342	0	0	2988
		PWR	0	0	0	160	4	215	624	429	0	0	1432
1992	22	BWR	0	0	0	0	0	0	999	592	0	0	1591
		PWR	0	0	0	0	0	236	677	1269	689	164	3035
Totals		BWR	92	0	304	700	997	1304	1625	934	0	0	5956
		PWR	0	0	0	160	4	451	1301	1698	689	164	4467
													10423

Emplacement Year 2015

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1992	23	BWR	0	0	0	44	372	1351	752	0	0	0	0
		PWR	0	0	0	0	9	29	0	0	0	0	38
1993	22	BWR	0	0	0	75	172	1348	1398	434	0	0	0
		PWR	0	0	128	64	0	80	394	975	1087	197	3427
1994	21	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	0	253	1046	154	2934
												42	1495
Totals		BWR	0	0	0	119	544	2709	2150	434	0	0	5956
		PWR	0	0	128	64	9	109	394	1228	2133	351	4467
												50	10423

Emplacement Year 2016

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1993	23	BWR	0	0	0	0	0	0	0	0	0	0	53
		PWR	0	0	0	0	0	0	0	0	0	0	0
1994	22	BWR	0	0	0	16	715	1051	1276	0	0	0	3058
		PWR	0	0	0	2	264	567	566	0	0	0	1399
1995	21	BWR	0	0	0	0	0	1593	1152	0	0	0	2845
		PWR	0	0	0	0	26	330	534	1422	426	64	2802
1996	20	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	0	0	134	132	266
Totals		BWR	0	0	0	16	715	2744	2428	0	0	0	5956
		PWR	0	0	0	2	230	897	1100	1422	560	196	4467
													10423

12:08:58 06/26/89C PRSXIII 2

Employment Year 2017

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1995	22	BWR	0	0	0	55	270	846	0	0	0	0	1171
		PWR	0	0	0	0	0	0	0	0	0	0	0
1996	21	BWR	0	0	0	16	381	1536	1324	0	0	0	3257
		PWR	0	0	0	0	5	541	695	1239	365	0	2835
1997	20	BWR	0	0	0	0	0	85	1400	43	0	0	1528
		PWR	0	0	0	0	0	0	0	593	858	174	1632
Totals		BWR	0	0	0	71	651	2467	2724	43	0	0	5956
		PWR	0	0	0	0	5	541	685	1832	1223	174	4467
													10423

Emplacement Year 2018

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1997	21	BWR	0	0	0	43	325	1342	0	0	0	0	1710
		PWR	0	0	0	0	4	338	555	412	0	0	1309
1998	20	BWR	0	0	0	0	0	2325	1887	34	0	0	4246
		PWR	0	0	0	0	1	190	471	1220	674	169	2733
1999	19	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	0	0	310	108	425
Totals		BWR	0	0	0	43	325	3667	1887	34	0	0	5956
		PWR	0	0	0	0	5	528	1026	1632	984	277	4467
													10423

Emplacement Year 2019

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1998	21	BWR	0	0	0	0	42	195	125	0	0	0	362
		PWR	0	0	0	0	0	0	0	0	0	0	0
1999	20	BWR	0	0	0	0	41	215	727	877	327	0	2187
		PWR	0	0	0	63	0	3	257	509	895	537	2264
2000	19	BWR	0	0	0	0	0	0	1328	2046	33	0	3407
		PWR	0	0	0	0	0	0	0	47	1037	774	2203
												330	15
Totals		BWR	0	0	0	0	83	410	2180	2923	360	0	5956
		PWR	0	0	0	63	0	3	257	556	1932	330	4467
													10423

12:08:58 06/26/89c PRXIII a

Emplacement Year 2020

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
2000	20	BWR	0	0	0	26	121	1108	0	0	0	0	1255
		PWR	0	0	36	0	4	417	515	0	0	0	972
2001	19	BWR	0	0	0	26	237	1538	918	455	0	0	3174
		PWR	0	0	0	0	7	193	416	1131	808	106	2668
2002	18	BWR	0	0	0	0	0	0	1387	140	0	0	1527
		PWR	0	0	0	0	0	0	0	0	574	245	827
Totals		BWR	0	0	0	52	358	2646	2305	595	0	0	5956
		PWR	0	0	36	0	11	610	931	1131	1382	351	4467
													10423

12:08:58 06/26/89c PRXIII a

Emplacement Year 2021

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
2002	19	BWR PWR	0 0	20 0	0 0	46 0	75 1	1600 301	250 620	0 952	0 404	0 0	2011 2278
2003	18	BWR PWR	0 0	0 0	0 0	26 0	240 0	1497 0	1823 158	243 1052	0 837	0 135	3829 2189
2004	17	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	116 0	0 0	0 0	116 0
Totals		BWR PWR	0 0	20 0	0 0	72 0	315 1	3097 301	2073 778	359 2004	0 1241	0 135	5956 4467 10423

Emplacement Year 2022

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
2003	19	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	4	301	239	0	0	0	0	544
2004	18	BWR	0	0	0	26	35	2221	1586	47	0	0	0
		PWR	0	0	0	0	4	192	512	1308	703	210	15
2005	17	BWR	0	0	0	0	0	192	1517	332	0	0	0
		PWR	0	0	0	0	0	0	0	0	858	113	8
Totals		BWR	0	0	0	26	35	2413	3103	379	0	0	0
		PWR	0	0	0	0	8	493	751	1308	1561	322	23
													10423

Emplacement Year 2023

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
2005	18	BWR	0	0	0	25	278	697	0	0	0	0	1000
		PWR	0	0	0	0	1	378	582	1129	203	0	2293
2006	17	BWR	0	0	0	25	182	1750	1676	609	0	0	4242
		PWR	0	0	0	0	0	0	145	1077	798	124	2174
2007	16	BWR	0	0	0	0	0	0	380	334	0	0	714
		PWR	0	0	0	0	0	0	0	0	0	0	0
Totals		BWR	0	0	0	50	460	2447	2056	943	0	0	5956
		PWR	0	0	0	0	1	378	727	2206	1001	124	4467
													10423

Emplacement Year 2024

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
2006	18	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	4	229	163	0	0	0	0	396
2007	17	BWR	0	0	0	25	216	994	581	0	0	0	1816
		PWR	0	104	0	0	105	267	548	1248	924	278	3505
2008	16	BWR	0	0	0	0	0	1590	2204	346	0	0	4140
		PWR	0	0	0	0	0	0	0	0	477	82	566
Totals		BWR	0	0	0	25	216	2584	2785	346	0	0	5956
		PWR	0	104	0	0	109	496	711	1248	1401	360	4467
													10423

Emplacement Year 2025

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals	
2008	17	BWR	0	0	0	0	26	197	152	0	0	0	0	375
		PWR	0	0	0	0	0	4	260	357	1158	191	0	1970
2009	16	BWR	0	152	146	336	172	226	1700	1690	464	0	0	4886
		PWR	0	0	0	0	0	0	0	265	1096	921	15	2497
2010	15	BWR	0	0	0	0	0	0	0	360	335	0	0	695
		PWR	0	0	0	0	0	0	0	0	0	0	0	0
Totals		BWR	0	152	146	336	198	423	1852	2050	799	0	0	5956
		PWR	0	0	0	0	0	4	260	622	2254	1112	15	4467
													10423	

Emplacement Year 2026

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
2009	17	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	25	7	25	1	366	395	0	0	0	819
2010	16	BWR	0	4	308	8	146	390	1954	1015	0	0	3825
		PWR	0	12	32	49	0	35	337	351	1192	1008	3191
2011	15	BWR	0	0	0	0	0	0	0	1383	152	0	1535
		PWR	0	0	0	0	0	0	0	0	0	2	10
Totals		BWR	0	4	308	8	146	390	1954	2398	152	0	5360
		PWR	0	12	57	56	25	36	703	746	1192	1008	4020
													9380

Emplacement Year 2027

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals	
2011	16	BWR	0	158	0	158	118	369	1495	752	0	0	0	3050
		PWR	0	0	100	36	117	36	240	510	1332	503	132	3006
2012	15	BWR	0	0	0	0	0	0	0	1197	553	0	0	1750
		PWR	0	0	0	0	0	0	0	0	0	387	200	594
Totals		BWR	0	158	0	158	118	369	1495	1949	553	0	0	4800
		PWR	0	0	100	36	117	36	240	510	1332	890	332	3600
													7	8400

Dis Yr	Type	Initial Inventory - Number of Assemblies in Burnup Ranges										12:08:55 06/26/89c	PRSXIII a
1968	BWR	5	0	0	0	0	0	0	0	0	0	0	0
	PWR	0	0	0	0	0	0	0	0	0	0	0	0
1969	BWR	0	5	14	73	2	1	0	0	0	0	0	0
	PWR	0	0	0	0	0	0	0	0	0	0	0	0
1970	BWR	0	0	0	0	0	0	0	0	0	0	0	0
	PWR	0	0	4	95	0	0	0	0	0	0	0	0
1971	BWR	244	49	19	113	19	0	0	0	0	0	0	0
	PWR	0	12	0	0	6	46	0	0	0	0	0	0
1972	BWR	373	197	174	54	4	0	0	0	0	0	0	0
	PWR	0	0	31	74	90	83	53	0	0	0	0	0
1973	BWR	51	88	165	230	24	5	0	0	0	0	0	0
	PWR	0	0	0	59	0	85	21	0	0	0	0	0
1974	BWR	0	405	630	247	33	4	0	0	0	0	0	0
	PWR	41	4	225	33	118	148	4	0	0	0	0	0
1975	BWR	2	7	242	669	134	17	0	0	0	0	0	0
	PWR	7	107	231	131	181	82	58	0	0	0	0	0
1976	BWR	5	340	495	826	15	0	0	0	0	0	0	0
	PWR	0	0	8	430	195	145	142	0	0	0	0	0
1977	BWR	0	239	220	1049	535	4	0	0	0	0	0	0
	PWR	0	0	6	210	291	330	205	40	0	0	0	0
1978	BWR	17	208	155	424	1348	86	0	0	0	0	0	0
	PWR	0	4	120	220	82	793	284	145	1	0	0	0
1979	BWR	0	0	108	587	614	799	2	0	0	0	0	0
	PWR	0	0	66	233	152	562	534	105	1	0	0	0
1980	BWR	76	2	3	515	2021	660	53	0	0	0	0	0
	PWR	0	0	2	0	158	555	686	65	5	0	0	0
1981	BWR	0	1	1	314	1202	882	56	4	0	0	0	0
	PWR	0	0	40	4	59	540	894	82	3	0	0	0
1982	BWR	0	1	26	118	741	1001	71	3	2	0	0	0
	PWR	0	11	3	181	188	153	697	276	6	1	5	0
1983	BWR	0	0	5	25	496	1964	244	0	0	0	0	0
	PWR	0	12	16	156	112	386	737	337	12	0	1	0
1984	BWR	0	74	92	3	675	1044	677	0	2	0	0	0
	PWR	0	0	133	100	115	486	870	261	9	0	0	0
1985	BWR	92	232	100	211	369	1587	60	0	1	0	0	0
	PWR	0	0	48	58	45	525	766	575	63	1	0	0
1986	BWR	276	212	232	378	257	856	388	0	0	0	0	0
	PWR	0	1	64	321	27	456	846	586	85	3	3	0
1987	BWR	284	264	401	232	418	1547	68	114	0	0	0	0
	PWR	0	0	65	242	204	296	973	796	115	0	0	0

1988	BWR PWR	400 0	0 0	0 0	192 52	64 204	1043 97	1226 334	703 1010	0 1146	0 192	0 5	0 1	0 69
1989	BWR PWR	92 0	20 0	216 56	380 149	687 24	935 213	180 643	176 860	0 275	0 8	0 0	0 0	0 0
1990	BWR PWR	92 0	0 0	304 0	644 9	384 124	1736 262	1228 773	108 1151	0 484	0 27	0 21	0 0	0 0
1991	BWR PWR	0 0	0 0	0 0	56 160	660 4	1304 215	626 624	342 1380	0 480	0 150	0 0	0 0	0 0
1992	BWR PWR	0 0	0 0	0 0	44 0	372 9	1361 265	1751 677	592 1269	0 689	0 164	0 0	0 0	0 0
1993	BWR PWR	0 0	0 0	0 128	128 64	172 0	1348 80	1398 394	434 975	0 1087	0 197	0 8	0 0	0 0
1994	BWR PWR	0 0	0 0	0 0	0 0	16 2	715 264	1051 567	1276 819	0 1046	0 154	0 42	0 0	0 0
1995	BWR PWR	0 0	0 0	0 0	0 0	55 0	270 26	2539 330	1152 534	0 1422	0 426	0 64	0 0	0 0
1996	BWR PWR	0 0	0 0	0 0	0 0	16 0	381 5	1536 541	1324 685	0 1239	0 499	0 132	0 0	0 0
1997	BWR PWR	0 0	0 0	0 0	0 0	43 0	325 4	1427 338	1400 555	43 1005	0 858	0 174	0 0	0 0
1998	BWR PWR	0 0	0 0	0 0	0 0	42 0	195 1	2450 190	1887 471	34 1220	0 674	0 169	0 0	0 0
1999	BWR PWR	0 0	0 0	0 0	0 63	41 0	215 3	727 257	877 509	327 895	0 847	0 108	0 0	0 0
2000	BWR PWR	0 0	0 0	0 0	0 36	26 0	121 4	2436 417	2046 562	33 1037	0 774	0 330	0 15	0 0
2001	BWR PWR	0 0	0 0	0 0	0 0	26 0	237 7	1538 193	918 416	455 1131	0 808	0 106	0 0	0 0
2002	BWR PWR	0 0	20 0	20 0	0 0	46 0	75 1	1600 301	1637 620	140 952	0 978	0 245	0 0	0 0
2003	BWR PWR	0 0	0 0	0 0	0 0	26 0	240 4	1497 301	1823 397	243 1052	0 837	0 135	0 0	0 0
2004	BWR PWR	0 0	0 0	0 0	0 0	26 0	35 4	2221 192	1586 512	163 1308	0 703	0 210	0 15	0 0
2005	BWR PWR	0 0	0 0	0 0	0 0	25 0	278 1	889 378	1517 582	332 1129	0 1061	0 113	0 0	0 0
2006	BWR PWR	0 0	0 0	0 0	0 0	25 0	182 4	1750 229	1676 308	609 1077	0 798	0 124	0 0	0 0
2007	BWR PWR	0 0	0 0	0 0	0 104	25 0	216 105	994 267	961 548	334 1248	0 924	0 278	0 31	0 0

2003	BWR PWR	0 0	0 0	0 0	0 0	26 0	197 4	1742 260	2204 357	346 1158	0 668	0 82	0 7
2009	BWR PWR	0 0	152 0	146 25	336 7	172 25	226 1	1700 366	1690 660	464 1096	0 921	0 200	0 15
2010	BWR PWR	0 0	4 12	308 32	8 49	146 0	390 35	1954 337	1375 351	335 1192	0 1008	0 168	0 7
2011	BWR PWR	0 0	158 0	0 100	158 36	118 117	369 36	1495 240	2135 510	152 1332	0 503	0 134	0 8
2012	BWR PWR	0 0	0 12	324 0	0 60	43 112	368 1	1373 339	1863 605	553 910	0 820	0 200	0 7
2013	BWR PWR	0 0	0 24	456 188	7 224	216 122	449 137	959 440	1512 745	92 1241	0 655	0 188	0 8
2014	BWR PWR	0 0	128 0	1132 173	108 159	882 181	514 121	1944 379	894 414	555 1115	0 458	0 168	0 7
2015	BWR PWR	0 0	0 0	0 76	0 108	0 0	127 49	1114 376	869 606	241 1019	0 488	0 127	0 0
2016	BWR PWR	0 20	16 0	400 0	16 112	262 173	180 100	709 123	350 580	730 826	0 528	0 175	0 24
2017	BWR PWR	0 0	0 0	0 0	0 126	20 112	126 40	736 266	1151 443	75 763	0 384	0 190	0 14
2018	BWR PWR	0 0	0 0	196 0	0 41	196 27	128 1	849 315	532 564	245 618	0 601	0 32	0 0
2019	BWR PWR	0 0	0 0	0 0	0 0	0 0	49 1	943 157	1279 235	45 421	0 318	0 111	0 0
2020	BWR PWR	0 0	0 0	0 32	0 108	0 153	129 0	538 127	92 425	312 760	0 421	0 49	0 16
2021	BWR PWR	0 0	0 0	0 41	0 115	0 0	45 43	569 248	1088 495	128 833	0 390	0 46	0 0
2022	BWR PWR	0 0	116 0	100 0	384 28	0 128	346 130	1009 139	1878 260	248 697	0 352	0 87	0 30
2023	BWR PWR	0 0	168 0	0 48	156 84	144 0	0 48	766 232	1188 261	8 373	0 334	0 30	0 1
2024	BWR PWR	0 0	0 0	232 50	0 195	0 203	447 75	479 243	505 476	0 635	0 207	0 32	0 0
2025	BWR PWR	0 0	0 0	744 84	52 45	572 48	248 167	1089 104	541 209	8 409	0 216	0 51	0 25
2026	BWR PWR	0 0	28 0	428 42	28 67	428 128	132 41	499 65	115 396	4 255	0 198	0 55	0 0
2027	BWR PWR	172 0	0 1	360 258	88 206	414 53	164 155	412 253	40 215	0 286	0 54	0 44	0 0

[illegible]

Appendix E

Levelized Energy Receipt Schedule

From

Oldest Fuel Inventory

12:09:26 06/26/89c PRSXIII S

Empl Yr	Pkgs	LIFO		FIFO		BWR		assv	PWR		TOTAL	
		age	range	mod	take	save	age		age	burn	age	burn
2003	200	15	4	1	0.000	0.150	18.7	800	18.7	27.7	18.6	32.7
2004	200	15	4	1	0.000	0.300	21.1	800	20.9	38.3	21.0	34.0
2005	200	15	4	1	0.000	0.200	19.6	800	19.4	37.2	19.5	33.1
2006	447	15	4	1	0.000	0.190	17.88	1788	19.4	36.7	19.3	33.8
2007	894	15	4	1	0.000	0.100	18.0	3576	18.0	37.0	17.8	33.0
2008	1489	15	4	1	0.100	0.050	17.3	5956	17.3	34.6	17.2	32.6
2009	1489	15	4	1	0.500	0.000	19.9	5956	17.2	36.4	18.2	33.2
2010	1489	15	4	1	0.700	0.000	20.7	5956	19.9	35.1	20.2	32.7
2011	1489	15	4	1	0.850	0.000	21.8	5956	19.5	37.4	20.3	33.9
2012	1489	15	4	1	0.900	0.000	23.5	5956	21.0	37.6	21.9	34.0
2013	1489	15	4	1	0.900	0.000	20.2	5956	22.6	36.7	21.8	34.4
2014	1489	15	4	1	0.800	0.000	22.4	5956	21.6	37.2	23.1	34.1
2015	1489	15	4	1	0.700	0.000	25.9	5956	23.2	37.0	22.9	34.4
2016	1489	15	4	1	0.600	0.000	24.5	5956	23.6	36.8	23.9	34.3
2017	1489	15	4	1	0.600	0.000	24.6	5956	22.8	37.8	23.4	35.2
2018	1489	15	4	1	0.500	0.000	23.8	5956	23.2	37.0	23.4	35.1
2019	1489	15	4	1	0.400	0.000	23.3	5956	23.5	38.6	23.4	35.9
2020	1489	15	4	1	0.200	0.000	25.0	5956	24.1	38.0	24.4	34.9
2021	1489	15	4	1	0.200	0.000	24.1	5956	21.4	38.5	22.4	34.9
2022	1489	15	4	1	0.200	0.000	22.3	5956	23.0	37.4	22.8	34.7
2023	1489	15	4	1	0.000	0.000	28.2	5956	23.1	39.1	24.9	34.1
2024	1489	15	4	1	0.000	0.000	20.4	5956	24.4	37.4	22.9	35.3
2025	1489	15	4	1	0.000	0.000	17.1	5956	21.0	38.9	19.6	36.3
2026	1340	15	4	1	0.000	0.000	15.7	5360	20.1	39.5	18.5	37.2
2027	1200	15	4	1	0.000	0.000	15.6	4800	15.8	41.4	15.8	38.7

Tot/Ave 31283

125132 21.7 29.5 71.5 93849

12:09:27 06/26/89c PRSXIII S

31283 21 44 34.66 85.73 125132 93849 218981 3979917 908017 62084

Emplacement Year 2003

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1968	35	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	5 0
1969	34	BWR PWR	0 0	14 0	73 0	2 0	1 0	0 0	0 0	0 0	0 0	0 0	95 0
1970	33	BWR PWR	0 0	0 0	0 90	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 90
1971	32	BWR PWR	0 0	0 0	1 0	19 0	0 0	0 0	0 0	0 0	0 0	0 0	20 0
1987	16	BWR PWR	0 0	0 0	0 0	0 0	498 0	68 0	114 395	0 115	0 0	0 0	680 510
Totals		BWR PWR	5 0	14 0	74 90	21 0	499 0	68 0	114 395	0 115	0 0	0 0	800 600 1400

12:09:26 06/26/89 PRXIII S

Emplacement Year 2004

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1970	34	BWR PWR	0 0	0 4	0 5	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 9
1971	33	BWR PWR	61 0	48 12	19 0	112 0	0 6	0 46	0 0	0 0	0 0	0 0	240 64
1972	32	BWR PWR	0 0	0 0	0 0	0 0	0 54	0 53	0 0	0 0	0 0	0 0	0 107
1988	16	BWR PWR	0 0	0 0	0 0	0 0	0 0	560 0	0 153	0 192	0 5	0 69	560 420
Totals		BWR PWR	61 0	48 12	19 4	112 5	0 6	0 100	560 53	0 153	0 192	0 69	800 600 1400

12:09:26 06/26/89c PRXIII S

Emplacement Year 2005

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1971	34	BWR	0	0	0	0	0	0	0	0	0	0	160
		PWR	0	0	0	0	0	0	0	0	0	0	0
1972	33	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	0	0	0	0	120
1989	16	BWR	0	0	0	0	0	0	0	0	0	0	540
		PWR	0	0	0	0	0	0	0	0	0	0	480
Totals		BWR	0	0	0	0	0	0	0	0	0	0	800
		PWR	0	0	0	0	0	0	0	0	0	0	600
													1400

12:09:26 06/26/89c PRSXIII 3

Emplacement Year 2006

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1971	35	BWR PWR	23	0	0	0	0	0	0	0	0	0	23
			0	0	0	0	0	0	0	0	0	0	0
1972	34	BWR PWR	0	84	174	54	4	0	0	0	0	0	316
			0	0	31	73	0	0	0	0	0	0	104
1973	33	BWR PWR	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	44	0	85	21	0	0	0	150
1990	16	BWR PWR	0	0	0	0	0	113	1228	108	0	0	1449
			0	0	0	0	0	0	0	555	484	27	1087
Totals		BWR PWR	23	84	174	54	4	113	1228	108	0	0	1788
			0	0	31	117	0	85	21	555	484	27	1341
													3129

Emplacement Year 2007

Dis yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1972	35	BWR PWR	113 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	357 0
1973	34	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 15
1974	33	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 253
1990	17	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	231 0
1991	16	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	2988 2414
Totals		BWR PWR	113 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	3576 2682 6258

Emplacement Year 2008

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1972	36	BWR PWR	129 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	129 0
1973	35	BWR PWR	0 0	0 0	139 0	24 0	5 0	0 0	0 0	0 0	0 0	0 0	168 0
1974	34	BWR PWR	0 0	0 0	0 173	0 33	0 17	0 0	0 0	0 0	0 0	0 0	0 223
1990	18	BWR PWR	0 0	0 0	0 0	0 0	1194 0	0 0	0 283	0 0	0 0	0 0	1194 283
1991	17	BWR PWR	0 0	0 0	0 0	0 160	0 4	0 215	0 220	0 0	0 0	0 0	0 599
1992	16	BWR PWR	0 0	0 0	0 0	44 0	372 9	1361 265	1751 677	592 1269	0 689	0 164	4120 3073
1993	15	BWR PWR	0 0	0 0	0 12	0 6	17 0	134 8	139 39	43 97	0 108	0 19	345 289
Totals		BWR PWR	129 0	0 0	195 199	413 30	2694 488	1890 936	635 1649	0 797	0 182	0 0	5956 4467 10423

Emplacement Year 2009

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals		
1973	36	BWR PWR	88	165	97	0	0	0	0	0	0	0	0	0	395
			0	0	0	0	0	0	0	0	0	0	0	0	
1974	35	BWR PWR	0	614	247	33	4	0	0	0	0	0	0	0	898
			41	52	0	0	0	0	0	0	0	0	0	97	
1975	34	BWR PWR	0	0	0	0	0	0	0	0	0	0	0	0	0
			0	0	0	139	82	58	0	0	0	0	0	279	
1993	16	BWR PWR	0	0	116	155	1214	1259	391	0	0	0	0	0	3135
			0	116	58	0	72	355	878	979	178	8	1	2645	
1994	15	BWR PWR	0	0	0	8	357	525	638	0	0	0	0	1528	
			0	0	0	1	132	283	409	523	77	21	0	1446	
Totals		BWR PWR	88	779	454	196	1575	1784	1029	0	0	0	0	5956	
			41	168	58	140	286	696	1287	1502	255	29	1	4467	
														10423	

Emplacement Year 2010

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1974	36	BWR PWR	0	405	16	0	0	0	0	0	0	0	421
			0	0	0	0	0	0	0	0	0	0	0
1975	35	BWR PWR	2	7	242	669	134	17	0	0	0	0	1071
			7	107	231	131	42	0	0	0	0	0	518
1976	34	BWR PWR	0	0	0	109	15	0	0	0	0	0	124
			0	0	0	60	195	145	142	0	0	0	542
1994	16	BWR PWR	0	0	0	0	8	358	526	638	0	0	1530
			0	0	0	0	1	132	284	410	523	77	1448
1995	15	BWR PWR	0	0	0	0	38	189	1777	806	0	0	2810
			0	0	0	0	0	18	231	373	995	298	1959
			0	0	0	0	0	0	0	0	0	44	0
Totals		BWR PWR	2	412	258	778	195	564	2303	1444	0	0	5956
			7	107	231	191	238	295	657	783	1518	65	4467
													10423

12:09:26 06/26/89c PRSXIII S

Emplacement Year 2011

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals		
1976	35	BWR PWR	5	340	495	717	0	0	0	0	0	0	0	0	1557 378
1977	34	BWR PWR	0	0	0	0	423	4	0	0	0	0	0	0	427 612
1995	16	BWR PWR	0	0	0	0	17	81	762	346	0	0	0	0	1206 843
1996	15	BWR PWR	0	0	0	0	13	323	1305	1125	0	0	0	0	2766 2634
Totals		BWR PWR	5	340	495	717	453	408	2067	1471	0	0	0	0	5956 4467 10423

Emplacement Year 2012

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1977	35	BWR	0	239	220	1049	112	0	0	0	0	0	1520
		PWR	0	0	6	210	254	0	0	0	0	0	470
1978	34	BWR	0	0	0	0	847	86	0	0	0	0	933
		PWR	0	0	0	0	0	456	284	145	1	0	886
1996	16	BWR	0	0	0	0	3	58	231	199	0	0	491
		PWR	0	0	0	0	0	1	82	103	186	20	467
1997	15	BWR	0	0	0	0	38	292	1284	1260	38	0	2912
		PWR	0	0	0	0	0	3	304	499	904	156	2644
Totals		BWR	0	239	220	1049	1000	436	1515	1459	38	0	5956
		PWR	0	0	6	210	254	460	670	747	1091	176	4467
													10423

Emplacement Year 2013

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals	
1978	35	BWR	17	208	155	424	501	0	0	0	0	0	0	1305
		PWR	0	4	120	220	82	337	0	0	0	0	0	763
1979	34	BWR	0	0	0	0	0	224	2	0	0	0	0	226
		PWR	0	0	0	0	0	338	534	105	1	0	0	978
1997	16	BWR	0	0	0	0	5	33	13	140	5	0	0	326
		PWR	0	0	0	0	0	1	34	56	101	86	18	297
1998	15	BWR	0	0	0	0	37	173	2180	1679	30	0	0	4099
		PWR	0	0	0	0	0	0	169	419	1085	599	150	2429
Totals		BWR	17	208	155	424	543	430	2325	1819	35	0	0	5956
		PWR	0	4	120	220	82	676	737	580	1187	685	168	4467
														10423

Emplacement Year 2014

Dis Yr	Age	Type	Number of Assemblies in Burndup Ranges										Totals
1979	35	BWR PWR	0 0	0 0	108 66	587 233	614 152	575 224	0 0	0 0	0 0	0 0	1884 675
1980	34	BWR PWR	0 0	0 0	0 0	0 0	688 0	660 75	53 686	0 65	0 5	0 0	1401 831
1998	16	BWR PWR	0 0	0 0	0 0	0 0	5 0	22 1	270 21	208 52	4 135	0 75	509 304
1999	15	BWR PWR	0 0	0 0	0 0	0 62	40 0	212 2	219 254	868 503	323 886	0 838	2162 2657
Totals		BWR PWR	0 0	0 0	108 66	587 295	1347 152	1469 302	1042 961	1076 620	327 1026	0 913	5956 4467 10423

12:09:26 06/26/89c PRSXIII S

Emplacement Year 2015

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1980	35	BWR PWR	2	3	515	1333	0	0	0	0	0	0	1929
			0	2	0	158	480	0	0	0	0	0	640
1981	34	BWR PWR	0	0	0	0	216	55	4	0	0	0	276
			0	0	0	0	279	894	82	3	0	0	1258
1999	15	BWR PWR	0	0	0	1	3	8	9	4	0	0	25
			0	0	1	0	1	3	6	9	2	1	32
2000	15	BWR PWR	0	0	0	20	96	1948	1636	26	0	0	3726
			0	0	28	0	3	333	449	829	619	12	2537
Totals		BWR PWR	2	3	515	1354	315	2012	1649	30	0	0	5956
			0	2	29	158	763	1230	537	841	628	13	4467
													10423

Emplacement Year 2016

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1981	35	BWR PWR	1 0	1 40	314 4	1202 59	666 261	0 0	0 0	0 0	0 0	0 0	2184 364
1982	34	BWR PWR	0 11	0 3	0 181	0 188	541 153	71 697	3 276	2 6	0 1	0 5	617 1521
1983	33	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 67	0 12	0 0	0 1	0 80
2000	16	BWR PWR	0 0	0 0	0 8	6 0	25 1	488 84	410 113	7 208	0 155	0 56	936 638
2001	15	BWR PWR	0 0	0 0	0 0	18 0	165 4	1076 135	642 291	318 791	0 565	0 74	2219 1864
Totals		BWR PWR	1 11	1 43	314 193	1226 247	1397 419	1635 916	1055 747	327 1017	0 721	0 146	5956 4467 10423

Emplacement Year 2017

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1982	35	BWR PWR	0 0	1 0	26 0	118 0	741 0	460 0	0 0	0 0	0 0	0 0	1346 0
1983	34	BWR PWR	0 0	0 12	0 16	0 156	0 112	1289 366	244 737	0 270	0 0	0 0	1533 1669
1984	33	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 105	0 9	0 0	0 0	0 114
2001	16	BWR PWR	0 0	0 0	0 0	0 0	8 0	72 3	462 58	276 125	137 340	0 243	955 804
2002	15	BWR PWR	0 0	12 0	12 0	0 0	27 0	45 0	960 180	982 372	84 571	0 586	2122 1860
Totals		BWR PWR	0 0	13 12	38 16	116 156	176 112	1866 389	1666 975	1258 872	221 920	0 179	5956 4467
													10423

Emplacement Year 2018

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1983	35	BWR PWR	0	0	5	25	496	675	0	0	0	0	1201
			0	0	0	0	0	0	0	0	0	0	0
1984	34	BWR PWR	0	0	0	0	0	747	677	0	2	0	1426
			0	0	131	100	115	486	870	156	0	0	1858
2002	16	BWR PWR	0	8	8	0	19	30	640	655	56	0	1416
			0	0	0	0	0	1	121	246	381	98	1245
2003	15	BWR PWR	0	0	0	0	13	120	748	911	121	0	1913
			0	0	0	0	0	2	150	198	526	67	1364
Totals		BWR PWR	0	8	13	25	528	1572	2065	1566	179	0	5955
			0	0	131	100	115	489	1141	602	907	165	4467
													10423

Emplacement Year 2019

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1984	35	BWR	74	92	3	675	297	0	0	0	0	0	1141
		PWR	0	2	0	0	0	0	0	0	0	0	2
1985	34	BWR	0	0	0	0	1227	60	0	1	0	0	1288
		PWR	0	0	0	0	516	766	575	63	1	0	1921
2003	16	BWR	0	0	0	13	120	749	912	122	0	0	1916
		PWR	0	0	0	0	2	151	199	526	419	68	1369
2004	15	BWR	0	0	0	10	14	888	634	65	0	0	1611
		PWR	0	0	0	0	1	76	204	523	281	84	1175
Totals		BWR	74	92	3	698	1658	1697	1546	188	0	0	5956
		PWR	0	2	0	0	519	993	978	1112	701	152	4467
													10423

Emplacement Year 2020

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1985	35	BWR	92	232	100	211	369	360	0	0	0	0	1364
		PWR	0	0	48	58	45	9	0	0	0	0	160
1986	34	BWR	0	0	0	65	257	856	388	0	0	0	1566
		PWR	0	0	0	0	0	364	846	586	85	3	1887
2004	16	BWR	0	0	0	0	16	21	1333	952	98	0	2420
		PWR	0	0	0	0	0	3	116	308	785	422	1769
2005	15	BWR	0	0	0	0	5	55	177	303	66	0	606
		PWR	0	0	0	0	0	0	75	116	225	212	651
Totals		BWR	92	232	100	276	647	1292	1898	1255	164	0	5956
		PWR	0	0	48	58	45	376	1037	1010	1095	637	4467
													10423

12:09:26 06/26/89c PRXIII S

Emplacement Year 2021

Dis Yr		Age	Type	Number of Assemblies in Burnup Ranges												Totals
1986	35	BWR	276	212	232	513	0	0	0	0	0	0	0	0	0	1033
		PWR	0	1	64	321	27	93	0	0	0	0	0	0	0	505
1987	34	BWR	0	0	0	174	413	1049	0	0	0	0	0	0	0	1641
		PWR	0	0	0	0	0	0	430	401	0	0	0	0	0	831
2005	16	BWR	0	0	0	0	20	223	712	1214	266	0	0	0	0	2435
		PWR	0	0	0	0	0	0	303	466	904	849	91	0	7	2621
2006	15	BWR	0	0	0	0	5	36	350	335	121	0	0	0	0	847
		PWR	0	0	0	0	0	0	45	61	215	159	24	0	6	510
Totals		BWR	276	212	232	497	443	1308	1062	1549	387	0	0	0	0	5956
		PWR	0	1	64	321	27	93	778	928	1119	1008	115	13	13	4467
																10423

12:09:26 06/26/89c PASXIII S

Emp:placement Year 2022

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1987	35	BWR PWR	284 0	264 0	401 65	58 242	0 204	0 296	0 543	0 0	0 0	0 0	1007 1350
1988	34	BWR PWR	0 0	0 0	0 0	0 0	0 907	0 0	143 0	0 360	0 0	0 0	1050 360
2006	16	BWR PWR	0 0	0 0	0 0	0 0	20 4	146 0	1400 184	1341 247	488 862	0 100	3395 2060
2007	15	BWR PWR	0 0	0 0	0 20	0 0	5 0	43 21	198 53	192 109	66 249	0 55	504 697
Totals		BWR PWR	284 0	264 0	401 85	58 242	25 204	1096 321	1741 780	1533 716	554 1111	0 155	5956 4467 10423

Emplacement Year 2023

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges												Totals
1988	35	BWR	400	0	192	64	1043	319	0	0	0	0	0	0	2018
		PWR	0	0	0	0	0	16	1010	633	0	0	0	0	1659
1989	34	BWR	0	0	194	380	687	651	0	0	0	0	0	0	1912
		PWR	0	0	0	0	0	0	0	0	0	0	0	0	0
2007	16	BWR	0	0	0	0	20	173	796	769	268	0	0	0	2026
		PWR	0	0	84	0	0	84	214	439	999	740	223	25	2808
Totals		BWR	400	0	386	444	1750	1143	796	769	268	0	0	0	5956
		PWR	0	0	84	0	0	100	1224	1072	999	740	223	25	4457
															10423

Emplacement Year 2024

Dis yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1988	36	BWR PWR	0	0	0	0	0	0	0	0	0	0	0
			0	52	204	97	318	0	0	0	0	0	671
1989	35	BWR PWR	92	20	0	0	0	0	0	0	0	0	134
			0	0	0	0	0	596	664	0	0	0	1260
1990	34	BWR PWR	0	0	644	384	258	0	0	0	0	0	1307
			0	0	0	0	0	0	0	0	0	0	0
2008	16	BWR PWR	0	0	0	26	197	1742	2204	346	0	0	4515
			0	0	0	0	4	260	357	1158	668	82	2536
Totals		BWR PWR	92	20	43	410	455	1742	2204	346	0	0	5956
			0	0	52	97	322	856	1021	1158	668	82	4467
													10423

Emplacement Year 2025

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1989	36	BWR PWR	0	0	0	0	0	0	0	0	0	0	0
			0	0	56	149	24	213	47	0	0	0	489
1990	35	BWR PWR	92	0	233	0	0	0	0	0	0	0	375
			0	0	0	0	0	349	313	0	0	0	662
2009	16	BWR PWR	0	152	145	336	172	226	1700	1690	464	0	4886
			0	0	25	7	25	1	366	660	1096	200	3316
2010	15	BWR PWR	0	0	0	0	0	0	0	360	335	0	695
			0	0	0	0	0	0	0	0	0	0	0
Totals		BWR PWR	92	152	429	336	172	226	1700	2050	799	0	5956
			0	0	81	156	49	214	762	973	1096	200	4467
													10423

Emplacement Year 2026

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1990	36	BWR PWR	0 0	0 0	0 0	0 124	0 262	0 424	0 0	0 0	0 0	0 0	0 819
2010	16	BWR PWR	0 0	4 12	308 32	8 49	146 0	1954 337	1015 351	0 1192	0 1003	0 168	3825 3191
2011	15	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	1383 0	152 0	0 0	0 2	1535 10
Totals		BWR PWR	0 0	4 12	308 32	8 58	146 124	390 297	1954 761	2398 351	152 1192	0 1008	5360 4020 9380

Emplacement Year 2027

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
2011	16	BWR	0	158	0	158	118	369	1495	752	0	0	3050
		PWR	0	0	100	36	117	36	240	510	1332	503	3006
2012	15	BWR	0	0	0	0	0	0	0	1197	553	0	1750
		PWR	0	0	0	0	0	0	0	0	0	367	594
Totals		BWR	0	158	0	158	118	369	1495	1949	553	0	4800
		PWR	0	0	100	36	117	36	240	510	1332	890	3600
													8400

Dis Yr	Type	Initial Inventory	Number of Assemblies in Burndup Ranges										12:09:25 06/26/89c	PRXIII s
1968	BWR	5	0	0	0	0	0	0	0	0	0	0	0	0
	PWR	0	0	0	0	0	0	0	0	0	0	0	0	0
1969	BWR	0	5	14	73	2	1	0	0	0	0	0	0	0
	PWR	0	0	0	0	0	0	0	0	0	0	0	0	0
1970	BWR	0	0	0	0	0	0	0	0	0	0	0	0	0
	PWR	0	0	4	95	0	0	0	0	0	0	0	0	0
1971	BWR	244	48	19	113	19	0	0	0	0	0	0	0	0
	PWR	0	12	0	0	6	46	0	0	0	0	0	0	0
1972	BWR	373	197	174	54	4	0	0	0	0	0	0	0	0
	PWR	0	0	31	74	90	83	53	0	0	0	0	0	0
1973	BWR	51	88	165	230	24	5	0	0	0	0	0	0	0
	PWR	0	0	0	59	0	85	21	0	0	0	0	0	0
1974	BWR	0	405	630	247	33	4	0	0	0	0	0	0	0
	PWR	41	4	225	33	118	148	4	0	0	0	0	0	0
1975	BWR	2	7	242	669	134	17	0	0	0	0	0	0	0
	PWR	7	107	231	131	181	82	58	0	0	0	0	0	0
1976	BWR	5	340	495	826	15	0	0	0	0	0	0	0	0
	PWR	0	0	8	430	195	145	142	0	0	0	0	0	0
1977	BWR	0	239	220	1049	535	4	0	0	0	0	0	0	0
	PWR	0	0	6	210	291	330	205	40	0	0	0	0	0
1978	BWR	17	208	155	424	1348	86	0	0	0	0	0	0	0
	PWR	0	4	120	220	82	793	284	145	1	0	0	0	0
1979	BWR	0	0	108	587	614	799	2	0	0	0	0	0	0
	PWR	0	0	66	233	152	562	534	105	1	0	0	0	0
1980	BWR	76	2	3	515	2021	660	53	0	0	0	0	0	0
	PWR	0	0	2	0	158	555	686	65	5	0	0	0	0
1981	BWR	0	1	1	314	1202	882	56	4	0	0	0	0	0
	PWR	0	0	40	4	59	540	894	82	3	0	0	0	0
1982	BWR	0	1	26	118	741	1001	71	3	2	0	0	0	0
	PWR	0	11	3	181	188	153	697	276	6	1	5	0	0
1983	BWR	0	0	5	25	496	1964	244	0	0	0	0	0	0
	PWR	0	12	16	156	112	386	737	337	12	0	1	0	0
1984	BWR	0	74	92	3	675	1044	677	0	2	0	0	0	0
	PWR	0	0	133	100	115	486	870	261	9	0	0	0	0
1985	BWR	92	232	100	211	369	1587	60	0	1	0	0	0	0
	PWR	0	0	48	58	45	525	766	575	63	1	0	0	0
1986	BWR	276	212	232	378	257	856	388	0	0	0	0	0	0
	PWR	0	1	64	321	27	456	846	586	85	3	3	0	0
1987	BWR	284	264	401	232	418	1547	58	114	0	0	0	0	0
	PWR	0	0	65	242	204	296	973	796	115	0	0	0	0

1988	BWR PWR	400 0	0 0	192 52	64 204	1043 97	1226 334	703 1010	0 1146	0 192	0 5	0 1	0 69
1989	BWR PWR	92 0	20 0	216 56	380 149	687 24	935 213	180 643	176 860	0 275	0 8	0 0	0 1
1990	BWR PWR	92 0	0 0	304 0	644 9	384 124	1796 262	1228 773	108 1151	0 484	0 27	0 21	0 0
1991	BWR PWR	0 0	0 0	0 0	56 160	660 4	1304 215	626 624	342 1380	0 480	0 150	0 0	0 0
1992	BWR PWR	0 0	0 0	0 0	44 0	372 9	1361 265	1751 677	592 1269	0 689	0 164	0 0	0 0
1993	BWR PWR	0 0	0 0	0 128	128 64	172 0	1348 80	1398 394	434 975	0 1087	0 197	0 8	0 1
1994	BWR PWR	0 0	0 0	0 0	0 0	16 2	715 264	1051 567	1276 819	0 1046	0 154	0 42	0 0
1995	BWR PWR	0 0	0 0	0 0	0 0	55 0	270 26	2539 330	1152 534	0 1422	0 426	0 64	0 0
1996	BWR PWR	0 0	0 0	0 0	0 0	16 0	381 5	1536 541	1324 685	0 1239	0 499	0 132	0 0
1997	BWR PWR	0 0	0 0	0 0	0 0	43 0	325 4	1427 338	1400 555	43 1005	0 858	0 174	0 7
1998	BWR PWR	0 0	0 0	0 0	0 0	42 0	195 1	2450 190	1887 471	34 1220	0 674	0 169	0 8
1999	BWR PWR	0 0	0 0	0 0	0 63	41 0	215 3	727 257	877 509	327 895	0 847	0 108	0 7
2000	BWR PWR	0 0	0 0	0 0	0 36	26 0	121 4	2436 417	2346 562	33 1037	0 774	0 330	0 15
2001	BWR PWR	0 0	0 0	0 0	0 0	26 0	237 7	1538 193	918 416	455 1131	0 808	0 106	0 7
2002	BWR PWR	0 0	20 0	20 0	0 0	46 0	75 1	1600 301	1637 620	140 952	0 978	0 245	0 8
2003	BWR PWR	0 0	0 0	0 0	0 0	26 0	240 4	1497 301	1823 397	243 1052	0 837	0 135	0 7
2004	BWR PWR	0 0	0 0	0 0	0 0	26 0	35 4	2221 192	1586 512	163 1308	0 703	0 210	0 15
2005	BWR PWR	0 0	0 0	0 0	0 0	25 0	278 1	989 378	1517 582	332 1129	0 1061	0 113	0 8
2006	BWR PWR	0 0	0 0	0 0	0 0	25 0	182 4	1750 229	1676 308	609 1077	0 798	0 124	0 30
2007	BWR PWR	0 0	0 0	0 104	0 0	25 0	216 105	994 267	961 548	334 1248	0 924	0 278	0 31

2008	BWR PWR	0 0	0 0	0 0	0 0	26 0	197 4	1742 260	2204 357	346 1158	0 668	0 82	0 7
2009	BWR PWR	0 0	152 0	146 25	336 7	172 25	226 1	1700 366	1690 660	464 1096	0 921	0 200	0 15
2010	BWR PWR	0 0	4 12	308 32	8 49	146 0	290 35	1954 337	1375 351	335 1192	0 1008	0 168	0 7
2011	BWR PWR	0 0	158 0	0 100	158 36	118 117	369 36	1495 240	2135 510	152 1332	0 503	0 134	0 8
2012	BWR PWR	0 0	0 12	324 0	0 60	43 112	368 1	1373 339	1863 605	553 910	0 820	0 200	0 7
2013	BWR PWR	0 0	0 24	456 188	7 224	216 122	449 137	959 440	1512 745	92 1241	0 655	0 188	0 8
2014	BWR PWR	0 0	128 0	1132 173	108 153	882 181	514 121	1944 379	894 414	555 1115	0 458	0 168	0 7
2015	BWR PWR	0 0	0 0	0 76	0 108	0 0	127 49	1114 376	869 606	241 1019	0 488	0 127	0 0
2016	BWR PWR	0 20	16 0	400 0	16 112	262 173	180 100	709 123	350 580	730 828	0 528	0 175	0 24
2017	BWR PWR	0 0	0 0	0 0	0 126	20 112	126 40	736 266	1151 443	75 763	0 384	0 190	0 14
2018	BWR PWR	0 0	0 0	196 0	0 41	196 27	128 1	849 315	532 564	245 618	0 601	0 32	0 0
2019	BWR PWR	0 0	0 0	0 0	0 0	0 0	49 1	943 157	1279 235	45 421	0 318	0 111	0 0
2020	BWR PWR	0 0	0 0	0 32	0 108	0 153	129 0	538 127	92 425	312 760	0 421	0 49	0 16
2021	BWR PWR	0 0	0 0	0 41	0 115	0 0	45 43	569 248	1088 495	128 833	0 390	0 46	0 0
2022	BWR PWR	0 0	116 0	100 0	384 28	0 128	346 130	1009 139	1878 260	248 697	0 352	0 87	0 30
2023	BWR PWR	0 0	168 0	0 48	156 84	144 0	0 48	766 232	1188 261	8 373	0 334	0 30	0 1
2024	BWR PWR	0 0	0 0	232 50	0 195	0 203	447 75	479 243	505 476	0 635	0 207	0 32	0 0
2025	BWR PWR	0 0	0 0	744 84	52 45	572 48	248 167	1089 104	541 209	8 409	0 216	0 51	0 25
2026	BWR PWR	0 0	28 0	428 42	28 67	428 128	132 41	499 65	115 396	4 255	0 198	0 55	0 0
2027	BWR PWR	172 0	0 1	360 258	88 206	414 53	164 155	412 253	40 215	0 286	0 54	0 44	0 0

Appendix F

Levelized Energy Receipt Schedule

From

"Hi-Graded" Inventory

15:00 13 11/02/89e PRSXIII u

Empl Yr	Pkgs	age	LIFO		mod	take	FIFO		assy	BWR		engy	assy	PWR		age	TOTAL		engy
			range	rate			rate	age		burn	age			burn	burn				
2003	200	10	3	0.400	1	0.000	0.400	800	17.9	31.7	82.6	600	18.0	39.9	105.2	17.9	37.0	97.2	97.2
2004	200	10	3	0.400	1	0.000	0.400	800	17.9	30.9	80.7	600	17.9	40.3	106.2	17.9	37.0	97.1	97.1
2005	200	10	3	0.400	1	0.000	0.400	800	18.3	30.9	79.6	600	18.3	40.3	106.2	18.3	37.3	97.1	97.1
2006	447	10	3	0.400	1	0.000	0.400	1788	18.3	31.4	81.7	1341	17.7	40.9	107.7	17.6	37.5	98.4	98.4
2007	894	10	3	0.300	1	0.000	0.300	357.6	16.2	32.2	83.3	2682	15.9	41.0	109.6	16.0	37.9	100.2	100.2
2008	1489	10	3	0.050	1	0.050	0.000	5956	16.2	31.0	79.9	4467	11.9	40.1	103.6	13.4	36.9	99.1	99.1
2009	1489	10	3	0.000	1	0.000	0.000	5956	13.1	32.6	85.6	4467	14.9	40.5	108.5	14.5	37.7	100.4	100.4
2010	1489	10	3	0.500	1	0.500	0.000	5956	17.1	31.4	80.6	4467	14.7	40.6	109.0	15.5	37.3	98.3	98.3
2011	1489	10	3	0.690	1	0.690	0.000	5956	17.1	32.3	83.9	4467	14.6	40.7	109.2	14.6	37.7	100.2	100.2
2012	1489	10	3	0.860	1	0.860	0.000	5956	19.6	32.1	82.3	4467	14.1	40.8	110.0	15.0	37.7	100.1	100.1
2013	1489	10	3	0.000	1	0.000	0.000	5956	15.6	33.0	85.0	4467	15.3	40.6	107.9	15.4	37.9	99.7	99.7
2014	1489	10	3	0.950	1	0.950	0.000	5956	17.2	32.4	82.0	4467	16.6	39.9	104.7	16.9	37.2	96.6	96.6
2015	1489	10	3	0.850	1	0.850	0.000	5956	20.7	30.7	76.3	4467	16.2	40.2	105.6	17.8	36.8	95.1	95.1
2016	1489	10	3	0.750	1	0.750	0.000	5956	17.6	32.5	82.3	4467	18.4	40.3	103.7	18.2	37.5	96.0	96.0
2017	1489	10	3	0.600	1	0.600	0.000	5956	21.1	30.6	75.1	4467	17.8	40.4	104.6	18.9	36.9	94.1	94.1
2018	1489	10	3	0.500	1	0.500	0.000	5956	19.8	31.6	79.2	4467	18.0	40.6	104.4	19.3	37.4	95.4	95.4
2019	1489	10	3	0.400	1	0.400	0.000	5956	16.8	33.5	84.2	4467	18.2	40.4	103.5	17.7	37.5	96.6	96.6
2020	1489	10	3	0.300	1	0.300	0.000	5956	17.5	32.8	82.0	4467	17.2	40.5	104.8	17.3	37.8	96.7	96.7
2021	1489	10	3	0.200	1	0.200	0.000	5956	17.7	31.5	79.0	4467	18.1	40.9	104.7	18.0	37.5	95.5	95.5
2022	1489	10	3	0.180	1	0.180	0.000	5956	16.6	34.1	85.0	4467	16.2	40.4	103.2	17.6	38.2	96.7	96.7
2023	1489	10	3	0.000	1	0.000	0.000	5956	19.3	32.6	80.0	4467	19.8	40.5	101.7	19.6	37.6	93.9	93.9
2024	1489	10	3	0.000	1	0.000	0.000	5956	20.1	32.3	78.5	4467	16.1	41.0	106.2	17.5	37.9	95.3	95.3
2025	1489	10	3	0.000	1	0.000	0.000	5956	14.9	32.4	81.7	4467	19.3	40.6	101.9	17.8	37.7	94.7	94.7
2026	1340	10	3	0.000	1	0.000	0.000	5360	25.3	32.8	75.2	4020	14.1	41.7	110.2	18.1	38.5	97.7	97.7
2027	1230	10	3	0.000	1	0.000	0.000	4800	10.8	34.9	91.3	3600	10.4	41.2	111.8	10.5	38.5	104.5	104.5

31263 16.73

125132

93849

4178875

978759

74458

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31263 16.73 37.63 97.44 125132 93849 218961 4178875 978759 74458

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Emplacement Year 2003

Dis yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1969	34	BWR PWR	0	0	0	0	0	0	0	0	0	0	3
			0	0	0	0	0	0	0	0	0	0	0
1971	32	BWR PWR	0	0	0	0	0	0	0	0	0	0	19
			0	0	0	0	0	0	0	0	0	0	0
1972	31	BWR PWR	0	0	0	0	0	0	0	0	0	0	4
			0	0	0	0	0	0	0	0	0	0	53
1973	30	BWR PWR	0	0	0	0	0	0	0	0	0	0	29
			0	0	0	0	0	0	0	0	0	0	21
1974	29	BWR PWR	0	0	0	0	0	0	0	0	0	0	37
			0	0	0	0	0	0	0	0	0	0	4
1975	28	BWR PWR	0	0	0	0	0	0	0	0	0	0	151
			0	0	0	0	0	0	0	0	0	0	58
1976	27	BWR PWR	0	0	0	0	0	0	0	0	0	0	15
			0	0	0	0	0	0	0	0	0	0	104
1977	26	BWR PWR	0	0	0	0	0	0	0	0	0	0	62
			0	0	0	0	0	0	0	0	0	0	0
1992	11	BWR PWR	0	0	0	0	0	0	0	0	0	0	480
			0	0	0	0	0	0	0	0	0	0	360
Totals		BWR PWR	0	0	0	0	0	0	0	0	0	0	800
			0	0	0	0	0	0	0	0	0	0	600
													1400

Emplacement Year 2004

Dis Yr	Age	Type	Number of Assets in Surplus Ranges										Totals
1976	28	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	38	0	0	0	0	0	0	38
1977	27	BWR	0	0	0	0	0	0	0	0	0	0	344
		PWR	0	0	0	30	40	0	0	0	0	0	220
1993	11	BWR	0	0	0	22	434	0	0	0	197	0	456
		PWR	0	0	0	0	0	136	197	8	1	542	
Totals		BWR	0	0	0	22	434	0	0	0	197	0	800
		PWR	0	0	0	38	40	136	197	8	1	600	
													1400

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Emplacement year 2005

Dis yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals	
1977	28	BWR	0	0	0	133	0	0	0	0	0	0	0	133
		PWR	0	0	0	0	0	25	0	0	0	0	0	25
1978	27	BWR	0	0	0	0	86	0	0	0	0	0	0	251
		PWR	0	0	0	0	0	117	145	1	0	0	0	263
1994	11	BWR	0	0	0	0	0	0	0	416	0	0	0	416
		PWR	0	0	0	0	0	0	0	0	116	154	42	312
Totals		BWR	0	0	0	298	86	0	416	0	0	0	0	800
		PWR	0	0	0	0	0	142	145	117	154	42	0	600
														1400

Emplacement Year 2006

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1978	28	BWR	0	0	0	0	0	0	0	0	0	0	733
		PWR	0	0	0	167	0	0	0	0	0	0	167
1979	27	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	276	105	1	0	0	0	0	382
1995	11	BWR	0	0	0	0	1055	0	0	0	0	0	1055
		PWR	0	0	0	0	0	302	426	64	0	0	792
Totals		BWR	0	0	0	0	1055	0	0	0	0	0	1788
		PWR	0	0	0	443	105	303	426	64	0	0	1341
													3129

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Emplacement Year 2007

Dis Yr	Age	Type	Number of Assemblies in Burnup Range												Totals
1978	29	BWR	0	0	0	0	450	0	0	0	0	0	0	0	450
		PWR	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	28	BWR	0	0	0	0	0	620	2	0	0	0	0	0	622
		PWR	0	0	0	0	0	0	258	0	0	0	0	0	258
1980	27	BWR	0	0	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	476	65	5	0	0	0	546
1996	11	BWR	0	0	0	0	0	0	1180	1324	0	0	0	0	2504
		PWR	0	0	0	0	0	0	0	8	1239	499	132	0	1878
Totals		BWR	0	0	0	0	450	620	1182	1324	0	0	0	0	3576
		PWR	0	0	0	0	0	0	734	73	1244	499	132	0	2682
															6258

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Emplacement Year 2009

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1980	29	BWR	0	0	0	0	0	0	0	0	0	0	921
		PWR	0	0	0	0	32	0	0	0	0	0	32
1981	28	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	894	82	3	0	0	0	979
1982	27	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	61	6	1	5	0	73
1998	11	BWR	0	0	0	40	186	2328	1793	33	0	0	4380
		PWR	0	0	0	0	0	181	448	1159	641	161	2598
1999	10	BWR	0	0	0	12	64	218	263	98	0	0	655
		PWR	0	0	0	0	0	77	152	268	254	32	785
Totals		BWR	0	0	0	973	250	2546	2056	131	0	0	5956
		PWR	0	0	0	0	0	1184	743	1436	896	198	4467
													10423

Emplacement Year 2010

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1980	30	BWR PWR	0	0	0	0	869	0	0	0	0	0	869 0
1981	29	BWR PWR	0	0	0	0	283	862	56	4	0	0	1225 0
1982	28	BWR PWR	0	0	0	0	0	0	0	0	0	0	0 912
1983	27	BWR PWR	0	0	0	0	0	0	0	0	0	0	0 151
1999	11	BWR PWR	0	0	0	0	29	151	509	614	229	0	1532 1838
2000	10	BWR PWR	0	0	0	0	13	60	1218	1023	16	0	2330 1566
Totals		BWR PWR	0	0	0	0	1194	1093	1783	1641	245	0	5956 4467
													10423

Assembly	Accessories	Time	Number of Assemblies in Burnup Ranges	Totals
1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40
41	42	43	44	45
46	47	48	49	50
51	52	53	54	55
56	57	58	59	60
61	62	63	64	65
66	67	68	69	70
71	72	73	74	75
76	77	78	79	80
81	82	83	84	85
86	87	88	89	90
91	92	93	94	95
96	97	98	99	100
101	102	103	104	105
106	107	108	109	110
111	112	113	114	115
116	117	118	119	120
121	122	123	124	125
126	127	128	129	130
131	132	133	134	135
136	137	138	139	140
141	142	143	144	145
146	147	148	149	150
151	152	153	154	155
156	157	158	159	160
161	162	163	164	165
166	167	168	169	170
171	172	173	174	175
176	177	178	179	180
181	182	183	184	185
186	187	188	189	190
191	192	193	194	195
196	197	198	199	200
201	202	203	204	205
206	207	208	209	210
211	212	213	214	215
216	217	218	219	220
221	222	223	224	225
226	227	228	229	230
231	232	233	234	235
236	237	238	239	240
241	242	243	244	245
246	247	248	249	250
251	252	253	254	255
256	257	258	259	260
261	262	263	264	265
266	267	268	269	270
271	272	273	274	275
276	277	278	279	280
281	282	283	284	285
286	287	288	289	290
291	292	293	294	295
296	297	298	299	300
301	302	303	304	305
306	307	308	309	310
311	312	313	314	315
316	317	318	319	320
321	322	323	324	325
326	327	328	329	330
331	332	333	334	335
336	337	338	339	340
341	342	343	344	345
346	347	348	349	350
351	352	353	354	355
356	357	358	359	360
361	362	363	364	365
366	367	368	369	370
371	372	373	374	375
376	377	378	379	380
381	382	383	384	385
386	387	388	389	390
391	392	393	394	395
396	397	398		

[illegible]

15:00:14 11/02/89e PRSXIII U

Emplacement Year 2012

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1982	30	BWR	0	0	0	0	0	0	0	0	0	0	1300
		PWR	0	0	0	0	0	0	0	0	0	0	0
1983	29	BWR	0	0	0	419	244	0	0	0	0	0	663
		PWR	0	0	0	0	0	0	0	0	0	0	0
1984	28	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	832	142	0	0	0	0	974
2001	11	BWR	0	0	0	9	477	285	142	0	0	0	987
		PWR	0	0	0	0	60	129	351	251	33	3	827
2002	10	BWR	0	0	0	39	64	1376	1407	120	0	0	3006
		PWR	0	0	0	0	258	533	818	841	210	6	2666
Totals		BWR	0	0	0	789	1116	2097	1692	262	0	0	5956
		PWR	0	0	0	0	0	1150	804	1169	1092	243	4467
													10423

15:00:14 11/02/89e PRSXIII u

Emplacement Year 2014

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1983	31	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	406 0
1984	30	BWR PWR	0 0	0 0	1 0	1044 0	677 0	0 0	2 0	0 0	0 0	0 0	1724 0
1985	29	BWR PWR	0 0	0 0	0 0	0 0	0 143	0 0	0 0	0 0	0 0	0 0	0 143
1986	28	BWR PWR	0 0	0 0	0 0	0 0	0 846	0 586	0 85	0 3	0 3	0 0	0 1523
1987	27	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 11	0 0	0 0	0 0	0 11
2004	10	BWR PWR	0 0	0 0	24 0	33 0	2109 182	1506 486	154 1242	0 667	0 199	0 14	3826 2790
Totals		BWR PWR	0 0	0 0	0 0	431 0	2786 1171	1506 1072	156 1338	0 670	0 202	0 14	5956 4467
													10423

15:00:14 11/02/89e PRSXIII u

Emplacement Year 2013

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1983	30	BWR	0	0	0	90	1545	0	0	0	0	0	1635
		PWR	0	0	0	0	0	0	0	0	0	0	0
1984	29	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	38	0	0	0	0	38
1985	28	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	623	575	63	1	0	1262
2002	11	BWR	0	0	0	7	11	224	230	20	0	0	492
		PWR	0	0	0	0	0	43	87	134	137	35	438
2003	10	BWR	0	0	0	26	240	1497	1823	243	0	0	3829
		PWR	0	0	0	0	0	301	397	1052	837	135	2729
Totals		BWR	0	0	0	123	1796	1721	2053	263	0	0	5956
		PWR	0	0	0	0	0	1005	1059	1249	975	170	4467
													10423

Emplacement	year	2015
1	2015	1
2	2015	1
3	2015	1
4	2015	1
5	2015	1
6	2015	1
7	2015	1
8	2015	1
9	2015	1
10	2015	1
11	2015	1
12	2015	1
13	2015	1
14	2015	1
15	2015	1
16	2015	1
17	2015	1
18	2015	1
19	2015	1
20	2015	1
21	2015	1
22	2015	1
23	2015	1
24	2015	1
25	2015	1
26	2015	1
27	2015	1
28	2015	1
29	2015	1
30	2015	1
31	2015	1
32	2015	1
33	2015	1
34	2015	1
35	2015	1
36	2015	1
37	2015	1
38	2015	1
39	2015	1
40	2015	1
41	2015	1
42	2015	1
43	2015	1
44	2015	1
45	2015	1
46	2015	1
47	2015	1
48	2015	1
49	2015	1
50	2015	1
51	2015	1
52	2015	1
53	2015	1
54	2015	1
55	2015	1
56	2015	1
57	2015	1
58	2015	1
59	2015	1
60	2015	1
61	2015	1
62	2015	1
63	2015	1
64	2015	1
65	2015	1
66	2015	1
67	2015	1
68	2015	1
69	2015	1
70	2015	1
71	2015	1
72	2015	1
73	2015	1
74	2015	1
75	2015	1
76	2015	1
77	2015	1
78	2015	1
79	2015	1
80	2015	1
81	2015	1
82	2015	1
83	2015	1
84	2015	1
85	2015	1
86	2015	1
87	2015	1
88	2015	1
89	2015	1
90	2015	1
91	2015	1
92	2015	1
93	2015	1
94	2015	1
95	2015	1
96	2015	1
97	2015	1
98	2015	1
99	2015	1
100	2015	1

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
			0	0	0	0	0	0	0	0	0	0	
1984	31	BWR	0	0	0	674	0	0	0	0	0	0	674
		PWR	0	0	0	0	0	0	0	0	0	0	0
1985	30	BWR	0	0	0	369	1587	60	0	1	0	0	2017
		PWR	0	0	0	0	0	0	0	0	0	0	0
1986	29	BWR	0	0	0	0	89	388	0	0	0	0	477
		PWR	0	0	0	0	0	0	0	0	0	0	0
1987	28	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	640	796	104	0	0	1540
2004	11	BWR	0	0	0	2	2	112	80	9	0	0	205
		PWR	0	0	0	0	0	10	26	66	11	1	150
2005	10	BWR	0	0	0	21	236	755	1289	282	0	0	2583
		PWR	0	0	0	0	0	321	494	959	96	6	2777
Totals		BWR	0	0	0	1066	1914	1315	1369	292	0	0	5956
		PWR	0	0	0	0	0	971	1316	1129	937	7	4467
													10423

15:00:14 11/02/89e PRSXIII U

Emplacement Year 2016

Dis Yr			Age		Number of Assemblies in Burnup Ranges												Totals
1985	30	BWR	0	0	0	0	257	767	0	0	0	0	0	0	0	0	1024
		PWR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1987	29	BWR	0	0	0	0	0	1113	68	114	0	0	0	0	0	0	1295
		PWR	0	0	0	0	0	0	333	0	0	0	0	0	0	0	
1988	28	BWR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	333
		PWR	0	0	0	0	0	0	305	1145	192	5	1	69	0	0	
2005	11	BWR	0	0	0	0	4	42	134	228	50	0	0	0	0	0	458
		PWR	0	0	0	0	0	0	57	88	170	160	17	2	0	0	
2006	10	BWR	0	0	0	0	18	136	1312	1257	456	0	0	0	0	0	3179
		PWR	0	0	0	0	0	0	171	231	807	598	93	22	0	0	
Totals			0	0	0	0	279	2058	1514	1599	506	0	0	0	0	0	5956
			0	0	0	0	0	0	866	1465	1169	763	111	93	0	0	4467
																	10423

15:00:14 11/02/89e PRSXIII U

Emplacement Year 2018

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1988	30	BWR	0	0	0	0	0	0	0	0	0	0	447
		PWR	0	0	0	0	0	0	0	0	0	0	0
1989	29	BWR	0	0	0	0	0	0	0	0	0	0	1978
		PWR	0	0	0	0	0	0	0	0	0	0	643
1990	28	BWR	0	0	0	0	0	0	0	0	0	0	260
		PWR	0	0	0	0	0	0	0	0	0	0	1237
2007	11	BWR	0	0	0	0	0	0	0	0	0	0	1014
		PWR	0	0	0	0	0	0	0	0	0	0	1322
2008	10	BWR	0	0	0	0	0	0	0	0	0	0	2257
		PWR	0	0	0	0	0	0	0	0	0	0	1265
Totals		BWR	0	0	0	0	0	0	0	0	0	0	5956
		PWR	0	0	0	0	0	0	0	0	0	0	4467
													10423

15:00:15 11/02/89 PRXIII U

Emplacement Year 2019

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1990	29	BWR	0	0	0	0	0	0	0	0	0	0	1999
		PWR	0	0	0	0	0	0	0	0	0	0	1219
1991	28	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	0	0	0	0	679
2008	11	BWR	0	0	0	0	0	0	0	0	0	0	2258
		PWR	0	0	0	0	0	0	0	0	0	0	1267
2009	10	BWR	0	0	0	0	0	0	0	0	0	0	1699
		PWR	0	0	0	0	0	0	0	0	0	0	1302
Totals		BWR	0	0	0	0	0	0	0	0	0	0	5956
		PWR	0	0	0	0	0	0	0	0	0	0	4467
													10423

Emplacement Year 2020

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1990	30	BWR	0	0	0	0	0	0	0	0	0	0	1257
		PWR	0	0	0	0	0	0	0	0	0	0	0
1991	29	BWR	0	0	0	0	546	342	0	0	0	0	888
		PWR	0	0	0	0	263	1331	0	0	0	0	1594
2009	11	BWR	0	0	0	104	136	1020	1014	279	0	0	2553
		PWR	0	0	0	0	0	220	396	658	553	120	1956
2010	10	BWR	0	0	0	43	117	586	412	100	0	0	1258
		PWR	0	0	0	0	0	101	105	357	302	50	917
Totals		BWR	0	0	0	0	531	1126	2152	1768	379	0	5956
		PWR	0	0	0	0	0	0	584	1832	1015	170	4467
													10423

15:00:15 11/02/89e PRSXIII U

Emplacement Year 2021

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1991	30	BWR	0	0	0	0	660	1304	80	0	0	0	2044
		PWR	0	0	0	0	0	0	361	0	0	0	361
1992	29	BWR	0	0	0	0	0	0	6	112	0	0	118
		PWR	0	0	0	0	0	0	0	924	493	0	1417
2010	11	BWR	0	0	0	0	103	273	1368	963	235	0	2942
		PWR	0	0	0	0	0	0	236	246	835	706	2146
2011	10	BWR	0	0	0	0	23	73	299	427	30	0	852
		PWR	0	0	0	0	0	0	48	102	266	100	543
Totals		BWR	0	0	0	0	786	1650	1753	1502	265	0	5956
		PWR	0	0	0	0	0	0	645	1272	1594	806	4467
													10423

Emplacement Year 2022

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1992	30	BWR PWR	0 0	0 0	0 0	0 0	40 0	1745 677	0 345	0 0	0 0	0 0	1785 1022
1993	29	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 745	0 0	0 0	0 745
2011	11	BWR PWR	0 0	0 0	95 0	296 0	1196 192	1708 408	122 1066	0 403	0 108	0 7	3417 2184
2012	10	BWR PWR	0 0	0 0	7 0	66 0	247 61	335 108	99 163	0 147	0 36	0 1	754 516
Totals		BWR PWR	0 0	0 0	102 0	402 0	3188 930	2043 861	221 1974	0 550	0 144	0 8	5956 4467
													10423

15:00:15 11/02/89e PRXIII U

Emplacement Year 2023

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1992	31	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1693 0
1993	30	BWR PWR	0 0	0 0	0 0	817 394	0 975	0 206	0 0	0 0	0 0	0 0	817 1575
1994	29	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 527	0 0	0 0	0 0	0 0	0 527
2012	11	BWR PWR	0 0	0 0	0 0	1126 278	1528 497	454 747	0 673	0 164	0 6	0 6	3446 2365
Totals		BWR PWR	0 0	0 0	0 0	1943 672	1528 1472	454 1480	0 673	0 164	0 6	0 6	5956 4467
													10423

Emplacement Year 2024

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1993	31	BWR	0	0	0	172	1348	559	0	0	0	0	2079
		PWR	0	0	0	0	0	0	0	0	0	0	0
1994	30	BWR	0	0	0	0	0	0	649	0	0	0	649
		PWR	0	0	0	0	0	0	787	403	0	0	1190
2013	11	BWR	0	0	0	216	449	959	1512	92	0	0	3228
		PWR	0	0	0	0	0	440	745	1241	655	188	3277
Totals		BWR	0	0	0	388	1797	1518	2161	92	0	0	5956
		PWR	0	0	0	0	0	440	1532	1644	655	188	4467
													10423

15:00:15 11/02/89e PRSXIII u

Emplacement Year 2025

Dis Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1994	31	BWR	0	0	0	0	0	956	211	0	0	0	1167
		PWR	0	0	0	0	0	567	32	0	0	0	599
1995	30	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	207	1120	0	0	1327
2014	11	BWR	0	0	0	882	514	1944	894	555	0	0	4789
		PWR	0	0	0	0	0	379	414	1115	458	168	2541
Totals		BWR	0	0	0	882	514	2900	1105	555	0	0	5956
		PWR	0	0	0	0	0	946	653	2235	458	168	4467
													10423

15:00:16 11/02/89e PRXIII u

Emplacement Year 2026

Dis. Yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
1994	32	BWR	0	0	0	16	715	95	0	0	0	0	826
		PWR	0	0	0	0	0	0	0	0	0	0	0
1995	31	BWR	0	0	0	55	270	2539	97	0	0	0	2961
		PWR	0	0	0	0	0	330	327	0	0	0	657
2015	11	BWR	0	0	0	0	0	463	869	241	0	0	1573
		PWR	0	0	0	0	0	376	606	1019	488	127	2616
2016	10	BWR	0	0	0	0	0	0	0	0	0	0	0
		PWR	0	0	0	0	0	0	0	20	526	175	747
Totals		BWR	0	0	0	71	985	3097	966	241	0	0	5360
		PWR	0	0	0	0	0	706	933	1039	1016	302	4020
													9380

15:00:15 11/02/89e PRSXIII u

Emplacement Year 2027

Dis yr	Age	Type	Number of Assemblies in Burnup Ranges										Totals
2015	12	BWR PWR	0 0	0 0	0 0	0 0	127 0	651 0	0 0	0 0	0 0	0 0	778 0
2016	11	BWR PWR	0 0	0 0	0 0	262 0	180 0	709 123	350 580	730 803	0 0	0 0	2231 1511
2017	10	BWR PWR	0 0	0 0	0 0	0 0	0 0	565 266	1151 443	75 753	0 384	190 29	1791 2060
2018	9	BWR PWR	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 29	0 29
Totals		BWR PWR	0 0	0 0	0 0	262 0	307 0	1925 389	1501 1023	805 1571	0 384	0 219	4800 3600 8400

1988	BWR PWR	400 0	0 0	0 0	192 52	64 204	1043 97	1226 334	703 1010	0 1146	0 192	0 5	0 1	0 69
1989	BWR PWR	92 0	20 0	216 56	380 149	687 24	935 213	180 643	176 860	0 275	0 0	0 8	0 0	0 1
1990	BWR PWR	92 0	0 0	304 0	644 9	384 124	1796 262	1228 773	108 1151	0 484	0 27	0 21	0 0	0 0
1991	BWR PWR	0 0	0 0	0 0	56 160	660 4	1304 215	626 624	342 1380	0 480	0 150	0 0	0 0	0 0
1992	BWR PWR	0 0	0 0	0 0	44 0	372 9	1361 265	1751 677	592 1269	0 689	0 164	0 0	0 0	0 0
1993	BWR PWR	0 0	0 0	0 128	128 64	172 0	1348 80	1398 394	434 975	0 1087	0 197	0 8	0 1	0 0
1994	BWR PWR	0 0	0 0	0 0	0 0	16 2	715 264	1051 567	1276 819	0 1046	0 154	0 42	0 0	0 0
1995	BWR PWR	0 0	0 0	0 0	0 0	55 0	270 26	2539 330	1152 534	0 1422	0 426	0 64	0 0	0 0
1996	BWR PWR	0 0	0 0	0 0	0 0	16 0	381 5	1536 541	1324 685	0 1239	0 499	0 132	0 0	0 0
1997	BWR PWR	0 0	0 0	0 0	0 0	43 0	325 4	1427 338	1400 555	43 1005	0 858	0 174	0 0	0 7
1998	BWR PWR	0 0	0 0	0 0	0 0	42 0	195 1	2450 190	1887 471	34 1220	0 674	0 169	0 0	0 8
1999	BWR PWR	0 0	0 0	0 0	0 63	41 0	215 3	727 257	877 509	327 895	0 847	0 108	0 7	0 0
2000	BWR PWR	0 0	0 0	0 0	0 36	26 0	121 4	2436 417	2046 562	33 1037	0 774	0 330	0 15	0 0
2001	BWR PWR	0 0	0 0	0 0	0 0	26 0	237 7	1538 193	918 416	455 1131	0 808	0 106	0 0	0 7
2002	BWR PWR	0 0	20 0	0 0	0 0	46 0	75 1	1600 301	1637 620	140 952	0 978	0 245	0 8	0 0
2003	BWR PWR	0 0	0 0	0 0	0 0	26 0	240 4	1497 301	1823 397	243 1052	0 837	0 135	0 7	0 0
2004	BWR PWR	0 0	0 0	0 0	0 0	26 0	35 4	2221 192	1586 512	163 1308	0 703	0 210	0 15	0 0
2005	BWR PWR	0 0	0 0	0 0	0 0	25 0	278 1	889 378	1517 582	332 1129	0 1061	0 113	0 8	0 0
2006	BWR PWR	0 0	0 0	0 0	0 0	25 0	182 4	1750 229	1676 308	609 1077	0 798	0 124	0 30	0 0
2007	BWR PWR	0 0	0 0	0 104	0 0	25 0	216 105	994 267	961 548	334 1248	0 924	0 278	0 31	0 0

2008	BWR PWR	0 0	0 0	0 0	0 0	26 0	197 4	1742 260	2204 357	346 1158	0 668	0 82	0 7
2009	BWR PWR	0 0	152 0	146 25	336 7	172 25	226 1	1700 366	1690 660	464 1096	0 921	0 200	0 15
2010	BWR PWR	0 0	4 12	308 32	8 49	146 0	390 35	1954 337	1375 351	335 1192	0 1008	0 168	0 7
2011	BWR PWR	0 0	152 0	0 100	158 36	118 117	369 36	1495 240	2135 510	152 1332	0 503	0 134	0 8
2012	BWR PWR	0 0	0 12	324 0	0 60	43 112	368 1	1373 339	1253 605	553 910	0 820	0 200	0 7
2013	BWR PWR	0 0	0 24	456 188	7 224	216 122	449 137	959 440	1512 745	92 1241	0 655	0 188	0 8
2014	BWR PWR	0 0	128 0	1132 173	108 159	882 181	514 121	1944 379	894 414	555 1115	0 458	0 168	0 7
2015	BWR PWR	0 0	0 0	0 76	0 106	0 0	127 49	1114 376	869 606	241 1019	0 488	0 127	0 0
2016	BWR PWR	0 20	16 0	400 0	16 112	262 173	180 100	709 123	350 580	730 828	0 528	0 175	0 24
2017	BWR PWR	0 0	0 0	0 0	0 126	20 112	126 40	736 266	1151 443	75 763	0 384	0 190	0 14
2018	BWR PWR	0 0	0 0	196 0	0 41	196 27	128 1	849 315	532 564	245 618	0 601	0 32	0 0
2019	BWR PWR	0 0	0 0	0 0	0 0	0 0	49 1	943 157	1279 235	45 421	0 318	0 111	0 0
2020	BWR PWR	0 0	0 0	0 32	0 108	0 153	129 0	538 127	92 425	312 760	0 421	0 49	0 16
2021	BWR PWR	0 0	0 0	0 41	0 115	0 0	45 43	569 248	1088 495	128 833	0 390	0 46	0 0
2022	BWR PWR	0 0	116 0	100 0	384 28	0 128	346 130	1009 139	1878 260	248 697	0 352	0 87	0 30
2023	BWR PWR	0 0	168 0	0 48	156 84	144 0	0 48	766 232	1188 261	8 373	0 334	0 30	0 1
2024	BWR PWR	0 0	0 0	232 50	0 195	0 203	447 75	479 243	505 476	0 635	0 207	0 32	0 0
2025	BWR PWR	0 0	0 0	744 84	52 45	572 48	248 167	1089 104	541 209	8 409	0 216	0 51	0 25
2026	BWR PWR	0 0	28 0	428 42	28 67	428 128	132 41	499 65	115 396	4 255	0 198	0 55	0 0
2027	BWR PWR	172 0	0 0	360 258	88 206	414 53	164 155	412 253	40 215	0 286	0 54	0 44	0 0

Dis Yr	Type	Unallocated Inventory - Number of Assemblies in Burnup Ranges										15:00:16 11/02/89e	PRXIII u
1968	BWR PWR	5 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
1969	BWR PWR	0 0	5 0	14 0	73 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
1970	BWR PWR	0 0	0 0	0 4	0 95	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
1971	BWR PWR	244 0	48 12	19 0	113 0	0 6	0 46	0 0	0 0	0 0	0 0	0 0	0 0
1972	BWR PWR	373 0	197 0	174 31	54 74	0 90	0 83	0 0	0 0	0 0	0 0	0 0	0 0
1973	BWR PWR	51 0	88 0	165 0	230 59	0 0	0 85	0 0	0 0	0 0	0 0	0 0	0 0
1974	BWR PWR	0 41	405 4	630 225	247 33	0 118	0 148	0 0	0 0	0 0	0 0	0 0	0 0
1975	BWR PWR	2 7	7 107	242 231	669 131	0 181	0 82	0 0	0 0	0 0	0 0	0 0	0 0
1976	BWR PWR	5 0	340 0	495 8	826 430	0 195	0 145	0 0	0 0	0 0	0 0	0 0	0 0
1977	BWR PWR	0 0	239 0	220 6	1049 210	0 291	0 330	0 0	0 0	0 0	0 0	0 0	0 0
1978	BWR PWR	17 0	208 4	155 120	424 220	0 82	0 793	0 0	0 0	0 0	0 0	0 0	0 0
1979	BWR PWR	0 0	0 0	108 66	587 233	0 152	0 562	0 0	0 0	0 0	0 0	0 0	0 0
1980	BWR PWR	76 0	2 0	3 2	515 0	0 158	0 555	0 0	0 0	0 0	0 0	0 0	0 0
1981	BWR PWR	0 0	1 0	1 40	314 4	0 59	0 540	0 0	0 0	0 0	0 0	0 0	0 0
1982	BWR PWR	0 0	1 11	26 3	118 181	0 188	0 153	0 0	0 0	0 0	0 0	0 0	0 0
1983	BWR PWR	0 0	0 12	5 16	25 156	0 112	0 386	0 0	0 0	0 0	0 0	0 0	0 0
1984	BWR PWR	0 0	74 0	92 133	3 100	0 115	0 486	0 0	0 0	0 0	0 0	0 0	0 0
1985	BWR PWR	92 0	232 0	100 48	211 58	0 45	0 525	0 0	0 0	0 0	0 0	0 0	0 0
1986	BWR PWR	276 0	212 1	232 64	378 321	0 27	0 456	0 0	0 0	0 0	0 0	0 0	0 0
1987	BWR PWR	284 0	264 0	401 65	232 242	0 204	0 296	0 0	0 0	0 0	0 0	0 0	0 0

APPENDIX G

Reference Information and Technical Data Base Summary

Values for the conductivity, density and heat capacity of Topopah Spring welded tuff, as discussed in Section 1.2.3, were taken from the YMP Reference Information Base, Version 3.001. This report contains neither candidate information for the YMP Reference Information Base nor candidate data for the YMP Site and Engineering Properties Data Base.

END

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