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Yucca Mountain Site Characterization Project

Repository Thermal Response: A Preliminary Evaluation of the Effects of Modeled Waste Stream Resolution

Eric E. Ryder, Ellen Dunn

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Repository Thermal Response: A Preliminary Evaluation of the Effects of Modeled Waste Stream Resolution

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ABSTRACT

One of the primary factors that influences our predictions of host-rock thermal response within a high level waste repository is how the waste stream is represented in the models. In the context of thermal modeling, *waste stream* refers to an itemized listing of the type (pressurized-water or boiling-water reactor), age, burnup, and enrichment of the spent nuclear fuel assemblies entering the repository over the 25-year emplacement phase. The effect of package-by-package variations in spent fuel characteristics on predicted repository thermal response is the focus of this report. A three-year portion of the emplacement period was modeled using three approaches to waste stream resolution. The first assumes that each package type emplaced in a given year is adequately represented by average characteristics. For comparison, two models that explicitly account for each waste package's individual characteristics were run; the first assuming a random selection of packages and the second an ordered approach aimed at locating the higher power output packages toward the center of the emplacement area. Results indicate that the explicit representation of packages results in hot and cold spots that could have performance assessment and design implications. Furthermore, questions are raised regarding the representativeness of average characteristics with respect to integrated energy output and the possible implications of a mass-based repository loading approach.

The work documented in this report was performed for the U.S. Department of Energy, Yucca Mountain Site Characterization Project Office, for contract DE-AC04-94AL85000; under work description WBS 1.2.1.5, QA grading report 1.2.1.5, Revision 00. This work was conducted using controls specified in Sandia National Laboratories Work Agreement WA-191, Revision 00.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Chapter

ONE

Introduction

The Yucca Mountain Site Characterization Project (YMP) is currently assessing the feasibility of locating a high-level nuclear waste repository[1] at Yucca Mountain, Nevada. The radioactive waste proposed for emplacement at the Yucca Mountain site is composed of spent-fuel assemblies discharged from commercial light-water reactors and Defense High Level Waste (DHLW) resulting from plutonium production. As the isotopes of the spent-fuel assemblies decay, heat is produced. The introduction of this waste heat into the geologic setting will alter the in situ stress state. Strain produced by this alteration and the heat transferred to the rock will in turn alter the ambient hydrologic and chemical systems. Reliable predictions of the host-rock thermal response to waste emplacement are therefore vital to the development of our understanding of coupled interactions.

One of the basic factors that influences our predictions of host-rock thermal response is how the waste stream is represented in the models. In the context of thermal modeling, *waste stream* refers to an itemized listing of the type (pressurized-water or boiling-water reactor), age, burnup, and enrichment of the spent nuclear fuel assemblies entering the repository over the 25-year emplacement phase. Given that over 200,000 assemblies may make up a waste stream, waste stream characteristics are often averaged, or *smeared*, in repository thermal calculations. One approach to waste stream smearing is the representation of the entire waste inventory by a single set of average characteristics. Providing the coarsest resolution of the waste stream, this approach is generally adopted for models that rely on plate or disk source representations of the potential repository. For models that use explicit representations of waste packages or groups of waste packages (e.g., line-source models or finite-cylinder models), a level of realism is gained through the application of yearly average waste stream characteristics to the appropriate sections of the overall repository model. Carrying this increase in resolution to the next level, package-to-package variations in waste age, burnup, and enrichment can be captured in those repository-scale thermal models that explicitly model each waste package. Use of such detail in the waste stream is not the typical practice due to the large number of packages that must be modeled (anywhere from several thousand to tens of thousands). It is important, however, to understand the impacts that a package-by-package waste stream representation has on predictions of host-rock temperatures.

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[1] The term repository appears throughout this document and its appendices. The use of the term repository to identify the facility or some portion of the facility that may be constructed and operated at Yucca Mountain is not intended to imply that such a facility will be constructed or operated at this site.

The primary objective of this report is to examine the effects of increased waste stream resolution on predicted host-rock thermal response. As a secondary objective, the implications of a mass-based loading approach for the repository in conjunction with large capacity waste packages are also investigated.

Chapter

Two

Thermal Modeling Assumptions

Underlying all repository thermal loading analyses are design assumptions regarding waste package design, waste stream characteristics, emplacement mode, waste emplacement density, and general repository layout. The assumptions made for this investigation will be discussed in the following sections.

2.1 WASTE PACKAGE DESIGN

For repository-scale analyses of host-rock thermal response, the internal details of the waste package are not of a scale that is typically modeled. For this analysis, the waste package details were smeared on a canister scale. Specifically, the waste packages were assumed to be adequately represented by 4.91-m long right-circular cylinders with a diameter of 1.83 m containing a uniformly diffuse heat-generating material. These dimensions are consistent with a non-self-shielded, metallic multi-barrier concept proposed to hold either 21 intact pressurized-water-reactor (PWR) assemblies or 40 intact boiling-water-reactor (BWR) assemblies [TRW, 1993a].

The gross thermal decay characteristics of each waste package are a function of the characteristics of the individual assemblies loaded into a given container. The specific assemblies that make up a package are assigned in the *waste stream.*

2.2 WASTE STREAM

For these analyses, waste stream characteristics for a youngest-fuel-first (YFF) scenario were assumed for the spent fuel. For this scenario, waste stream flowthrough is assumed at the monitored retrieval and storage system (MRS) and no fuel younger than 5 years out-of-reactor is accepted for disposal at the repository.

Reporting of the waste stream characteristics can be done at many levels. For the purposes of this investigation, yearly average information for each waste package type and package-by-package information for emplacement years 2028, 2029, and 2030 were required. Summaries of the yearly average information for each waste package type (PWR or BWR) and the package-by-package details for the specified emplacement years can be found in Appendix A.

2.3 WASTE EMPLACEMENT DENSITY

The density of waste emplacement at the repository is typically expressed in terms of an areal power density (APD), or alternatively as an areal mass loading (AML). One drawback of defining waste emplacement density based on APD is that it does not maintain a constant value through time. Calculated using the instantaneous value of power output at emplacement, APD decreases at a rate consistent with the decay characteristics associated with the waste emplaced. Because of this, an alternate designation for waste emplacement density based on mass per unit area is often used, namely *areal mass loading*. AML is based on the tonnage of waste per unit area and has the primary appeal of remaining constant through time. It is noted, however, that AML and APD can be directly related if information on waste package design and waste stream characteristics is known.

For these analyses, an AML of 78.2 metric tons of uranium (MTU) per acre was assumed. Given the YFF waste stream used, this translates to a total heated area of approximately 800 acres and an overall APD of 100 kW/acre [YMP, 1993].

2.4 REPOSITORY LAYOUT

The current two-level repository concept identifies two primary emplacement regions [TRW, 1993b]. Access to these emplacement regions is via a main drift that connects the north and south ramps and runs parallel to the Ghost Dance fault. Emplacement drifts are spaced 30.5 m (100 ft) apart on centers and are aligned at N70W.

The larger of the two regions, the *upper block*, is situated to the west of the main drift access and identifies approximately 900 acres of waste emplacement area. The upper block slopes in two sections (one at 0.5% and the other at 2.0%) from an elevation of 1065 m (3493 ft) at the northern end to 1111 m (3645 ft) at the southern end of the block. A standoff of 76.2 m (250 ft) between the main drift access and the first waste packages in an emplacement drift is also specified.

The emplacement region defined to the east of the main drift, the *lower block*, provides approximately 220 acres of waste emplacement area. Since the lower block is defined to the east of the Ghost Dance fault, a lateral standoff of 266.7 m (875 ft) has been defined between the main drift and the first canister within an emplacement drift. This is done in an attempt to remove the waste emplacement area from the fault's region of influence.

2.5 MODELED REPOSITORY

As indicated previously, only about 800 acres is required to emplace the YFF waste stream at 78.2 MTU/acre. Thus, only the first 93 drifts of the upper block were modeled in this study. Because of the model's formulation and the short time period being investigated (1,000 years), the slopes of the upper block were ignored and the repository assumed to be flat. It was further assumed that the packages were oriented consistent with an in drift emplacement mode.

As defined in [TRW, 1993b], the drifts were assumed to be spaced 30.5 m apart on centers, with the spacings of individual packages within each drift determined on the basis of the assumed AML and the MTUs contained in a given package.

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Chapter

THREE

Thermal Model

For the three-dimensional thermal modeling required for this evaluation, the repository site was assumed to be composed of a single, semi-infinite, homogeneous, isotropic material with constant properties. In addition, no open air spaces (drifts) or variations in surface topography were modeled. Using these assumptions, analytical solutions to the heat conduction equation can be derived.

The specific model chosen for this study, as documented in Wilson et al. [1994], is constructed from the combination of two of these analytical solutions. The primary solution is formulated based on the uniform distribution of a heat-generating material throughout a right-circular cylinder. The second solution, based on a point heat source, is used to reduce computational requirements and is only applied when the distance from the source is such that the difference between predictions from the cylindrical and point-source solutions is negligible.

As implemented, the thermal model chosen approximates the power decay characteristics of spent fuel as the 4-term exponential summation:

$$P(t) = \sum_{i=1}^{n} a_i e^{-b_i t}$$

where a_i and b_i are fitted constants, and t is time. In order to apply the detailed information supplied as part of the YFF waste stream, tabularized power outputs associated with each burnup and enrichment pair had to be converted into exponential summations. For these analyses, four-term exponential fits valid for a temporal range of 5 to 1,000 years were performed using the method documented by Mansure and Petney [1991].

As indicated above, it was assumed that the waste is isolated in a semi-infinite rock mass. A thermal conductivity of 2.1 W/m-K and a heat capacitance of 2.14 J/cm^3-K were used for the thermal properties of the semi-infinite mass. These values are consistent with values reported in the RIB for TSw2. For these analyses, the surface temperature of the modeled region was assumed to remain constant throughout the 1,000 year modeled time frame.

Chapter

FOUR

Results

Results for this study were obtained for a plane 5 m above the centerpoints of the waste packages. Temperature predictions from analyses run in support of north ramp design activities [YMP, 1993] are used as the basis of comparison for two investigations of waste stream variability. Results from the north ramp design efforts will be presented first, followed by a discussion of results for the two models developed to evaluate the effect of waste stream resolution on predicted temperature profiles.

4.1 BASE CASE

For the purposes of comparison, a *Base Case* model was run [YMP, 1993] that uses the yearly average characteristics of each waste package type to represent all of the PWR and BWR packages received in a given year (see Appendix A). To eliminate bias, a nonunique, randomized selection process was used to establish the order of emplacement for each year's inventory (i.e., the sequence of PWR and BWR packages within the drifts). Canister-to-canister spacings in a drift were assigned based on yearly average values of MTUs per canister defined for each type of waste package.

Figures 4-1 through 4-8 show the predicted isotherms 5 m above the upper block for selected times. The general behavior is as expected given the assumptions applied to the model. Examining the behavior of the temperature predictions for the 5 m plane, the impacts of stepped emplacement can be seen as a growth of the thermal perturbations from the northern end of the repository block, where emplacement begins, to the southern end, where emplacement ends. It is further apparent from Figures 4-1 through 4-8 that the isothermal contours do not form regular bands that expand uniformly across the repository area as time progresses. Instead, the isothermal contours are somewhat irregular. This is a direct result of two of the assumptions applied to these analyses: waste package capacity and constant AML.

The waste package assumed for these analyses has a significantly larger capacity than that of the alternate designs proposed in the Site Characterization Plan [SCP; DOE, 1988]. This means that the power output of the spent-fuel waste stream (approximately 80 MW for these analyses) is contained in 7,650 packages, whereas if an SCP-type design were assumed, over 30,000 waste packages would be defined. When more packages are used to contain the same amount of heat-generating material, it would be reasonable to expect that the more uniform distribution of heat would result in a more uniform heating of the rock mass. For these analyses, however, the concentration of the waste stream's heat output into 7,650 packages results in a coarser distribution of the overall heat source, the effect of which can be seen in Figures 4-1 through 4-8.

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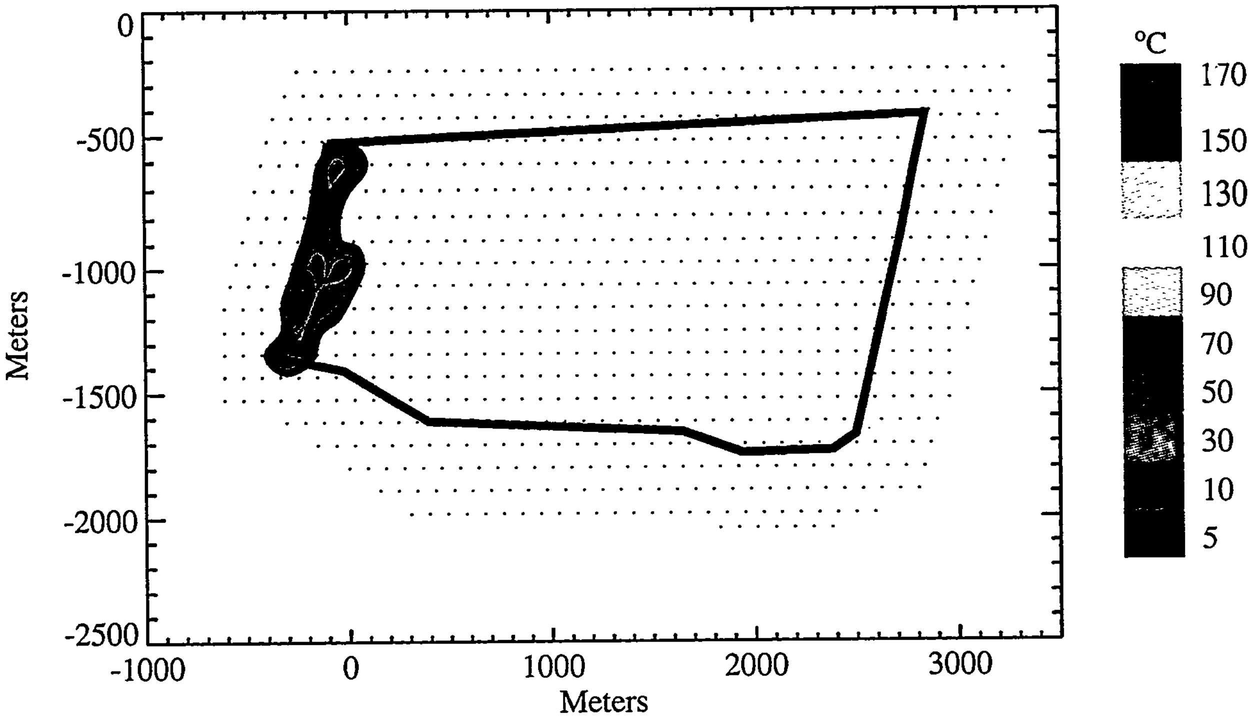

Figure 4-1. Contours of Temperature Change 5 m Above the Repository Plane 5 Years After the Start of Waste Emplacement

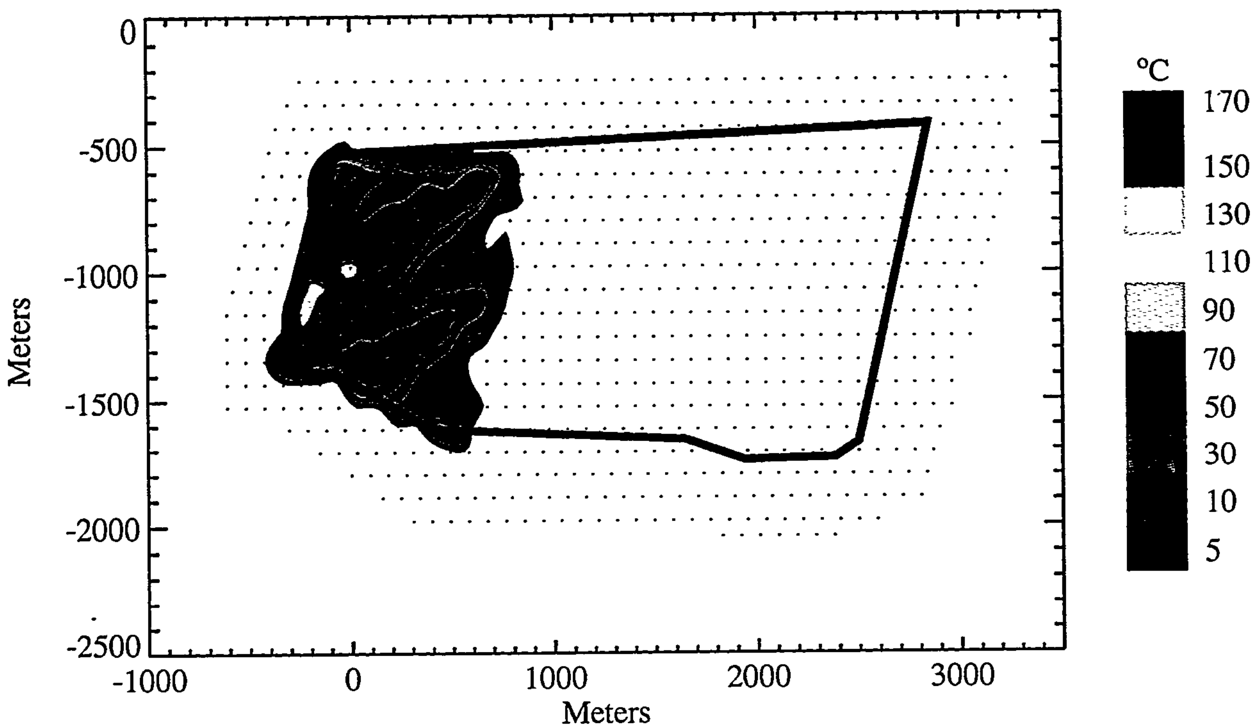

Figure 4-2. Contours of Temperature Change 5 m Above the Repository Plane 10 Years After the Start of Waste Emplacement

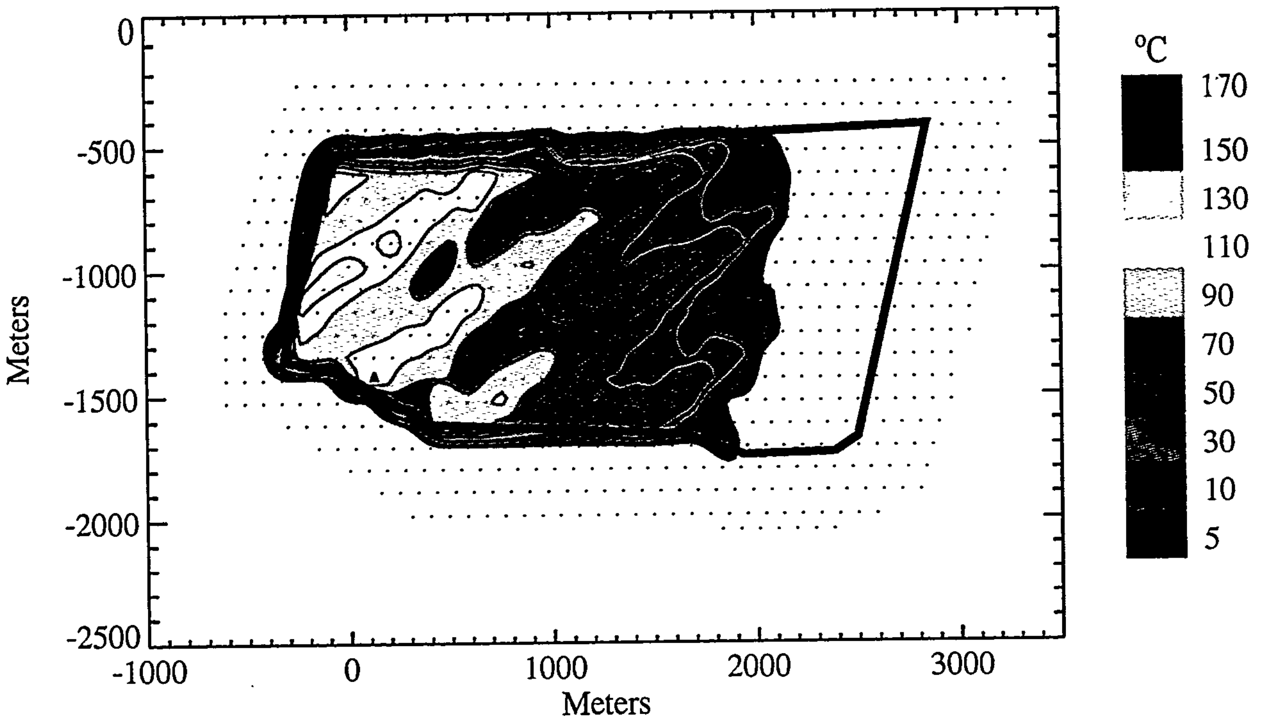

Figure 4-3. Contours of Temperature Change 5 m Above the Repository Plane 20 Years After the Start of Waste Emplacement

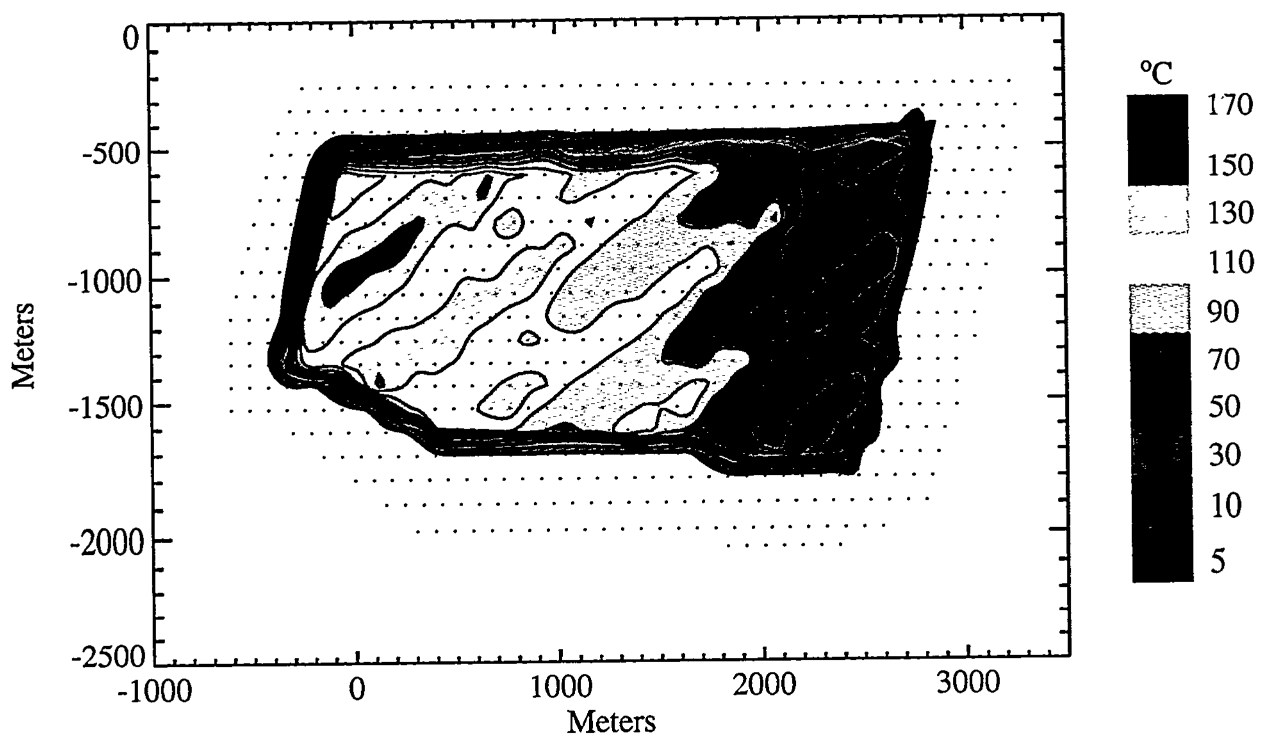

Figure 4-4. Contours of Temperature Change 5 m Above the Repository Plane 30 Years After the Start of Waste Emplacement

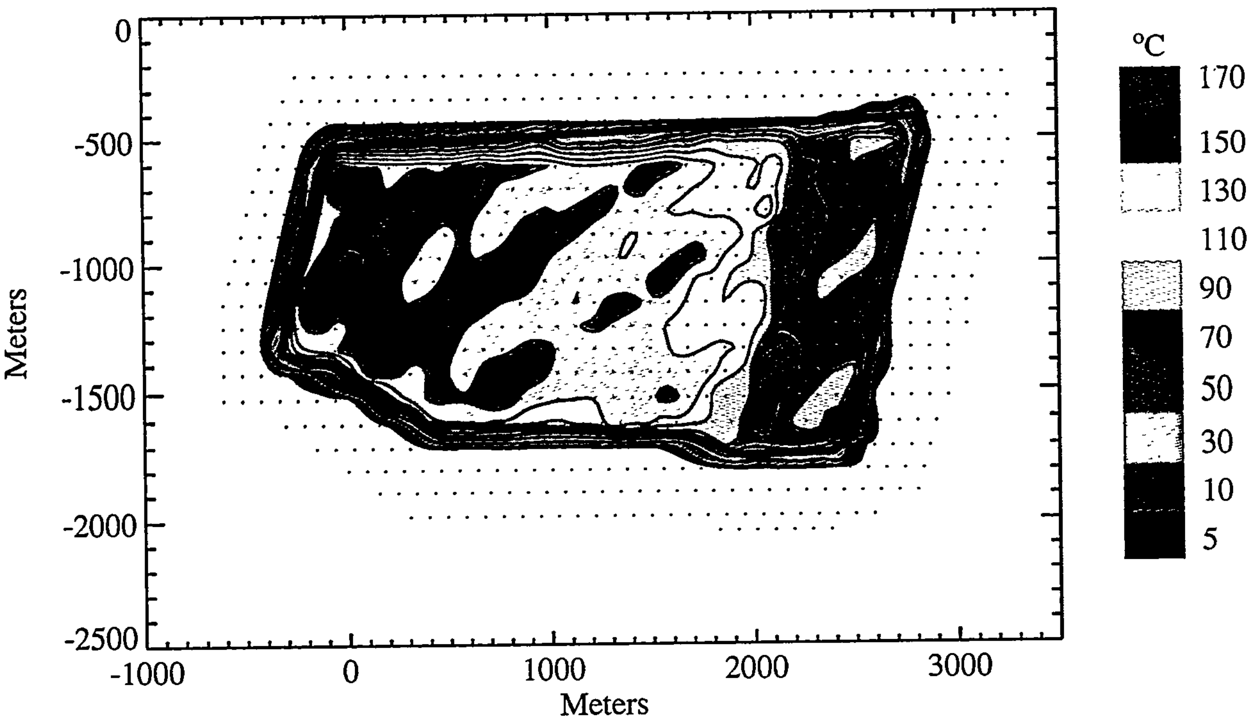

Figure 4-5. Contours of Temperature Change 5 m Above the Repository Plane 50 Years After the Start of Waste Emplacement

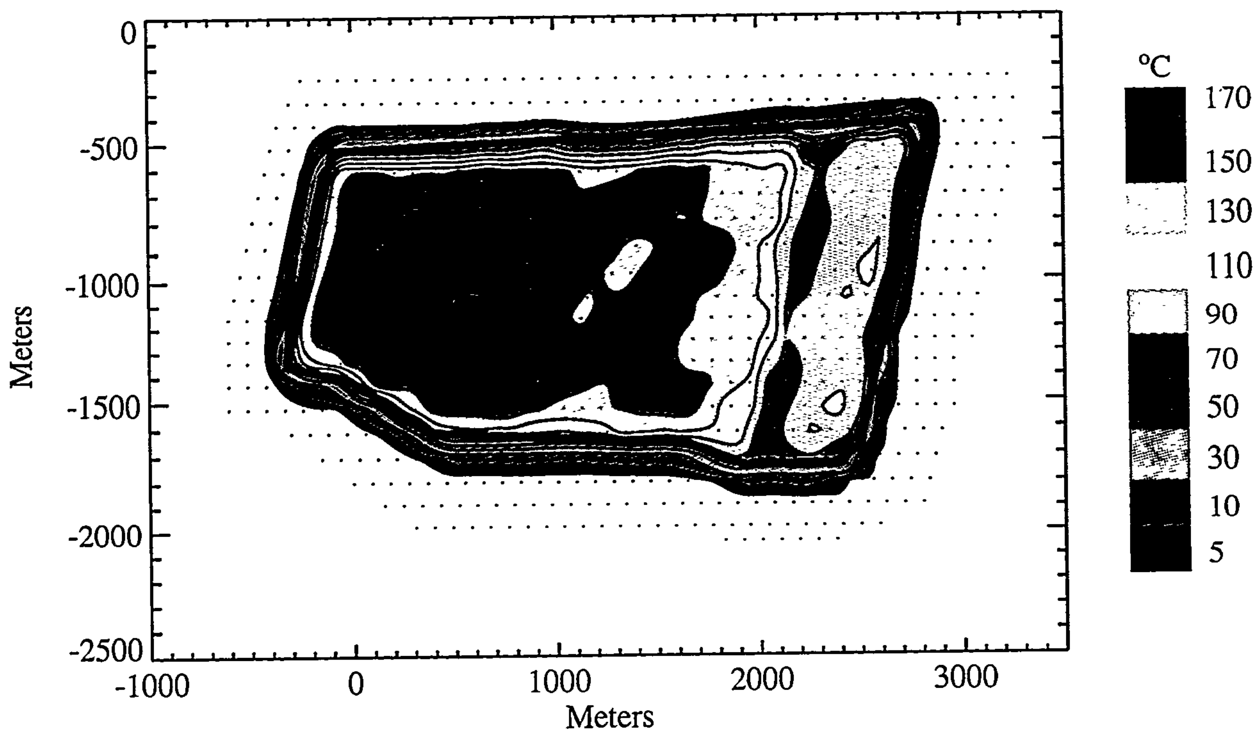

Figure 4-6. Contours of Temperature Change 5 m Above the Repository Plane 100 Years After the Start of Waste Emplacement

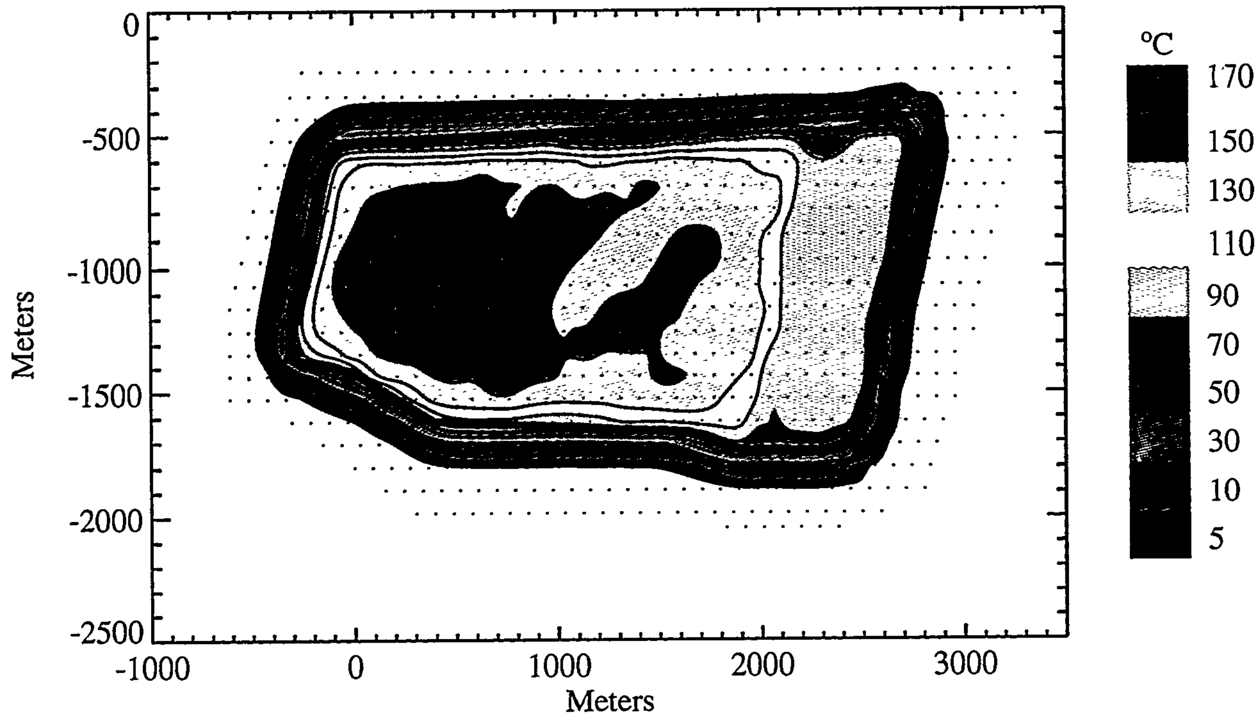

Figure 4-7. Contours of Temperature Change 5 m Above the Repository Plane 200 Years After the Start of Waste Emplacement

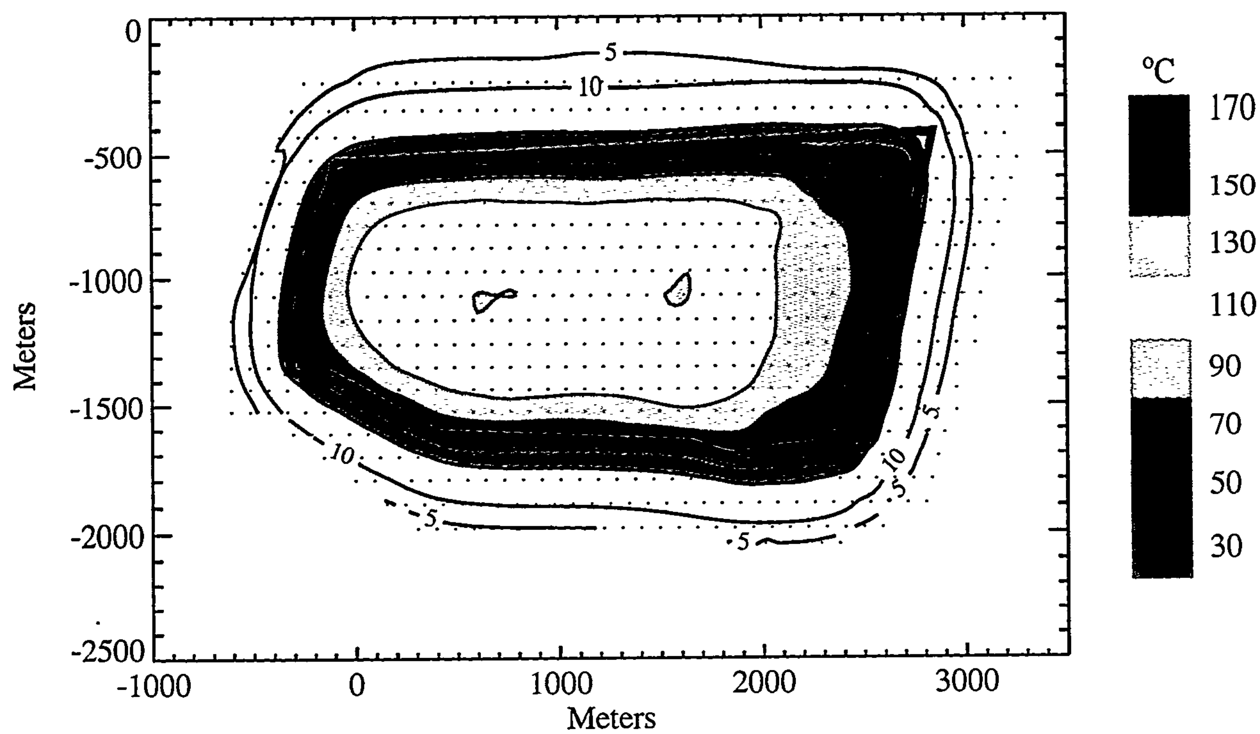

Figure 4-8. Contours of Temperature Change 5 m Above the Repository Plane 1000 Years After the Start of Waste Emplacement

The second assumption that adds to the nonuniformity of the early-time temperature contours is the assumption of a constant AML of 78.2 MTU/acre. Although this results in an overall APD of 100 kW/acre, the local areal power densities (LAPDs) defined for the Base Case range from 39.5 to 125.1 kW/acre (see Table 4-1). (LAPD being defined as the initial power output of a canister divided by the product of the adjacent canister and drift spacings). One of the impacts of this is the creation of regions of high temperature that persist for several hundred years. Another effect is a temporally persistent drop in the induced temperature response at the southern end of the upper block in comparison to the northern end. This can be traced to the drop in equivalent LAPDs documented for both the PWR and BWR packages in Table 4-1 that begins around emplacement year 2030.

Table 4-1. LAPD Values For Base Case Resulting From Constant AML Assumption of 78.2 MTU/acre

Emplacement Year	LAPD (kW/acre)	
	BWR	PWR
2010	107.6	116.6
2011	116.4	111.6
2012	123.4	114.8
2013	111.6	124.8
2014	109.6	123.7
2015	116.1	118.9
2016	109.2	125.1
2017	105.4	111.9
2018	117.6	124.9
2019	96.9	114.4
2020	109.0	119.4
2021	90.2	125.1
2022	91.1	112.0
2023	103.4	106.1
2024	96.0	109.6
2025	97.5	113.1
2026	110.4	101.8
2027	83.6	106.2
2028	74.7	94.6
2029	56.2	104.9
2030	39.5	51.7
2031	51.1	60.6
2032	58.2	68.8
2033	57.3	72.6
2034	56.5	71.5

How these general trends are effected by increased resolution in the waste stream descriptions is the topic of the following sections. The focus of the increased waste stream resolution is on emplacement years 2028, 2029, and 2030. Thus, only a portion of the overall 5 m grid (with higher resolution) will be presented in the comparisons that follow (see Figure 4-9).

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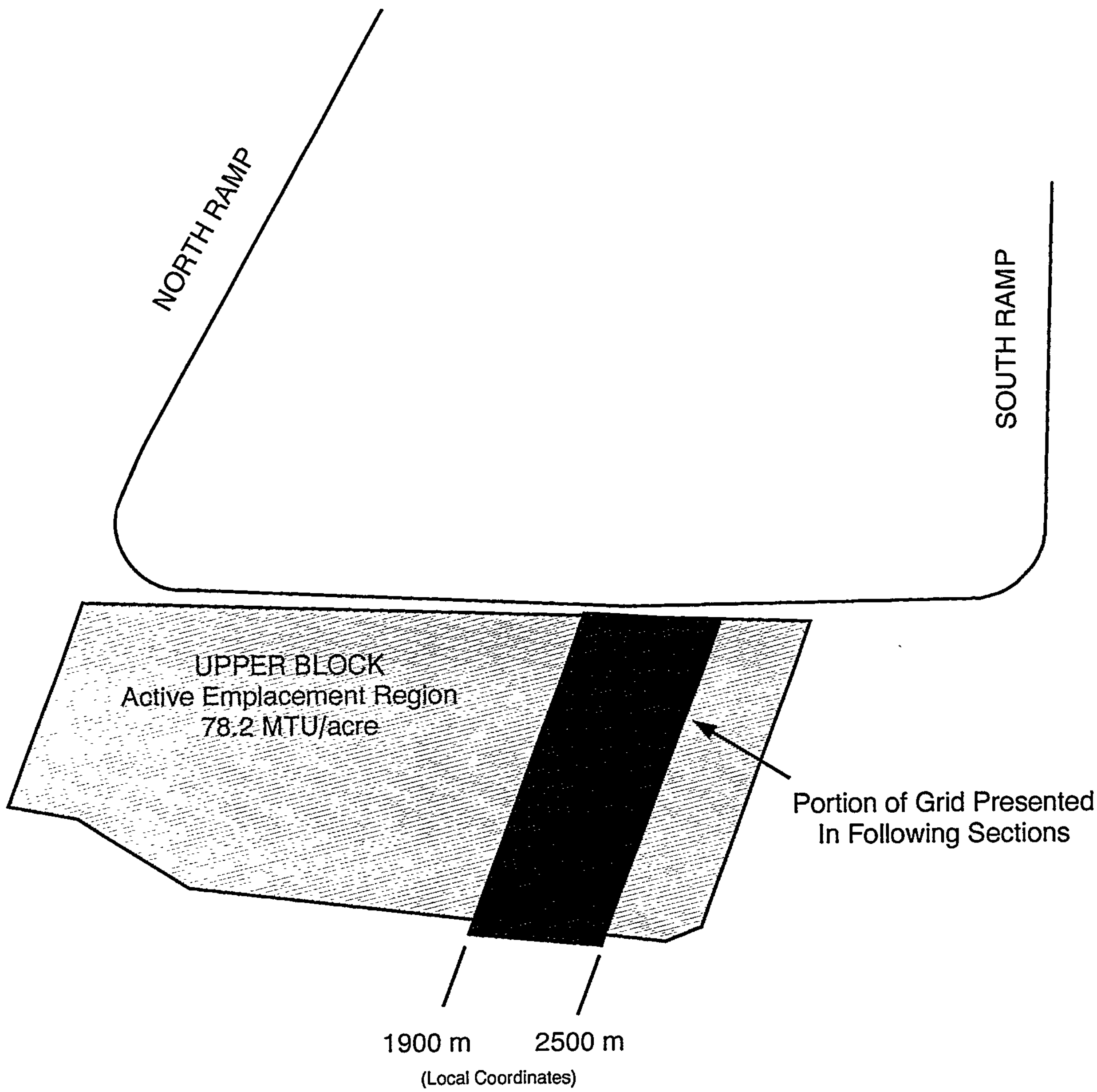

Figure 4-9. Location of High Resolution Grid

4.2 CASE I: RANDOM EMPLACEMENT

Because the model used in generating the Base Case results is linear, it is possible to remove sections of the solution (i.e., the thermal contributions of specific emplacement years) and replace them with solutions obtained using different waste stream assumptions. Case I uses the majority of the Base Case solution with the exception that the temperature contributions from the Base Case waste for years 2028, 2029, and 2030 are replaced with a more detailed representation of the waste stream. Specifically, individual decay curves based on each waste package's burnup and enrichment are used. Also, initial power outputs and capacities (MTUs) for each waste package in the three-year period are explicitly modeled. In order to make the more detailed three-year replacement solution consistent with the Base Case, the emplacement order of waste package types (PWR or BWR) within each of the three years is preserved in Case I. Which PWR or BWR package is emplaced for any given PWR- or BWR-designated position was chosen randomly. Package spacing was then calculated based on the MTUs contained by each package, consistent with the 78.2 MTU/acre AML requirement. Figure 4-10 shows the distribution of waste packages as indexed by initial power output for emplacement years 2028, 2029, and 2030 for the Base Case and Case I simulations. It is apparent that additional waste stream realism is achieved by going from the Base Case to the Case I model.

Figures 4-11 and 4-12 are difference plots of the temperature solutions obtained for the Base Case and Case I models (positive values indicate that the Base Case is predicting higher temperatures and negative values indicate that the Case I solution is predicting higher temperatures). Table 4-2 documents the maximum and minimum temperature differences predicted between the Base Case and Case I models. Early time difference plots (times less than 140 years) indicate that the increased waste stream resolution results in an increase in the number and magnitude of hot and cold spots within the represented region. Beyond 140 years, Case I temperature predictions are, in general, less than the Base Case solution. In fact, the Base Case shows a persistent long-term prediction of higher temperatures as compared to Case I. The Base Case predicts long-term temperatures as being 6 to 22°C higher than those obtained using the more detailed Case I model.

The early-time behavior of the comparison between the Base Case and Case I can be linked to the range of LAPDs that result from the constant AML assumption. For emplacement years 2028 through 2030, Table 4-3 shows that the values of LAPD span a wide range. Depending on the proximity of specific canisters, therefore, this range results in the generation of short-term (less than 140 years) hot and cold spots within the predicted thermal profiles.

The explanation of why the Base Case predicts higher long-term temperatures than Case I is more involved, but appears linked to the representativeness of the assumed yearly average characteristics used in the Base Case model. Using the PWR-type waste emplaced in 2029 as an example, Figure 4-13 shows a scatter plot of initial canister power output as a function of waste age. Superimposing the assumed average characteristics of 12.13 kW/canister and 26.25 years out-of-reactor, it is apparent that these average characteristics do not correspond to either of the two well defined groupings of packages.

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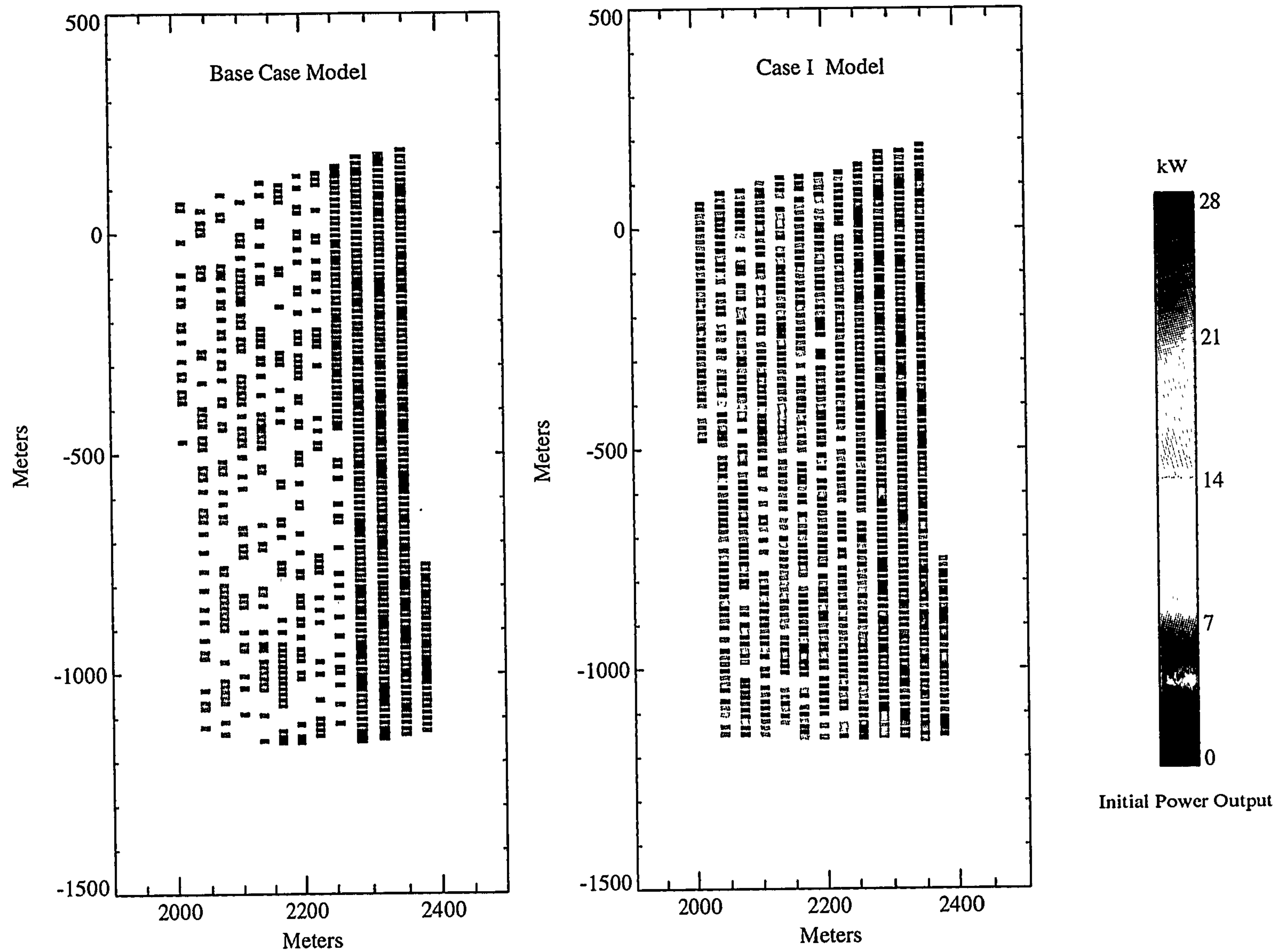

Figure 4-10. Comparison of the Initial Canister Power Distributions for the Base Case and the Case I Models

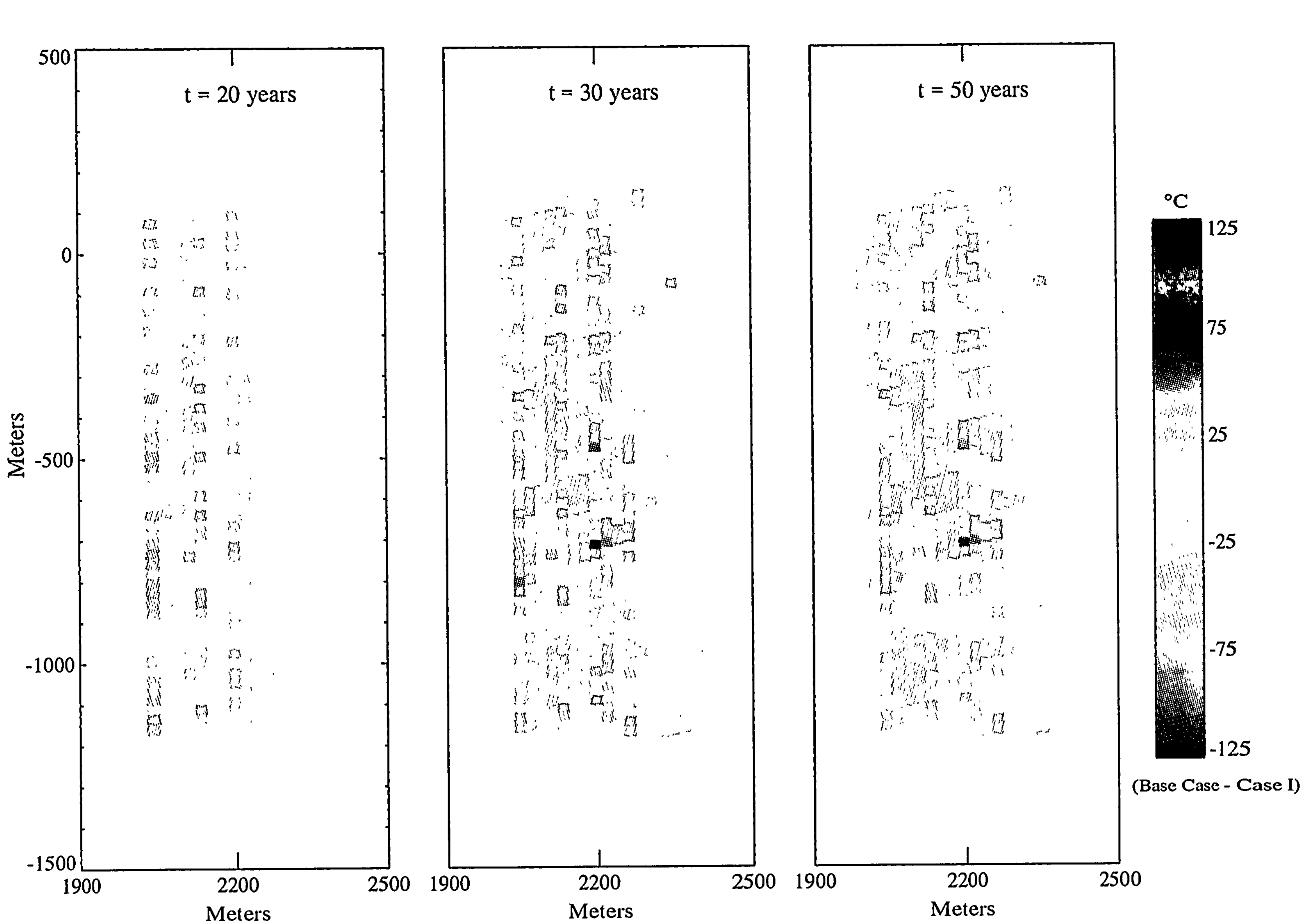

Figure 4-11. Temperature Difference History Between the Base Case and the Case I Models

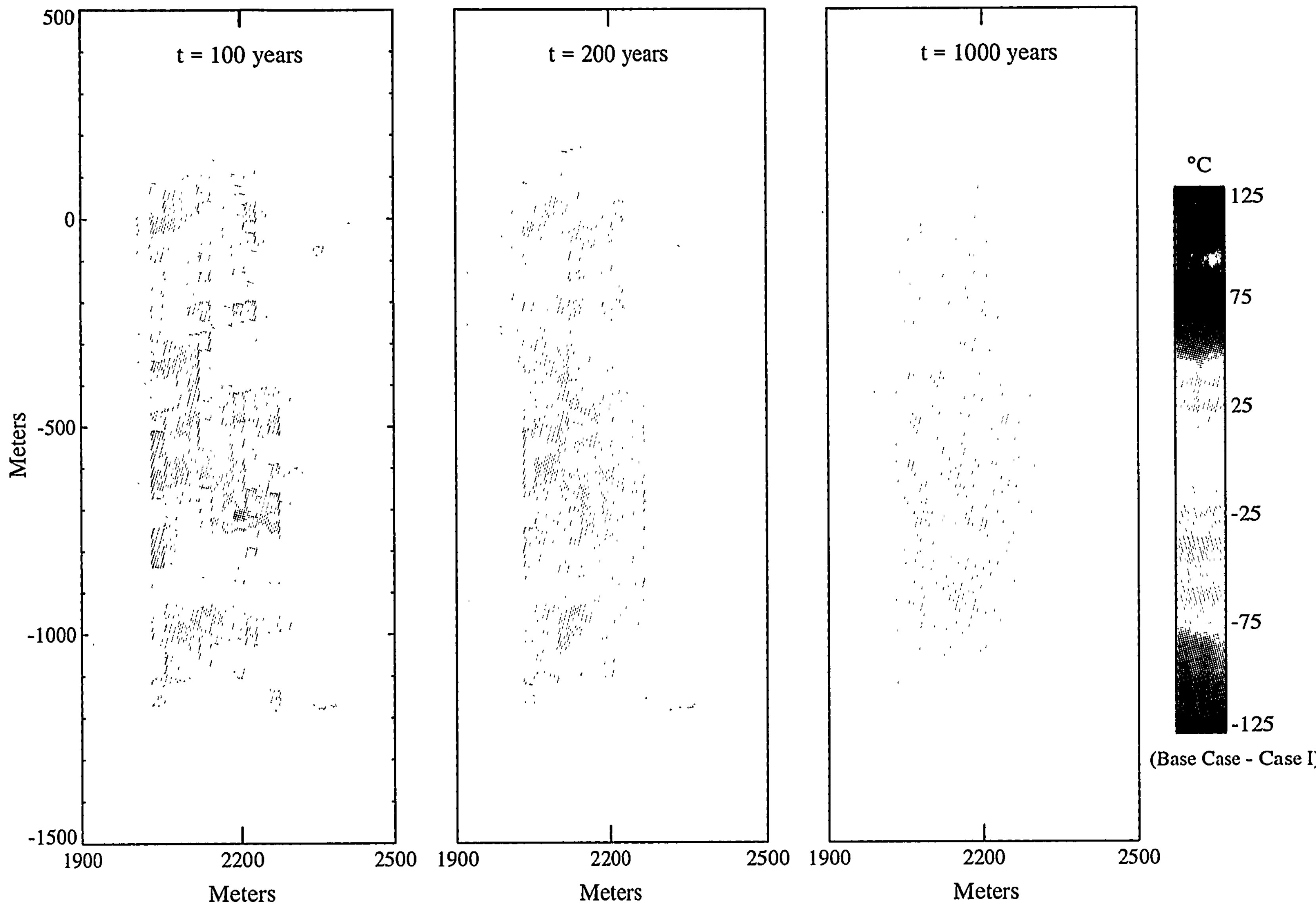

Figure 4-12. Temperature Difference History Between the Base Case and the Case I Models (concluded)

Table 4-2. Maximum and Minimum Temperature Differences Predicted Between the Base Case and Case I (T_{Base}-$T_{Case\ I}$)

Time (years)	Minimum (°C)	Maximum (°C)
18	0.00	0.00
19	-53.93	28.74
20	-63.66	35.23
21	-66.74	39.07
22	-67.79	43.61
23	-68.11	46.71
24	-67.75	49.09
25	-67.07	51.05
26	-66.25	52.67
27	-65.31	54.06
28	-64.19	55.20
29	-63.20	56.19
30	-62.38	56.98
40	-53.13	59.76
50	-43.59	58.19
60	-34.97	55.23
70	-27.67	52.21
80	-21.43	49.30
90	-16.19	46.75
100	-12.68	44.53
120	-11.18	41.01
140	-10.06	38.48
160	-9.22	36.67
180	-8.56	35.32
200	-8.01	34.30
300	-6.07	31.12
400	-4.64	29.05
500	-3.42	27.55
600	-2.36	26.38
700	-1.47	25.37
800	-0.72	24.37
900	-0.11	23.35
1000	0.37	22.24

Table 4-3. Range of LAPD Values for Case I

Year	Type	Minimum LAPD (kW/acre)	Maximum LAPD (kW/acre)
2028	PWR	9.84	213.6
	BWR	6.57	217.1
2029	PWR	9.84	229.5
	BWR	4.16	218.4
2030	PWR	3.77	73.5
	BWR	0.54	63.0

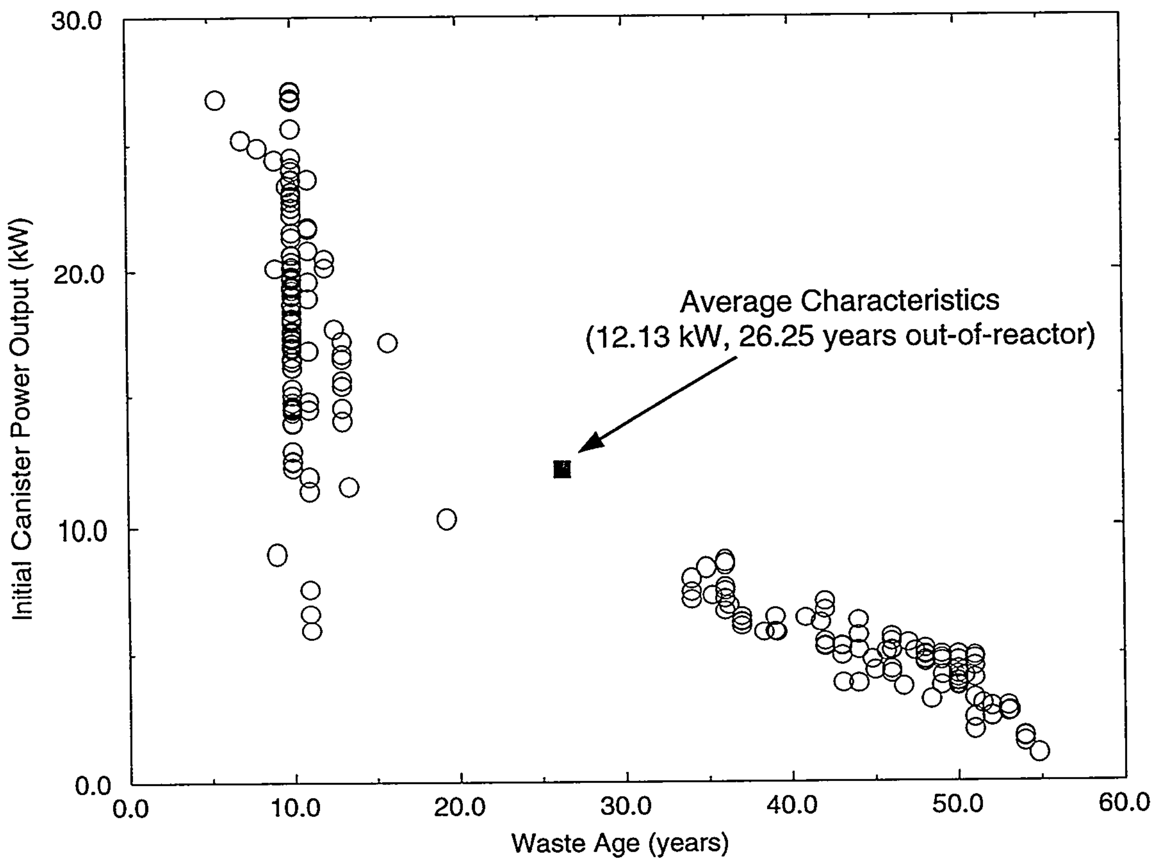

Figure 4-13. Initial Canister Power Output versus Waste Age for 2029 PWR Waste Packages

While this has no impact on the initial power introduced into the system (less than 1%), the integrated energy introduced is substantially different. Figure 4-14 shows the integrated energy output for the 2029 PWR-type waste calculated for the assumed average waste characteristics and for the detailed package-by-package characteristics. It is clear from this figure that use of the average characteristics results in more energy being introduced into the system (approximately 26% more over 1,000 year for the 2029 PWR waste). As a result, long-term temperatures predicted for the Base Case are higher when compared to those for Case I.

4.3 CASE II: ORDERED EMPLACEMENT

As a bounding case, a detailed modeling of waste packages for years 2028, 2029, and 2030 was carried out using an ordered approach to the emplacement of the packages. Packages identical in each year to those used in Case I were placed such that the highest output packages were centered in a *circular* configuration (see Figure 4-15). This should provide an indication of upper bound temperature variations that could result for a YFF waste stream, should such a central ordering of high output packages occur.

Figures 4-16 and 4-17 are temperature difference plots between the Base Case and Case II predictions. Immediately evident is the temperature response due to the strong interactions of the higher output packages toward the center of the detailed region, and a corresponding reduction in thermal perturbations along the cooler edge regions. Table 4-4 documents the maximum and minimum temperature variations for times out to 1,000 years following the start of emplacement. As expected, the temperature differences between the Base Case and Case II are greater in magnitude and more ordered than the differences predicted between the Base Case and Case I.

With respect to operations and retrieval, the ordering of the waste stream in a manner consistent with the Case II model could result in serious difficulties. Figures 4-18 and 4-19 show the temperature change history due to the Case II loading. The maximum temperature increase along the 5 m grid exceeds 250°C at 60 years. This increase superimposed on the ambient temperature at the repository exceeds the tridymite and the cristobolite inversion temperatures. Should these silica phases be present in any quantity, such temperatures could cause stability problems along sections of the emplacement drifts. From a performance assessment standpoint, the concentration of the highest output packages toward the center of the repository would result in an accentuation of edge effects that could expose greater numbers of packages to moisture intrusion.

It is noted, however, that without an intentional attempt to order the packages in the manner prescribed in Case II, such an ordering would be unlikely. However, the general trends observed could occur in response to random, small-scale ordering of hot and cold packages. It is important, therefore, to recognize the effects a realistic waste stream can have on repository-scale temperature predictions. The clustering of hot packages could result in thermomechanical instabilities, and the clustering of cold packages could prove problematic to the performance of the repository.

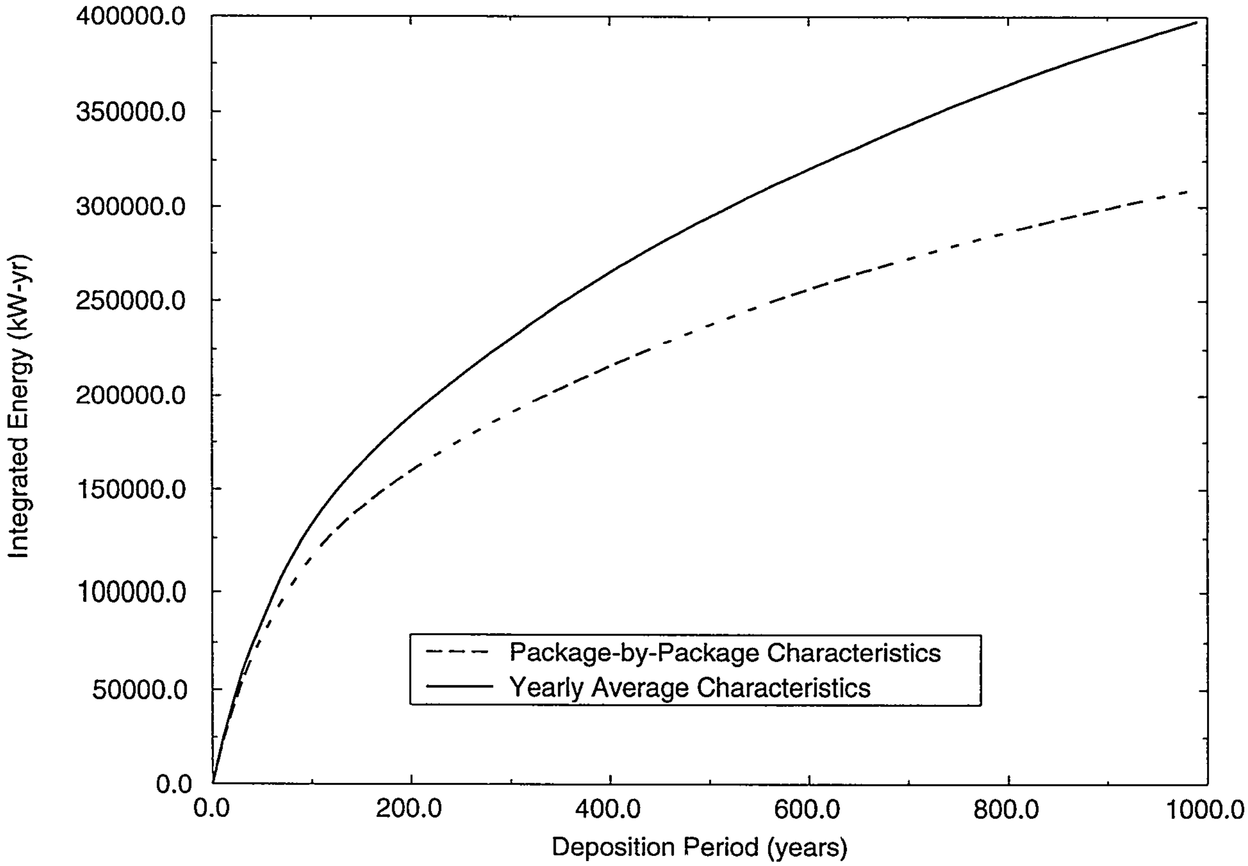

Figure 4-14. Integrated Energy Deposition for 2029 PWR Waste Packages Calculated Using Both the Yearly Averaged Characteristics and Package-by-Package Characteristics

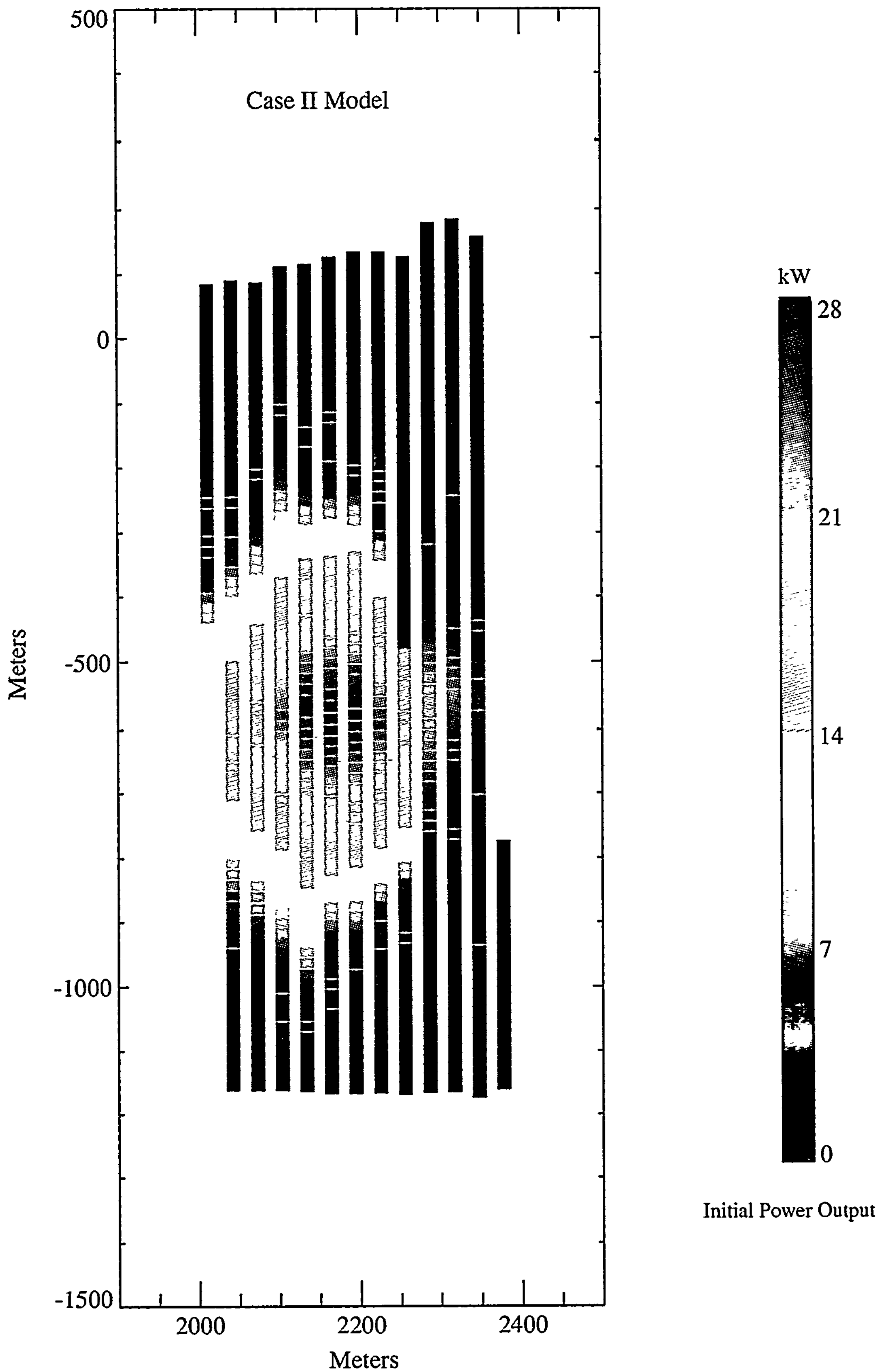

Figure 4-15. Initial Canister Power Distribution for the Case II Model

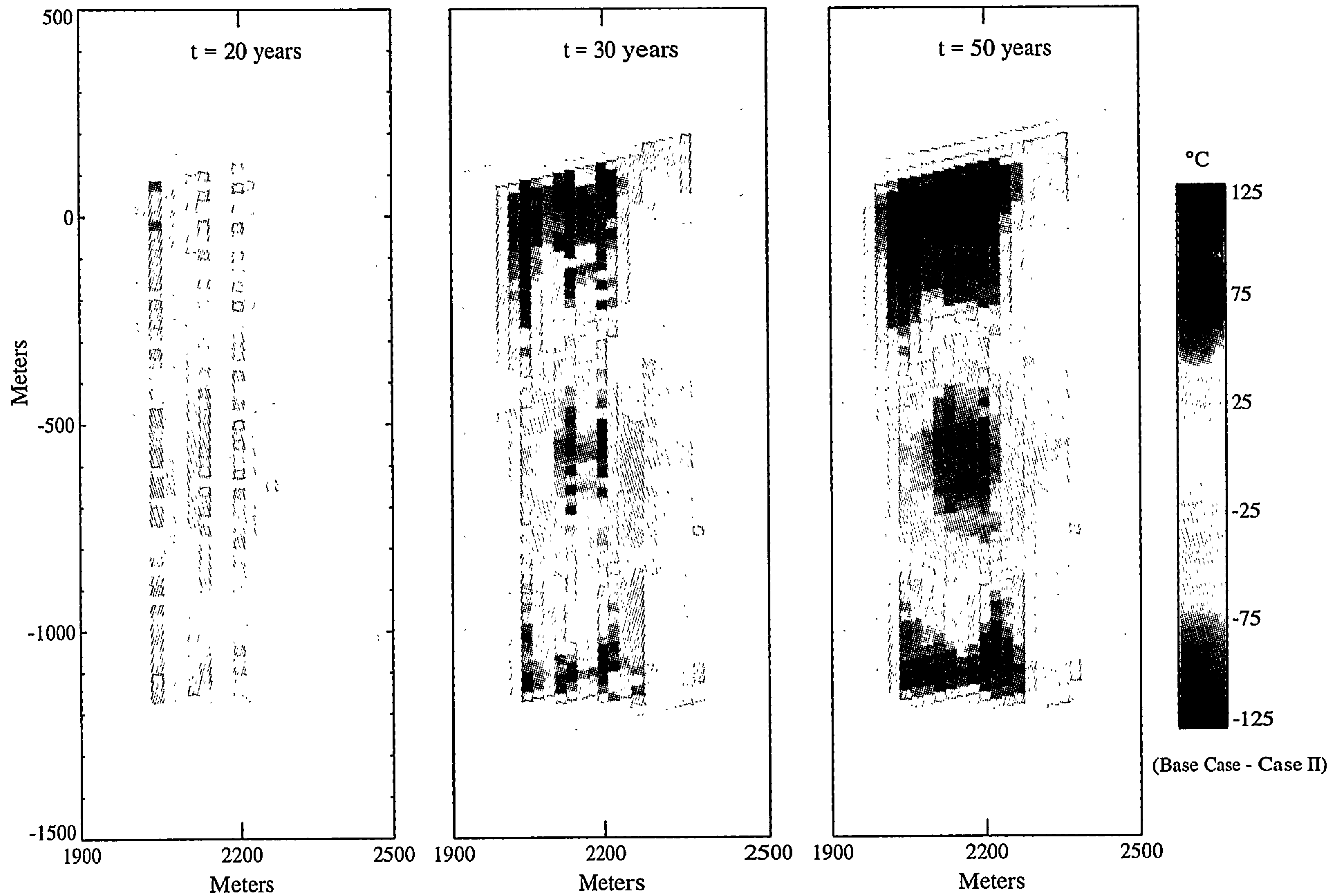

Figure 4-16. Temperature Difference History Between the Base Case and the Case II Models

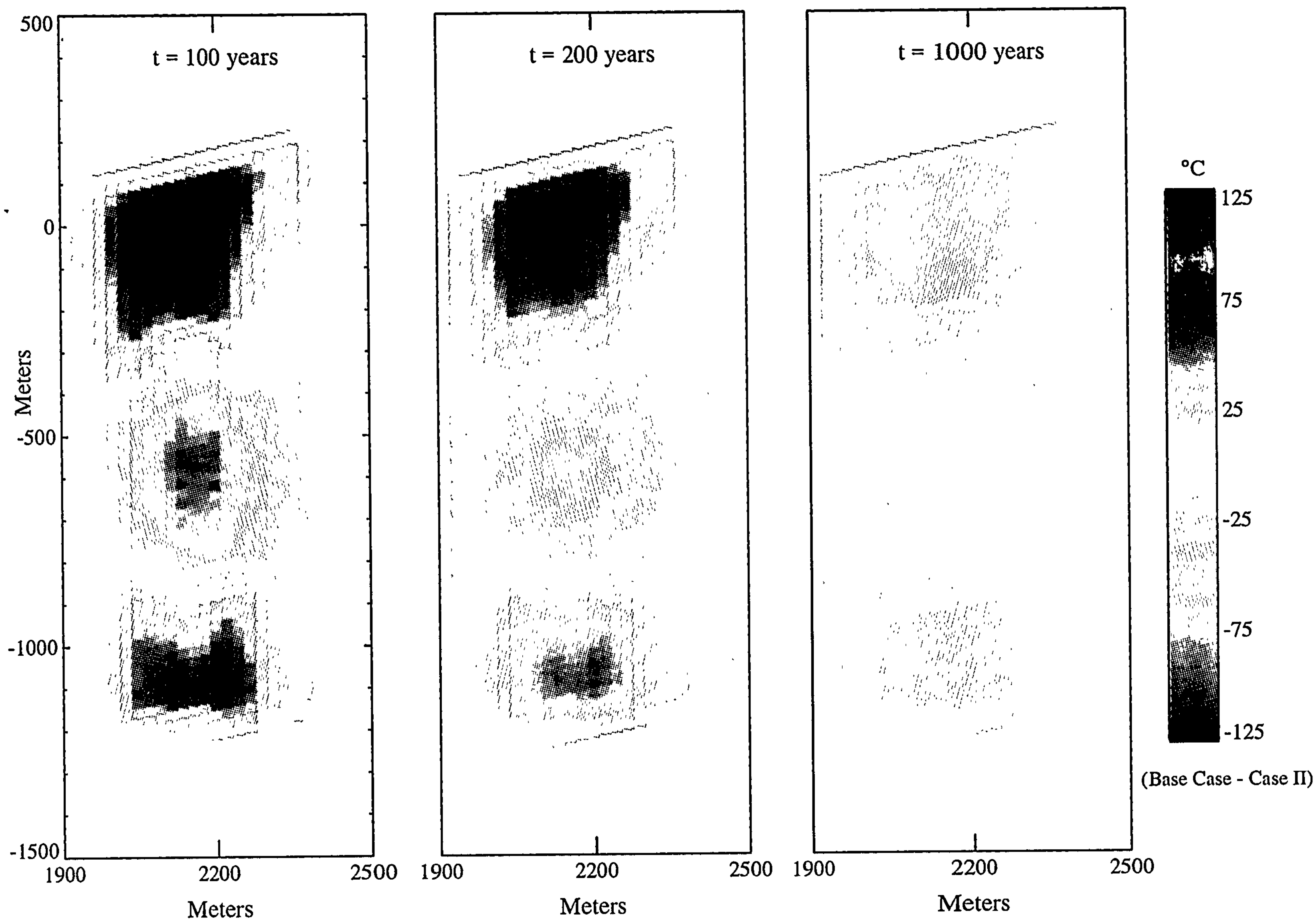

Figure 4-17. Temperature Difference History Between the Base Case and the Case II Models (concluded)

Table 4-4. Maximum and Minimum Temperature Differences Predicted Between the Base Case and Case II (T_{Base}-$T_{Case\ II}$)

Time (years)	Minimum (°C)	Maximum (°C)
18	0.00	0.00
19	-44.10	36.49
20	-59.94	48.35
21	-72.21	55.64
22	-82.84	61.22
23	-89.84	65.87
24	-95.09	69.89
25	-99.29	73.44
26	-102.80	76.59
27	-105.76	79.42
28	-108.23	81.94
29	-110.40	84.21
30	-112.31	86.27
40	-121.71	101.20
50	-121.73	106.78
60	-117.55	107.87
70	-111.48	106.67
80	-104.75	104.54
90	-97.80	102.01
100	-91.52	99.21
120	-80.09	93.51
140	-70.12	88.23
160	-61.73	83.57
180	-54.70	79.54
200	-48.93	76.08
300	-30.29	64.18
400	-20.63	56.88
500	-15.29	51.29
600	-11.61	46.69
700	-8.52	42.78
800	-6.55	39.35
900	-4.94	36.39
1000	-3.62	33.49

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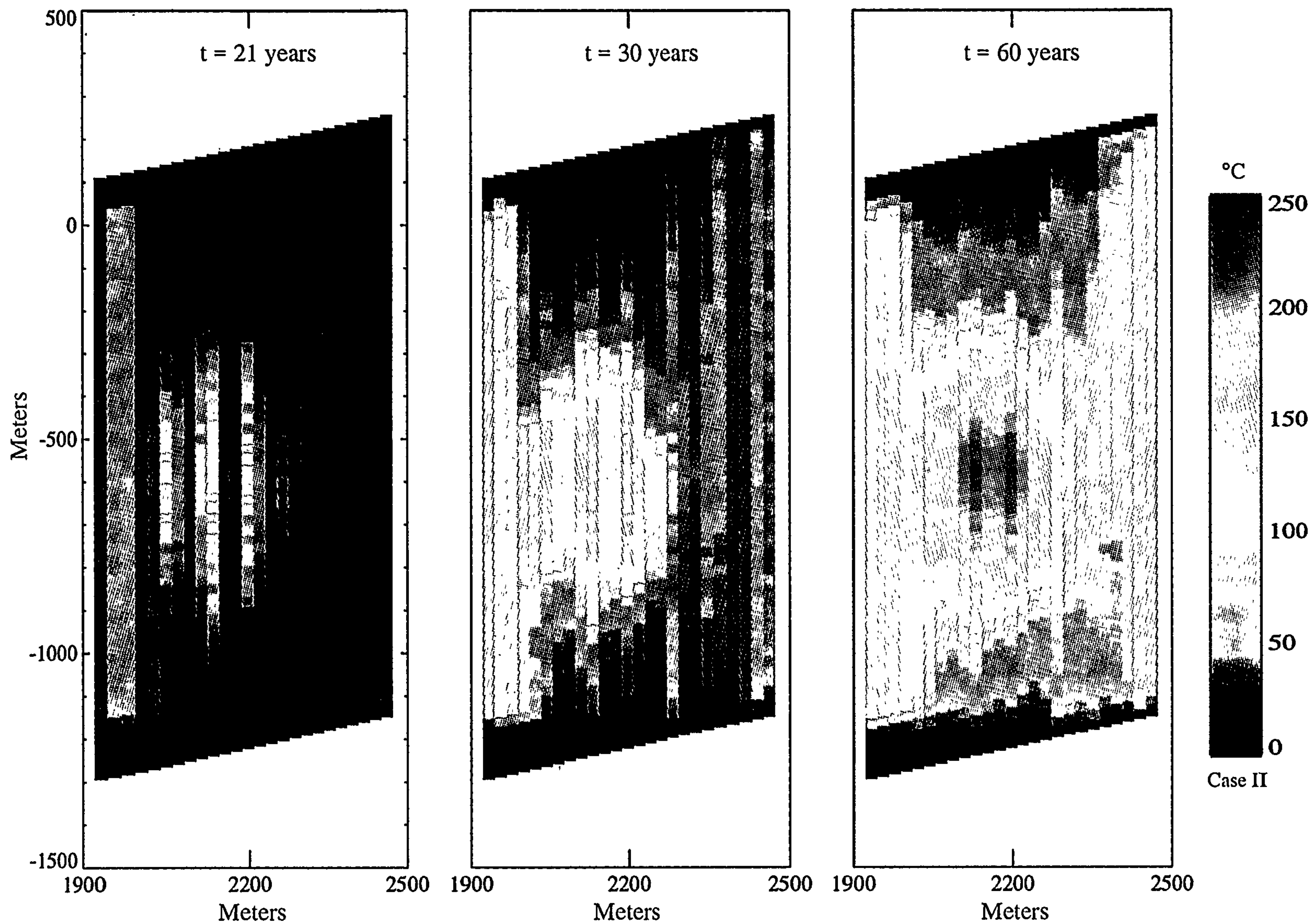

Figure 4-18. Predicted Temperature Changes for the Case II Model

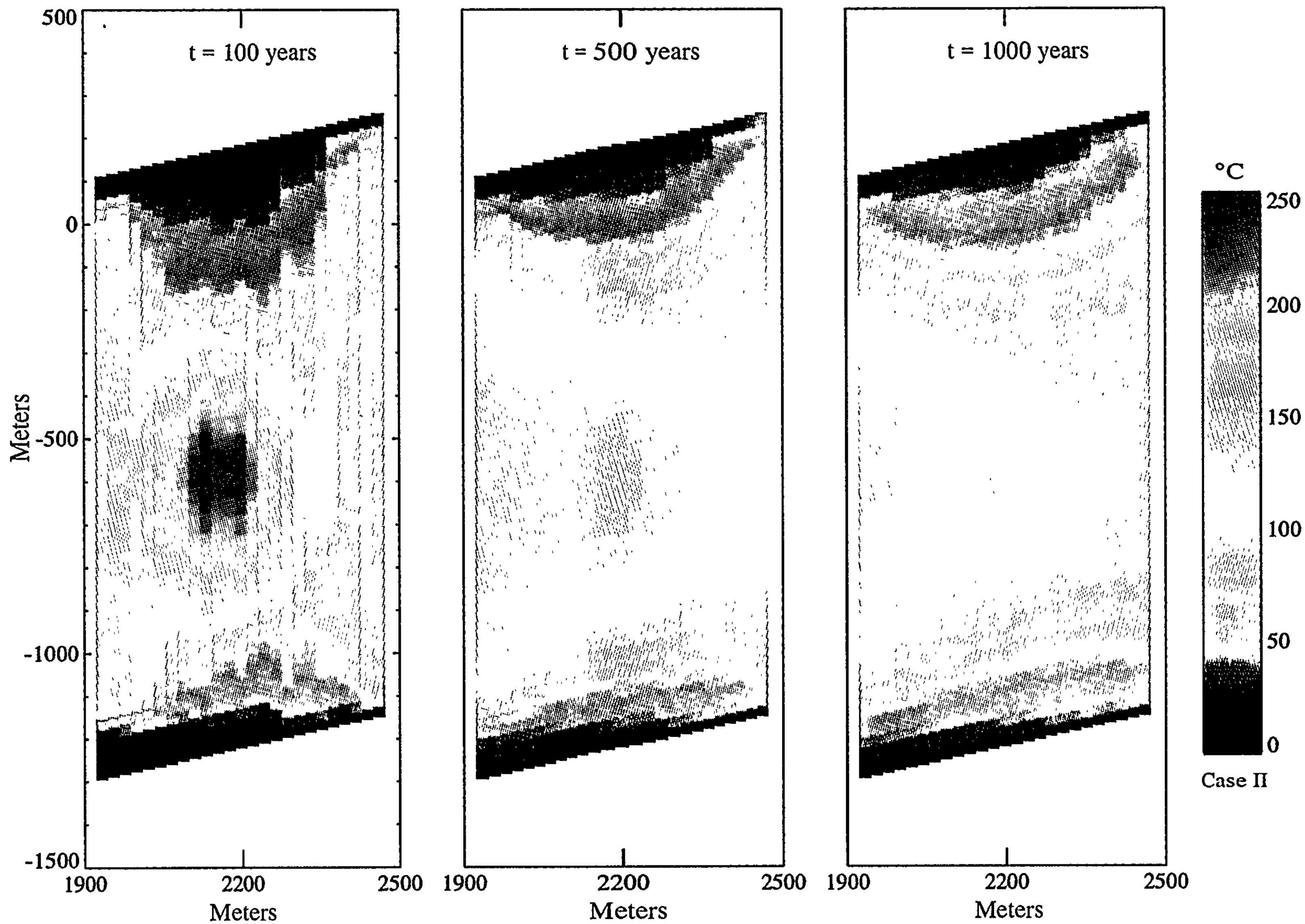

Figure 4-19. Predicted Temperature Changes for the Case II Model (concluded)

Chapter

FIVE

Discussion

Waste stream variability appears to be both a pre- and postclosure issue. Early-time predictions (less than 140 years) using detailed waste stream representations show an increase in the number of localized hot and cold spots over those predicted using the yearly averaged approach. These localized regions have design and performance assessment implications that should be pursued. For example, the interaction of high power output packages placed in proximity to one another may be sufficient to cause silica phase inversions within the host rock, leading to near-field stability problems. Alternatively, performance issues are raised when low power output packages are grouped. Such groupings may result in regions within the induced thermal profile that become the focus of condensate drainage or episodic water intrusions.

To expect all design and performance assessment models to capture detailed waste stream variability is both unrealistic and inappropriate. Although waste stream variability appears to have some very clear implications, the level of resolution required in waste stream modeling is highly dependent upon the question being asked. Design issues related to the operations and retrieval aspects of the repository may require levels of detail similar to those presented in this report. For long-term performance, however, such detail may not be an issue and average characteristics may be appropriate.

If average characteristics are used, however, the assumed averages must be examined for *representativeness*. As shown in Section 4.2, average characteristics assumed for PWR waste received in 2029, while statistically accurate, resulted in 26% more energy being introduced by the 2029 PWR inventory over a 1,000 year period as compared to that calculated for more detailed package-by-package descriptions. This is primarily due to the fact that the yearly average characteristics did not adequately capture the two well defined groupings (see Figure 5-1) of package characteristics for the 2029 PWR waste.

This lack of *representativeness* was noted for all waste received in 2028 and 2029, resulting in 25 to 32% more energy being introduced over 1,000 years. For the 2030 waste inventory (BWR and PWR), however, integrated energy output calculated for the yearly average characteristics and the package-by-package characteristics matched to within 4% over 1,000 years. Examining the distribution of 2030 packages in relation to the assumed yearly average characteristics, a stronger correlation was observed. This points to an approach that may correct temperature prediction errors introduced through

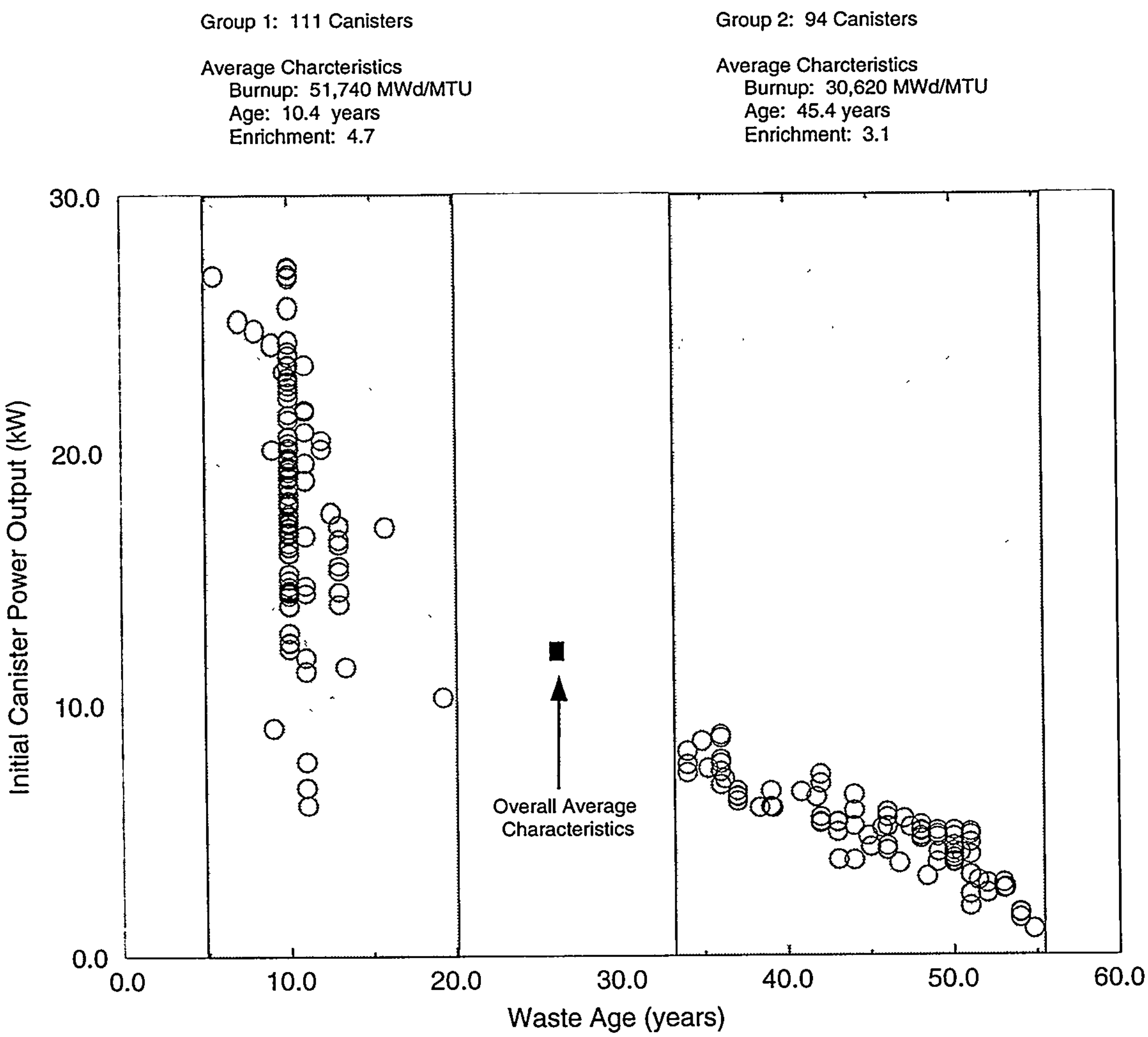

Figure 5-1. Logical Groupings for Averaging Waste Stream Characteristics for 2029 PWR Waste Packages

inconsistent integrated energy depositions without the complexity of having to model each waste package. Instead of using the entire inventory to define waste characteristics, logical groupings of waste packages (e.g., as determined by plotting initial package power output versus age) could be used to develop sets of representative waste stream characteristics. The limit of this approach is the modeling of each waste package. However, as the following example illustrates, marked improvement can be gained by minor increases in modeled waste stream resolution.

As discussed previously, when the 2029 PWR waste inventory is assumed to have the characteristics of 26.3-year-old 42,168 MWd/MTU waste with an enrichment of 3.9 approximately 26% additional energy is deposited into the system over a 1,000 year period. If the 2029 PWR waste is assumed to be composed of 111 canisters (1020.6 MTU) of 10.4-year-old, 51,740 MWd/MTU PWR waste with an enrichment of 4.7 and 94 canisters (829.8 MTU) of 45.4-year-old 30,620 MWd/MTU waste with an enrichment of 3.1 (averages based on linear regression of the two groupings), the integrated energy output at 1,000 years falls within 0.3% of that calculated on a package-by-package basis. It is apparent, therefore, that minor increases in waste stream resolution can result in significant improvement in the correlation between average and detailed waste characteristics.

Finally, the use of a constant AML in defining waste package layouts should be reexamined. As discussed in Chapter 4, when a constant AML is applied to a realistic waste stream, variability in the package-to-package waste characteristics results in hot and cold spots in the induced thermal profile. Some of the hot spots are of sufficient magnitude to raise stability questions related to the operations and retrieval phases of a repository. Similarly, the cold spots raise performance assessment questions. Thus, while it has been claimed that long-term performance can be directly linked to AML, the pre- and postclosure issues raised in this report require that alternative approaches (e.g., emplacing canisters based on an integrated energy output) be examined further.

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APPENDIX A

Yearly Average and Detailed Waste Stream Characteristics

As indicated in Section 2.2, a YFF waste stream was used to define the waste characteristics (burnup, age, enrichment) for the thermal models presented in this report. Tables A-1 and A-2 document the yearly average characteristics for the entire 25-year emplacement period. Table A-3 provides the package-by-package details for emplacement years 2028, 2029, and 2030.

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Table A-1. YFF10, MPA Receipt Rates, 21 PWR/40 BWR Waste Packages
Annual Heat Output Data (Watts/package) (MPY12140.OUT)

BWR Packages containing 40 assemblies

	Year	No. WP	Min	Max	Mean
1	2010	18	9568.	10001.	9789.
2	2011	23	9534.	10917.	10528.
3	2012	18	9506.	11749.	10955.
4	2013	58	8518.	10944.	10108.
5	2014	68	8379.	10495.	10046.
6	2015	138	8333.	11498.	10531.
7	2016	139	8451.	10706.	9961.
8	2017	117	8406.	10691.	9640.
9	2018	154	8602.	11671.	10723.
10	2019	136	8186.	9395.	8837.
11	2020	143	8241.	11764.	9981.
12	2021	149	7492.	10556.	8229.
13	2022	131	6901.	11135.	8326.
14	2023	147	8605.	11276.	9396.
15	2024	126	6568.	11071.	8701.
16	2025	142	7201.	11248.	8907.
17	2026	139	8380.	11352.	10018.
18	2027	156	5511.	10508.	7794.
19	2028	173	3796.	10284.	7040.
20	2029	152	2936.	9693.	5326.
21	2030	200	2731.	3746.	3383.
22	2031	176	3683.	4731.	4477.
23	2032	163	4434.	5489.	5268.
24	2033	137	4287.	5645.	5215.
25	2034	115	3904.	6177.	5115.
	Avg.	3118	6886.	9710.	8332.

PWR Packages containing 21 assemblies

	Year	No. WP	Min	Max	Mean
1	2010	29	13188.	14499.	13651.
2	2011	27	11935.	14281.	12881.
3	2012	30	12781.	14541.	13344.
4	2013	53	13774.	15355.	14501.
5	2014	143	12035.	14521.	14096.
6	2015	226	11920.	14272.	13745.
7	2016	218	13363.	15545.	14537.
8	2017	241	12236.	14963.	12891.
9	2018	209	13492.	16475.	14321.
10	2019	224	12312.	15545.	13266.
11	2020	223	12817.	15509.	13701.
12	2021	208	13070.	15516.	14401.
13	2022	232	11901.	15680.	12954.
14	2023	213	10916.	15016.	12246.
15	2024	233	11889.	16456.	12730.
16	2025	217	12395.	15549.	13080.
17	2026	223	9523.	15916.	11758.
18	2027	200	11055.	16224.	12303.
19	2028	194	8286.	14685.	10962.
20	2029	205	10538.	15792.	12134.
21	2030	193	3902.	7239.	5506.
22	2031	207	5534.	6962.	6797.
23	2032	209	6449.	7985.	7798.
24	2033	191	6847.	8543.	8180.
25	2034	184	7370.	8273.	8008.
	Avg.	4532	10781.	13814.	11992.

Table A-2. YFF10, MPA Receipt Rates, 21 PWR/40 BWR Waste Packages
Annual Heat Output Data (Watts/package) (MPY12140.OUT)

Uniform basket option number 5: 40 BWR assemblies
21 PWR assemblies
One source per year

	Time at Emplace	Type (1-B) (2-P)	MTU	Wgt Avg Age	Wgt Avg Burnup	Wgt Avg Enrich	No. of BWR WPs	No. of PWR WPs
1	2010.00	1	128.13	10.98	35263.94	3.1	18	
2	2010.00	2	265.50	10.83	41496.88	3.8		29
3	2011.00	1	162.64	11.18	36996.95	3.3	23	
4	2011.00	2	243.76	12.65	40599.81	3.9		27
5	2012.00	1	125.00	10.49	37610.62	3.3	18	
6	2012.00	2	272.71	12.15	42495.71	4.0		30
7	2013.00	1	410.91	12.70	36277.61	3.3	58	
8	2013.00	2	481.59	10.48	43431.70	4.0		53
9	2014.00	1	487.49	13.53	36701.89	3.3	68	
10	2014.00	2	1274.41	11.88	44199.35	4.0		143
11	2015.00	1	978.66	12.77	37045.92	3.3	138	
12	2015.00	2	2043.21	13.92	43794.82	4.0		226
13	2016.00	1	991.22	14.59	36657.88	3.3	139	
14	2016.00	2	1980.98	13.16	45368.24	4.1		218
15	2017.00	1	837.08	15.05	35783.89	3.2	117	
16	2017.00	2	2170.88	17.13	43473.44	4.0		241
17	2018.00	1	1098.59	12.50	37277.05	3.3	154	
18	2018.00	2	1873.97	14.83	45638.01	4.1		209
19	2019.00	1	969.91	18.47	35218.21	3.2	136	
20	2019.00	2	2032.03	17.90	44287.20	4.0		224
21	2020.00	1	1024.43	13.74	34700.30	3.3	143	
22	2020.00	2	2000.48	16.93	45159.43	4.1		223
23	2021.00	1	1063.21	18.66	32794.93	3.2	149	
24	2021.00	2	1872.45	16.41	46066.61	4.2		208
25	2022.00	1	936.22	16.47	31733.81	3.3	131	
26	2022.00	2	2098.26	19.46	43898.26	4.1		232
27	2023.00	1	1045.20	17.08	34844.20	3.3	147	
28	2023.00	2	1923.52	19.67	42253.60	4.0		213
29	2024.00	1	893.67	16.18	32231.61	3.3	126	
30	2024.00	2	2115.78	19.44	42491.98	4.1		233
31	2025.00	1	1014.90	16.76	32016.54	3.3	142	
32	2025.00	2	1962.19	20.04	43879.06	4.1		217
33	2026.00	1	999.83	17.97	35146.93	3.3	139	
34	2026.00	2	2013.73	23.97	41390.75	4.0		223
35	2027.00	1	1137.69	25.30	29937.71	3.0	156	
36	2027.00	2	1811.87	23.82	42350.60	3.9		200
37	2028.00	1	1275.09	30.75	27956.86	2.9	173	
38	2028.00	2	1757.44	26.98	40041.13	3.8		194
39	2029.00	1	1127.63	39.59	24252.52	2.6	152	
40	2029.00	2	1855.03	26.25	42168.04	3.9		205
41	2030.00	1	1341.27	43.35	25675.29	2.7	200	
42	2030.00	2	1608.14	41.99	34877.21	3.4		193
43	2031.00	1	1207.03	40.05	30779.61	2.9	176	
44	2031.00	2	1814.80	38.10	38028.32	3.6		207
45	2032.00	1	1153.72	36.93	32979.42	3.0	163	
46	2032.00	2	1852.72	35.64	41027.68	3.7		209
47	2033.00	1	976.04	37.70	32252.19	3.1	137	
48	2033.00	2	1683.83	34.72	42591.40	3.8		191
49	2034.00	1	813.99	38.35	30038.21	3.0	115	
50	2034.00	2	1613.51	35.53	42099.95	3.8		184

Total number of sources is 50

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030

Year	Type	MTU	Waste Age	Burnup	Enrichment
2028.00	BWR	6.93	13.11	37804.89	3.2
2028.00	BWR	7.75	56.30	7284.79	2.1
2028.00	BWR	7.77	56.00	9197.21	2.1
2028.00	BWR	7.78	55.68	12370.03	2.1
2028.00	BWR	7.78	55.00	12682.00	2.1
2028.00	BWR	7.78	55.00	12682.00	2.1
2028.00	BWR	7.72	54.28	10839.45	2.1
2028.00	BWR	7.69	54.00	11365.47	2.1
2028.00	BWR	7.68	54.00	11722.00	2.1
2028.00	BWR	7.68	54.00	11722.00	2.1
2028.00	BWR	7.79	54.00	13118.96	2.1
2028.00	BWR	7.81	54.00	14587.00	2.1
2028.00	BWR	7.81	54.00	14587.00	2.1
2028.00	BWR	7.81	54.00	14587.00	2.1
2028.00	BWR	7.81	54.00	14587.00	2.1
2028.00	BWR	7.80	54.00	15785.25	2.1
2028.00	BWR	7.77	54.00	16829.88	2.1
2028.00	BWR	7.77	54.00	16887.00	2.1
2028.00	BWR	7.77	54.00	16887.00	2.1
2028.00	BWR	3.88	53.15	12593.05	2.2
2028.00	BWR	7.84	53.00	16755.51	2.1
2028.00	BWR	7.84	53.00	17186.00	2.1
2028.00	BWR	7.82	53.00	17352.96	2.1
2028.00	BWR	7.76	53.00	18819.00	2.1
2028.00	BWR	7.76	53.00	18819.00	2.1
2028.00	BWR	7.76	53.00	18819.00	2.1
2028.00	BWR	7.76	53.00	19217.90	2.1
2028.00	BWR	7.73	52.68	17994.74	2.1
2028.00	BWR	7.69	52.00	14698.00	2.1
2028.00	BWR	7.69	52.00	14698.00	2.1
2028.00	BWR	7.69	52.00	14698.00	2.1
2028.00	BWR	7.74	52.00	16166.89	2.1
2028.00	BWR	7.83	52.00	19437.00	2.1
2028.00	BWR	7.83	52.00	19437.00	2.1
2028.00	BWR	7.78	51.68	19250.25	2.1
2028.00	BWR	7.38	51.00	18916.81	2.2
2028.00	BWR	7.47	51.00	19144.67	2.2
2028.00	BWR	7.69	51.00	19496.00	2.1
2028.00	BWR	7.69	51.00	19496.00	2.1
2028.00	BWR	7.69	51.00	19496.00	2.1
2028.00	BWR	7.69	51.00	19496.00	2.1
2028.00	BWR	7.73	51.00	22430.31	2.3
2028.00	BWR	7.47	50.40	20212.55	2.4
2028.00	BWR	7.35	50.00	19075.45	2.2
2028.00	BWR	7.78	50.00	21557.42	2.1
2028.00	BWR	7.71	49.90	23366.05	2.3

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2028.00	BWR	7.69	49.00	23271.35	2.1
2028.00	BWR	7.69	49.00	23425.00	2.1
2028.00	BWR	7.69	49.00	23425.00	2.1
2028.00	BWR	7.64	48.86	22645.75	2.2
2028.00	BWR	7.36	48.00	19875.00	2.6
2028.00	BWR	7.37	48.00	21084.96	2.6
2028.00	BWR	7.36	48.00	23500.16	2.3
2028.00	BWR	7.37	48.00	25268.79	2.6
2028.00	BWR	7.37	47.48	24262.26	2.5
2028.00	BWR	7.37	47.00	23247.00	2.6
2028.00	BWR	7.42	47.00	23918.54	2.5
2028.00	BWR	7.37	47.00	24371.00	2.5
2028.00	BWR	7.37	47.00	24371.00	2.5
2028.00	BWR	7.40	47.00	24487.62	2.5
2028.00	BWR	7.45	47.00	25579.27	2.4
2028.00	BWR	7.36	47.00	27668.00	2.5
2028.00	BWR	7.36	47.00	27668.00	2.5
2028.00	BWR	7.36	46.80	27271.46	2.5
2028.00	BWR	7.44	46.00	25968.74	2.7
2028.00	BWR	7.50	46.00	27124.06	2.5
2028.00	BWR	7.37	46.00	27772.00	2.5
2028.00	BWR	7.37	46.00	27772.00	2.5
2028.00	BWR	7.39	46.00	28275.69	2.5
2028.00	BWR	7.43	45.65	27227.45	2.7
2028.00	BWR	7.33	45.00	23360.00	2.7
2028.00	BWR	7.37	45.00	23773.95	2.6
2028.00	BWR	7.36	45.00	26645.30	2.7
2028.00	BWR	7.38	45.00	27084.00	2.7
2028.00	BWR	7.37	45.00	29568.25	2.8
2028.00	BWR	7.31	45.00	31337.61	2.8
2028.00	BWR	7.36	44.10	25491.29	2.3
2028.00	BWR	7.33	43.60	26702.78	2.6
2028.00	BWR	7.33	40.00	21000.00	2.2
2028.00	BWR	7.33	40.00	21000.00	2.2
2028.00	BWR	7.34	39.72	21775.06	2.2
2028.00	BWR	7.38	38.30	10844.21	1.2
2028.00	BWR	7.41	38.00	4000.00	.7
2028.00	BWR	7.18	36.77	19093.68	1.8
2028.00	BWR	7.09	36.00	19000.00	1.8
2028.00	BWR	7.37	36.00	27133.58	2.4
2028.00	BWR	7.41	36.00	30653.71	2.7
2028.00	BWR	7.40	35.28	33724.63	3.2
2028.00	BWR	7.40	35.00	34000.00	3.2
2028.00	BWR	7.40	35.00	34000.00	3.2
2028.00	BWR	7.14	34.16	31466.36	3.0
2028.00	BWR	7.09	34.00	31000.00	3.0
2028.00	BWR	7.09	34.00	31000.00	3.0

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2028.00	BWR	7.09	34.00	31000.00	3.0
2028.00	BWR	7.14	26.02	34874.73	3.2
2028.00	BWR	7.22	14.44	36878.09	3.4
2028.00	BWR	7.09	14.00	37072.00	3.6
2028.00	BWR	7.13	14.00	37494.46	3.5
2028.00	BWR	7.26	14.00	38732.00	3.3
2028.00	BWR	7.26	14.00	38732.00	3.3
2028.00	BWR	7.26	14.00	38732.00	3.3
2028.00	BWR	7.20	14.00	38897.75	3.4
2028.00	BWR	7.09	14.00	39213.00	3.6
2028.00	BWR	7.09	14.00	39757.50	3.6
2028.00	BWR	7.09	14.00	40781.00	3.6
2028.00	BWR	7.23	13.64	37000.62	3.6
2028.00	BWR	7.48	13.00	29800.00	3.7
2028.00	BWR	7.48	13.00	29800.00	3.7
2028.00	BWR	7.24	13.00	37766.52	4.0
2028.00	BWR	7.11	13.00	42279.00	4.2
2028.00	BWR	7.09	13.00	42621.63	4.2
2028.00	BWR	7.09	13.00	42760.93	4.2
2028.00	BWR	7.19	13.00	43761.73	4.1
2028.00	BWR	7.34	12.36	25507.58	3.4
2028.00	BWR	7.26	12.00	19970.96	3.2
2028.00	BWR	7.26	12.00	25705.88	3.3
2028.00	BWR	7.26	12.00	27784.00	3.3
2028.00	BWR	7.26	12.00	27784.00	3.3
2028.00	BWR	7.47	12.00	29163.51	3.5
2028.00	BWR	7.48	12.00	29234.00	3.5
2028.00	BWR	7.48	12.00	29234.00	3.5
2028.00	BWR	7.43	10.20	16935.40	3.4
2028.00	BWR	7.42	10.00	15558.00	3.4
2028.00	BWR	7.42	10.00	15558.00	3.4
2028.00	BWR	7.42	10.00	15558.00	3.4
2028.00	BWR	7.18	10.00	41099.54	3.4
2028.00	BWR	7.25	10.00	41912.00	3.4
2028.00	BWR	7.39	10.00	42340.37	3.5
2028.00	BWR	7.34	10.00	42689.26	3.5
2028.00	BWR	7.19	10.00	43110.00	3.5
2028.00	BWR	7.19	10.00	43110.00	3.5
2028.00	BWR	7.33	10.00	43535.00	3.8
2028.00	BWR	7.41	10.00	43535.00	3.8
2028.00	BWR	7.41	10.00	43535.00	3.8
2028.00	BWR	7.40	10.00	43535.86	3.8
2028.00	BWR	7.30	10.00	43542.00	3.5
2028.00	BWR	7.30	10.00	43542.00	3.5
2028.00	BWR	7.18	10.00	44328.47	3.6
2028.00	BWR	7.37	8.34	38157.67	3.5
2028.00	BWR	7.37	8.00	37854.87	3.4

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2028.00	BWR	7.36	8.00	37939.00	3.5
2028.00	BWR	7.15	7.56	39049.12	3.4
2028.00	BWR	6.90	7.00	42914.00	3.8
2028.00	BWR	6.90	7.00	42914.00	3.8
2028.00	BWR	6.90	7.00	42914.00	3.8
2028.00	BWR	6.90	7.00	42914.00	3.8
2028.00	BWR	7.06	7.00	43268.78	3.8
2028.00	BWR	7.07	7.00	43287.00	3.8
2028.00	BWR	7.09	7.00	44542.75	3.7
2028.00	BWR	7.10	7.00	45017.00	3.6
2028.00	BWR	7.10	7.00	45017.00	3.6
2028.00	BWR	7.08	6.90	41655.38	3.6
2028.00	BWR	6.91	6.00	11912.88	3.5
2028.00	BWR	6.91	6.00	13700.00	3.5
2028.00	BWR	6.91	6.00	13700.00	3.5
2028.00	BWR	6.91	6.00	20621.72	3.5
2028.00	BWR	6.98	6.00	23103.01	3.5
2028.00	BWR	7.35	6.00	35981.41	3.3
2028.00	BWR	7.03	6.00	37568.70	3.5
2028.00	BWR	7.08	6.00	42933.00	3.5
2028.00	BWR	7.08	6.00	42933.00	3.5
2028.00	BWR	7.08	6.00	42933.00	3.5
2028.00	BWR	7.08	6.00	42933.00	3.5
2028.00	BWR	7.02	6.00	42949.37	3.5
2028.00	BWR	6.81	6.00	43008.00	3.4
2028.00	BWR	6.83	6.00	43037.93	3.5
2028.00	BWR	6.95	5.80	41956.89	3.8
2028.00	BWR	7.11	5.00	37254.37	3.8
2028.00	BWR	7.08	5.00	37559.00	3.5
2028.00	BWR	7.08	5.00	37559.00	3.5
2028.00	BWR	7.08	5.00	40810.06	3.7
2028.00	BWR	7.07	5.00	44413.00	3.9
2028.00	BWR	7.07	5.00	44413.00	3.9
2028.00	BWR	9.27	15.28	45441.03	4.3
2028.00	PWR	8.23	56.00	17955.00	2.8
2028.00	PWR	8.26	56.00	19823.16	2.7
2028.00	PWR	8.36	56.00	21081.58	2.5
2028.00	PWR	8.26	55.35	22165.43	2.8
2028.00	PWR	8.10	54.00	26898.32	3.2
2028.00	PWR	8.17	54.00	29511.85	3.0
2028.00	PWR	8.47	53.32	15956.38	3.0
2028.00	PWR	8.61	53.00	9368.00	3.0
2028.00	PWR	8.64	53.00	10558.83	2.1
2028.00	PWR	9.50	53.00	15188.06	1.8
2028.00	PWR	5.18	53.00	17269.58	2.1
2028.00	PWR	8.28	53.00	24582.79	2.9
2028.00	PWR	8.44	52.28	21488.43	2.6

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2028.00	PWR	8.49	52.00	24015.11	2.6
2028.00	PWR	8.21	51.24	20753.14	2.2
2028.00	PWR	8.28	51.00	28504.56	2.9
2028.00	PWR	8.37	51.00	30108.82	3.1
2028.00	PWR	8.40	51.00	30281.56	3.0
2028.00	PWR	8.41	51.00	30532.00	3.0
2028.00	PWR	9.67	50.04	23980.94	2.8
2028.00	PWR	9.32	50.00	25711.74	3.0
2028.00	PWR	7.94	50.00	26677.00	2.9
2028.00	PWR	7.76	50.00	26682.12	2.5
2028.00	PWR	7.73	50.00	26683.00	2.5
2028.00	PWR	7.73	50.00	26683.00	2.5
2028.00	PWR	7.89	50.00	27970.15	2.6
2028.00	PWR	8.08	50.00	33295.62	3.2
2028.00	PWR	9.15	49.34	27504.38	2.7
2028.00	PWR	9.70	49.00	27051.22	2.7
2028.00	PWR	9.57	49.00	28882.33	2.6
2028.00	PWR	9.59	49.00	30527.19	2.6
2028.00	PWR	8.58	49.00	31499.11	3.1
2028.00	PWR	9.49	48.08	25577.40	2.7
2028.00	PWR	9.08	48.00	29385.47	2.9
2028.00	PWR	8.98	48.00	31214.00	2.9
2028.00	PWR	9.50	48.00	33583.47	3.0
2028.00	PWR	9.56	47.18	29147.58	2.7
2028.00	PWR	9.25	47.00	27166.92	2.5
2028.00	PWR	7.70	47.00	30498.63	2.9
2028.00	PWR	8.21	46.58	31922.11	3.0
2028.00	PWR	9.14	46.00	30440.74	2.9
2028.00	PWR	9.60	46.00	30674.00	2.8
2028.00	PWR	9.60	46.00	30674.00	2.8
2028.00	PWR	8.96	46.00	32530.69	3.1
2028.00	PWR	9.46	46.00	33036.00	3.2
2028.00	PWR	8.97	46.00	34447.18	3.2
2028.00	PWR	9.20	46.00	37546.55	3.1
2028.00	PWR	3.17	45.28	29489.39	2.9
2028.00	PWR	9.72	45.00	29717.58	3.0
2028.00	PWR	9.59	45.00	31965.80	2.9
2028.00	PWR	9.59	45.00	32688.00	2.9
2028.00	PWR	9.60	45.00	32762.35	3.2
2028.00	PWR	9.64	45.00	32875.00	3.1
2028.00	PWR	9.41	44.68	35805.05	2.8
2028.00	PWR	9.09	44.00	31626.28	2.9
2028.00	PWR	9.66	43.04	30950.25	3.0
2028.00	PWR	9.47	42.00	28856.51	2.9
2028.00	PWR	9.06	42.00	31371.00	2.9
2028.00	PWR	9.06	41.90	30886.46	2.9
2028.00	PWR	9.16	40.80	31946.75	2.9

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2028.00	PWR	9.65	40.00	37937.27	3.2
2028.00	PWR	9.28	39.50	34311.86	3.2
2028.00	PWR	9.01	38.95	33334.23	3.3
2028.00	PWR	9.06	38.00	37072.21	3.3
2028.00	PWR	8.94	38.00	39000.00	3.3
2028.00	PWR	8.90	37.29	29972.43	3.3
2028.00	PWR	8.88	37.00	35000.00	3.4
2028.00	PWR	9.50	37.00	35732.72	3.3
2028.00	PWR	9.05	37.00	36000.00	3.4
2028.00	PWR	8.88	37.00	36000.00	3.5
2028.00	PWR	9.41	37.00	36936.14	3.8
2028.00	PWR	9.74	37.00	38000.00	3.7
2028.00	PWR	9.25	37.00	41841.20	3.5
2028.00	PWR	8.88	36.10	38714.29	3.3
2028.00	PWR	8.91	36.00	39000.00	3.6
2028.00	PWR	8.92	36.00	45382.16	3.8
2028.00	PWR	9.27	35.82	41622.17	3.7
2028.00	PWR	10.42	35.00	29299.04	3.3
2028.00	PWR	8.88	35.00	33285.71	3.7
2028.00	PWR	8.88	35.00	35142.86	3.5
2028.00	PWR	8.88	35.00	36000.00	3.6
2028.00	PWR	8.89	35.00	36096.09	3.6
2028.00	PWR	8.87	35.00	43674.97	3.6
2028.00	PWR	9.00	34.94	45150.50	3.5
2028.00	PWR	11.37	34.00	35000.00	3.1
2028.00	PWR	10.97	34.00	35372.61	3.2
2028.00	PWR	8.87	34.00	47282.47	3.9
2028.00	PWR	10.89	33.16	34493.44	3.7
2028.00	PWR	11.09	32.74	35545.00	3.5
2028.00	PWR	11.36	31.00	46000.00	4.0
2028.00	PWR	8.47	30.00	35000.00	3.1
2028.00	PWR	8.47	30.00	35000.00	3.1
2028.00	PWR	9.58	25.75	42831.32	3.9
2028.00	PWR	9.84	25.00	46087.26	3.7
2028.00	PWR	9.49	24.15	42982.82	3.8
2028.00	PWR	9.39	22.90	38849.13	3.7
2028.00	PWR	9.59	21.00	40803.50	4.0
2028.00	PWR	9.74	21.00	63667.52	4.4
2028.00	PWR	9.37	20.15	52137.54	4.6
2028.00	PWR	9.30	20.00	49732.00	4.6
2028.00	PWR	9.30	20.00	49732.00	4.6
2028.00	PWR	9.31	19.81	49058.39	4.5
2028.00	PWR	9.50	16.00	35870.00	3.8
2028.00	PWR	9.56	16.00	40665.32	4.2
2028.00	PWR	9.49	15.82	60538.10	4.5
2028.00	PWR	9.77	15.00	51674.00	4.5
2028.00	PWR	9.75	15.00	55773.39	4.6

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2028.00	PWR	9.66	13.19	44298.69	4.0
2028.00	PWR	9.28	13.00	49380.66	4.5
2028.00	PWR	9.66	13.00	55990.00	4.4
2028.00	PWR	8.32	13.00	56802.46	5.6
2028.00	PWR	8.17	13.00	60042.25	5.8
2028.00	PWR	8.01	13.00	64267.00	6.1
2028.00	PWR	8.94	12.38	39827.89	5.1
2028.00	PWR	9.64	12.00	24180.00	4.5
2028.00	PWR	9.64	12.00	25149.43	4.2
2028.00	PWR	9.60	12.00	25853.41	4.4
2028.00	PWR	9.58	12.00	48410.62	4.9
2028.00	PWR	9.58	12.00	49518.00	4.9
2028.00	PWR	9.70	11.24	32970.92	4.4
2028.00	PWR	9.74	11.00	27919.08	4.3
2028.00	PWR	9.74	11.00	33562.42	4.3
2028.00	PWR	9.78	11.00	39654.76	4.3
2028.00	PWR	9.83	11.00	42885.00	4.2
2028.00	PWR	9.82	11.00	43063.68	4.2
2028.00	PWR	9.68	11.00	45597.37	4.4
2028.00	PWR	9.64	11.00	46350.00	4.0
2028.00	PWR	9.66	11.00	47897.85	4.5
2028.00	PWR	9.70	11.00	48842.26	4.6
2028.00	PWR	9.56	11.00	51350.21	4.7
2028.00	PWR	8.77	11.00	55754.46	4.8
2028.00	PWR	8.90	11.00	57671.34	4.8
2028.00	PWR	9.72	11.00	58873.45	4.9
2028.00	PWR	9.65	11.00	59871.00	4.7
2028.00	PWR	9.75	11.00	59871.00	5.1
2028.00	PWR	9.45	11.00	60206.51	5.1
2028.00	PWR	8.39	10.75	54305.71	4.9
2028.00	PWR	8.77	10.00	18636.00	4.2
2028.00	PWR	8.48	10.00	20785.00	4.5
2028.00	PWR	9.01	10.00	23910.66	4.5
2028.00	PWR	9.35	10.00	28764.73	4.4
2028.00	PWR	8.48	10.00	29099.00	4.6
2028.00	PWR	9.50	10.00	29362.09	4.3
2028.00	PWR	9.37	10.00	39082.82	4.3
2028.00	PWR	9.06	10.00	43281.55	4.3
2028.00	PWR	8.89	10.00	44681.41	4.0
2028.00	PWR	8.38	10.00	44940.00	3.7
2028.00	PWR	8.78	10.00	45187.88	4.1
2028.00	PWR	8.63	10.00	45551.79	4.2
2028.00	PWR	8.43	10.00	45858.86	4.6
2028.00	PWR	8.45	10.00	45879.00	4.6
2028.00	PWR	8.79	10.00	46144.99	4.3
2028.00	PWR	8.93	10.00	46224.00	4.3
2028.00	PWR	8.97	10.00	46224.00	4.4

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2028.00	PWR	8.65	10.00	46390.85	4.3
2028.00	PWR	8.68	10.00	47106.09	4.6
2028.00	PWR	9.13	10.00	47738.77	4.6
2028.00	PWR	8.53	10.00	48395.63	4.3
2028.00	PWR	8.54	10.00	48681.00	4.0
2028.00	PWR	8.54	10.00	48681.00	4.0
2028.00	PWR	8.86	10.00	48824.14	4.5
2028.00	PWR	9.80	10.00	49595.00	4.3
2028.00	PWR	9.15	10.00	50092.88	4.4
2028.00	PWR	8.87	10.00	50711.00	4.5
2028.00	PWR	9.49	10.00	50728.38	4.5
2028.00	PWR	9.65	10.00	50834.27	4.5
2028.00	PWR	8.89	10.00	51783.00	4.7
2028.00	PWR	8.83	10.00	52096.24	5.1
2028.00	PWR	8.61	10.00	52222.30	4.6
2028.00	PWR	8.60	10.00	52886.98	4.4
2028.00	PWR	8.75	10.00	53494.12	4.7
2028.00	PWR	9.29	10.00	54664.85	4.9
2028.00	PWR	9.03	10.00	54960.19	4.5
2028.00	PWR	9.62	10.00	55625.24	4.7
2028.00	PWR	9.93	10.00	55730.61	4.9
2028.00	PWR	9.18	10.00	55857.74	4.7
2028.00	PWR	8.79	10.00	55900.79	4.7
2028.00	PWR	8.78	10.00	55982.63	4.8
2028.00	PWR	8.95	10.00	56213.09	4.6
2028.00	PWR	8.97	10.00	56835.00	5.1
2028.00	PWR	8.43	10.00	58267.52	4.8
2028.00	PWR	9.70	10.00	59608.03	4.8
2028.00	PWR	9.22	10.00	59984.46	4.8
2028.00	PWR	8.83	10.00	60347.00	4.8
2028.00	PWR	8.52	10.00	60631.58	4.7
2028.00	2	9.60	10.00	60935.75	5.2
2028.00	2	9.66	10.00	62683.31	5.2
2028.00	2	9.31	10.00	64931.27	5.2
2028.00	2	9.10	10.00	66594.05	5.3
2028.00	2	9.54	8.23	27673.34	4.7
2028.00	2	9.84	8.00	37259.64	4.8
2028.00	2	9.49	7.24	54956.90	4.4
2028.00	2	9.38	6.62	54221.04	4.3
2029.00	BWR	7.14	24.21	30182.32	3.1
2029.00	BWR	7.65	57.00	3911.00	1.7
2029.00	BWR	7.65	57.00	3911.00	1.7
2029.00	BWR	7.67	57.00	3973.17	1.9
2029.00	BWR	7.71	57.00	4076.00	2.1
2029.00	BWR	7.74	56.25	5525.79	2.1
2029.00	BWR	7.75	56.00	6043.63	2.2
2029.00	BWR	7.70	55.35	8561.68	2.2

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2029.00	BWR	7.75	55.00	9302.27	2.2
2029.00	BWR	7.68	55.00	10551.91	2.2
2029.00	BWR	7.67	55.00	11374.00	2.1
2029.00	BWR	7.71	55.00	11752.25	2.2
2029.00	BWR	7.72	55.00	12289.52	2.2
2029.00	BWR	7.74	55.00	13009.80	2.3
2029.00	BWR	7.73	54.70	12507.24	2.2
2029.00	BWR	7.67	54.00	11811.00	2.1
2029.00	BWR	7.67	54.00	11811.00	2.1
2029.00	BWR	7.73	54.00	12214.08	2.1
2029.00	BWR	7.75	54.00	12347.00	2.1
2029.00	BWR	7.75	54.00	12377.37	2.1
2029.00	BWR	7.81	54.00	13710.40	2.2
2029.00	BWR	7.74	54.00	15390.57	2.3
2029.00	BWR	7.74	54.00	16289.42	2.3
2029.00	BWR	7.74	54.00	16642.00	2.2
2029.00	BWR	7.74	54.00	16642.00	2.2
2029.00	BWR	7.74	54.00	16642.00	2.2
2029.00	BWR	7.74	54.00	17062.31	2.3
2029.00	BWR	7.74	54.00	17969.29	2.3
2029.00	BWR	7.74	54.00	18944.00	2.3
2029.00	BWR	7.71	53.33	13812.50	2.2
2029.00	BWR	7.70	53.00	11291.00	2.2
2029.00	BWR	7.70	53.00	11980.30	2.2
2029.00	BWR	7.66	53.00	15552.92	2.1
2029.00	BWR	7.68	53.00	16054.20	2.1
2029.00	BWR	7.66	53.00	16280.25	2.1
2029.00	BWR	7.66	53.00	16579.00	2.1
2029.00	BWR	7.66	53.00	16579.00	2.1
2029.00	BWR	7.66	53.00	16583.27	2.1
2029.00	BWR	7.74	53.00	16748.00	2.1
2029.00	BWR	7.74	53.00	16748.00	2.1
2029.00	BWR	7.74	53.00	16748.00	2.1
2029.00	BWR	7.59	53.00	18507.00	2.2
2029.00	BWR	7.59	53.00	18507.00	2.2
2029.00	BWR	7.65	52.55	17590.01	2.2
2029.00	BWR	7.72	52.00	16488.00	2.2
2029.00	BWR	7.72	52.00	16488.00	2.2
2029.00	BWR	7.72	52.00	16488.00	2.2
2029.00	BWR	7.72	52.00	16488.00	2.2
2029.00	BWR	7.72	52.00	16488.00	2.2
2029.00	BWR	7.52	52.00	18040.20	2.2
2029.00	BWR	7.40	52.00	19013.29	2.2
2029.00	BWR	7.73	52.00	19494.00	2.1
2029.00	BWR	7.73	52.00	19494.00	2.1
2029.00	BWR	7.73	52.00	19494.00	2.1
2029.00	BWR	7.73	52.00	19494.00	2.1

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2029.00	BWR	3.91	51.05	5195.27	2.2
2029.00	BWR	3.89	51.00	6486.91	2.2
2029.00	BWR	6.31	51.00	17867.40	2.2
2029.00	BWR	7.68	51.00	21575.36	2.1
2029.00	BWR	7.74	51.00	21906.00	2.1
2029.00	BWR	7.74	51.00	21906.00	2.1
2029.00	BWR	7.74	51.00	21906.00	2.1
2029.00	BWR	7.71	51.00	22212.08	2.1
2029.00	BWR	7.63	51.00	23031.00	2.1
2029.00	BWR	7.63	51.00	23031.00	2.1
2029.00	BWR	7.63	51.00	23031.00	2.1
2029.00	BWR	7.68	50.27	23808.72	2.1
2029.00	BWR	7.73	50.00	24179.00	2.1
2029.00	BWR	7.73	50.00	24179.00	2.1
2029.00	BWR	7.73	50.00	24179.00	2.1
2029.00	BWR	7.73	50.00	24179.00	2.1
2029.00	BWR	7.77	50.00	25371.63	2.1
2029.00	BWR	7.76	50.00	25559.00	2.1
2029.00	BWR	7.76	50.00	25559.00	2.1
2029.00	BWR	7.76	50.00	25559.00	2.1
2029.00	BWR	7.75	49.60	24182.51	2.1
2029.00	BWR	7.70	49.00	22482.00	2.1
2029.00	BWR	7.70	49.00	22482.00	2.1
2029.00	BWR	7.70	49.00	22482.00	2.1
2029.00	BWR	7.73	49.00	22650.34	2.1
2029.00	BWR	7.73	49.00	22699.00	2.1
2029.00	BWR	7.73	49.00	22699.00	2.1
2029.00	BWR	7.72	49.00	22719.06	2.1
2029.00	BWR	7.50	49.00	23494.45	2.3
2029.00	BWR	7.35	49.00	26064.39	2.5
2029.00	BWR	7.40	49.00	30322.79	2.4
2029.00	BWR	3.17	48.47	24146.58	2.2
2029.00	BWR	7.36	48.00	25028.00	2.7
2029.00	BWR	7.56	48.00	25238.93	2.6
2029.00	BWR	7.43	48.00	26590.63	2.5
2029.00	BWR	7.36	47.52	22390.23	2.2
2029.00	BWR	7.48	47.00	24566.18	2.5
2029.00	BWR	7.46	47.00	24665.60	2.5
2029.00	BWR	7.35	47.00	24702.00	2.5
2029.00	BWR	7.35	47.00	24983.03	2.6
2029.00	BWR	7.36	47.00	26590.51	2.6
2029.00	BWR	7.35	47.00	28808.87	2.6
2029.00	BWR	7.32	46.70	28559.20	2.8
2029.00	BWR	7.33	46.00	23360.00	2.7
2029.00	BWR	7.33	46.00	27526.74	2.8
2029.00	BWR	7.30	45.33	29242.15	2.9
2029.00	BWR	7.29	45.00	29000.00	2.9

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2029.00	BWR	7.31	43.49	24106.97	2.5
2029.00	BWR	7.33	41.00	16000.00	1.8
2029.00	BWR	7.33	41.00	16000.00	1.8
2029.00	BWR	7.33	40.73	22623.76	2.1
2029.00	BWR	7.33	39.77	27454.19	2.3
2029.00	BWR	7.29	27.63	29903.19	3.1
2029.00	BWR	7.25	24.00	28704.00	3.2
2029.00	BWR	7.28	22.25	37781.16	3.2
2029.00	BWR	7.28	22.00	37816.00	3.2
2029.00	BWR	7.21	19.42	38585.52	3.4
2029.00	BWR	7.09	15.00	41251.47	3.6
2029.00	BWR	7.09	15.00	42743.00	3.6
2029.00	BWR	7.09	15.00	42878.08	3.6
2029.00	BWR	7.09	15.00	43720.29	3.6
2029.00	BWR	7.09	15.00	46252.00	3.6
2029.00	BWR	7.31	14.41	45709.58	3.8
2029.00	BWR	7.48	14.00	44700.00	3.8
2029.00	BWR	7.48	14.00	44700.00	3.8
2029.00	BWR	7.40	13.66	38892.54	3.7
2029.00	BWR	7.26	13.00	27784.00	3.3
2029.00	BWR	7.27	13.00	28211.90	3.3
2029.00	BWR	7.26	13.00	32988.00	3.3
2029.00	BWR	7.26	13.00	34707.91	3.4
2029.00	BWR	7.43	13.00	42216.85	3.6
2029.00	BWR	7.48	13.00	43850.00	3.7
2029.00	BWR	7.48	13.00	43850.00	3.7
2029.00	BWR	7.43	10.68	42780.42	3.8
2029.00	BWR	7.41	10.00	42467.00	3.8
2029.00	BWR	7.41	10.00	42467.00	3.8
2029.00	BWR	7.41	10.00	42467.00	3.8
2029.00	BWR	7.40	8.27	39446.48	3.6
2029.00	BWR	7.39	7.00	37745.16	3.4
2029.00	BWR	7.38	7.00	37829.00	3.5
2029.00	BWR	7.11	7.00	40684.76	3.5
2029.00	BWR	6.93	7.00	43177.00	3.8
2029.00	BWR	6.93	7.00	43177.00	3.8
2029.00	BWR	6.93	7.00	43177.00	3.8
2029.00	BWR	7.10	6.32	37336.70	3.4
2029.00	BWR	7.38	6.00	35904.34	3.3
2029.00	BWR	7.32	6.00	38176.85	3.4
2029.00	BWR	7.26	6.00	39092.00	3.4
2029.00	BWR	7.26	6.00	39092.00	3.4
2029.00	BWR	7.21	6.00	39806.90	3.5
2029.00	BWR	6.92	5.95	42388.19	3.8
2029.00	BWR	7.04	5.00	11211.00	2.7
2029.00	BWR	7.04	5.00	11211.00	2.7
2029.00	BWR	7.07	5.00	16393.95	2.6

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2029.00	BWR	6.81	5.00	41328.05	3.3
2029.00	BWR	6.81	5.00	41471.00	3.3
2029.00	BWR	6.81	5.00	41471.00	3.3
2029.00	PWR	9.34	19.27	39841.75	4.2
2029.00	PWR	8.44	54.81	9816.61	3.2
2029.00	PWR	8.60	54.00	12430.27	2.8
2029.00	PWR	8.66	54.00	13050.00	2.4
2029.00	PWR	8.66	54.00	13050.00	2.4
2029.00	PWR	8.45	54.00	13661.25	2.4
2029.00	PWR	9.26	53.12	18382.39	2.3
2029.00	PWR	9.55	53.00	18723.00	2.2
2029.00	PWR	8.93	53.00	18723.00	2.3
2029.00	PWR	8.24	52.00	17989.93	2.0
2029.00	PWR	8.18	52.00	18042.00	1.9
2029.00	PWR	8.50	52.00	20189.32	2.0
2029.00	PWR	8.85	51.46	19907.76	1.9
2029.00	PWR	8.43	51.00	13003.00	1.5
2029.00	PWR	8.43	51.00	13003.00	1.5
2029.00	PWR	8.39	51.00	17297.49	2.0
2029.00	PWR	7.74	51.00	26293.00	3.0
2029.00	PWR	8.25	51.00	30532.83	3.0
2029.00	PWR	8.34	51.00	33464.86	3.3
2029.00	PWR	8.32	51.00	35470.17	3.4
2029.00	PWR	8.42	51.00	35722.00	3.4
2029.00	PWR	9.15	50.39	27721.67	2.8
2029.00	PWR	9.70	50.00	23025.86	2.3
2029.00	PWR	9.03	50.00	24688.74	2.0
2029.00	PWR	8.29	50.00	25785.00	2.0
2029.00	PWR	8.87	50.00	26491.31	2.5
2029.00	PWR	9.51	50.00	27853.46	2.6
2029.00	PWR	8.65	50.00	28471.69	2.8
2029.00	PWR	8.11	50.00	28593.00	3.1
2029.00	PWR	8.69	50.00	29408.30	2.8
2029.00	PWR	9.47	50.00	30663.16	2.9
2029.00	PWR	9.59	50.00	31509.83	2.9
2029.00	PWR	9.48	49.05	26499.39	2.8
2029.00	PWR	7.97	49.00	28237.72	2.8
2029.00	PWR	9.32	49.00	31527.88	3.1
2029.00	PWR	9.50	49.00	31803.00	3.1
2029.00	PWR	8.68	49.00	32704.37	3.1
2029.00	PWR	8.07	48.37	23836.20	2.9
2029.00	PWR	9.06	48.00	30699.69	2.9
2029.00	PWR	9.00	48.00	31304.00	2.9
2029.00	PWR	9.00	48.00	31304.00	2.9
2029.00	PWR	9.19	48.00	31726.79	2.9
2029.00	PWR	9.58	48.00	31908.00	2.8
2029.00	PWR	9.10	48.00	32236.19	2.9

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2029.00	PWR	8.56	48.00	32831.32	3.1
2029.00	PWR	9.75	47.38	31219.20	3.1
2029.00	PWR	9.75	47.00	32514.93	3.0
2029.00	PWR	5.18	46.69	38908.06	3.1
2029.00	PWR	8.84	46.00	28903.51	2.9
2029.00	PWR	9.75	46.00	30673.81	2.9
2029.00	PWR	7.80	46.00	31224.55	3.0
2029.00	PWR	9.21	46.00	32300.99	3.2
2029.00	PWR	9.63	46.00	32857.27	3.1
2029.00	PWR	9.62	46.00	34025.88	3.2
2029.00	PWR	8.80	45.69	32575.53	2.8
2029.00	PWR	9.63	45.00	26139.24	3.0
2029.00	PWR	9.34	44.84	30145.22	3.4
2029.00	PWR	7.78	44.00	29579.00	4.0
2029.00	PWR	7.78	44.00	29579.00	4.0
2029.00	PWR	8.46	44.00	34178.28	3.4
2029.00	PWR	8.35	44.00	37813.91	3.5
2029.00	PWR	8.17	44.00	42112.00	3.7
2029.00	PWR	9.36	43.08	22480.61	2.5
2029.00	PWR	9.63	43.00	28999.78	3.1
2029.00	PWR	9.65	43.00	31264.00	3.4
2029.00	PWR	9.21	43.00	32793.02	3.6
2029.00	PWR	8.95	42.00	33370.56	3.8
2029.00	PWR	8.66	42.00	34231.00	4.0
2029.00	PWR	8.85	42.00	34566.95	3.8
2029.00	PWR	9.67	42.00	37319.49	3.3
2029.00	PWR	9.65	42.00	38637.00	3.2
2029.00	PWR	9.46	41.73	35209.77	3.1
2029.00	PWR	9.38	40.82	36113.86	3.2
2029.00	PWR	8.94	39.13	34085.53	3.3
2029.00	PWR	8.95	39.00	35000.00	3.8
2029.00	PWR	8.95	39.00	35000.00	3.9
2029.00	PWR	8.65	39.00	38294.43	3.6
2029.00	PWR	7.61	38.33	38648.15	3.6
2029.00	PWR	8.88	37.00	35000.00	3.6
2029.00	PWR	8.88	37.00	35000.00	3.6
2029.00	PWR	8.75	37.00	35855.04	3.3
2029.00	PWR	8.66	37.00	36142.86	3.4
2029.00	PWR	8.80	37.00	37286.48	3.8
2029.00	PWR	8.70	36.24	39172.98	3.7
2029.00	PWR	8.70	36.00	38000.00	3.7
2029.00	PWR	8.96	36.00	39476.14	3.8
2029.00	PWR	8.96	36.00	41000.00	3.9
2029.00	PWR	8.83	36.00	42128.97	3.9
2029.00	PWR	8.90	36.00	46000.00	3.9
2029.00	PWR	8.68	36.00	46479.92	3.9
2029.00	PWR	8.90	35.23	39838.98	3.8

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2029.00	PWR	8.97	34.88	43639.08	3.7
2029.00	PWR	8.88	34.00	38761.91	3.9
2029.00	PWR	8.88	34.00	40190.48	4.0
2029.00	PWR	8.88	34.00	42000.00	3.8
2029.00	PWR	8.22	15.80	64408.25	5.7
2029.00	PWR	8.94	13.38	41441.30	4.9
2029.00	PWR	9.64	13.00	45107.19	4.8
2029.00	PWR	9.64	13.00	46325.97	4.8
2029.00	PWR	8.68	13.00	52039.20	4.7
2029.00	PWR	8.10	13.00	54950.02	4.6
2029.00	PWR	8.02	13.00	57855.52	4.2
2029.00	PWR	7.86	13.00	59196.61	4.8
2029.00	PWR	7.80	13.00	59563.00	5.0
2029.00	PWR	8.54	12.57	58182.59	5.0
2029.00	PWR	9.74	12.00	56591.00	4.7
2029.00	PWR	9.74	12.00	57271.36	4.7
2029.00	PWR	8.82	11.05	22153.94	4.3
2029.00	PWR	8.77	11.00	24664.00	4.2
2029.00	PWR	8.51	11.00	29282.24	4.6
2029.00	PWR	8.63	11.00	39283.20	4.6
2029.00	PWR	8.48	11.00	41569.00	4.8
2029.00	PWR	9.04	11.00	45768.07	4.6
2029.00	PWR	8.72	11.00	47569.86	4.5
2029.00	PWR	9.43	11.00	50045.99	4.8
2029.00	PWR	9.70	11.00	53224.43	4.8
2029.00	PWR	9.20	11.00	56820.48	4.9
2029.00	PWR	9.82	11.00	58722.00	5.0
2029.00	PWR	9.83	11.00	58722.00	5.0
2029.00	PWR	9.85	11.00	58722.00	5.1
2029.00	PWR	8.74	11.00	61100.03	4.8
2029.00	PWR	9.32	11.00	64753.53	5.1
2029.00	PWR	9.54	10.00	36789.43	3.8
2029.00	PWR	9.49	10.00	36853.95	4.1
2029.00	PWR	9.64	10.00	36862.00	4.0
2029.00	PWR	9.26	10.00	39143.58	4.2
2029.00	PWR	8.85	10.00	43032.07	4.2
2029.00	PWR	8.89	10.00	43312.00	4.4
2029.00	PWR	10.60	10.00	43520.54	4.8
2029.00	PWR	8.99	10.00	44086.00	4.2
2029.00	PWR	8.54	10.00	44543.32	3.8
2029.00	PWR	8.45	10.00	44669.02	3.8
2029.00	PWR	8.80	10.00	44929.79	4.6
2029.00	PWR	8.74	10.00	45143.00	4.4
2029.00	PWR	8.74	10.00	45316.13	4.4
2029.00	PWR	8.73	10.00	45725.02	4.4
2029.00	PWR	8.91	10.00	46084.25	4.3
2029.00	PWR	9.68	10.00	46135.00	4.0

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2029.00	PWR	9.33	10.00	46146.39	4.2
2029.00	PWR	8.83	10.00	46200.95	4.5
2029.00	PWR	8.52	10.00	46576.00	4.7
2029.00	PWR	8.53	10.00	46639.02	4.7
2029.00	PWR	9.28	10.00	48217.23	4.7
2029.00	PWR	9.61	10.00	48680.00	4.7
2029.00	PWR	9.20	10.00	48929.02	4.5
2029.00	PWR	8.40	10.00	49499.00	4.1
2029.00	PWR	8.52	10.00	49515.52	4.1
2029.00	PWR	9.71	10.00	49681.66	4.7
2029.00	PWR	8.95	10.00	50031.01	4.6
2029.00	PWR	8.66	10.00	50570.27	4.3
2029.00	PWR	9.04	10.00	50701.73	4.4
2029.00	PWR	9.33	10.00	50914.92	4.7
2029.00	PWR	8.79	10.00	51187.00	4.5
2029.00	PWR	9.36	10.00	51192.98	4.5
2029.00	PWR	9.70	10.00	51200.17	4.5
2029.00	PWR	8.98	10.00	51233.00	4.6
2029.00	PWR	9.61	10.00	51448.94	4.8
2029.00	PWR	9.39	10.00	51474.79	4.9
2029.00	PWR	8.90	10.00	51509.00	5.0
2029.00	PWR	8.88	10.00	51717.12	5.0
2029.00	PWR	8.78	10.00	52031.69	4.8
2029.00	PWR	9.22	10.00	53349.34	4.2
2029.00	PWR	8.96	10.00	54172.00	4.6
2029.00	PWR	9.30	10.00	54175.24	4.8
2029.00	PWR	9.20	10.00	54375.55	4.8
2029.00	PWR	9.51	10.00	54861.64	4.7
2029.00	PWR	9.69	10.00	54907.91	4.8
2029.00	PWR	9.25	10.00	54937.00	4.8
2029.00	PWR	9.25	10.00	54937.00	4.8
2029.00	PWR	9.25	10.00	54937.00	4.8
2029.00	PWR	9.22	10.00	54945.50	4.7
2029.00	PWR	8.95	10.00	55029.00	4.6
2029.00	PWR	8.84	10.00	55436.23	4.7
2029.00	PWR	8.91	10.00	55982.15	4.9
2029.00	PWR	9.28	10.00	56252.95	5.1
2029.00	PWR	9.10	10.00	56433.32	4.8
2029.00	PWR	8.33	10.00	56690.10	4.7
2029.00	PWR	9.22	10.00	57132.67	4.9
2029.00	PWR	9.74	10.00	57442.78	5.2
2029.00	PWR	9.57	10.00	58044.38	4.7
2029.00	PWR	9.56	10.00	58467.75	4.3
2029.00	PWR	11.40	10.00	58812.38	4.7
2029.00	PWR	11.50	10.00	58827.00	4.8
2029.00	PWR	9.68	10.00	58928.00	5.0
2029.00	PWR	8.93	10.00	59402.14	4.8

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2029.00	PWR	9.66	10.00	59707.00	4.6
2029.00	PWR	9.77	10.00	59707.00	5.1
2029.00	PWR	9.65	10.00	59769.14	5.1
2029.00	PWR	9.63	10.00	60463.28	5.2
2029.00	PWR	9.69	10.00	60533.77	5.2
2029.00	PWR	9.23	10.00	62864.20	5.0
2029.00	PWR	8.96	10.00	64727.27	5.0
2029.00	PWR	8.96	10.00	65296.99	4.9
2029.00	PWR	9.83	10.00	65718.88	5.1
2029.00	PWR	8.63	10.00	66955.33	5.1
2029.00	PWR	9.09	10.00	67360.98	5.1
2029.00	PWR	9.14	10.00	68086.46	4.8
2029.00	PWR	9.55	9.76	59913.21	4.8
2029.00	PWR	9.64	9.00	28063.00	4.6
2029.00	PWR	9.64	9.00	28063.00	4.6
2029.00	PWR	9.82	9.00	51540.29	4.7
2029.00	PWR	9.65	9.00	60654.34	5.1
2029.00	PWR	9.68	8.00	57702.77	4.7
2029.00	PWR	9.75	7.00	53372.78	4.1
2029.00	PWR	9.58	5.48	50506.13	4.3
2030.00	BWR	6.84	33.34	21012.11	2.9
2030.00	BWR	7.70	59.37	1107.30	2.1
2030.00	BWR	7.72	59.00	1574.40	2.1
2030.00	BWR	7.73	59.00	1576.00	2.1
2030.00	BWR	7.73	59.00	1576.00	2.1
2030.00	BWR	7.73	59.00	1576.00	2.1
2030.00	BWR	6.56	59.00	2815.28	2.1
2030.00	BWR	4.20	58.55	11422.25	2.1
2030.00	BWR	7.71	58.00	4076.00	2.1
2030.00	BWR	7.71	58.00	4076.00	2.1
2030.00	BWR	7.71	58.00	4076.00	2.1
2030.00	BWR	7.71	58.00	4076.00	2.1
2030.00	BWR	7.71	58.00	4076.00	2.1
2030.00	BWR	7.71	58.00	4076.00	2.1
2030.00	BWR	7.71	58.00	4076.00	2.1
2030.00	BWR	7.49	58.00	4362.58	2.2
2030.00	BWR	3.18	58.00	16892.87	2.3
2030.00	BWR	4.45	57.29	13196.78	3.2
2030.00	BWR	3.64	57.00	15790.57	2.8
2030.00	BWR	4.10	56.53	15399.17	3.1
2030.00	BWR	3.98	56.00	15717.93	3.1
2030.00	BWR	2.77	55.11	17553.55	2.4
2030.00	BWR	2.79	54.00	5009.00	2.4
2030.00	BWR	2.92	54.00	8289.13	2.3
2030.00	BWR	2.78	54.00	12754.00	2.4
2030.00	BWR	3.16	54.00	16115.21	2.5
2030.00	BWR	3.48	53.01	14175.88	2.4

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2030.00	BWR	4.05	52.00	10466.00	2.2
2030.00	BWR	4.06	52.00	12069.39	2.2
2030.00	BWR	4.08	52.00	16176.00	2.3
2030.00	BWR	4.08	52.00	16176.00	2.3
2030.00	BWR	4.08	52.00	16176.00	2.3
2030.00	BWR	4.11	52.00	20411.16	2.3
2030.00	BWR	4.17	52.00	21072.94	2.3
2030.00	BWR	4.70	50.82	21498.01	2.2
2030.00	BWR	7.36	47.00	21459.00	2.2
2030.00	BWR	7.36	47.00	21459.00	2.2
2030.00	BWR	7.36	47.00	21459.00	2.2
2030.00	BWR	7.36	47.00	21459.00	2.2
2030.00	BWR	7.35	47.00	21584.67	2.4
2030.00	BWR	7.09	47.00	24560.06	2.5
2030.00	BWR	7.01	47.00	25516.00	2.5
2030.00	BWR	7.00	47.00	26795.87	2.5
2030.00	BWR	6.99	47.00	28935.00	2.5
2030.00	BWR	7.03	46.35	26289.67	2.7
2030.00	BWR	7.06	46.00	24879.00	2.8
2030.00	BWR	7.35	46.00	28206.17	2.7
2030.00	BWR	6.37	45.52	24196.90	3.0
2030.00	BWR	7.31	45.00	21776.00	2.8
2030.00	BWR	7.33	45.00	24452.59	2.8
2030.00	BWR	7.30	45.00	25020.00	2.9
2030.00	BWR	7.22	44.99	24890.77	2.9
2030.00	BWR	5.20	44.00	18180.48	3.2
2030.00	BWR	7.17	44.00	19549.09	2.4
2030.00	BWR	7.15	44.00	21347.56	2.6
2030.00	BWR	7.06	44.00	22975.59	2.8
2030.00	BWR	7.25	44.00	24546.56	2.4
2030.00	BWR	7.00	44.00	25023.00	2.5
2030.00	BWR	7.00	44.00	25023.00	2.5
2030.00	BWR	7.00	44.00	25023.00	2.5
2030.00	BWR	7.05	44.00	25081.07	2.6
2030.00	BWR	7.09	44.00	25133.00	2.7
2030.00	BWR	7.09	44.00	25133.00	2.7
2030.00	BWR	7.23	44.00	25717.89	2.6
2030.00	BWR	7.12	44.00	27948.94	2.8
2030.00	BWR	7.13	44.00	29022.50	2.7
2030.00	BWR	7.06	44.00	29632.00	2.8
2030.00	BWR	7.06	44.00	29632.00	2.8
2030.00	BWR	7.06	44.00	29894.58	2.8
2030.00	BWR	6.33	43.81	25246.08	2.9
2030.00	BWR	4.41	43.00	9981.11	3.7
2030.00	BWR	5.56	43.00	21329.75	3.2
2030.00	BWR	7.06	43.00	24511.00	2.8
2030.00	BWR	7.06	43.00	24511.00	2.8

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2030.00	BWR	7.06	43.00	24511.00	2.8
2030.00	BWR	7.07	43.00	24536.43	2.7
2030.00	BWR	7.34	43.00	25000.00	2.4
2030.00	BWR	7.31	43.00	25000.00	2.8
2030.00	BWR	7.23	43.00	25020.08	2.9
2030.00	BWR	7.31	43.00	25265.00	2.9
2030.00	BWR	7.31	43.00	25265.00	2.9
2030.00	BWR	7.31	43.00	25820.68	2.8
2030.00	BWR	7.07	43.00	28400.00	2.8
2030.00	BWR	7.07	43.00	28400.00	2.8
2030.00	BWR	7.07	43.00	28400.00	2.8
2030.00	BWR	7.07	43.00	28400.00	2.8
2030.00	BWR	7.27	43.00	28575.89	2.9
2030.00	BWR	7.25	43.00	28691.91	2.8
2030.00	BWR	7.09	43.00	28909.00	2.7
2030.00	BWR	7.11	43.00	28994.02	2.7
2030.00	BWR	7.06	42.23	24541.36	2.6
2030.00	BWR	7.00	42.00	24484.00	2.5
2030.00	BWR	7.00	42.00	24484.00	2.5
2030.00	BWR	7.00	42.00	24484.00	2.5
2030.00	BWR	7.03	42.00	25812.79	2.6
2030.00	BWR	7.09	42.00	28000.00	2.6
2030.00	BWR	7.09	42.00	28000.00	2.6
2030.00	BWR	7.08	42.00	28000.00	2.7
2030.00	BWR	7.08	42.00	28000.00	2.7
2030.00	BWR	7.07	42.00	28000.00	2.7
2030.00	BWR	6.93	42.00	28000.00	2.7
2030.00	BWR	6.92	42.00	28000.00	2.8
2030.00	BWR	7.13	41.29	23811.00	2.9
2030.00	BWR	6.48	41.00	25666.07	3.1
2030.00	BWR	7.34	41.00	25929.00	2.9
2030.00	BWR	7.34	41.00	25929.00	2.9
2030.00	BWR	7.08	41.00	27389.98	3.0
2030.00	BWR	7.12	41.00	28000.00	3.0
2030.00	BWR	7.12	41.00	28000.00	3.0
2030.00	BWR	7.12	41.00	28000.00	3.0
2030.00	BWR	7.12	41.00	28000.00	3.0
2030.00	BWR	7.09	41.00	28799.22	2.7
2030.00	BWR	6.97	41.00	30542.37	2.7
2030.00	BWR	6.93	41.00	31000.00	2.7
2030.00	BWR	6.93	41.00	31000.00	2.7
2030.00	BWR	6.99	41.00	32032.28	2.7
2030.00	BWR	7.09	41.00	33715.00	2.8
2030.00	BWR	7.09	41.00	33718.58	2.8
2030.00	BWR	6.78	40.86	32295.57	2.9
2030.00	BWR	6.80	40.00	23962.85	3.1
2030.00	BWR	7.36	40.00	25850.00	2.9

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2030.00	BWR	7.36	40.00	26000.00	2.9
2030.00	BWR	7.37	40.00	26525.41	2.9
2030.00	BWR	7.30	40.00	27025.28	3.0
2030.00	BWR	7.15	40.00	28878.81	2.9
2030.00	BWR	7.09	40.00	30000.00	2.6
2030.00	BWR	7.09	40.00	30000.00	2.6
2030.00	BWR	7.09	40.00	30000.00	2.6
2030.00	BWR	7.09	40.00	30000.00	2.6
2030.00	BWR	7.09	40.00	30050.30	2.6
2030.00	BWR	7.14	40.00	32000.00	2.6
2030.00	BWR	7.07	40.00	32000.00	2.7
2030.00	BWR	6.92	40.00	32000.00	2.8
2030.00	BWR	6.92	40.00	32000.00	2.8
2030.00	BWR	6.92	40.00	32000.00	2.8
2030.00	BWR	6.99	40.00	32356.48	2.8
2030.00	BWR	6.20	39.65	29604.65	2.8
2030.00	BWR	7.03	39.00	24999.94	2.6
2030.00	BWR	7.14	39.00	26000.00	2.4
2030.00	BWR	7.14	39.00	26000.00	2.4
2030.00	BWR	6.64	39.00	26000.00	2.9
2030.00	BWR	6.97	39.00	26924.69	2.7
2030.00	BWR	7.20	39.00	27000.00	2.7
2030.00	BWR	7.14	39.00	28801.33	2.9
2030.00	BWR	7.14	39.00	29000.00	2.8
2030.00	BWR	7.14	39.00	29000.00	2.8
2030.00	BWR	7.12	39.00	29000.00	2.8
2030.00	BWR	7.09	39.00	29099.45	2.8
2030.00	BWR	7.05	39.00	30000.00	2.6
2030.00	BWR	7.09	39.00	30000.00	2.8
2030.00	BWR	7.09	39.00	30000.00	2.9
2030.00	BWR	7.09	39.00	30000.00	3.0
2030.00	BWR	7.09	39.00	30000.00	3.0
2030.00	BWR	7.00	39.00	30026.02	3.0
2030.00	BWR	7.29	39.00	31000.00	2.8
2030.00	BWR	7.29	39.00	31000.00	2.8
2030.00	BWR	7.29	39.00	31000.00	2.8
2030.00	BWR	7.09	39.00	31000.00	3.0
2030.00	BWR	7.09	39.00	31000.00	3.0
2030.00	BWR	7.09	39.00	31000.00	3.0
2030.00	BWR	7.09	39.00	31000.00	3.0
2030.00	BWR	7.09	39.00	31000.00	3.0
2030.00	BWR	7.09	39.00	31000.00	3.0
2030.00	BWR	6.77	39.00	31816.70	2.7
2030.00	BWR	6.81	39.00	32000.00	2.8
2030.00	BWR	6.73	39.00	32921.45	2.8
2030.00	BWR	6.70	39.00	33000.00	2.8
2030.00	BWR	7.00	39.00	33000.00	2.9

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2030.00	BWR	7.11	39.00	33000.00	3.1
2030.00	BWR	7.11	39.00	33000.00	3.2
2030.00	BWR	6.99	39.00	33516.78	3.1
2030.00	BWR	7.03	39.00	34926.63	2.8
2030.00	BWR	6.88	39.00	35000.00	2.8
2030.00	BWR	6.88	39.00	35000.00	2.8
2030.00	BWR	7.05	39.00	35000.00	2.9
2030.00	BWR	7.48	39.00	35000.00	3.0
2030.00	BWR	7.48	39.00	35000.00	3.0
2030.00	BWR	7.48	39.00	35000.00	3.0
2030.00	BWR	7.19	39.00	35661.83	2.9
2030.00	BWR	7.08	38.62	31848.33	3.0
2030.00	BWR	6.92	38.00	27677.67	2.9
2030.00	BWR	6.87	38.00	29000.00	2.8
2030.00	BWR	6.87	38.00	29000.00	2.8
2030.00	BWR	6.87	38.00	29000.00	2.8
2030.00	BWR	6.93	38.00	30530.50	2.8
2030.00	BWR	7.06	38.00	31000.00	3.0
2030.00	BWR	7.12	38.00	31000.00	3.0
2030.00	BWR	6.78	38.00	31658.64	3.0
2030.00	BWR	6.61	38.00	32026.69	3.0
2030.00	BWR	7.06	38.00	33000.00	2.8
2030.00	BWR	6.91	38.00	33000.00	2.8
2030.00	BWR	6.70	38.00	33000.00	2.8
2030.00	BWR	6.70	38.00	33000.00	2.8
2030.00	BWR	6.70	38.00	33000.00	2.8
2030.00	BWR	6.78	38.00	33234.15	2.8
2030.00	BWR	7.06	38.00	34925.01	3.0
2030.00	BWR	7.06	38.00	35000.00	3.0
2030.00	BWR	6.98	37.34	34343.66	2.9
2030.00	BWR	7.05	37.00	34000.00	2.9
2030.00	BWR	7.05	37.00	34350.03	2.9
2030.00	PWR	8.61	38.86	23953.86	3.8
2030.00	PWR	7.32	58.00	13963.20	3.3
2030.00	PWR	4.09	58.00	25247.00	4.1
2030.00	PWR	5.09	57.57	26875.44	3.9
2030.00	PWR	4.68	56.39	14355.92	4.1
2030.00	PWR	3.77	56.00	4749.00	4.2
2030.00	PWR	4.05	56.00	12039.77	4.1
2030.00	PWR	4.09	56.00	13159.00	4.1
2030.00	PWR	4.11	56.00	22287.67	4.1
2030.00	PWR	4.30	56.00	23234.48	4.0
2030.00	PWR	9.21	55.08	23988.80	3.1
2030.00	PWR	7.99	55.00	27915.37	3.6
2030.00	PWR	7.64	55.00	29162.00	4.0
2030.00	PWR	8.32	54.62	26928.32	3.3
2030.00	PWR	9.57	54.00	22952.00	2.2

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2030.00	PWR	9.57	54.00	22952.00	2.2
2030.00	PWR	7.80	54.00	30550.67	3.8
2030.00	PWR	7.62	54.00	31752.10	4.0
2030.00	PWR	8.36	53.56	30713.35	3.4
2030.00	PWR	9.57	52.24	29092.36	2.9
2030.00	PWR	9.57	52.00	29730.00	3.0
2030.00	PWR	8.53	52.00	29903.42	3.5
2030.00	PWR	8.71	51.21	30552.43	3.1
2030.00	PWR	7.87	50.05	30181.15	3.9
2030.00	PWR	7.76	50.00	30225.43	4.0
2030.00	PWR	8.40	49.44	31715.50	3.8
2030.00	PWR	8.65	49.00	33361.00	4.0
2030.00	PWR	8.74	48.79	33011.28	3.9
2030.00	PWR	8.57	47.00	32004.15	3.0
2030.00	PWR	8.36	47.00	33570.32	3.4
2030.00	PWR	8.67	47.00	33887.00	4.0
2030.00	PWR	8.67	46.86	34079.13	4.0
2030.00	PWR	8.64	46.00	35236.00	4.0
2030.00	PWR	8.64	46.00	35236.00	4.0
2030.00	PWR	8.67	45.38	32042.69	3.5
2030.00	PWR	8.81	45.00	32530.74	3.1
2030.00	PWR	8.16	45.00	34806.00	3.3
2030.00	PWR	8.16	45.00	34806.00	3.3
2030.00	PWR	7.88	45.00	35712.00	3.0
2030.00	PWR	8.80	44.43	34812.21	3.3
2030.00	PWR	9.64	44.00	34143.00	3.6
2030.00	PWR	8.68	44.00	35021.95	4.0
2030.00	PWR	8.63	44.00	35071.00	4.0
2030.00	PWR	8.59	43.92	34872.16	3.4
2030.00	PWR	9.68	43.00	30808.38	3.1
2030.00	PWR	5.52	43.00	31000.00	3.5
2030.00	PWR	5.43	43.00	31497.60	3.5
2030.00	PWR	9.05	43.00	33091.00	2.9
2030.00	PWR	8.86	43.00	33926.99	2.9
2030.00	PWR	9.09	43.00	35039.70	3.2
2030.00	PWR	8.49	43.00	35354.61	3.2
2030.00	PWR	9.51	43.00	37039.39	3.4
2030.00	PWR	7.68	43.00	38024.00	3.3
2030.00	PWR	7.68	43.00	38024.00	3.3
2030.00	PWR	7.68	43.00	38024.00	3.3
2030.00	PWR	8.05	43.00	39784.65	3.3
2030.00	PWR	9.13	42.25	31685.95	3.1
2030.00	PWR	6.42	42.00	31470.30	3.4
2030.00	PWR	4.81	42.00	32000.00	3.7
2030.00	PWR	6.65	42.00	32880.96	3.7
2030.00	PWR	8.45	42.00	34232.24	3.1
2030.00	PWR	8.24	42.00	35000.00	3.2

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2030.00	PWR	8.24	42.00	35000.00	3.2
2030.00	PWR	9.30	42.00	35269.07	3.5
2030.00	PWR	9.63	42.00	35341.00	3.6
2030.00	PWR	9.14	42.00	35867.65	3.2
2030.00	PWR	9.02	42.00	36000.00	3.1
2030.00	PWR	9.49	42.00	36577.87	3.5
2030.00	PWR	9.63	42.00	36703.00	3.6
2030.00	PWR	8.71	42.00	38017.00	3.5
2030.00	PWR	9.35	42.00	38505.79	3.5
2030.00	PWR	8.39	42.00	39043.08	3.2
2030.00	PWR	7.68	42.00	39494.00	3.3
2030.00	PWR	7.68	42.00	39494.00	3.3
2030.00	PWR	7.58	42.00	39590.85	3.4
2030.00	PWR	7.37	42.00	39763.00	3.5
2030.00	PWR	8.44	42.00	40200.81	3.5
2030.00	PWR	9.31	42.00	40965.63	3.6
2030.00	PWR	9.66	41.00	10042.72	3.1
2030.00	PWR	5.77	41.00	26237.95	3.5
2030.00	PWR	8.65	41.00	34000.00	4.0
2030.00	PWR	8.39	41.00	34263.65	3.8
2030.00	PWR	9.44	41.00	36766.15	3.3
2030.00	PWR	9.73	41.00	37000.00	3.3
2030.00	PWR	8.56	41.00	37165.93	3.4
2030.00	PWR	7.46	41.00	38000.00	3.4
2030.00	PWR	7.53	41.00	40053.23	3.4
2030.00	PWR	7.63	40.95	41529.11	3.4
2030.00	PWR	9.69	40.00	20626.70	3.6
2030.00	PWR	9.69	40.00	25185.52	3.2
2030.00	PWR	9.07	40.00	29554.69	3.4
2030.00	PWR	8.12	40.00	30090.00	3.9
2030.00	PWR	9.67	40.00	30971.54	3.1
2030.00	PWR	8.67	40.00	31451.78	3.3
2030.00	PWR	7.88	40.00	32000.00	3.5
2030.00	PWR	4.85	40.00	32000.00	3.8
2030.00	PWR	8.04	40.00	32798.84	3.3
2030.00	PWR	9.60	40.00	33684.17	3.5
2030.00	PWR	9.00	40.00	34625.50	3.5
2030.00	PWR	8.15	40.00	35000.00	3.3
2030.00	PWR	8.37	40.00	35131.46	3.2
2030.00	PWR	9.65	40.00	35798.00	3.2
2030.00	PWR	9.27	40.00	36003.00	3.2
2030.00	PWR	7.57	40.00	37000.00	3.2
2030.00	PWR	9.40	40.00	37000.00	3.3
2030.00	PWR	9.40	40.00	37000.00	3.3
2030.00	PWR	8.06	40.00	37000.00	3.4
2030.00	PWR	7.66	40.00	37204.41	3.4
2030.00	PWR	8.52	40.00	38000.00	3.3

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (continued)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2030.00	PWR	9.11	40.00	38000.00	3.4
2030.00	PWR	9.16	40.00	38000.00	3.4
2030.00	PWR	8.76	40.00	38410.23	3.4
2030.00	PWR	8.92	40.00	39000.00	3.5
2030.00	PWR	7.86	40.00	39101.98	3.4
2030.00	PWR	9.74	40.00	39432.00	3.3
2030.00	PWR	9.74	40.00	39675.49	3.2
2030.00	PWR	9.68	40.00	40000.00	3.2
2030.00	PWR	8.26	40.00	40206.03	3.3
2030.00	PWR	7.86	40.00	40758.00	3.3
2030.00	PWR	7.86	40.00	40758.00	3.3
2030.00	PWR	7.77	40.00	40813.38	3.3
2030.00	PWR	7.56	40.00	41000.00	3.4
2030.00	PWR	7.36	40.00	41000.00	3.8
2030.00	PWR	7.69	40.00	43493.59	3.4
2030.00	PWR	9.25	39.25	33281.09	2.6
2030.00	PWR	9.74	39.00	28809.00	2.4
2030.00	PWR	9.74	39.00	28809.00	2.4
2030.00	PWR	9.72	39.00	28976.94	2.6
2030.00	PWR	9.20	39.00	30000.00	3.6
2030.00	PWR	9.19	39.00	32533.35	3.3
2030.00	PWR	9.23	39.00	33000.00	3.4
2030.00	PWR	8.13	39.00	33090.34	3.7
2030.00	PWR	7.68	39.00	34000.00	3.9
2030.00	PWR	7.67	39.00	34000.00	4.0
2030.00	PWR	7.98	39.00	34496.79	3.6
2030.00	PWR	9.72	39.00	35000.00	3.2
2030.00	PWR	8.94	39.00	35582.41	3.4
2030.00	PWR	8.78	39.00	36849.51	3.6
2030.00	PWR	9.31	39.00	37910.98	3.3
2030.00	PWR	9.02	39.00	38000.00	3.5
2030.00	PWR	8.35	39.00	38000.00	3.7
2030.00	PWR	8.67	39.00	38707.90	3.5
2030.00	PWR	7.56	39.00	39000.00	3.6
2030.00	PWR	9.59	39.00	39425.56	3.5
2030.00	PWR	9.15	39.00	40000.00	3.2
2030.00	PWR	9.32	39.00	40000.00	3.3
2030.00	PWR	9.72	39.00	40000.00	3.4
2030.00	PWR	7.99	39.00	40000.00	3.5
2030.00	PWR	9.22	39.00	40000.00	3.6
2030.00	PWR	7.81	39.00	40000.00	3.8
2030.00	PWR	7.53	39.00	40287.84	3.7
2030.00	PWR	8.49	39.00	41000.00	3.4
2030.00	PWR	9.48	39.00	41000.00	3.4
2030.00	PWR	7.95	39.00	41000.00	3.5
2030.00	PWR	7.65	39.00	41305.29	3.8
2030.00	PWR	7.67	39.00	42847.64	3.5

Table A-3. Waste Variability Study Packages for the Years 2028 through 2030 (concluded)

Year	Type	MTU	Waste Age	Burnup	Enrichment
2030.00	PWR	7.59	39.00	43524.15	3.5
2030.00	PWR	7.55	39.00	44187.09	3.5
2030.00	PWR	9.22	38.44	33725.13	3.4
2030.00	PWR	9.64	38.00	25523.81	3.7
2030.00	PWR	9.64	38.00	26000.00	3.8
2030.00	PWR	9.36	38.00	29345.09	3.5
2030.00	PWR	8.33	38.00	32000.00	3.2
2030.00	PWR	8.40	38.00	32000.00	3.3
2030.00	PWR	8.57	38.00	32187.05	3.3
2030.00	PWR	8.08	38.00	33764.76	3.0
2030.00	PWR	7.47	38.00	34000.00	3.4
2030.00	PWR	4.84	38.00	34000.00	3.9
2030.00	PWR	7.11	38.00	34805.33	3.3
2030.00	PWR	9.23	38.00	35752.13	3.2
2030.00	PWR	9.62	38.00	36000.00	3.2
2030.00	PWR	9.11	38.00	36559.15	3.3
2030.00	PWR	9.74	38.00	37000.00	3.3
2030.00	PWR	9.74	38.00	37000.00	3.3
2030.00	PWR	8.11	38.00	37225.45	3.4
2030.00	PWR	9.60	38.00	38000.00	3.2
2030.00	PWR	9.63	38.00	38000.00	3.3
2030.00	PWR	9.72	38.00	38000.00	3.4
2030.00	PWR	9.67	38.00	38000.00	3.4
2030.00	PWR	8.68	38.00	38264.31	3.5
2030.00	PWR	8.49	38.00	39617.13	3.4
2030.00	PWR	8.42	38.00	40000.00	3.4
2030.00	PWR	8.60	38.00	40000.00	3.5
2030.00	PWR	9.72	38.00	40000.00	3.5
2030.00	PWR	8.31	38.00	40000.00	3.5
2030.00	PWR	7.44	38.00	40000.00	3.8
2030.00	PWR	7.50	38.00	40527.17	3.6
2030.00	PWR	7.49	38.00	41050.70	3.7
2030.00	PWR	7.54	38.00	42143.61	3.5
2030.00	PWR	8.23	38.00	43000.00	3.8
2030.00	PWR	7.54	38.00	44628.16	3.5
2030.00	PWR	7.95	37.36	44726.61	3.9
2030.00	PWR	8.18	37.00	44000.00	4.0

APPENDIX B

RIB Appendix

Information from the Reference Information Base Used in this Report:

A thermal conductivity of 2.1 W/mK and a heat capacitance of 2.14 J/cm^{3}K were used to represent the thermal properties of the rock mass. These values are consistent with values reported in the RIB for TSw2.

Candidate Information for the Reference Information Base:

This report contains no candidate information for the Reference Information Base.

Candidate Information for the Geographic Nodal Information Study and Evaluation System:

This report contains no candidate information for the Geographic Nodal Information Study and Evaluation System.

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