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OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
CALCULATION COVER SHEET

1. QA: QA

2. Calculation Title

Heat Decay Data and Repository Footprint for Thermal-Hydrologic and Conduction-Only Models for TSPA-SR

3. Document Identifier (Including Revision Number)

CAL-MGR-HS-000001 Rev 00

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9. Remarks

Revision History

10. Revision No.	11. Description of Revision
Rev 00	Initial Issue

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TABLES

1. PURPOSE

The repository heat decay data contained within this calculation is specified for both mountain-scale and drift-scale thermal-hydrologic (TH), thermal-hydrologic-mechanical (THM), and thermal-hydrologic-chemical (THC) simulations used in total systems performance assessments (TSPA). Repository thermal output data, and how it decays in time, is required by the models that compute changes to the geologic system as a result of a heat addition. The mountain-scale problem requires a repository-wide waste stream including the total heat output of each fuel type to be emplaced in the repository. These models apply a smeared heat source over a predefined repository footprint area specified in the model. The drift-scale problem requires the heat output of a number of representative (specific) waste package types. These models apply specific waste package heat outputs resolved at the scale of the waste package itself. The results of this calculation will supply details of the repository heat load for each model type. It also provides a schematic of the repository footprint outlines for the License Application Design Selection (LADS), the total repository footprint for TSPA site recommendation (SR) including the contingency area, and the actual loaded repository footprint. This calculation is performed under procedure AP-3.12Q, Rev. 0/ICN 0, *Calculations*. It is directed by the development plan TDP-MGR-HS-000001 (CRWMS M&O 1999f) which was developed under procedure AP-2.13Q, Rev. 0/ICN 1, *Technical Product Development Plans* for use in Performance Assessment activities.

2. METHOD

This calculation applies standard mathematical techniques to compute heat decay curves for mountain-scale models, two-dimensional drift-scale models, and three-dimensional emplacement drift representations. Standard graphing packages (described in section 4) are used to visualize resulting heat loading curves applied to the models.

3. ASSUMPTIONS

3.1 It is assumed that the non-commercial waste heating data, as applied in TSPA-VA, can be applied in the thermal loading analysis for TSPA-SR as presented in this calculation. The assumption is applied in the calculation section 5 of this document in the development of the repository-wide thermal decay curve, the development of the idealized drift segment, and the development of the line-averaged heat load used in two-dimensional models. The basis for this assumption is found in the design transmittal, CRWMS M&O 1999b, page 1/28.

4. USE OF COMPUTER SOFTWARE AND MODELS

Microsoft Excel 97 is used to perform standard mathematical operations (e.g., multiplication) to generate the results of this calculation. It is also used to graphically represent the trends of these operations. This software package is appropriate for this application. Samples of user-defined formulas (as implemented in the excel spreadsheet) are presented in the calculation section of this document. The resulting spreadsheets "heatTSPA-SR-99184-Ta.xls" for this calculation have been submitted to the technical data management system (TDMS). The sheets to be used in this file name are listed as: MTN-scale, DRFT-Scale(3-D models), DRFT-Scale(2-D models).

5. CALCULATION

Data Inputs:

The basis for the use of this thermal loading data is from the design transmittal process. This process is governed by the quality assurance procedure QAP-3-12 *Transmittal of Design Input* Rev 8 (prior to PVAR) and more currently, AP-3.14Q *Transmittal of Input* Rev 0/ICN 0. A listing of design transmittals is given in table 1.

Table 1. Design Input Transmittals

Item Defined	Input Tracking Number	Date Received	QA Status
Heat Source (non-commercial)	PA-WP-99184.T (CRWMS M&O 1999b)	May 19, 1999	NQ
Heat Source (commercial)	PA-WP-99184.Ta (CRWMS M&O 1999c)	June 11, 1999	NQ
Repository Footprint	SEI-SSR-99172.T (CRWMS M&O 1999a) PA-SSR-99218.Ta (CRWMS M&O 1999d)	April 9, 1999 August 18, 1999	NQ NQ
Ventilation Efficiency	PA-SSR-99241.T (CRWMS M&O 1999e)	September 30, 1999	NQ

The design input transmittal process provided the necessary data required of both commercial and non-commercial wastes potentially emplaced at Yucca Mountain and specified in repository heating models used by TSPA. The use of the data required in repository heating models is documented below.

Commercial Wastes:

The commercial spent nuclear fuel (CSNF) data is given in table 2 (CRWMS M&O 1999c, Table 1). With this specific information for each fuel type, the mountain-scale (e.g., repository-wide) and the drift-scale (e.g., individual waste package) heat loading can be defined. The average heat outputs (note, only shown at time t = 0.01 years) of each assembly type are given in table 3 (CRWMS M&O 1999c, Table 2). Using the average heat output per assembly with the number of assemblies per waste package specifies the initial heat load of a waste package potentially applied in a TH model. For example, the majority 21-PWR initial heat output is 21 * 539.7 = 11,333.7 Watts. As noted below, this waste package is indeed represented in the drift-scale models used by TSPA.

Table 2. CSNF Waste Package and Fuel Assembly Inventories (CRWMS M&O 1999c)

Waste Package Type	Number of Fuel Assemblies	Number of Waste Packages
21-PWR, Absorber Plates	89,845	4,279
21-PWR, Control Rods	1,827	87
12-PWR, Long	1,887	158
44-BWR, Absorber Plates	127,106	2,889
24-BWR, Thick Absorber Plates	134	6

Table 3. Average Initial Heat Generation Rates (at t ≈ 0) for Each Assembly Type Given in Watts per Assembly (CRWMS M&O 1999c)

21-PWR, Absorber Plates	21-PWR, Control Rods	12-PWR, Long	44-BWR, Absorber Plates	24-BWR, Thick Absorber Plates
539.7	112.9	795.02	162.15	20.46

The non-commercial waste package inventory, defense high-level waste (HLW) and Department of Energy Spent Nuclear Fuel (DSNF), is given in the following tables. Table 4 indicates the number of non-commercial waste packages (CRWMS M&O 1999b, Table 3). The average heat outputs (note, only shown at time approximately equal to 0 years) of each non commercial assembly type are given in table 5 (CRWMS M&O 1998, Table 3-3).

Non-Commercial Wastes:

Table 4. Non-CSNF Waste Package Inventory (CRWMS M&O 1999b)

Waste Package Type	Number of Waste Packages
5-DHLW/Co-Disposal	1249
5-DHLW/Co-Disposal Long	414
Naval SNF	285
DOE/Other (4 canisters per package)	598

Table 5. Average Initial Heat Generation Rates (at t ≈ 0) for Each Non-CSNF Assembly Type Given in Watts per Assembly (DTN: SNT05071897001.004)

5-DHLW/Co-Disposal[1]	4-DOE SNF[2]
811.62	198.25

[1] heat output of 5-DHLW/Co-Disposal Long is assumed to be zero (CRWMS M&O 1999b)
[2] heat output of Naval SNF is assumed to be zero (CRWMS M&O 1999b)

5.1 MOUNTAIN-SCALE MODELS

Using the information contained in tables 2 and 3, the repository-wide thermal load for the commercial waste can be calculated for mountain-scale models as the following. The total heat output (at $t \approx 0$ years) is computed for the CSNF, pressurized water reactor (PWR) and boiling water reactor (BWR) assemblies:

$$\text{PWR (Watts)} = 89{,}845 * 539.7 + 1{,}827 * 112.9 + 1{,}887 * 795.02 = 50{,}196{,}000 \text{ W}$$
$$\text{BWR (Watts)} = 127{,}106 * 162.15 + 134 * 20.46 = 20{,}613{,}000 \text{ W}$$

So the initial total, repository-wide, thermal load for the CSNF only is:

$$\text{Total CSNF (Watts)} = \text{PWR} + \text{BWR} = 70{,}809{,}000 \text{ W} \qquad \text{(EQN. 1)}$$

It is noted that this total value does not include the influence of heat removed by forced ventilation. If a 60 MTU/acre repository mass load is assumed for 63,000 metric tons of commercial waste, the required area to emplace waste is 63,000/60 = 1050 acres. Subsequently, the initial areal power density (APD) for the CSNF only is computed as the following:

$$\text{APD CSNF} = 70{,}809{,}000 \text{ W/1050 acre/1000 W} = 67.4 \text{ kW/acre} \qquad \text{(EQN. 2)}$$

The time-dependent heat generation rates provided in the design transmittals and that are used in this calculation were for average fuel assemblies/waste packages at the time of emplacement. Consequently, the APD for CSNF found in equation 2 represents the average over the repository at the time of emplacement. The repository-wide non-CSNF heating component is determined in a similar manner.

Using the information in tables 4 and 5, the total heat output (at $t \approx 0$ years) is computed for the non-CSNF in a similar manner:

$$\text{Total Non-CSNF (Watts)} = 5 * 1249 * 811.62 + 4 * 598 * 198.25 = 5{,}543{,}000 \text{ W} \qquad \text{(EQN. 3)}$$

It is noted that this total non-CSNF value does not include the influence of heat removed by forced ventilation. The repository-wide thermal output (assumes simultaneous waste emplacement) at initial waste emplacement is obtained by adding equations 1 and 3:

$$\text{Total (Watts)} = \text{Total CSNF (Watts)} + \text{Total Non-CSNF (Watts)} = 76{,}352{,}000 \text{ W} \qquad \text{(EQN. 4)}$$

With this, the total repository APD is computed at time $t = 0$ as the following:

$$\text{APD} = 76{,}352{,}000 \text{ W/1050 acre/1000 W} = 72.7 \text{ kW/acre} \qquad \text{(EQN. 5)}$$

As in equation 2, this value corresponds to the average APD at the time of waste emplacement.. The (total) repository-wide heat decay curve is shown in figure 1 and is obtained from CRWMS M&O 1999b, Table 3; CRWMS M&O 1999c, Tables 1 and 2; and DTN: SNT05071897001.004, filenames: "avgdhlw.txt" and "nrctor4pck.txt". Additionally, this figure provides a thermal-loading curve modified for the design specified ventilation efficiency of 70% heat removal during the preclosure ventilation period.

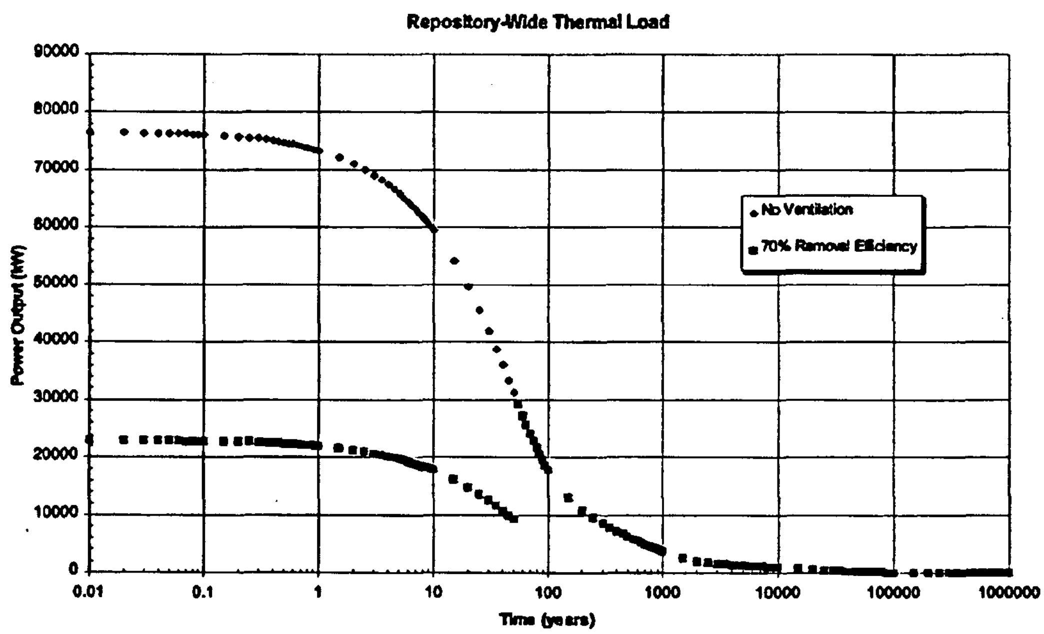

Figure 1. Repository-Wide Thermal Loading in kW.

Although specifically shown for 50 years, the heat removal curve shown in figure 1 can be modified for a ventilation process of any specified time duration (e.g., the preclosure duration of the forced ventilation process). The LADS models removed 50% of the waste package heat over a period of 50 years. That preclosure heat removal efficiency required about 5 to 10 m^3/s of air flow through the repository drifts. For TSPA-SR models, the heat removal efficiency is specified to be approximately 70% heat removed during a 50 year preclosure period (CRWMS M&O 1999g, Section 2.1.1.2). This requires a ventilation rate of approximately 10 to 15 m^3/s per emplacement drift (CRWMS M&O 1999e Page 2/4 and 3/4). For illustration purposes, a ratio of time integrated versions of the curves shown in figure 1 is depicted in figure 2. It indicates the total energy output of the repository (specifically available for host rock heating) resulting from a ventilation process divided by that of the total energy output not including ventilation. From this figure it is noted that 30% of the energy remains in the repository system (e.g., energy that is not removed by forced ventilation) during the preclosure period. After about 5000 years, the difference between the ventilated case energy output and the total unventilated energy output is reduced such that the ratio between them is increased to 90%. That is, the ventilated case total energy output (available for host rock heating) is only 90% of the total (unventilated) energy output. As time increases, the difference between ventilated and unventilated decreases as indicated in figure 2.

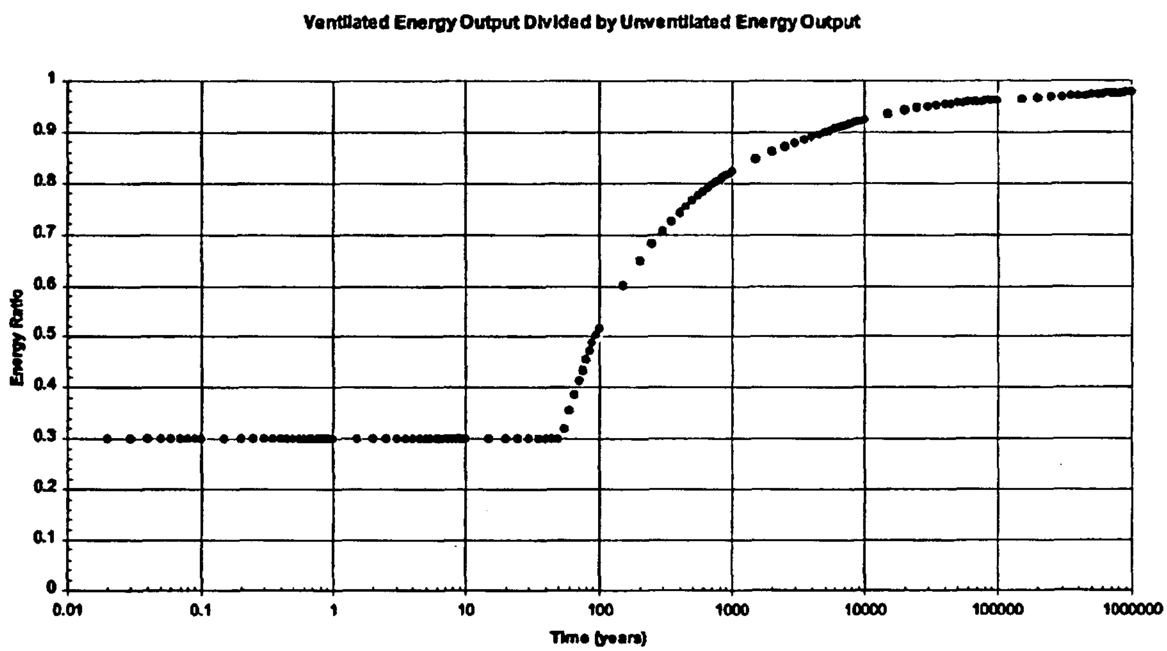

Figure 2. Energy Output Ratio Between the Ventilated and Unventilated Heat Decay Curves Shown in Figure 1.

5.2 DRIFT-SCALE MODELS

Drift-scale models require heat decay characteristics for individual waste package types. Models of this type contain heat sources discretized at the scale of the waste package itself. The level of heating detail in a drift-scale model depends on the model dimension. Three-dimensional drift-scale models explicitly include different waste package types at variable distances between waste packages. This is a general model that allows for a determination of the physical characteristics (e.g., temperature, relative humidity, etc.) for a variety of different waste packages variably spaced in an emplacement drift. Two-dimensional drift-scale models average the heat over a representative drift segment (as defined by a three-dimensional model) in meters. The resulting "averaged" thermal load is given in watts per meter while implicitly containing the various heat outputs from different waste package types as well as the distances between them. This model is representative of the "average" thermal behavior in the emplacement drift.

An example of a representative drift segment is given in table 6 (CRWMS M&O 1999c, Worksheet 2 and 3). It is an idealized representation of the waste packages that may populate the repository. The waste package selections (for a three-dimensional drift-scale model) are based on the total number of a particular waste type in the repository. An example of the 21-PWR waste package is the following. The fraction of the total, majority, 21-PWR in the repository is 4279/9965 = 0.429. In the idealized 7-waste package model, the fraction of this type is 3/7 ≈ 0.429. Since the idealized segment does not contain 9965 waste packages, it is not possible to exactly represent any given type or include those types that are few in number in the entire repository waste stream (e.g., to include a 12-PWR in an idealized segment would require a 32 waste package model).

Table 6. Representative Drift Segment (CRWMS M&O 1999c)

Waste Package Type		Fraction of Total In Repository	Length (m)	Fraction of Total in Model	Heat Generation Rate (kW)	# In Model	Length (m)	Mass (MTU)
21-PWR	Absorber	0.429	5.305	0.429	11.334	3	15.915 + 0.3	27.149
	Control Rods	0.009	5.305	0.000	2.371	0	0.000	0.0
12-PWR	Long	0.016	5.791	0.000	9.540	0	0.000	0.0
44-BWR	Absorber	0.290	5.275	0.290	7.135	2	10.550 + 0.2	15.575
24-BWR	Thick Plates	0.001	5.245	0.000	0.491	0	0.000	0.0
5-DHLW		0.125	3.730	0.214	4.058	1.5	5.595 + 0.15	NA
5-DHLW	Long	0.042	5.357	0.000	0.000	0	0.000	NA
Naval	Combined	0.029	5.888	0.000	0.000	0	0.000	NA
DOE/other		0.060	5.570	0.071	0.793	0.5	2.785 + 0.05	NA
		1.000		1.000		7	35.545	42.724

NA – not applicable

Calculations similar to equations 2 and 5 are applicable for the idealized repository drift segment used to build the drift-scale TSPA models. For an 81-meter spacing (center-to-center) between repository emplacement drifts (CRWMS M&O 1999g, Section 2.2.1.1.1), the initial APD for the CSNF only is computed as the following:

$$\text{APD CSNF} = \{3 * 11.334 + 2 * 7.135\}\ \text{kW}/\{81 * 35.545\}\ \text{m}^2 * 4046.86 = 67.9\ \text{kW/acre} \quad \text{(EQN. 6)}$$

and for the initial total,

$$APD = \{3 * 11.334 + 2 * 7.135 + 1.5 * 4.058 + 0.5 * 0.793\}\ kW/\{81 * 35.545\}\ m^2 * 4046.86$$
$$= 77\ kW/acre \qquad \text{(EQN. 7)}$$

This value is greater than the total computed in equation 5 due to the discrete nature of the idealized drift and the error incurred in using a model that contains fewer than 9965 waste packages. From equation 6, the CSNF component is well represented in the 7-waste package model. However, the HLW is somewhat over-represented by this idealized drift model.

Using the detailed information contained in table 6, the idealized drift segment used to construct the TSPA drift-scale models is illustrated as the following.

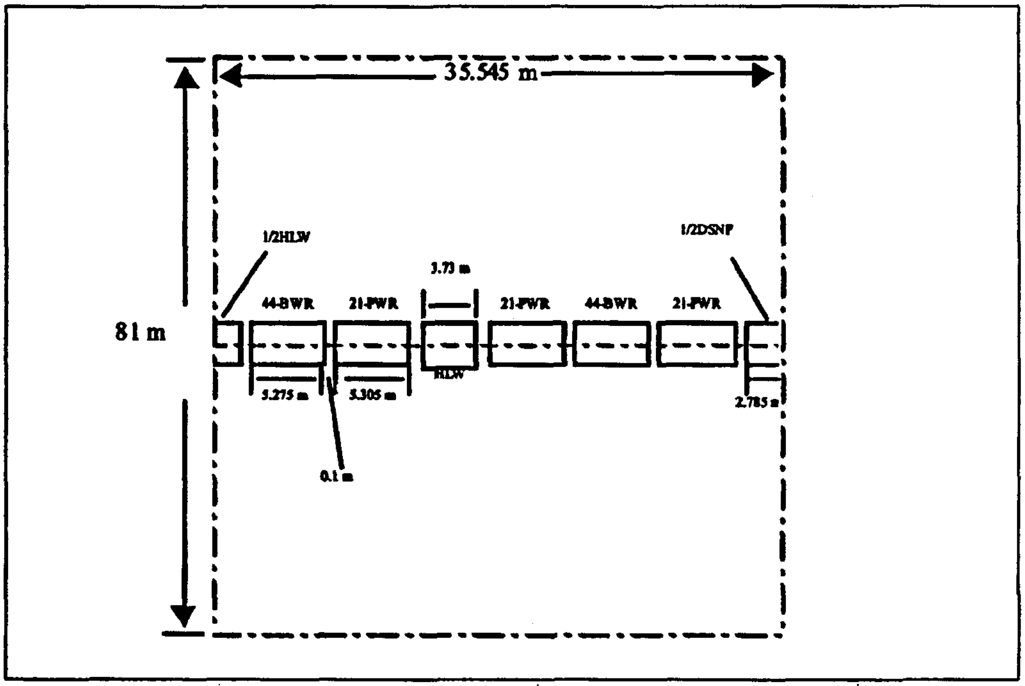

Figure 3. Representative Drift Segment used in TSPA Drift-Scale Models (not to scale).

It is noted that this "idealized" emplacement drift layout contains five CSNF waste packages and 2 non-CSNF waste packages. Figure 3 indicates the 3-D emplacement drift segment in which the 2-D line averaged (drift-scale) model is based on. In the case of the 2-D model, the heat output of each waste package shown in the figure is averaged over the length of the segment (35.545 m). The initial lineal heat load (LHL) utilized in the 2-D drift-scale models is computed using table 6 and the waste packages shown in figure 3 as the following:

$$LHL = \{3 * 11.334 + 2 * 7.135 + 1.5 * 4.058 + 0.5 * 0.793\} \text{ kW}/35.545 \text{ m} = 1.54 \text{ kW/m} \quad \text{(EQN. 8)}$$

The lineal heat load is shown in figure 4 and is obtained from CRWMS M&O 1999c, Table 2, Worksheet 3; and DTN: SNT05071897001.004, filenames: "avgdhlw.txt" and "nrctor4pck.txt". Additionally, this figure provides a lineal heat load modified for the design specified ventilation efficiency of 70% heat removed during the preclosure ventilation period (specified here as 50 years). After 50 years, full power repository heating resumes.

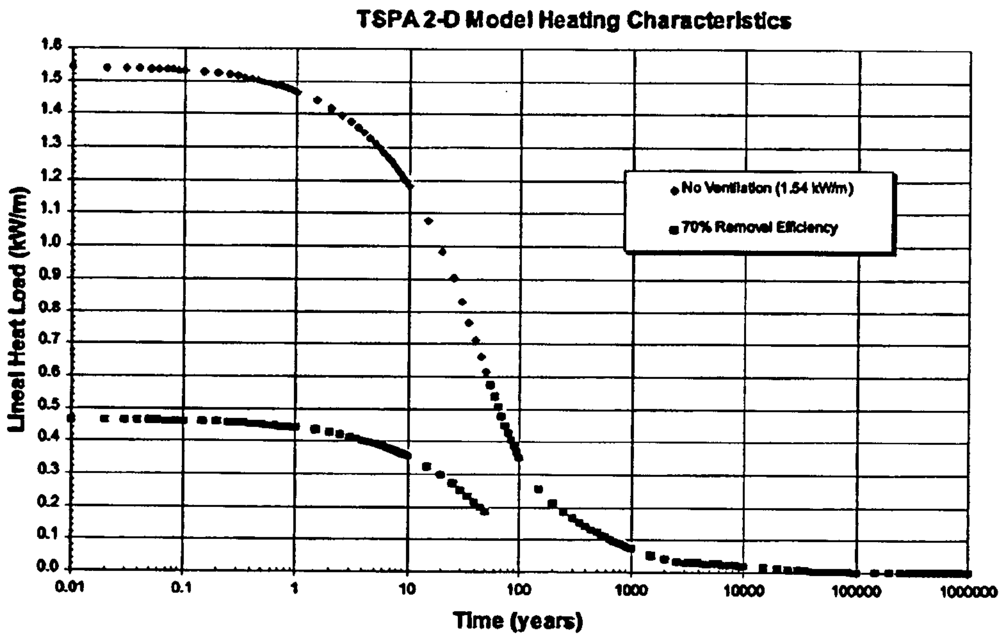

Figure 4. Lineal Heat Loading Curves used in 2-D TSPA Models.

6. RESULTS

Since unqualified data were used in the development of the results presented in this section, they should be considered to be verified (TBV). Any use of the data from this calculation for inputs into documents supporting construction, fabrication, or procurement is required to be controlled as TBV in accordance with appropriate procedures. This calculation does not contain any assumptions that need to be confirmed prior to the use of the results of the calculation.

The heating data given in the previous sections are contained in the TDMS under the data tracking number (DTN), SN9907T0872799.001 and is tracked with the TBV number 3599. The data has been submitted to the TDMS according to procedure AP-SIII.3Q *Submittal and Incorporation of Data to the Technical Data Management System*, Rev0, ICN 2. The data submitted to the TDMS are not qualified (NQ). The data DTN contains the raw (without ventilation) heat loading data for both mountain-scale and drift-scale models used in TSPA. Specifically, it includes the repository-wide heat decay curve given in figure 1, the individual heat decay curves of the individual waste packages displayed in table 6 and figure 3, and the LHL curve shown in figure 4. Additionally, it contains the heat decay curves for a ventilation duration of (50 years) and a heat removal efficiency (50 %) as specified in LADS. As described in this calculation, the design specified ventilation duration and heat removal efficiency for TSPA-SR is 50 years and 70 %, respectively. Therefore, the raw values should be used with the appropriate factors applied for the heat removal efficiency and preclosure duration.

Repository Footprint:

The repository footprint data is given in this section. It includes both the repository footprint as developed for LADS and the newer footprint for TSPA-SR. It is noted that due to the date of transmittal of the new footprint (see table 1), a number of analysis and model reports (AMRs) proceeded with the LADS footprint as the basis of the repository outline. Figure 5 overlays each footprint for comparison purposes.

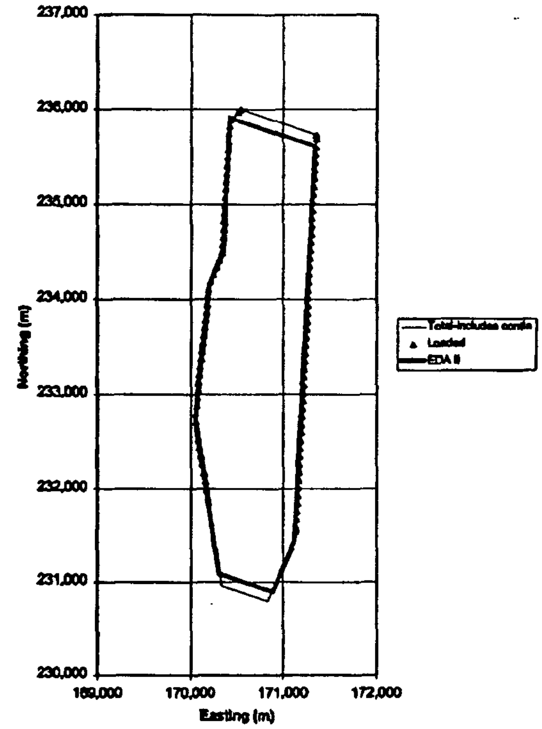

Figure 5. Repository Footprint, LADS and TSPA-SR (CRWMS M&O 1999a; CRWMS M&O 1999d).

The detailed outline information for the LADS footprint is given in table 7. Each of the following segments are connected by straight line segments as indicated in the table below. The following data is presented in a clockwise manner starting from the far northeast corner of the repository. The values are in meters where N represents northing, E easting, and EL., repository elevation.

This document may be affected by technical product input information that requires confirmation. Any changes to the document that may occur as a result of completing the confirmation activities will be reflected in subsequent revisions. The status of the input information quality may be confirmed by review of the Document Input Reference System database.

Table 7. LADS Footprint Coordinates (CRWMS M&O 1999a)

Segment AB:	
N 235 611.814	N 231 435.342
E 171 343.408	E 171 124.528
EL. 1044.70	EL. 1101.02
Segment BC:	
N 231 435.342	N 230 897.466
E 171 124.528	E 170 893.964
EL. 1101.02	EL. 1111.02
Segment CD:	
N 230 897.466	N 231 086.867
E 170 893.964	E 170 311.019
EL. 1111.02	EL. 1111.02
Segment DE:	
N 231 086.867	N 232 749.315
E 170 311.019	E 170 055.118
EL. 1111.02	EL. 1088.40
Segment EF:	
N 232 749.315	N 234 147.767
E 170 055.118	E 170 205.807
EL. 1088.40	EL. 1069.13
Segment FG:	
N 234 147.767	N 234 508.665
E 170 205.807	E 170 354.437
EL. 1069.13	EL. 1063.59
Segment GH:	
N 234 508.665	N 235 909.300
E 170 354.437	E 170 427.845
EL. 1063.59	EL. 1044.66
Segment HA:	
N 235 909.300	N 235 611.814
E 170 427.845	E 171 343.408
EL. 1044.66	EL. 1044.70

7. REFERENCES

7.1 CRWMS M&O 1998. "Thermal Hydrology." Chapter 3 of *Total System Performance Assessment – Viability Assessment (TSPA-VA) Analyses Technical Basis Document.* B00000000-01717-4301-00003 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981008.0003.

7.2 CRWMS M&O 1999a. *Subsurface Design for Enhanced Design Alternative (EDA) II.* Design Input Transmittal SEI-SSR-99172.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990409.0100.

7.3 CRWMS M&O 1999b. *Enhanced Design Alternative (EDA) II Repository Estimated Waste Package Types and Quantities.* Design Input Transmittal PA-WP-99184.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990526.0188.

7.4 CRWMS M&O 1999c. *Enhanced Design Alternative (EDA) II Repository Estimated Waste Package Types and Quantities.* Design Input Transmittal PA-WP-99184.Ta. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990809.0289.

7.5 CRWMS M&O 1999d. *Request for Repository Subsurface Design Information to Support TSPA-SR.* Input Transmittal PA-SSR-99218.Ta. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990901.0312.

7.6 CRWMS M&O 1999e. *Performance Assessment Operations – Thermal Hydrology and Coupled Processes Abstraction Core Team.* Input Transmittal PA-SSR-99241.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991027.0159.

7.7 CRWMS M&O 1999f. *Heat Decay and Repository Footprint for Thermal-Hydrologic and Conduction-Only Models for TSPA-SR, TDP-MGR-HS-000001 Rev 00.* Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990824.0144.

7.8 CRWMS M&O 1999g. *Monitored Geologic Repository: Project Description Document.* B00000000-01717-1705-00003 REV 00 DCN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991117.0160.

7.9 QAP-3-12, Rev. 8. *Transmittal of Design Input.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19990309.0261.

7.10 AP-2.13Q, Rev. 0, ICN 1. *Technical Product Development Planning.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19991115.0230.

7.11 AP-3.12Q, Rev. 0, ICN 0. *Calculations.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19990702.0312.

7.12 AP-3.14Q, Rev. 0 ICN 0. *Transmittal of Input.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19990701.0621.

7.13 AP-SIII.3Q, Rev. 0 ICN 2. *Submittal and Incorporation of Data to the Technical Data Management System.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.19991214.0632.

7.14 SNT05071897001.004. Total System Performance Assessment-Viability Assessment (TSPA-VA) Heat Loading Data. Submittal Date: 03/26/1998.

8. ATTACHMENTS

ATTACHMENT NUMBER	TITLE	NUMBER OF PAGES
I	Document Input Reference System (DIRS) Form	3

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
DOCUMENT INPUT REFERENCE SHEET

1. Document Identifier No./Rev.: CAL-MGR-HS-000001 Rev. 00 (as of 20-apr-2000 14:16:48)	Change: N/A	Title: HEAT DECAY DATA AND REPOSITORY FOOTPRINT FOR THERMAL-HYDROLOGIC AND CONDUCTION ONLY MODELS FOR TSPA-SR

Input Document			4. Input Status	5. Section Used in	6. Input Description	7. TBV/TBD Priority	8. TBVDue To		
2a.	2. Technical Product Input Source Title and Identifier(s) with Version	3. Section					Unqual.	From Uncontrolled Source	Un-Confirmed
1	CRWMS M&O 1998. "Thermal Hydrology." Chapter 3 of *Total System Performance Assessment-Viability Assessment (TSPA-VA) Analyses Technical Basis Document.* B00000000-01717-4301-00003 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19981008.0003.	Tbl 3-3	TBV-3928	5.0	USE OF THE TSPA-VA HEAT LOADING DTN FOR THE NON-COMMERCIAL WASTE HEAT	1	N/A	X	N/A
2	CRWMS M&O 1999. *Subsurface Design for Enhanced Design Alternative (EDA) II.* Design Input Transmittal SEI-SSR-99172.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990409.0100.	Fig 2	TBV-3929	6.0, 5.0	USE OF THE LADS FOOTPRINT COORDINATES/ELEVATIONS IN TSPA-SR MODELS	1	N/A	X	N/A
		p 1/1	TBV-3929	6.0, 5.0	USE OF THE LADS FOOTPRINT COORDINATES/ELEVATIONS IN TSPA-SR MODELS	1	N/A	X	N/A
3	CRWMS M&O 1999. *Enhanced Design Alternative (EDA) II Repository Estimated Waste Package Types and Quantities.* Design Input Transmittal PA-WP-99184.Ta. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990809.0289.	Tbl 1	TBV-3930	5.0, 5.1	COMMERCIAL WASTE PACKAGE NUMBERS (E.G. HOW MANY), TIME-DEPENDENT HEAT	1	N/A	X	N/A

		Tbl 2	TBV-3930	5.0, 5.1	COMMERCIAL WASTE PACKAGE NUMBERS (E.G. HOW MANY), TIME-DEPENDENT HEAT	1	N/A	X	N/A
		Workshe et 2	TBV-3930	5.2	COMMERCIAL WASTE PACKAGE NUMBERS (E.G. HOW MANY), TIME-DEPENDENT HEAT	1	N/A	X	N/A
		Workshe et 3	TBV-3930	5.2	COMMERCIAL WASTE PACKAGE NUMBERS (E.G. HOW MANY), TIME-DEPENDENT HEAT	1	N/A	X	N/A
4	CRWMS M&O 1999. *Request for Repository Subsurface Design Information to Support TSPA-SR.* Input Transmittal PA-SSR-99218.Ta. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990901.0312.	Att. I	TBV-3931	6.0, 5.0	TSPA-SR FOOTPRINT CCOORDINATES (BOTH LOADED AND CONTINGENCY)	1	N/A	X	N/A
		p I-1	TBV-3931	6.0, 5.0	TSPA-SR FOOTPRINT CCOORDINATES (BOTH LOADED AND CONTINGENCY)	1	N/A	X	N/A
		p I-2	TBV-3931	6.0, 5.0	TSPA-SR FOOTPRINT CCOORDINATES (BOTH LOADED AND CONTINGENCY)	1	N/A	X	N/A
5	CRWMS M&O 1999. *Enhanced Design Alternative (EDA) II Repository Estimated Waste Package Types and Quantities.* Design Input Transmittal PA-WP-99184.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990526.0188.	1.0 p 1/28	TBV-3932	3.0	JUSTIFICATION OF ASSUMPTION; NON-CSNF WASTE PACKAGE NUMBERS (E.G. HOW MANY)	1	N/A	X	N/A

		Tbl 3	TBV-3932	5.0, 5.1	JUSTIFICATION OF ASSUMPTION; NON-CSNF WASTE PACKAGE NUMBERS (E.G. HOW MANY)	1	N/A	X	N/A
6	CRWMS M&O 1999. *Performance Assessment Operations-Thermal Hydrology and Coupled Processes Abstraction Core Team.* Input Transmittal PA-SSR-99241.T. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991027.0159.	p 2/4	TBV-3933	5.0, 5.1, 5.2	Provides information basis for the ventilation duration (50 years) and heat removal efficiency (70%) in the figures	1	N/A	X	N/A
		p 3/4	TBV-3933	5.0, 5.1, 5.2	Provides information basis for the ventilation duration (50 years) and heat removal efficiency (70%) in the figures	1	N/A	X	N/A
7	SNT05071897001.004. Total System Performance Assessment - Viability Assessment (TSPA-VA) Heat Loading Data. Submittal date: 03/26/1998.	avgdhlw.txt	TBV-3934	5.0, 5.1, 5.2	NON COMMERCIAL WASTE HEAT OUTPUTS (W/ASSY)	1	N/A	X	N/A
		nrctor4pck.txt	TBV-3934	5.0, 5.1, 5.2	NON COMMERCIAL WASTE HEAT OUTPUTS (W/ASSY)	1	N/A	X	N/A
8	CRWMS M&O 1999. *Heat Decay Data and Repository Footprint for Thermal-Hydrologic and Conduction-Only Models for TSPA-SR.* TDP-MGR-HS-000001 REV 00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990824.0144.	Entire	N/A - Reference Only	1.0	Development plan is used to guide the calculation	N/A	N/A	N/A	N/A
9	CRWMS M&O 1999. *Monitored Geologic Repository Project Description Document.* B00000000-01717-1705-00003 REV 00 DCN 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19991117.0160.	2.1.1	N/A - Management Edict or TDL	5.1	Reference for 70% heat removal for 50 year ventilation period.	N/A	N/A	N/A	N/A
		2.2.1.1.1	N/A - Management Edict or TDL	5.2	Reference for 81 meter drift spacing	N/A	N/A	N/A	N/A