S

ENGINEERING CHANGE NOTICE

Page 1 of 8

1. ECN 645109

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	M. A. Reilly/ Process Engineering/ R3-86/ 376-5486	[] Yes [X] No	July 15, 1998
	6. Project Title/No./Work Order No.	7. Bldg./Sys./Fac. No.	8. Approval Designator
	SNF Project	SNF Project	SQ
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.)	10. Related ECN No(s).	11. Related PO No.
	HNF-SD-SNF-TI-015, Rev. 4	NA	NA

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	NA	NA Design Authority/Cog. Engineer Signature & Date	NA Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

See pages 3 of this ECN.

13b. Design Baseline Document? [X] Yes [] No

14a. Justification (mark one)

Criteria Change	[]	Design Improvement	[X]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

Updated to include latest revisions of supporting documentation.

15. Distribution (include name, MSIN, and no. of copies)

See Attached Distribution Sheet

RELEASE STAMP

DATE: JUL 22 1998
STA: 4
HANFORD RELEASE
ID: 50

A-7900-013-2 (05/96) GEF095

ENGINEERING CHANGE NOTICE	Page 2 of 8	1. ECN (use no. from pg. 1) 645109

16. Design Verification Required	17. Cost Impact				18. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	NA[] $	Additional	NA[] $	Improvement	NA[]
[X] No	Savings	NA[] $	Savings	NA[] $	Delay	NA[]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenanca Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision

21. Approvals

Signature		Date	Signature	Date
Design Authority	A. M. Segrest	7/20/98	Design Agent	
Cog. Eng.	M.A. Reilly	7/15/98	PE	
Cog. Mgr.	J.R. Frederickson	7/16/98	QA	
QA	R. P. Ruth DWS 7/17/98	7/20/98	Safety	
Safety	R. G. Morgan	7/20/98	Design	
Environ.			Environ.	
Other			Other	
			DEPARTMENT OF ENERGY	
			Signature or a Control Number that tracks the Approval Signature	
			ADDITIONAL	

13a. Description of Change Continued.

Deleted text is shown as strikeout.
Corrected text is shown as shaded.
Added text is shown as shaded.

1) Section 4.0 Changes

Table 4-1. Fuel Surface Area

FUEL SURFACE AREA Notes: 1) ~~Current loading scenarios include one scrap basket per MCO.~~ Design Basis: Based on Mark IV fuel, 4 fuel baskets and 1 scrap basket bounds an MCO loaded with 5 fuel baskets and 1 scrap basket of Mark IA fuel. 2) The criticality safety analysis allows 2 scrap baskets per MCO	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Geometric fuel surface area per MCO with one (1) scrap basket and four (4) tier baskets	~~130,000~~ 80,000 cm^2	1	~~20,000~~ 19,000 cm^2	2
Geometric fuel surface area per MCO with two (2) scrap baskets and three (3) tier baskets	120,000 cm^2	56	19,000 cm^2	2
Geometric fuel surface area per tier basket	~~17,500~~ 8,600 cm^2	3	~~750~~ 425 cm^2	14
Geometric fuel surface area per scrap basket	~~60,000~~ 45,000 cm^2	4	17,000 cm^2	13

2) Section 5.0 Changes

Table 5-2. MCO Maximum Internal Pressure

MCO MAXIMUM INTERNAL PRESSURE	Calculated Safety Basis Value	Endnote
MCO Maximum Internal Pressure	~~4.4~~ 4.2 atm absolute (~~64.7~~ 61.7 psia)	47

Table 5-3. MCO Maximum Temperatures in CSB Storage

MCO MAXIMUM TEMPERATURES in CSB STORAGE Assuming a 7 day storage with vault temperature at 62 °C implying a bounding CSB storage tube temperature of 92 °C.	Calculated Safety Basis Value		Endnote
MCO Maximum Wall Temperature	108°C	(226°F)	48
MCO Maximum Gas Temperature	125°C	(257°F)	49
MCO Maximum Fuel Temperature	~~139~~153 °C	(~~282~~307 °F)	50
MCO Maximum Scrap Temperature	123 °C	(253 °F)	57

4) Section 6.0 Changes

[1] ~~L. A. Lawrence and~~ D. E. Ball and D. R. Duncan, "Fuel Surface Area," HNF-SD-SNF-CN-017, Revision ~~1~~ 2 , released ~~February 10~~ June 5, 1998, p. ~~2~~ 10.

[2] HNF-SD-SNF-CN-017, Revision ~~1~~ 2, released ~~February 10~~ June 5, 1998, p. ~~5~~ 7.

[3-4] HNF-SD-SNF-CN-017, Revision ~~1~~ 2, released ~~February 10~~ June 5, 1998, p. ~~6~~ 9.

~~"For a total estimate of approximately A_g = 70,000 cm^2 for damaged fuel."~~

~~70,000 cm^2 / 4 fuel baskets = 17,500 cm^2~~

~~[4] HNF SD SNF CN 017, Revision 1, released February 10, 1998, p. 7 .~~

[10 - 12] A. L. Pajunen, "Evaluation of Radiolytic Gas Generation from Water Dissociation in a Multi-Canister Overpack," HNF-SD-SNF-CN-006, Revision 0, released April 21, 1996 7, p. 10, Table 1.

[13 - 14] HNF-SD-SNF-CN-017, Revision ~~1~~ 2, released ~~February 10~~ June 5, 1998, p. ~~5~~ 7.

[16] HNF-SD-SNF-CN-017, Revision 2, released June 5, 1998, p. 6.

"Average value of A_g = 1.7 x 10^5 cm^2 per MCO, assuming 4 fuel baskets per MCO."

1,700 cm^2 / 4 baskets = 425 cm^2 per basket

[39 - 40] ~~PNNL 11471 Climatological Data Summary 1996 w/ Historical Data.~~ D. J. Hoitink and K. W. Burk, PNNL-11794, Hanford Site Climatological Data Summary 1997, with Historical Data, published March 1998, Summary p. iii.

[47] J. R. Frederickson and M. G. Plys, "MCO Internal Gas Composition and Pressure During Interim Storage," HNF-SD-SNF-TI-040, Revision ~~1~~ 2, released ~~March 19~~ June 18, 1998, p. ~~2-3~~ 2-4.

[48 - 49] D. R. Duncan and M. G. Plys, "Simulation of Normal and Off-Normal Multi-Canister Overpack Behavior," HNF-2256, Revision ~~0~~ 1, released ~~April 9~~ July 1, 1998, p. ~~L-127~~ T-33.

[50] HNF-2256, Revision ~~0~~ 1, released ~~April 9~~ July 1, 1998, p. ~~L-127~~ 2-3.

[56] HNF-SD-SNF-CN-017, Revision 2, released June 5, 1998, p. 10.

[57] HNF-2256, Revision 1, released July 1, 1998, p. 2-3.

Table 6-1. Technical Databook Supporting Document Review Status

Document Number	Document Title	Author	Reviewed, Approved and Released in the Hanford Document Control System	Is the OCRWM QARD applicable per HNF-SD-SNF-RPT-007? If YES, an OCRWM QARD Document Review is required.	Does the OCRWM Document Review require the additional rigor of an OCRWM QARD Peer Review? (See AP 6-009)	Current Review Status After the SNF Project has received procedure validation by OCRWM QARD personnel, SNF Project Review Packages will require SNF Project QA validation.
HNF-2586, Revision 0	Summary Assessment of Fuel Damage Distributions in the K Basins	A. L. Pitner	4/23/98	YES	YES	Review Required in accordance with AP 6-009.
HNF-SD-SNF-TI-009, Revision 1	105-K Basin Material Design Basis Feed *Description for SNF* Project Facilities	W. L. Willis and A. N. Praga	1/9/98	YES	YES	Review Required in accordance with *AP 6-009*.
WHC-SD-SNF-TI-016, Revision 0~~A and supplemental ECN 638939~~	Development of Design Basis Capacity for SNF Project Systems	A. L. Pajunen	~~2/27/96 and ECN 4/21/97~~ 7/21/97	NO	Not Applicable	Not Applicable
WHC-SD-SNF-ANAL-011 Revision 0	Comparison of Spent Fuel Databases for K Basins	F. Schmittroth & K. D. Dobbin	9/12/96	NO	Not Applicable	Not Applicable
Thermophysical Properties of Matter Volume 7	Thermal Radiative Properties, Metallic Elements and Alloys	Thermophysical Properties Research Center	Published 1970	NO	Not Applicable	Not Applicable
Nuclear ~~Systems Materials Handbook~~ Science Engineering, Volume 19	Determinations of the Total Emissivity of Polished Oxidized Uranium Surfaces	L. Baker Jr., et al.	Published 1963	NO	Not Applicable	Not Applicable

Table 6-1. Technical Databook Supporting Document Review Status

Document Number	Document Title	Author	Reviewed, Approved and Released in the Hanford Document Control System	Is the OCRWM QARD applicable per HNF-SD-SNF-RPT-0077 If YES, an OCRWM QARD Document Review is required.	Does the OCRWM Document Review require the additional rigor of an OCRWM QARD Peer Review? (See AP 6-009)	Current Review Status After the SNF Project has received procedure validation by OCRWM QARD personnel, SNF Project Review Packages will require SNF Project QA validation.
~~PNNL-11471~~ PNNL-11794	~~Climatological Data Summary 1996~~ Hanford Site Climatological Data Summary 1997 with Historical Data	D. J. Holtkink and K. W. Burk	Published ~~1996~~ 3/1998	NO	Not Applicable	Not Applicable
HNF-SD-SNF-CN-035, Revision 1	Statistical Analysis of Oxidation Rates for K Basin Fuel in Dry Air	D. J. Trimble and T. L. Welsh	2/6/98	YES	YES	This document to be revised, with review to follow.
Prog. Solid St. Chem., Vol. 15.	Oxidation Mechanisms and Catalytic Properties of the Actinides	C. A. Colmenares	Published Handbook	NO	Not Applicable	Not Applicable
HNF-SD-SNF-TI-040, Revision 2	MCO Internal Gas Composition and Pressure During Interim Storage	~~J. R. Frederickson~~ D. R. Duncan and M. G. Plys	~~3/19/98~~ 6/18/98	YES	YES	Review Completed per AP 6-009. Review Package submitted to SNF Project File, on EDT 624307, awaiting assignment of Accession number.
HNF-2256, Revision 1	Simulation of Normal and Off-Normal Multi-Canister Overpack	D. R. Duncan and M. G. Plys	7/1/98	YES	YES	Review Required in accordance with AP 6-009.
HNF-2234, Revision 1	Sensitivity of Probabilistic MCO Water Content Estimates to Key Assumptions	D. R. Duncan and M. G. Plys	3/23/98	YES	YES	Review Completed per AP 6-009. Review Package submitted to SNF Project File, on EDT 624308, awaiting assignment of Accession number.
HNF-SD-SNF-OCD-001, Revision 2	SNF Project Product Specification	A. L. Pajunen and J. P. Sederburg	3/28/98	NO	NO	Not Applicable

Table 6-1. Technical Databook Supporting Document Review Status

Document Number	Document Title	Author	Reviewed, Approved and Released in the Hanford Document Control System	Is the OCRWM QARD applicable per HNF-SD-SNF-RPT-0077 If YES, an OCRWM QARD Document Review is required.	Does the OCRWM Document Review require the additional rigor of an OCRWM QARD Peer Review? (See AP 6-009)	Current Review Status After the SNF Project has received procedure validation by OCRWM QARD personnel, SNF Project Review Packages will require SNF Project QA validation.
HNF-SD-SNF-CN-017, Revision ~~1~~ 2	Fuel Surface Area	~~L. A. Lawrence and~~ D. E Ball and D. R. Duncan	~~2/10/98~~ 6/5/98	YES	YES	Revision 2 is being Peer Reviewed in accordance with AP 6-009.
HNF-SD-SNF-TI-020, Revision 2	SNF Project Recommended Reaction Rate Constants for Corrosion of N-Reactor Fuel	T. D. Cooper, and A. L. Pajunen	6/15/98	YES	YES	Review Package in SNF Project File Accession, # S29702316. Review done prior to AP 6-009, pkg may require supplementation.
HNF-SD-W441-CN-001, Revision ~~1~~ 2	SNF Inventory in Bulk MCO Water at the Cold Vacuum Drying Facility	D. L. Sherrell	6/11/98	To be evaluated	To be evaluated	To be evaluated
HNF-SD-SNF-CN-006, Revision 0	Evaluation of Radiolytic Gas Generation from Water Dissociation in a Multi-Canister Overpack	A. L. Pajunen	4/21/96 ~~7~~	YES	YES	Review Package in SNF Project File, Accession # S2970130. Review done prior to AP 6-009, pkg may require supplementation.
HNF-1523, Revision 0	K Basins Particulate Water Content, Behavior, and Impact	D. R. Duncan and D. E. Ball	11/19/98 ~~7~~	YES	YES	Review Completed per AP 6-009. Review Package in SNF Project File, Accession # S2980602.
HNF-1527, Revision 0	Estimates of Particulate Mass in Multi-Canister Overpacks	J. P. Sloughter, et al.	11/19/97	YES	YES	Review Completed per AP 6-009. Review Package in SNF Project File, Accession # S2980602.

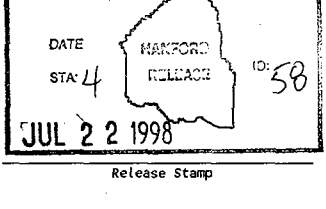
SPENT NUCLEAR FUEL PROJECT TECHNICAL DATABOOK

M. A. Reilly
DE&S Hanford, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: ~~645102~~ 645109 Rev 5 7/22/98 UC: 510
Org Code: 2T970 Charge Code: LB051
B&R Code: EW3135040 Total Pages: 38

Key Words: 105 K East Basin, 105 K West Basin, Canister Storage Building, Fuel Parameters, Sludge Parameters, Design Basis, Safety Basis, Vacuum Drying, Hot Conditioning, Fuel Movement, MCO, SPR

Abstract: The Spent Nuclear Fuel (SNF) Project Technical Databook is developed for use as a common authoritative source of fuel behavior and material parameters in support of the Hanford SNF Project. The Technical Databook will be revised as necessary to add parameters as their Databook submittals become available.



Release Approval Date

Release Stamp

Approved for Public Release

RECORD OF REVISION	(1) Document Number HNF-SD-SNF-TI-015	Page 1

(2) Title

SPENT NUCLEAR FUEL PROJECT TECHNICAL DATABOOK

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	Authorized for Release (6) Cog. Mgr. Date
0	(7) Initial Release, EDT 613013, 9/20/95	S. M. Scott	P. K. Shen 9/7/95
1	Rev 0 with ECN 191395 completely rewritten and reformatted, ECN 638911, 3/5/97	D. R. Duncan	J. R. Frederickson 3/3/97
2	ECN 638928 Section 4 and 5 reformatted. Tables 4-1, 4-2, 4-3, 4-4, 4-6, 4-7, 4-9, 4-11, 4-12, and 4-13 had parameters or source document changes.	D. R. Duncan	J. R. Frederickson 5/1/97
3	Incorporated approved and released ECN 645055 and ECN 645061 into Revision 3. Additions have been shaded. Strikeout's remain in place where determined most beneficial for review purposes. Section 1.0, • Paragraphs restructured for clarity. • Reworded to include: Identification of the Technical Databook as a Technical Baseline document. Required application of SNF-1951, the Deviation Notice process. Section 2.0, • Text added to describe Table 2-1. • Table 2-1 added to define supporting document OCRWM QARD applicability and status. Section 3.0, • Deleted first paragraph as the "recent review" statement is no longer recent. • Reworded 2nd paragraph for clarity. • Deleted the following due to duplication of text information: Table 3-1. General Description of Inputs and Systems for Design and Safety Bases, Table 3-2. Example 1 Design / Safety Bases for Shipment of MCO from CVD to CSB., Table 3-3. Design / Safety Bases for Staging of MCO at the CSB Section 4.0, • Deleted the following as they supported Hot Conditioning only: Table 4-5 KE & KW Reaction Rate with Hydrogen, Table 4-8 Hydride Decomposition • Table 4-9, Fuel Damage, strikeout and redline changes to reflect latest characterization data. • Delete Table 4-10, Fuel Decay Heat per MTU, it was established as a place holder for future information. It has been determined the information is no longer required. • Tables 4-12, N Fuel Source Terms Continued and 4-13 revised to consistently implement Revision 1 of HNF-SD-SNF-TI-009 in the Technical Databook. Table 4-11, Fuel Decay / Heat Generation per MCO, implemented HNF-SD-SNF-TI-009 by ECN 645055. Section 5.0, • Changed Endnote numbers to remove duplication as ECN's 645055 and 645061 had used endnote numbers already in use. ECN-645043	M. A. Reilly 5/21/98	J. R. Frederickson 5/21/98

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	Authorized for Release (6) Cog. Mgr. Date
4	General changes: • Rev 4 issued as Volume 1 of the Technical Databook. • Sections 1, 2 and 3: Deleted text not shown. *New text is identified by left margin vertical* lines. Text relocated in the document is not redlined. Section 1, Paragraph 2 identifies Volume 1 pertaining to K Basin Fuel, and Volume 2 will address sludge and water removal projects. Section 2, Rewritten from describing sections of the databook, to stating how the values should be used within project analyses and modeling. Section 3, Rewritten from a general discussion on design and safety analysis, to a definition section. Definitions specific to Technical Databook use. Section 4, 1st, 2nd and 3rd paragraphs rewritten to eliminate duplication of definitions now located in Section 3. Values that were changed are marked by strikeout and vertical lines in the left margin. Table 4-7. 1. Corrected the endnotes to recognize the originating document for particulate mass numbers as HNF-1527, revision 0. 2. Added Water Mass parameter and value for uncleaned fuel, endnote HNF-SD-SNF-OCD-001, revision 2. 3. Added value for residual free water estimate after cold vacuum drying, reference HNF-1851, revision 1. Table 4-7a. Deleted, Similar information presented as Table 5-1. Section 5.0, Added text describing Derived Physical Quantities for calculated values, and why they are provided. Section includes tables that include calculation values, and endnotes (HNF-SD-W441-CN-001, revision 2; HNF-SD-SNF-Ti-040, revision 1; HNF-2256, revision 0; and HNF-2234, revision 1. Added: Table 5-1 Particulate Mass Generated per MCO Table 5-2 MCO Maximum Internal Pressure Table 5-3 MCO Maximum Temperatures in CSB Storage Table 5-4 Water Content associated with Particulate in MCO Section 6.0, Changes to endnotes are indicated by strikeouts and left margin vertical lines. Table 6-1 (had been Table 2-1) co-located with endnotes for convenience. Changes are indicated by strikeouts and left margin vertical lines. ECN-645102	M. A. Reilly 6/18/98	J. R. Frederickson 6/18/98

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	Authorized for Release (6) Cog. Mgr. Date
5 RS	Changes are identified with a change bar in the left margin of the document. ECN-645109 shows corrected and additional text as shaded, and deleted text as strikeout. Table 4-1, Changed to reflect the analyses completed in HNF-SD-SNF-CN-017, Revision 2 (See Page 3 of ECN 645109). Table 5-2, Changed to reflect the analyses completed in HNF-SD-SNF-TI-040, Revision 2 (See page 4 of ECN 645109). Table 5-3, Changed to reflect the analyses completed in HNF-2256, Revision 1 (See page 4 of ECN 645109). Section 6.0, endnotes updated to source documents for Table 4-1, 5-2, and 5-3 changes. Corrected editorial errors. (See page 5 of ECN 645109). Table 6-1, Corrected editorial errors, and updated to current revisions of source documents (See pages 6-8 of ECN 645109).	M. A. Reilly M.A. Reilly 7/15/98	J. R. Frederickson 7/16/98

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List of Tables

List of Figures

Spent Nuclear Fuel Project
Technical Databook
Volume 1, Fuel

1.0 PURPOSE

The Spent Nuclear Fuel (SNF) Project Technical Databook provides project-approved summary tables of selected parameters and derived physical quantities, with nominal design and safety basis values. It contains the parameters necessary for a complete documentation basis of the SNF Project technical and safety baseline.

The databook is presented in two volumes. Volume 1 presents K Basins SNF related information. Volume 2 (not yet available) will present selected sludge and water information, as it relates to the sludge and water removal projects.

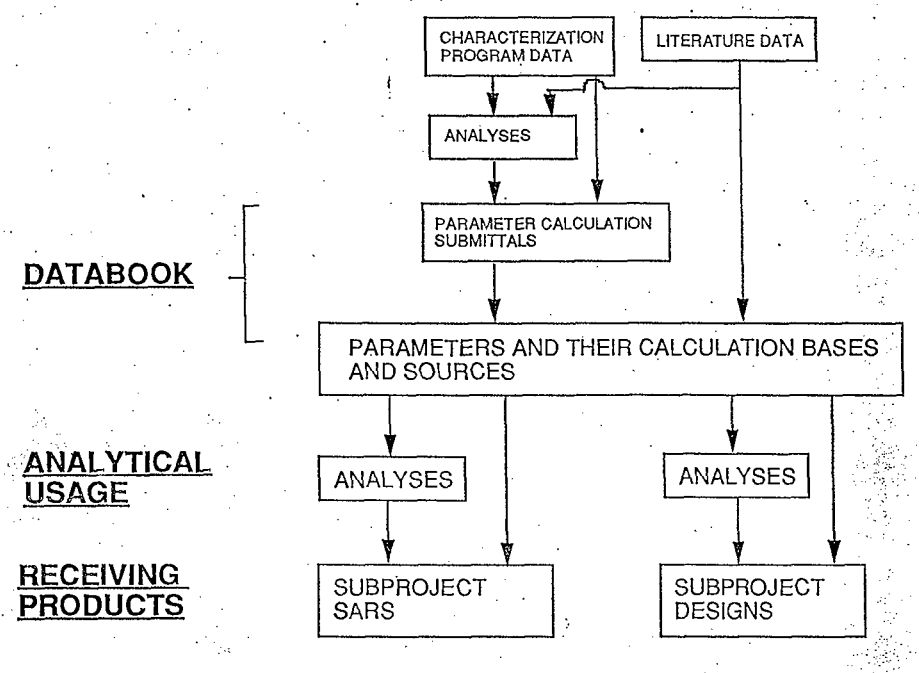
2.0 SCOPE

The values, within this databook, shall be used as the foundation for analyses, modeling, assumptions, or other input to SNF project safety analyses or design. All analysis and modeling using a parameter available in this databook are required to use and cite the appropriate associated value, and document any changes to those values (i.e., analysis assumptions, equipment conditions, etc). Characterization and analysis efforts are ongoing to validate, or update these values.

Figure 1 graphically depicts sources and receiving products of the Technical Databook. Sources include literature data, Characterization Program data, and analyses or calculations.

As a SNF Project Technical Baseline document, changes to this databook shall be controlled by both the *Engineering Document Change Control Requirements*, HNF-PRO-440, and the *SNF Baseline Change Control*, HNF-1951. Before implementing any Technical Databook Engineering Change Notice (ECN), possible sub-project cost, scope and schedule impacts are to be evaluated per SNF-1951.

Figure 1. A Graphical Depiction of the SNF Project Technical Databook Sources and Receiving Products



3.0 DEFINITIONS

design basis
The set of requirements that bound the design of structures, systems, or components within the facility. These design requirements include consideration of safety, plant availability, efficiency, reliability, and maintainability. Certain aspects of the design basis are important to safety. (Basis: Project Hanford Management System (PHMS) Glossary)

design basis value
A nominal design basis value is based on anticipated operating conditions. A value range may exist, the conservative end of the performance range is used, whether the conservative end is high or low. (Basis: Technical Databook definition)

safety basis
The combination of information relating to the control of hazards at a nuclear facility (including design, engineering analyses, and administrative controls) upon which Department of Energy depends for its conclusions that activities at the facility can be conducted safely. (Basis: PHMS Glossary)

safety basis value
A safety basis value is based on credible extremes of the parameter range. (Basis: Technical Databook definition)

4.0 PARAMETER SUMMARY TABLE

The tables within this section present the key engineering, physical, and chemical parameters, with project-approved values. Included are basic K Basin fuel physical properties, behavioral characteristics, and corrosion products, as well as parameters with interpreted values from technical handbooks and open literature.

Parameter values are given for both design basis and safety basis, according to the definitions in Section 3.0.

Table 4-1. Fuel Surface Area

FUEL SURFACE AREA

Notes: 1) Design Basis: Based on Mark 1V fuel. 4 fuel baskets and 1 scrap basket bounds an MCO loaded with 5 fuel baskets and 1 scrap basket of Mark 1A fuel.

2) The criticality safety analysis allows 2 scrap baskets per MCO

	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Geometric fuel surface area per MCO with one (1) scrap basket and four (4) tier baskets	80,000 cm^2	1	19,000 cm^2	2
Geometric fuel surface area per MCO with two (2) scrap baskets and three (3) tier baskets	120,000 cm^2	56	19,000 cm^2	2
Geometric fuel surface area per tier basket	8,600cm^2	3	425cm^2	14
Geometric fuel surface area per scrap basket	45,000cm^2	4	17,000 cm^2	13

Table 4-2. KE & KW Fuel Reaction Enhancement Factor

KE & KW FUEL REACTION ENHANCEMENT FACTOR

$\xi = (2)(5)$
where:
2 is the average fuel surface increase due to radiation
5 is the fuel surface area increase due to roughness

SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
10	5	3	16

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-3. KE & KW Fuel Reaction Rate with Air

KE & KW FUEL REACTION RATE (with air as a function of temperature, pressure, & humidity)

Basic Rate Equation: Rate [mg(wt gain)/hr] = $A_g \xi K$

where: A_g = Geometric Surface Area of Uranium, cm^2
ξ = Reactivity Enhancement Factor, Dimensionless
K = Rate Constant (can be dependent on temperature and reactant concentration), mg(wt gain)/hr-cm^2

	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Rate Constant (K)	Units of mg(weight gain)/cm^2/hr where P is the partial water pressure in kPa, T is in K, and RH is relative humidity.		The Design Basis is the same as the Safety Basis.	See Safety Basis Endnote
	Dry Air (<10-15 vppm H_2O)			
	$U + \left(\frac{2+x}{2}\right) O_2 \rightarrow UO_{2+x}$	46		
	Where x < 0.25			
	for T<692°K Log K = 7.19-3732/T (1)	42		
	for T>692°K Log K = 28.381-7Log[T]-4638.2/T (2)	6		
	Moist Air			
	$U + \left(\frac{2+x}{2}\right) O_2 \rightarrow UO_{2+x}$	46		
	Where x < 0.25			
	for T<373 K (11-75%RH) Log K = 13.8808-5769.9/T (3)	7		
	for T<373 K (100%RH) Log K = 8.333-3730/T (4)	7		
	for 373<T<463 K (<100%RH) LogK=10.566-4990/T+0.3Log[P] (5)	7		
	for T>463 K (<100%RH) Log K = 6.1931-2963/T+0.3Log[P] (6)	7		

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-3. KE & KW Fuel Reaction Rate with Air Continued

KE & KW FUEL REACTION RATE (with air as a function of temperature, pressure, & humidity) Continued

Basic Rate Equation: Rate [mg(wt gain)/hr] = $A_s \xi K$

where: A_s = Geometric Surface Area of Uranium, cm^2

ξ = Reactivity Enhancement Factor, Dimensionless

K = Rate Constant (can be dependent on temperature and reactant concentration), mg(wt gain)/hr-cm^2

	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Rate Constant (K)	**Transitions Between Equations For Moist Air** 1. Moist Air to Oxygen Free Water Vapor For $[O_2]$ > 100 vppm in presence of water vapor, Use moist Air Equations. For 10 < $[O_2]$ < 100 vppm in presence of water vapor, Linearly interpolate between moist air and oxygen free water vapor at the same temperature and partial pressure of water. For $[O_2]$ <10 vppm in presence of water vapor, Use oxygen free water vapor. 2. Moist Air of Varying Water Content For T < 305 K RH < 75% - use Dry Air Equation (1) 75% ≤ RH ≤ 100% - linear interpolation between equations (1) and (4) For 305 K ≤ T ≤ 368 K RH < 10% - Linear Interpolation between equations (1) and (3) 10% ≤ RH ≤ 75% - Use Equation (3) 75% ≤ RH ≤ 100%- Linear Interpolation between Equations (3) and (4) For 368 K ≤ T ≤ T_1 where T_1 = 397 K to 448 K, depending on RH (see Endnote 44) RH < 10% - Linear Interpolation between Equations (1) and (4) 10% ≤ RH ≤ 100% - Use Equation (4) For T_1 ≤ T ≤ 463 K, Use greater of Equations (1) and (5) For 463 K ≤ T ≤ 692 K, Use greater of Equations (1) and (6) For T > 692 K, Use greater of Equations (2) and (6)	43 44	The Design Basis is the same as the Safety Basis.	See Safety Basis Endnote

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-4. KE & KW Reaction Rate with Water

KE & KW FUEL REACTION RATE (with water as a function of temperature & dissolved oxygen content)

Basic Rate Equation: Rate [mg(wt gain)/hr] = $A_s \xi K$

where: A_s = Geometric Surface Area of Uranium, cm^2

ξ = Reactivity Enhancement Factor, Dimensionless

K = Rate Constant (can be dependent on temperature and reactant concentration), mg(wt gain)/hr-cm^2

	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Rate Constant (K)	Units of mg(weight gain)/cm^2/hr where P is the partial water pressure in kPa and T is in °K **Oxygen Free Water Vapor** $U+(2+x)H_2O \rightarrow UO_{2+x}+(2+x)H_2$ Where $x < 0.25$ for Liquid Water, T<373°K Log K = 7.634-3016/T (7) for Water Vapor, T<523°K Log K = 4.33-2144/T+0.5Log[P] (8) for Water Vapor, 523<T<735°K (43-93kPa H_2O) Log K = -22.915417+(30066.5/T)-9.119078*10^5/T^2 (9) for Water Vapor, 735<T<923°K (43-93 kPa H_2O) Log K = -23.905197+(42718.8/T)-1.787581*10^7/T^2 (10)	45 8	The Design Basis is the same as the Safety Basis.	See Safety Basis Endnote

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-5. Deleted

Table 4-6. Radiolytic G Value

RADIOLYTIC G VALUE	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Oxygen Production G values as a function of alpha radiation	0.75 (X_w) molecules O_2/100 eV absorbed by particulate $0 \leq X_w \leq 1$ where: X_w = Weight fraction water in fuel particulate	10	Oxygen generation is only a consideration of the safety basis, therefore the design basis is the same as the safety basis.	Same as Safety Basis Endnote
Oxygen Production G values as a function of beta radiation	0.225 (X_w) molecules O_2/100 eV absorbed by particulate $0 \leq X_w \leq 1$ where: X_w = Weight fraction water in fuel particulate	11	Oxygen generation is only a consideration of the safety basis, therefore the design basis is the same as the safety basis.	Same as Safety Basis Endnote
Oxygen Production G values as a function of gamma radiation	1 (X_w) molecules O_2/100 eV absorbed by particulate $0 \leq X_w \leq 0.225$ 0.225 molecules O_2/100 eV absorbed by particulate $0.225 < X_w \leq 1$ where: X_w = Weight fraction water in fuel particulate	12	Oxygen generation is only a consideration of the safety basis, therefore the design basis is the same as the safety basis.	Same as Safety Basis Endnote

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-7. Canister Particulate Mass & Water Content

CANISTER PARTICULATE MASS & WATER CONTENT

	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Cladding Film Scrap				
Particulate mass, kg.	1.2	51	0.4	52
From $Al(OH)_3$	1.2	15	0.3	17
From $UO_4 4H_2O$	0.0		0.1	
Water mass, kg.	0.42		0.115	
From $Al(OH)_3$, 35%	0.42		0.105	
From $UO_4 4H_2O$, 11%	0.0		0.01	
Cladding Film, Fuel				
Particulate mass, kg.	6.8	51	2.0	52
From $Al(OH)_3$	6.8	15	1.7	17
From $UO_4 4H_2O$	0.0		0.3	
Water mass, kg.	2.38	53	NDA	NDA
Particulate mass, kg, after cleaning	2.0	15	0.81	17
From $Al(OH)_3$	2.0		0.51	
From $UO_4 4H_2O$	0.0		0.3	
Water mass, kg. after cleaning	0.7		0.213	
From $Al(OH)_3$, 35%	0.7		0.18	
From $UO_4 4H_2O$, 11%	0.0		0.033	

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-7. Canister Particulate Mass & Water Content

CANISTER PARTICULATE MASS & WATER CONTENT	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Oxide Film Scrap				
Particulate mass, kg.	0.6	51	0.09	52
Water content before passing proof test, %	5.5%	15	4.%	17
Water mass, kg. before passing proof test	0.033		0.0036	
Oxide Film, Fuel				
Particulate mass, kg.	0.7	51	0.009	52
Water content before passing proof test, %	5.5%	15	4.%	17
Water mass, kg, before passing proof test	0.039		<1.g	
Particulate on Scrap				
Particulate mass, kg.	7.4	51	0.74	52
Water content before passing proof test, %	5.5%	15	4.0%	17
Water mass, kg, before passing proof test	0.41		0.03	

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-7. Canister Particulate Mass & Water Content

CANISTER PARTICULATE MASS & WATER CONTENT

	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Particulate on Fuel				
Particulate mass, kg.	4.32	51	1.64	52
Water content before passing proof test, %	5.5%	15	4.0%	17
Water mass, kg, before passing proof test	0.24		0.066	
Generated Particulate, Scrap (assuming a 75°C CVD process step)				
Particulate mass, kg.	13.16	51	2.14	52
Mass generated while hydration possible	4.12	15	-	17
Water content before passing proof test, %	0.55%		-	
Water mass, kg, before passing proof test	0.023		<1.g	
Generated Particulate, Fuel (assuming a 75°C CVD process step)				
Particulate mass, kg.	15.12	51	0.19	52
Mass generated while hydration possible	4.81	15	-	17
Water content before passing proof test, % (6)	0.55%		-	
Water mass, kg, before passing proof test	0.026		<1.g	
Residual free water estimate after Cold Vacuum Drying	< 200 g	54	NDA	NDA

Table 4-7a. Deleted, See Section 5.0, Table 5-1.

Table 4-8. Deleted

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-9. Fuel Damage

FUEL DAMAGE		SAFETY BASIS VALUE			DESIGN BASIS VALUE		
		Inner	Outer	Endnote No.	Inner	Outer	Endnote No.
KE	Intact Fuel - No evidence of cladding breach or deposited sludge.	86%	49%	19	86%	49%	19
	Breached Fuel - Minor cladding rupture with no reacted fuel or deposited sludge visibly present.	9%	9%		9%	9%	
	Defected Fuel - Definite evidence of cladding breach with reacted fuel egressing from the element. The amount of exposed fuel may be significant (e.g. loose end cap), but there is no gross cladding splitting, element dilation, or fuel voiding.	4%	38%		4%	38%	
	Bad Fuel - Gross failure is evident with substantial element dilation, cladding splitting, fuel "mushrooming," or fuel voiding.	1%	4%		1%	4%	
		SAFETY BASIS VALUE			DESIGN BASIS VALUE		
		Inner	Outer	Endnote No.	Inner	Outer	Endnote No.
KW	Intact Fuel - No evidence of cladding breach or deposited sludge.	84%	50%	19	84%	50%	19
	Breached Fuel - Minor cladding rupture with no reacted fuel or deposited sludge visibly present.	14%	39%		14%	39%	
	Defected Fuel - Definite evidence of cladding breach with reacted fuel egressing from the element, but there is no gross cladding splitting, element dilation, or fuel voiding.	0%	0%		0%	0%	
	Bad Fuel - Gross failure is evident with substantial element dilation, cladding splitting, fuel "mushrooming," or fuel voiding.	2%	11%		2%	11%	

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-10. Deleted

Table 4-11. Fuel Decay / Heat Generation per MCO

FUEL DECAY / HEAT GENERATION per MCO

		SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
FUEL TYPES	Mark IV	776 Watts Maximum Heat generation in W/MTU (decayed to 5/31/98) = 1420 W + 11.6 MTU = 122.4 W/MTU 270 assembly/MCO x 23.48 KgU/assembly = 6339.6 KgU/MCO 122.4 W/MTU x 6339.6 KgU/MCO = 775.96 W/MCO NOTE: 5 tier baskets per MCO represents bounding case.	21 22	403 Watts Average (includes MarkIV & Mark IA) Total fuel heat generation in the combined basins = 1.61e+05 W fuel decayed to 5/31/98	24
	Mark 1A Mark IA Note: KE Basin does not contain Mark IA Fuel.	585 Watts Maximum Heat generation in W/MTU (decayed to 5/31/98) = 1420 W + 11.6 MTU = 122.4 W/MTU 288 assembly/MCO x 16.59 KgU/assembly = 4777.92 KgU/MCO 122.4 W/MTU x 4777.92 KgU/MCO = 585 W/MCO NOTE: 6 tier baskets per MCO represents bounding case.	21 23	161,000 W total Heat load in KE+KW Basins + 400 MCO's (nominal to be processed = 403 W/ MCO	25
	SPR SPR Note: Total KE + KW SPR = 3.3 MTU.	329 Watts Total activity of selected radionuclides = 7.05e+04 Ci (decayed to 1/1/94) NOTE: All SPR fuel will be contained in 1 MCO.	27	Same as Safety Basis	See Safety Basis Endnote No.

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-12. N Fuel Source Terms

N FUEL SOURCE TERMS

Document WHC-SD-SNF-ANAL-011, titled "Comparison of Spent Fuel Databases for K Basin" compares the Safeguards Control and Accountability Transaction System (SCATS) and reconstructed SCATS (R-SCATS) databases. SCATS was the basis for both the COLDMAC database and the R-SCATS database. (See Endnote 28)

	SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
DATABASES used for the following purposes:				
K Basin Fuel Accountability Location	NA	NA	COLDMAC FUEL DATABASE is used to produce WHC-IP-0069, "N/K Fuels Inventory"	NA
K Basin SAR Safety/Regulatory Assessment Basis	R-SCATS FUEL DATABASE is used as the basis for WHC-SD-NR-ANAL-014, "Consolidated Fuel Decay Heat Calculations"	NA	NA	NA
CSB and CVD SAR Safety/Regulatory Assessment Basis	SCATS FUEL DATABASE is used as the basis for WHC-SD-SNF-TI-009, "105 K Basin Material Design Feed Description for SNF Project Facilities"	NA	NA	NA
Shielding (CSB & CVD)	Fission & Activation Product Totals 4.05×10^4 ci/MTU Actinide Totals 1.01×10^4 5.06×10^4 ci/MTU *	29	2.61×10^4 ci/MTU **	41
	* MkIV fuel with 16% Pu-240 aged 13.5 years, decayed to 5/31/98		** Fission & Activation Product Totals 4.74e+07 + Actinide Totals 7.51e+06 = 5.49e+07 Ci ÷ 2.10e+03 = 2.61e04 MTU	

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

Table 4-12. N Fuel Source Terms Continued

Radionuclide Inventory K East Basin

SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Safety Basis and Design Basis are the same.		30	

Isotope	Activity (Ci)	Mass (Kg)	Heat Generation (W)	Isotope	Activity (Ci)	Mass (Kg)	Heat Generation (W)
Fission and Activation Products							
H-3	1.80e+04	1.86e-03	6.04e-01	Sn-123	1.46e-05	1.78e-12	4.57e-08
C-14	3.62e+02	8.12e-02	1.06e-01	Sn-126	8.07e+01	2.84e+00	2.48e-02
Fe-55	9.64e+02	3.86e-04	3.22e-02	Sb-124	2.49e-18	1.42e-25	3.28e-20
Co-60	1.86e+03	1.64e-03	2.86e+01	Sb-125	1.69e+04	1.64e-02	5.31e+01
Ni-59	2.11e+01	2.79e-01	8.38e-04	Sb-126	1.13e+01	1.35e-07	2.05e-01
Ni-63	2.30e+03	3.73e-02	2.33e-01	Sb-126m	8.07e+01	1.03e-09	1.03e+00
Se-79	4.35e+01	6.24e-01	1.34e-02	Te-123m	2.33e-11	2.63e-18	3.37e-14
Kr-85	2.84e+05	7.24e-01	4.25e+02	Te-125m	4.13e+03	2.29e-04	3.46e+00
Sr-89	0.00	0.00	0.00	Te-127	7.90e-07	2.99e-16	1.07e-09
Sr-90	4.96e+06	3.64e+01	5.77e+03	Te-127m	8.07e-07	8.55e-14	3.98e-10
Y-90	4.97e+06	9.13e-03	2.75e+04	Te-129	0.00	0.00	0.00
Y-91	1.78e-14	7.26e-22	6.39e-17	Te-129m	0.00	0.00	0.00
Zr-93	2.01e+02	7.98e+01	2.30e-02	I-129	3.26e+00	1.85e+01	1.52e-03
Zr-95	1.35e-12	6.30e-20	6.83e-15	Cs-134	6.95e+03	5.37e-03	7.09e+01
Nb-93m	1.26e+02	4.46e-04	2.25e-02	Cs-135	3.96e+01	3.44e+01	1.32e-02
Nb-95	3.01e-12	7.69e-20	1.44e-14	Cs-137	6.55e+06	7.53e+01	6.62e+03
Nb-95m	1.00e-14	2.64e-23	1.33e-17	Ba-137m	6.19e+06	1.15e-05	2.43e+04
Tc-99	1.45e+03	8.55e+01	7.27e-01	Ce-141	0.00	0.00	0.00
Ru-103	0.00	0.00	0.00	Ce-144	7.56e+02	2.37e-04	4.98e-01
Ru-106	1.39e+03	4.15e-04	8.26e-02	Pr-143	0.00	0.00	0.00
Rh-103m	0.00	0.00	0.00	Pr-144	7.47e+02	9.89e-09	5.48e+00
Rh-106	1.39e+03	3.90e-10	1.32e+01	Pr-144m	9.07e+00	5.00e-11	3.05e-03
Pd-107	8.59e+00	1.67e+01	4.72e-04	Pm-147	2.45e+05	2.64e-01	9.00e+01
Ag-110	2.28e-04	5.47e-17	1.71e-09	Pm-148	0.00	0.00	0.00
Ag-110m	1.71e-02	3.60e-09	2.84e-04	Pm-148m	0.00	0.00	0.00
Cd-113m	1.80e+03	8.30e-03	1.98e+00	Sm-151	8.92e+04	3.39e+00	1.04e+01
Cd-115m	0.00	0.00	0.00	Eu-152	4.67e+02	2.70e-03	2.11e+00
In-113m	1.77e-07	1.06e-17	4.10e-10	Eu-154	5.30e+04	1.96e-01	4.75e+02
Sn-113	1.77e-07	1.76e-14	2.93e-11	Eu-155	1.12e+04	2.41e-02	8.12e+00
Sn-119m	2.50e-01	5.57e-08	1.28e-04	Gd-153	9.59e-05	2.72e-11	8.64e-08
Sn-121m	4.01e+01	6.78e-04	4.20e-02	Tb-160	2.29e-15	2.03e-22	1.83e-17
Fission and Activation Product Totals					2.34e+07	3.55e+02	6.53e+04
Actinides							
U-234	4.66e+02	7.46e+01	1.32e+01	Pu-241	3.42e+06	3.32e+01	1.06e+02
U-235	1.77e+01	8.19e+03	4.81e-01	Pu-242	3.07e+01	8.04e+00	8.94e-01
U-236	6.61e+01	1.02e+03	1.77e+00	Am-241	2.06e+05	6.00e+01	6.74e+03
U-238	3.80e+02	1.13e+06	9.46e+00	Am-242	1.13e+02	1.40e-07	9.43e-01
Np-237	3.02e+01	4.28e+01	8.70e-01	Am-242m	1.14e+02	1.17e-02	1.74e-01
Pu-238	6.05e+04	3.53e+00	1.97e+03	Am-243	7.12e+01	3.57e-01	2.25e+00
Pu-239	1.16e+05	1.87e+03	3.59e+03	Cm-242	9.40e+01	2.84e-05	3.40e+00
Pu-240	6.37e+04	2.80e+02	1.98e+03	Cm-244	8.71e+02	1.08e-02	2.99e+01
Actinide Totals					3.87e+06	1.14e+06	1.45e+04

06/02/1997 RADNUC2A run for K-East Basin fuel. Results decayed to 05/31/1998. Total fuel mass in K-East 1.15e+03 MTU. Total fuel activity in K-East 2.73e+07 Ci. Total fuel heat generation in K-East 8.06e+04 W. Pu-239 and Pu-240 have been adjusted to ensure consistency with data previously reported by safeguards.

Table 4-12. N Fuel Source Terms Continued

Radionuclide Inventory K West Basin

SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Safety Basis and Design Basis are the same.			31

Isotope	Activity (Ci)	Mass (Kg)	Heat Generation (W)	Isotope	Activity (Ci)	Mass (Kg)	Heat Generation (W)
Fission and Activation Products							
H-3	1.86e+04	1.93e-03	6.24e-01	Sn-123	2.75e-06	3.35e-13	8.58e-09
C-14	3.31e+02	7.43e-02	9.67e-02	Sn-126	7.50e+01	2.64e+00	2.30e-02
Fe-55	8.75e+02	3.50e-04	2.92e-02	Sb-124	5.45e-19	3.12e-26	7.21e-21
Co-60	2.10e+03	1.86e-03	3.22e+01	Sb-125	1.66e+04	1.61e-02	5.23e+01
Ni-59	1.99e+01	2.63e-01	7.88e-04	Sb-126	1.05e+01	1.26e-07	1.90e-01
Ni-63	2.19e+03	3.55e-02	2.21e-01	Sb-126m	7.50e+01	9.55e-10	9.61e-01
Se-79	4.28e+01	6.14e-01	1.32e-02	Te-123m	4.28e-12	4.82e-19	6.21e-15
Kr-85	3.06e+05	7.80e-01	4.60e+02	Te-125m	4.05e+03	2.25e-04	3.40e+00
Sr-89	0.00	0.00	0.00	Te-127	1.59e-07	6.02e-17	2.14e-10
Sr-90	5.17e+06	3.79e+01	6.01e+03	Te-127m	1.62e-07	1.72e-14	8.03e-11
Y-90	5.17e+06	9.50e-03	2.86e+04	Te-129	0.00	0.00	0.00
Y-91	4.47e-15	1.82e-22	1.60e-17	Te-129m	0.00	0.00	0.00
Zr-93	2.01e+02	7.98e+01	2.30e-02	I-129	3.11e+00	1.76e+01	1.46e-03
Zr-95	3.30e-13	1.54e-20	1.66e-15	Cs-134	8.96e+03	6.92e-03	9.14e+01
Nb-93m	1.22e+02	4.32e-04	2.18e-02	Cs-135	3.79e+01	3.29e+01	1.27e-02
Nb-95	7.33e-13	1.87e-20	3.52e-15	Cs-137	6.64e+06	7.63e+01	6.71e+03
Nb-95m	2.45e-15	6.44e-24	3.23e-18	Ba-137m	6.28e+06	1.17e-05	2.46e+04
Tc-99	1.43e+03	8.43e+01	7.18e-01	Ce-141	0.00	0.00	0.00
Ru-103	0.00	0.00	0.00	Ce-144	1.58e+02	4.95e-05	1.04e-01
Ru-106	4.34e+02	1.30e-04	2.58e-02	Pr-143	0.00	0.00	0.00
Rh-103m	0.00	0.00	0.00	Pr-144	1.56e+02	2.06e-09	1.15e+00
Rh-106	4.34e+02	1.22e-10	4.13e+00	Pr-144m	1.90e+00	1.05e-11	6.39e-04
Pd-107	7.68e+00	1.49e+01	4.22e-04	Pm-147	2.17e+05	2.34e-01	7.97e+01
Ag-110	5.66e-05	1.36e-17	4.25e-10	Pm-148	0.00	0.00	0.00
Ag-110m	4.26e-03	8.97e-10	7.06e-05	Pm-148m	0.00	0.00	0.00
Cd-113m	1.75e+03	8.07e-03	1.92e+00	Sm-151	8.66e+04	3.29e+00	1.01e+01
Cd-115m	0.00	0.00	0.00	Eu-152	4.77e+02	2.76e-03	2.16e+00
In-113m	3.74e-08	2.24e-18	8.64e-11	Eu-154	5.44e+04	2.02e-01	4.89e+02
Sn-113	3.74e-08	3.73e-15	6.21e-12	Eu-155	1.08e+04	2.32e-02	7.85e+00
Sn-119m	4.75e-02	1.06e-08	2.45e-05	Gd-153	3.23e-05	9.16e-12	2.91e-08
Sn-121m	3.95e+01	6.68e-04	4.15e-02	Tb-160	4.77e-16	4.23e-23	3.81e-18
Fission and Activation Product Totals					2.40e+07	3.52e+02	6.72e+04
Actinides							
U-234	4.08e+02	6.53e+01	1.15e+01	Pu-241	3.26e+06	3.16e+01	1.01e+02
U-235	1.60e+01	7.40e+03	4.34e-01	Pu-242	2.42e+01	6.34e+00	7.03e-01
U-236	6.11e+01	9.44e+02	1.63e+00	Am-241	1.69e+05	4.92e+01	5.54e+03
U-238	3.16e+02	9.40e+05	7.85e+00	Am-242	8.15e+01	1.01e-07	6.77e-01
Np-237	2.70e+01	3.83e+01	7.79e-01	Am-242m	8.19e+01	8.43e-03	1.25e-01
Pu-238	5.10e+04	2.98e+00	1.66e+03	Am-243	4.89e+01	2.45e-01	1.54e+00
Pu-239	1.01e+05	1.63e+03	3.13e+03	Cm-242	6.76e+01	2.04e-05	2.45e+00
Pu-240	5.53e+04	2.42e+02	1.72e+03	Cm-244	5.72e+02	7.07e-03	1.97e+01
Actinide Totals					3.64e+06	9.50e+05	1.22e+04

06/02/1997 RADNUC2A run for K-West Basin. Results decayed to 05/31/1998. Total fuel mass in K-West 9.53e+02 MTU. Total fuel activity in K-West 2.77e+07 Ci. Total Heat Generation of fuel in K-West 8.03e+04 W. Pu-239 and Pu-240 have been adjusted to ensure consistency with data previously reported by Safeguards.

Table 4-12. N Fuel Source Terms Continued

Chemical Inventory for Both KE and KW Basins

SAFETY BASIS VALUE Endnote No.	DESIGN BASIS VALUE Endnote No.
Safety Basis and Design Basis are the same.	32

Element	Uranium Alloy 601 (kg)	Zircaloy-2 Cladding (kg)	Braze Filler (kg)	Totals (kg)[2]
Al	1,480 - 1,900	11.1	0.411	1,700
B	0.530	0.074	0.00142	0.605
Be	21.0	-	142	163
C	769 - 1,550	40.7	1.42	1,200
Cd	0.530	0.074	0.00142	0.605
Co	-	1.48	0.0567	1.54
Cr	137	74 - 222	1.42 - 4.26	288
Cu	158	7.40	0.170	166
Fe	632 - 843	104 - 296	1.70 - 5.96	941
H	4.22	3.70	0.142	8.06
Hf	-	29.6	0.567	30.2
Mg	52.7	2.96	0.170	55.8
Mn	52.7	7.40	0.170	60.3
Mo	-	7.40	0.142	7.54
N	158	11.8	0.567	170
Na	-	2.96	0.0567	3.02
Ni	211	44.4 - 118	0.851 - 2.27	294
O	-	-	6.53	6.53
Pb	-	14.8	0.369	15.2
Si	261	14.8	0.709	277
Sn	-	1,780 - 2,520	32.3 - 48.2	2,190
Ti	-	7.40	0.142	7.54
V	-	7.40	0.142	7.54
W	-	7.40	0.284	7.68
Zr	753	145,000	2,780	148,000
Actinides				
U	2,100,000	0.518	0.0113	2,100,000
Np	81.1	-	-	81.1
Pu	4,120	-	-	4,120
	109	-	-	109
Am	0.018	-	-	0.018
Cm				
Fission Products[2a]				
Se	12.0	-	-	12.0
Sr	152	-	-	152
Tc	170	-	-	170
Pd	133	-	-	133
Kr	77.1			77.1
I	46.1	-	-	46.1
Cs	4.65	-	-	4.65
Pm	0.50	-	-	0.50
Sm	176	-	-	176
Xe	1040			1040

[2] For the values with a range, the midpoint of the range is used.

[2a] Stable fission product are based on the ratio of ^{99}Tc in Table 3.5 and the relative concentration of stable fission products from ORIGEN2 for 12% ^{240}Pu Mark IV assemblies.

Table 4-12. N Fuel Source Terms Continued

Shielding Design Basis
Based on Mk IV fuel at 16% Pu-240 aged 13.5 years.

SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Safety Basis and Design Basis are the same.			33

Isotope	Activity (Ci/MTU)	Heat Generation (W/MTU)	Isotope	Activity (Ci/MTU)	Heat Generation (W/MTU)
Fission and Activation Products					
H-3	4.03e+01	1.36e-03	Sn-123	4.08e-09	1.26e-11
C-14	5.27e-01	1.54e-04	Sn-126	1.22e-01	3.75e-05
Fe-55	5.23e+00	1.75e-04	Sb-124	0.00	0.00
Co-60	6.27e+00	9.64e-02	Sb-125	0.00	0.00
Ni-59	3.03e-02	1.21e-06	Sb-126	1.71e-02	3.10e-04
Ni-63	3.53e+00	3.57e-04	Sb-126m	1.22e-01	1.57e-03
Se-79	6.23e-02	1.93e-05	Te-123m	1.19e-13	1.72e-16
Kr-85	6.23e+02	9.33e-01	Te-125m	0.00	0.00
Sr-89	0.00	0.00	Te-127	1.16e-10	1.57e-13
Sr-90	8.19e+03	9.50e+00	Te-127m	1.19e-10	5.88e-14
Y-90	8.19e+03	4.53e+01	Te-129	0.00	0.00
Y-91	0.00	0.00	Te-129m	0.00	0.00
Zr-93	2.83e-01	3.25e-05	I-129	4.88e-03	2.29e-06
Zr-95	4.20e-18	2.12e-20	Cs-134	1.07e+02	1.10e+00
Nb-93m	1.38e-01	2.47e-05	Cs-135	5.77e-02	1.93e-05
Nb-95	9.33e-18	4.48e-20	Cs-137	1.13e+04	1.14e+01
Nb-95m	3.12e-20	4.12e-23	Ba-137m	1.07e+04	4.18e+01
Tc-99	2.08e+00	1.05e-03	Ce-141	0.00	0.00
Ru-103	0.00	0.00	Ce-144	1.75e+00	1.15e-03
Ru-106	9.38e+00	5.59e-04	Pr-143	0.00	0.00
Rh-103m	0.00	0.00	Pr-144	1.73e+00	1.26e-02
Rh-106	9.38e+00	8.97e-02	Pr-144m	2.10e-02	7.05e-06
Pd-107	1.44e-02	7.94e-07	Pm-147	1.06e+03	3.88e-01
Ag-110	4.15e-06	3.11e-11	Pm-148	0.00	0.00
Ag-110m	3.12e-04	5.18e-06	Pm-148m	0.00	0.00
Cd-113m	3.96e+00	4.35e-03	Sm-151	1.08e+02	1.26e-02
Cd-115m	0.00	0.00	Eu-152	1.22e+00	5.50e-03
In-113m	2.59e-11	5.98e-14	Eu-154	2.02e+02	1.81e+00
Sn-113	2.59e-11	4.30e-15	Eu-155	3.42e+01	2.48e-02
Sn-119m	0.00	0.00	Gd-153	3.92e-06	3.53e-09
Sn-121m	0.00	0.00	Tb-160	2.22e-19	1.78e-21
Fission and Activation Product Totals				4.05e+04	1.12e+02
Actinides					
U-234	3.92e-01	1.11e-02	Pu-241	9.42e+03	2.92e-01
U-235	1.31e-02	3.54e-04	Pu-242	7.46e-02	2.16e-03
U-236	7.12e-02	1.89e-03	Am-241	2.92e+02	9.57e+00
U-238	3.35e-01	8.35e-03	Am-242	3.19e-01	2.66e-03
Np-237	4.42e-02	1.27e-03	Am-242m	3.21e-01	4.91e-04
Pu-238	1.28e+02	4.16e+00	Am-243	2.22e-01	7.02e-03
Pu-239	1.68e+02	5.14e+00	Cm-242	2.65e-01	9.59e-03
Pu-240	1.28e+02	3.90e+00	Cm-244	4.62e+00	1.59e-01
Actinide Totals				1.01e+04	2.33e+01

06/02/1997 RADNUC2A run for shielding design basis (Mk IV fuel at 16% Pu-240). Results decayed to 05/31/1998. Total mass of fuel in this run 2.60e+00 MTU. Total activity of fuel in this run 1.32e+05 Ci. Total heat generation from the fuel in this run 3.55e+02 W.

Table 4-12. N Fuel Source Terms Continued

Safety/Regulatory Assessment Design Basis Feed
Based on MK IV Fuel at 16.72% Pu-240.

SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Safety Basis and Design Basis are the same.			34

Isotope	Activity (Ci/MTU)	Heat Generation (W/MTU)	Isotope	Activity (Ci/MTU)	Heat Generation (W/MTU)
Fission and Activation Products					
H-3	2.61e+01	8.77e-04	Sn-123	1.72e-16	5.35e-19
C-14	5.53e-01	1.62e-04	Sn-126	1.29e-01	3.97e-05
Fe-55	5.41e-01	1.80e-05	Sb-124	0.00	0.00
Co-60	2.09e+00	3.23e-02	Sb-125	0.00	0.00
Ni-59	3.18e-02	1.26e-06	Sb-126	1.81e-02	3.28e-04
Ni-63	3.47e+00	3.51e-04	Sb-126m	1.29e-01	1.66e-03
Se-79	6.54e-02	2.02e-05	Te-123m	1.50e-21	2.18e-24
Kr-85	3.70e+02	5.53e-01	Te-125m	0.00	0.00
Sr-89	0.00	0.00	Te-127	2.12e-19	2.85e-22
Sr-90	6.93e+03	8.03e+00	Te-127m	2.16e-19	1.07e-22
Y-90	6.93e+03	3.84e+01	Te-129	0.00	0.00
Y-91	0.00	0.00	Te-129m	0.00	0.00
Zr-93	2.95e-01	3.40e-05	I-129	5.16e-03	2.41e-06
Zr-95	0.00	0.00	Cs-134	6.47e+00	6.59e-02
Nb-93m	1.93e-01	3.45e-05	Cs-135	6.04e-02	2.02e-05
Nb-95	0.00	0.00	Cs-137	9.66e+03	9.78e+00
Nb-95m	0.00	0.00	Ba-137m	9.14e+03	3.59e+01
Tc-99	2.19e+00	1.10e-03	Ce-141	0.00	0.00
Ru-103	0.00	0.00	Ce-144	7.91e-04	5.23e-07
Ru-106	2.56e-02	1.52e-06	Pr-143	0.00	0.00
Rh-103m	0.00	0.00	Pr-144	7.82e-04	5.73e-06
Rh-106	2.56e-02	2.45e-04	Pr-144m	9.48e-06	3.18e-09
Pd-107	1.56e-02	8.56e-07	Pm-147	1.09e+02	4.02e-02
Ag-110	7.17e-10	5.38e-15	Pm-148	0.00	0.00
Ag-110m	5.39e-08	8.94e-10	Pm-148m	0.00	0.00
Cd-113m	2.78e+00	3.06e-03	Sm-151	1.02e+02	1.19e-02
Cd-115m	0.00	0.00	Eu-152	8.45e-01	3.81e-03
In-113m	1.36e-19	3.13e-22	Eu-154	1.13e+02	1.01e+00
Sn-113	1.36e-19	2.26e-23	Eu-155	1.06e+01	7.65e-03
Sn-119m	6.14e-08	3.16e-11	Gd-153	5.19e-10	4.67e-13
Sn-121m	6.27e-02	6.59e-05	Tb-160	0.00	0.00
Fission and Activation Product Totals				3.34e+04	9.38e+01
Actinides					
U-234	3.84e-01	1.09e-02	Pu-241	6.82e+03	2.11e-01
U-235	1.27e-02	3.44e-04	Pu-242	8.71e-02	2.55e-03
U-236	7.16e-02	1.91e-03	Am-241	4.34e+02	1.42e+01
U-238	3.31e-01	8.23e-03	Am-242	3.71e-01	3.08e-03
Np-237	4.66e-02	1.34e-03	Am-242m	3.72e-01	5.71e-04
Pu-238	1.33e+02	4.34e+00	Am-243	2.78e-01	8.82e-03
Pu-239	1.73e+02	5.28e+00	Cm-242	3.08e-01	1.11e-02
Pu-240	1.37e+02	4.19e+00	Cm-244	4.47e+00	1.54e-01
Actinide Totals				7.70e+03	2.85e+01

06/02/1997 RADNUC2A run for the safety basis (Mk IV fuel at 16.72% Pu-240). Results decayed to 05/31/1998. Total mass of the fuel in this run 1.16e+01 MTU. Total activity of the fuel in this run 4.77e+05 Ci. Total heat generation of the fuel in this run 1.42e+03 W.

Table 4-12. N Fuel Source Terms Continued

Safety/Regulatory Assessment Basis
Decayed to 5/31/2038.

SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Safety Basis and Design Basis are the same.			35

Isotope	Activity (Ci/MTU)	Heat Generation (W/MTU)	Isotope	Activity (Ci/MTU)	Heat Generation (W/MTU)
Fission and Activation Products					
H-3	3.32e+00	1.11e-04	Sn-123	0.00	0.00
C-14	5.64e-01	1.65e-04	Sn-126	1.33e-01	4.08e-05
Fe-55	2.72e-05	9.09e-10	Sb-124	0.00	0.00
Co-60	1.61e-02	2.47e-04	Sb-125	1.10e-03	3.44e-06
Ni-59	3.25e-02	1.29e-06	Sb-126	1.86e-02	3.36e-04
Ni-63	2.68e+00	2.71e-04	Sb-126m	1.33e-01	1.70e-03
Se-79	6.68e-02	2.06e-05	Te-123m	0.00	0.00
Kr-85	3.41e+01	5.10e-02	Te-125m	2.68e-04	2.25e-07
Sr-89	0.00	0.00	Te-127	0.00	0.00
Sr-90	2.91e+03	3.38e+00	Te-127m	0.00	0.00
Y-90	2.91e+03	1.61e+01	Te-129	0.00	0.00
Y-91	0.00	0.00	Te-129m	0.00	0.00
Zr-93	3.02e-01	3.47e-05	I-129	5.29e-03	2.48e-06
Zr-95	0.00	0.00	Cs-134	2.52e-05	2.58e-07
Nb-93m	2.73e-01	4.88e-05	Cs-135	6.19e-02	2.07e-05
Nb-95	0.00	0.00	Cs-137	4.19e+03	4.23e+00
Nb-95m	0.00	0.00	Ba-137m	3.96e+03	1.55e+01
Tc-99	2.23e+00	1.12e-03	Ce-141	0.00	0.00
Ru-103	0.00	0.00	Ce-144	0.00	0.00
Ru-106	2.06e-13	1.22e-17	Pr-143	0.00	0.00
Rh-103m	0.00	0.00	Pr-144	0.00	0.00
Rh-106	2.06e-13	1.96e-15	Pr-144m	0.00	0.00
Pd-107	1.61e-02	8.87e-07	Pm-147	5.97e-03	2.19e-06
Ag-110	0.00	0.00	Pm-148	0.00	0.00
Ag-110m	0.00	0.00	Pm-148m	0.00	0.00
Cd-113m	4.87e-01	5.35e-04	Sm-151	7.67e+01	8.96e-03
Cd-115m	0.00	0.00	Eu-152	1.32e-01	5.94e-04
In-113m	0.00	0.00	Eu-154	5.93e+00	5.31e-02
Sn-113	0.00	0.00	Eu-155	5.94e-02	4.29e-05
Sn-119m	0.00	0.00	Gd-153	0.00	0.00
Sn-121m	3.84e-02	4.04e-05	Tb-160	0.00	0.00
Fission and Activation Product Totals				1.41e+04	3.94e+01
Actinides					
U-234	3.81e-01	1.08e-02	Pu-241	1.19e+03	3.69e-02
U-235	1.25e-02	3.38e-04	Pu-242	9.39e-02	2.73e-03
U-236	7.19e-02	1.92e-03	Am-241	6.17e+02	2.03e+01
U-238	3.29e-01	8.20e-03	Am-242	3.42e-01	2.85e-03
Np-237	4.77e-02	1.37e-03	Am-242m	3.43e-01	5.27e-04
Pu-238	1.04e+02	3.40e+00	Am-243	3.09e-01	9.77e-03
Pu-239	1.75e+02	5.35e+00	Cm-242	2.84e-01	1.03e-02
Pu-240	1.41e+02	4.33e+00	Cm-244	1.24e+00	4.25e-02
Actinide Totals				2.23e+03	3.35e+01

06/04/1997 RADNUC2A run for safety basis fuel (following 40 years CSB storage). Results decayed to 05/31/2038. Total mass of fuel in this run 6.90e+00 MTU. Total activity of the fuel in this run 1.13e+05 Ci. Total heat generation from the fuel in this run 5.04e+02 W.

Table 4-13. Single Pass Reactor Source Terms

Total Activity of Selected Radionuclides in SPR Fuel Decayed to 1/1/94.

SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Safety Basis and Design Basis are the same.			27

Radionuclide	Activity (Ci)
^{3}H	7.03e+02
^{63}Ni	6.76e+01
^{85}Kr	7.33e+02
^{90}Sr	1.36e+04
^{90}Y	1.36e+04
^{99}Tc	6.67e+00
^{113m}Cd	1.69e+01
^{134}Cs	6.76e+00
^{137}Cs	3.48e+04
^{137m}Ba	3.30e+04
^{151}Sm	4.06e+02
^{154}Eu	4.70e+02
^{155}Eu	1.15e+02
^{238}Pu	1.45e+02
^{239}Pu	4.06e+02
^{240}Pu	6.42e+02
^{241}Pu	1.69e+04
^{241}Am	1.45e+03
Total	7.05e+04

Table 4-13. Single Pass Reactor Fuel Source Terms Continued

Total Chemical Inventory in SPR Fuel Metals
All quantities in kg.

SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Safety Basis and Design Basis are the same.			36

NA indicates that the impurity is not present at an appreciable level.

Impurity	Uranium Alloy 501	Aluminum Alloy X-8001	Al-Si Braze
Boron	NA[1]	1.20e-03	NA
Cadmium	NA	3.60e-03	NA
Carbon	2.54e+00	NA	NA
Chromium	2.20e-01	NA	NA
Cobalt	NA	1.20e-03	NA
Copper	NA	1.77e-01	9.30e-03
Iron	5.07e-01	8.40e-01	3.00e-02
Lithium	NA	9.60e-03	NA
Magnesium	8.45e-02	NA	NA
Manganese	8.45e-02	NA	NA
Nickel	3.38e-01	1.40e+00	NA
Nitrogen	3.38e-01	NA	NA
Silicon	2.54e-01	2.05e-01	NA
Others, each	NA	6.00e-02	3.00e-03
Others, total	NA	1.80e-01	1.20e-02

Table 4-14. Thermal Emissivity

THERMAL EMISSIVITY					
		SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Conservatively Low Heat Transfer Case	Stainless Steel	0.30	37	NDA	NDA
	Oxidized Fuel	0.70	38	NDA	NDA
Conservatively High Heat Transfer Case		NDA	NDA	NDA	NDA

Table 4-15. CSB Annual Temperature Cycle

CANISTER STORAGE BUILDING (CSB) ANNUAL TEMPERATURE CYCLE			
SAFETY BASIS VALUE	Endnote No.	DESIGN BASIS VALUE	Endnote No.
Historical Monthly Maxima and Minima for Hanford Site	39	Historical Monthly Averages for Hanford Site	40

Definitions:
Design Basis: May be the nominal (average), low or high nominal, or identical to safety basis as appropriate for the specific design case.
NA = Not Applicable NDA = No Data Available at this time

5.0 DERIVED PHYSICAL QUANTITIES (calculated values)

Section 5.0 provides a set of derived physical quantities whose values are products of key engineering, physical, and chemical parameter values in specific process scenarios.

The values are provided as input guidance for design and safety calculations, and are considered maximum calculated values using the appropriate safety basis, assumptions, worst case MCO properties and operating conditions relative to the selected physical quantity. These values do not address accident cases. Care should be taken, as they are not key parameter values, but derived variables and should be used within like processing scenarios only.

Table 5-1. Particulate Mass Generated per MCO

PARTICULATE MASS GENERATED per MCO (Uranium Metal)				
	Calculated Safety Basis		Calculated Design Basis	
	Value	Endnote	Value	Endnote
Between Fuel Washing at basins and Bulk Water Draining at CVD Facility	13 kg Uranium (15 kg as UO_2)	26	66.0 g (Equivalent to 75g of $UO_{2)}$	18
Between Bulk Water Draining at CVD Facility and Receipt at CSB	TBD	TBD	TBD	TBD
During 40 Years of Interim Storage at CSB	TBD	TBD	TBD	TBD
Total Generated	TBD	TBD	TBD	TBD

Table 5-2. MCO Maximum Internal Pressure

MCO MAXIMUM INTERNAL PRESSURE		
	Calculated Safety Basis Value	Endnote
MCO Maximum Internal Pressure	4.2 atm absolute (61.7 psia)	47

Table 5-3. MCO Maximum Temperatures in CSB Storage

MCO MAXIMUM TEMPERATURES in CSB STORAGE			
Assuming a 7 day storage with vault temperature at 62 °C implying a bounding CSB storage tube temperature of 92 °C.	Calculated Safety Basis Value		Endnote
MCO Maximum Wall Temperature	108°C	(226°F)	48
MCO Maximum Gas Temperature	125°C	(257°F)	49
MCO Maximum Fuel Temperature	153 °C	(307 °F)	50
MCO Maximum Scrap Temperature	123 °C	(253 °F)	57

Table 5-4. Water Content Associated with Particulate in MCO

WATER CONTENT ASSOCIATED WITH PARTICULATE IN MCO		
	Calculated Safety Basis Value	Endnote
Less than 10^{-6} Probability of Water Content Associated with Uranium Oxide Particulate in MCO	.65 kg	55

6.0 ENDNOTES

The endnote sources identified in Section 4 and Section 5 are listed numerically. Table 6-1 correlates each endnote source document with a status of the review processes required and performed in support of the *Office of Civilian Radioactive Waste Management* (OCRWM) *Quality Assurance Requirements and Description* (QARD), DOE/RW/0333P.

[1] D. E. Ball and D. R. Duncan, "Fuel Surface Area," HNF-SD-SNF-CN-017, Revision 2 , released June 5, 1998, p. 10.

[2] HNF-SD-SNF-CN-017, Revision 2, released June 5, 1998, p. 7.

[3-4] HNF-SD-SNF-CN-017, Revision 2, released June 5, 1998, p. 9.

[5] T. D. Cooper and A. L. Pajunen, "SNF Project Recommended Reaction Rate Constants for Corrosion of N-Reactor Fuel," HNF-SD-SNF-TI-020, Revision 2, released June 15, 1998, p. 4-2.

[6 - 8] HNF-SD-SNF-TI-020, Revision 2, released June 15, 1998, p. 2-1..

[9] D. L. Sherrell, "Spent Nuclear Fuel Inventory in Bulk MCO Water at the Cold Vacuum Drying Facility," HNF-SD-W441-CN-001, Revision 2, released June 11, 1998, p. 3, Table 2-1.

[10 - 12] A. L. Pajunen, "Evaluation of Radiolytic Gas Generation from Water Dissociation in a Multi-Canister Overpack," HNF-SD-SNF-CN-006, Revision 0, released April 21, 199 7, p. 10, Table 1.

[13] HNF-SD-SNF-CN-017, Revision 2, released June 5, 1998, p. 7.

[14] HNF-SD-SNF-CN-017, Revision 2, released June 5, 1998, p. 6.

> "Average value of A_g = 1.7 x 10^3 cm^2 per MCO, assuming 4 fuel baskets per MCO."
> 1,700 cm^2 / 4 baskets = 425 cm^2 per basket

[15] D. R. Duncan and D. E. Ball, "K-Basins Particulate Water Content, Behavior, and Impact," HNF-1523, Revision 0, released November 19, 1997, p. 4. Table 2-2, Bounding.

[16] A. B. Johnson, Jr. and A. L. Pitner, "Surface Area Considerations for Corroding N Reactor Fuel," PNNL-11174, p. 19.

[17] HNF-1523, Revision 0, released November 19, 1997, p. 4. Table 2-2, Best-Estimate.

[18] HNF-SD-W441-CN-001, Revision 2, released June 11, 1998, p. 3, Table 2-1.

[19] A. L. Pitner, "Summary Assessment of Fuel Damage Distributions in the K Basins," HNF-2586, Revision 0, released April 23, 1998, p. 6.

[20] HNF-SD-W441-CN-001, Revision 2, released June 11, 1998, p. 4, Table 2-2.

[21] W. L. Willis and A. N. Praga, "105-K Basin Material Design Basis Feed Description for SNF Project Facilities," HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 31 footnote.

[22] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 17. Table 3.1, Fuel Element Description Mark IV (mass of uranium - inner 7.48 + outer 16.0).

[23] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 17. Table 3.1, Fuel Element Description Mark IA (mass of uranium - inner 5.49 + outer 11.1).

[24] HNF-SD-SNF-TI-009, Revision 1, released January 19, 1998, p. 24, footnote.

[25] A. L. Pajunen, "Development of Design Basis Capacity for SNF Project Systems," WHC-SD-SNF-TI-016, Revision OA, released July 21, 1997, p. 3.

[26] HNF-SD-W441-CN-001, Revision 2, released June 11, 1998, p. 4, Table 2-2.

[27] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 38, Table 4.5.

[28] F. Schmittroth and K. D. Dobbin, "Comparison of Spent Fuel Databases for K Basin," WHC-SD-SNF-ANAL-011, Revision 0, released September 12, 1996, p. 7.

"The SCATS and R-SCATS databases were compared on a physical basis and from a burnup perspective. With minor exceptions, the two databases were nearly identical in both the number of fuel pieces and the mass of uranium. The agreement holds on a key-by-key basis as well as globally.

Burnup for the SCATS database is about 4% to 5% higher than for the R-SCATS database. Decay heat calculations which are dominated by ^{90}Sr, ^{137}Cs, and their daughters show the same relationship."

[29] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 30, Table 3.8.

[30] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 25, Table 3.6.

[31] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 26, Table 3.7.

[32] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 27, Table 3.4.

[33] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 30, Table 3.8.

[34] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 31, Table 3.9.

[35] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 32, Table 3.10.

[36] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 36, Table 4.3.

[37] Thermophysical Properties of Matter, "Thermal Radiative Properties Metallic Elements and Alloys," Volume 7, p. 1219.

[38] L. Baker Jr., et al., "Determinations of the Total Emissivity of Polished and Oxidized Uranium Surfaces," 1963, Nuclear Science Engineering, Vol. 15, p. 218.

[39 - 40] D. J. Hoitink and K. W. Burk, PNNL-11794, Hanford Site Climatological Data Summary 1997, with Historical Data, published March 1998, Summary p. iii.

[41] HNF-SD-SNF-TI-009, Revision 1, released January 9, 1998, p. 24, Table 3.6.

[42] D. J. Trimble and T. L. Welsh, "Statistical Analysis of Oxidation Rates for K Basin Fuel in Dry Air," HNF-SD-SNF-CN-035, Revision 1, released February 6, 1998, p. 11, Figure 1.

Mean fit of dry air literature data. Transition to High Temperature Correlation Calculated to provide continuous function.

[43] C. A. Colmenares, "Oxidation Mechanisms and Catalytic Properties of the Actinides," Prog. Solid St. Chem. Vol. 15., p. 308, Figure 31.

[44] The transitions between moist air correlations were developed to provide a consistent method of using equations to estimate reaction rates at conditions not specifically covered by data correlations. The transitions also produce continuous functions between correlations. To maintain continuity, the temperature for transition between correlations could not be specified as a single temperature, varying with the relative humidity. An implicit equation for RH <10% and explicit equation for RH >10% was developed based on an approximation of the saturation pressure variation with

temperature. The simplified saturation pressure correlation, Log P_{sat} = 7.6726 -2126.5/T where P_{sat} is in kPa and T is in K, is within 10% of Handbook data in the region of interest. Based on the saturated steam correlation the transition temperature, T_I, between correlations is found by the following:

For RH < 10%, solve the following equation for T

$$\text{Log}\ \{10^{(7.19-3732/T)}+P[10^{(1.6604-1630.5T)}-10^{(0.5174-1605.5/T)}]\}-10.566-0.3\text{Log}P+4990/T = 0$$

where P is the partial pressure of water.

For 10% $\leq$ RH $\geq$ 100%,

$$T_I = \frac{1260}{2.233+0.3\text{Log}(P)}$$

[45 - 46] Prog. Solid St. Chem. Vol. 15., p. 293.

[47] J. R. Frederickson and M. G. Plys, "MCO Internal Gas Composition and Pressure During Interim Storage," HNF-SD-SNF-TI-040, Revision 2, released June 18, 1998, p. 2-4.

[48 - 49] D. R. Duncan and M. G. Plys, "Simulation of Normal and Off-Normal Multi-Canister Overpack Behavior," HNF-2256, Revision 1, released July 1, 1998, p. T-33.

[50] HNF-2256, Revision 1, released July 1, 1998, p. 2-3.

[51] J. P. Sloughter, et al., "Estimate of Particulate Mass in Multi-Canister Overpacks," HNF-1527, Revision 0, released November 19, 1997, p. 27, Bounding.

[52] HNF-1527, Revision 0, released November 19, 1997, p. 27, Nominal.

[53] A. L. Pajunen and J. P. Sederburg, "Spent Nuclear Fuel Project Product Specification," HNF-SD-SNF-OCD-001, Revision 2, released March 28, 1998, p. 22.

[54] A. L. Pajunen, "Cold Vacuum Drying Residual Free Water Test Description," HNF-1851, Revision 1, released June 10, 1998, p. 4.

[55] D. R. Duncan and M. G. Plys, "Sensitivity of Probabilistic MCO Water Content Estimates to Key Assumptions," HNF-2234, Revision 1, released March 23, 1998, p. 1-2.

[56] HNF-SD-SNF-CN-017, Revision 2, released June 5, 1998, p. 10.

[57] HNF-2256, Revision 1, released July 1, 1998, p. 2-3.

Table 6-1. Technical Databook Supporting Document Review Status

Document Number	Document Title	Author	Reviewed, Approved and Released in the Hanford Document Control System	Is the OCRWM QARD applicable per HNF-SD-SNF-RPT-007? If YES, an OCRWM QARD Document Review is required.	Does the OCRWM Document Review require the additional rigor of an OCRWM QARD Peer Review? (See AP 6-009)	Current Review Status After the SNF Project has received procedure validation by OCRWM QARD personnel, SNF Project Review Packages will require SNF Project QA validation.
HNF-SD-SNF-CN-017, Revision 2	Fuel Surface Area	D. E Ball and D. R. Duncan	6/5/98	YES	YES	Revision 2 is being Peer Reviewed in accordance with AP 6-009.
HNF-SD-SNF-TI-020, Revision 2	SNF Project Recommended Reaction Rate Constants for Corrosion of N-Reactor Fuel	T. D. Cooper, and A. L. Pajunen	6/15/98	YES	YES	Review Package in SNF Project File Accession, # S29702316. Review done prior to AP 6-009, pkg may require supplementation.
HNF-SD-W441-CN-001, Revision 2	SNF Inventory in Bulk MCO Water at the Cold Vacuum Drying Facility	D. L. Sherrell	6/11/98	To be evaluated	To be evaluated	To be evaluated
HNF-SD-SNF-CN-006, Revision 0	Evaluation of Radiolytic Gas Generation from Water Dissociation in a Multi-Canister Overpack	A. L. Pajunen	4/21/97	YES	YES	Review Package in SNF Project File, Accession # S2970130. Review done prior to AP 6-009, pkg may require supplementation.
HNF-1523, Revision 0	K Basins Particulate Water Content, Behavior, and Impact	D. R. Duncan and D. E. Ball	11/19/97	YES	YES	Review Completed per AP 6-009. Review Package in SNF Project File, Accession # S2980602.
HNF-1527, Revision 0	Estimates of Particulate Mass in Multi-Canister Overpacks	J. P. Sloughter, et al.	11/19/97	YES	YES	Review Completed per AP 6-009. Review Package in SNF Project File, Accession # S2980602.

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HNF-2586, Revision 0	Summary Assessment of Fuel Damage Distributions in the K Basins	A. L. Pitner	4/23/98	YES	YES	Review Required in accordance with AP 6-009.
HNF-SD-SNF-TI-009, Revision 1	105-K Basin Material Design Basis Feed Description for SNF Project Facilities	W. L. Willis and A. N. Praga	1/9/98	YES	YES	Review Required in accordance with AP 6-009.
WHC-SD-SNF-TI-016, Revision 0A	Development of Design Basis Capacity for SNF Project Systems	A. L. Pajunen	7/21/97	NO	Not Applicable	Not Applicable
WHC-SD-SNF-ANAL-011 Revision 0	Comparison of Spent Fuel Databases for K Basins	F. Schmittroth & K. D. Dobbin	9/12/96	NO	Not Applicable	Not Applicable
Thermophysical Properties of Matter Volume 7	Thermal Radiative Properties, Metallic Elements and Alloys	Thermophysical Properties Research Center	Published 1970	NO	Not Applicable	Not Applicable
Nuclear Science Engineering, Volume 15	Determinations of the Total Emissivity of Polished Oxidized Uranium Surfaces	L. Baker Jr., et al.	Published 1963	NO	Not Applicable	Not Applicable
PNNL-11794	Hanford Site Climatological Data Summary 1997, with Historical Data	D. J. Hoitink and K. W. Burk	Published 3/1998	NO	Not Applicable	Not Applicable

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HNF-SD-SNF-CN-035, Revision 1	Statistical Analysis of Oxidation Rates for K Basin Fuel in Dry Air	D. J. Trimble and T. L. Welsh	2/6/98	YES	YES	This document to be revised, with review to follow.
Prog. Solid St. Chem., Vol. 15.	*Oxidation Mechanisms and Catalytic Properties of the Actinides*	*C. A. Colmenares*	*Published Handbook*	*NO*	*Not Applicable*	*Not Applicable*
HNF-SD-SNF-TI-040, Revision 2	MCO Internal Gas Composition and Pressure During Interim Storage	D. R. Duncan and M. G. Plys	6/18/98	YES	YES	Review Completed per AP 6-009. Review Package submitted to SNF Project File, on EDT 624307, awaiting assignment of Accession number.
HNF-2256, Revision 1	Simulation of Normal and Off-Normal Multi-Canister Overpack	D. R. Duncan and M. G. Plys	7/1/98	YES	YES	Review Required in accordance with AP 6-009.
HNF-2234, Revision 1	Sensitivity of Probabilistic MCO Water Content Estimates to Key Assumptions	D. R. Duncan and M. G. Plys	3/23/98	YES	YES	Review Completed per AP 6-009. Review Package submitted to SNF Project File, on EDT 624308, awaiting assignment of Accession number.
HNF-SD-SNF-OCD-001, Revision 2	SNF Project Product Specification	A. L. Pajunen and J. P. Sederburg	3/28/98	NO	NO	Not Applicable
HNF-1851, Revision 1	*Cold Vacuum Drying Residual Free Water Test Description*	*A. L. Pajunen*	6/10/98	YES	YES	Review Completed per AP 6-009. Review Package submitted to SNF Project File, on EDT 625201, and 624325, awaiting assignment of Accession number.

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PNNL-11174	Surface Area Considerations for Corroding N Reactor Fuel	A. B. Johnson,Jr. and A. L. Pitner	6/96	NO	NO	Not Applicable

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