WHC-EP-0830
Volume III
Revision 0

Hanford Spent Nuclear Fuel Project Recommended Path Forward

Volume III: Alternatives and Path Forward Evaluation
Supporting Documentation

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Spent Nuclear Fuel Project
John C. Fulton

Prepared for the U.S. Department of Energy
Office of Environmental Restoration and
Waste Management

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Hanford Company Richland, Washington

Hanford Operations and Engineering Contractor for the
U.S. Department of Energy under Contract DE-AC06-87RL10930

Approved for Public Release

MASTER

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DISCLAIMER

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EXECUTIVE SUMMARY

Volume I of the *Hanford Spent Nuclear Fuel Project - Recommended Path Forward* constitutes an aggressive series of projects to construct and operate systems and facilities to safely retrieve, package, transport, process, and store K Basins fuel and sludge.

Volume II provided a comparative evaluation of four Alternatives for the Path Forward and an evaluation for the Recommended Path Forward. Although Volume II contained extensive appendices, six supporting documents have been compiled in Volume III to provide additional background for Volume II.

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1.0 INTRODUCTION

1.1 PURPOSE

Volume I of the *Hanford Spent Nuclear Fuel Project - Recommended Path Forward* provided the recommended path for resolving the safety and environmental concerns associated with the deteriorating fuel in K Basins. The recommendation provides for the safe interim storage of this material pending establishment of a national spent nuclear fuel strategy and the criteria for its ultimate disposal.

Volume II provided a comparative evaluation of four Alternatives for the Path Forward and an evaluation for the Recommended Path Forward. Volume III provides selected information which serves to supplement Volume II.

1.2 SCOPE

Although Volume II of *Hanford Spent Nuclear Fuel Project - Recommended Path Forward* contained extensive appendices, a few documents have been selected to provide additional background for Volume II. The table below gives a brief description of the contents of the attached documents and the reference format information for issued documents.

2.0 SUPPORTING DOCUMENTATION

The supporting documentation is provided in the Attachments. The table below gives a brief description of the contents of the documents. Attachments A, B, and C are small documents which are pertinent but difficult to find, thus are conveniently located here. Attachment D provides the technical basis for the method adapted to evaluate Health Risk. Attachments E and F are letter reports which provide the results of thorough reviews of work on alternatives for expedited removal of K Basin fuel; these were completed prior to the decision on the Recommended Path Forward and help place the decision in perspective.

Table 1. Supporting Documentation.

Attachment	Information
A	<p>This document was issued by the NRC to clarify conditions relating to the use of NRC-certified packages for shipment of wastes. It was referenced in Volume II in Appendix B.</p> <p>NRC Information Notice 84-72: <i>Clarification of Conditions for Waste Shipments Subject to Hydrogen Gas Generation</i>, September 10, 1984, U.S. NRC, Washington, D.C.</p>
B	<p>This is a waste predetermination on K Basin sludge performed according to state and federal law. This document was referenced in Volume II in Appendix B.</p> <p>Lipinski, R. S., 1994, <i>Waste Remediation for Sludge From Hanford K Basin</i> (Waste Predetermination Request No. 24095 to A. N. Praga April 19, 1994) WHC, Richland, Washington</p>
C	<p>A list of questions use in the Interview meetings for the four Alternatives, which provided information for the Multi-Attribute Utility Decision Process, the Evaluation of Health Risks, and the Programmatic Risk Evaluation.</p>
D	<p>This provided the technical basis for the Priority Planning Grid which was adapted to the decision process for the Path Forward evaluations. This was referenced in Volume II in Appendix F.</p> <p>Ritts, J. J., 1990, <i>Westinghouse Hanford Company Basis Document for Priority Planning Grid Application Of The Risk Ranking Technique</i>, November, 1990, Tenera, L. P., transmitted by Westinghouse Hanford Company, Letter 9004346B R1, Dated November 26, 1990.</p>
E	<p>This is the letter communicating the results of the "murder board" review of the Independent Technical Assessment Team report for dry storage of K Basin spent fuel.</p> <p>Ermold, L. F., 1994, <i>Review of Dry Storage Option for Hanford K Basins Fuel</i>, LFE-94-071, to John C. Fulton, dated September 23, 1994.</p>
F	<p>This is the letter communicating the results of the "murder board" review of temporary storage of K Basin spent fuel in a new storage pool.</p> <p>Ermold, L. F., 1994, <i>Review of Expedited Fuel Removal From Hanford K Basins</i>, LFE-063-94, to John C. Fulton, dated July 25, 1994</p>

ATTACHMENT A

INFORMATION NOTICE NO. 84-72

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D. C. 20555

September 10, 1984

IE INFORMATION NOTICE NO. 84-72: CLARIFICATION OF CONDITIONS FOR WASTE
SHIPMENTS SUBJECT TO HYDROGEN GAS GENERATION

Addressees:

All nuclear power reactor facilities holding an operating license (OL) or construction permit (CP) and certain registered users of NRC Certificates of Compliance for transport packages.

Purpose:

The NRC's Office of Nuclear Materials Safety and Safeguards (NMSS) has identified a need to clarify conditions relating to the use of NRC-certified packages for shipment of wastes.

Discussion:

A potential exists for the generation of combustible quantities of hydrogen for certain waste forms containing radioactive material. This is pertinent to shipments of resins, binders, waste sludge, and wet filters. It is not pertinent to dry compacted or uncompacted waste and irradiated hardware.

In general, applications for waste package certificates of compliance have not addressed the potential for generation of combustible gas mixtures. Generic requirements have recently been included in certain NRC Certificates of Compliance to preclude the possibility of significantly reducing packaging effectiveness in use. These conditions are typically stated as follows:

- (1) For any package containing water and/or organic substances that could radiolytically generate combustible gases, it must be determined by tests and measurements of a representative package whether or not the following criteria are met over a period of time that is twice the expected shipment time:
 - (a) The hydrogen generated must be limited to a molar quantity that would be no more than 5% by volume (or equivalent limits for other inflammable gases) of the secondary container gas void, if present, at STP (i.e., no more than 0.063 g-moles/ft³ at 14.7 psia and 70°F) or
 - (b) The secondary container and cask cavity must be inerted with a diluent to ensure that oxygen must be limited to 5% by volume in those portions of the package that could have hydrogen greater than 5%.

For any package delivered to a carrier for transport, the secondary container must be prepared for shipment in the same manner in which determination for gas generation is made. The shipment period begins when the package is prepared (sealed) and must be completed within twice the expected shipment time.

- (2) For any package containing materials with radioactivity concentration not exceeding that for low specific activity (LSA) material, and shipped within 10 days of preparation, or within 10 days after venting of drums or other secondary containers, the determination in (1) above need not be made, and the time restriction in (1) above does not apply.

The generation of combustible gases is dependant on the waste form, radioactive concentration and isotope, free volume, total mass and accumulated dose in the waste. In addition, packaging limitations such as effective shielding provided may preclude the radioactive concentrations and hence the generation of combustible gases.

It is believed, in most cases, that the above combustible gas criteria for waste not exceeding LSA concentrations will be met by ensuring that waste packages are shipped within 10 days of preparation. However, in those cases where this is not feasible, licensees may request a specific approval for their proposed shipment. The application should address those factors that would preclude the generation of combustible gases over at least twice the expected shipment time. Such applications should be directed to NMSS.

In all other cases, a determination must be made in accordance with the provisions of the certificate that the requirements of (1) above are met. Any tests and measurements that are representative of the waste to be shipped and address the factors that affect gas generation may be used. The determination should be documented and retained as part of the records for the shipment.

Recipients of this notice should review the information discussed for possible applicability to their wasteshipments. No written response to this information notice is required. If you have any questions regarding this matter, please contact NMSS.

Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

Technical Contact: C. E. MacDonald, NMSS
301-427-4122

Attachment:
List of Recently Issued IE Information Notices

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Transportation Certification Branch
Approval Record
Combustible Gas Mixtures

Conditions were imposed on packages containing water and/or organic substances to limit the accumulation of radiolytically generated gases over the shipping period to preclude the possibility of significantly reducing the packaging effectiveness due to explosion.

Part of the conditions included "...it must be determined by tests and measurements of a representative package whether or not...."

There is no reason to believe that calculational methods could not be used as means of determining gas generation. So as not to preclude a valid analysis, part of the condition to limit the accumulation of radiolytically generated gases is revised to read "...it must be determined by tests and measurements or by analysis of a representative package whether or not...."

The analytic approach involves determining the hydrogen generated in the waste by radiolysis based on the absorbed dose of the waste over a given period of time. To satisfy the condition to preclude a combustible mixture, the period since closure and twice the shipping time must be considered. The calculation requires that the properties of the waste are known. These properties may be determined from test and measurement of representative waste forms or from data that is applicable to the waste form. The determination should be documented and retained as part of the records for the shipment.

Charles E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and
Material Safety, NMSS

Date: MAY 22 1985

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ATTACHMENT B

WASTE REMEDIATION FOR SLUDGE FROM HANFORD K BASIN

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**WESTINGHOUSE HANFORD COMPANY
GENERATOR & WASTE ACCEPTANCE SERVICES
WASTE PREDETERMINATION**

Page 1

REQUEST #:

24095

DATE:

April 19, 1994

SUBJECT		Predetermination for sludge from Hanford K-Basins.			
TO	A. N. Praga	COMPANY	Westinghouse Hanford Company		
PHONE	373-0583	ADDRESS	P.O. Box 1970		
FACILITY	K-Basins	MSIN	I6-24		
ANALYST	Richard S. Lipinski	MSIN	T3-05	PHONE	373-0923
REVIEWER
cc	File				

This waste predetermination is based on the MSDS information for products/materials listed in the predetermination request and was performed according to current state and Federal law (WAC 173-303 and 40 CFR 261). For questions or comments, please contact the Generator & Waste Acceptance Services analyst above and reference the request #. Thank you for your interest in waste predetermination.

REGULATED ?

Item #	MSDS #	Product/Material	Unused Product	Used Product	Empty Container	Rags with 10% Product	Possible Waste Codes
S3-032-01	—	K-Basin Sludge, Sample S3-032-01	Y	Y	N	Y	D006, D007, D008
S3-032-02	—	K-Basin Sludge, Sample S3-032-02	Y	Y	N	Y	D006, D007, D008
S3-032-03	—	K-Basin Sludge, Sample S3-032-03	Y	Y	N	Y	D006, D007, D008
S3-032-04	—	K-Basin Sludge, Sample S3-032-04	Y	Y	N	Y	D006

Comments: This predetermination is only for the chemicals present in the sludge. The presence of radionuclides was ignored.

DISCLAIMER

This predetermination is believed accurate based on the information provided. Predeterminations are performed to assist generators in selecting less hazardous products. Since solid waste regulations are subject to constant revision, waste status may change without notice. Waste designations must be performed on all wastes by Generator & Waste Acceptance Services to assure proper disposal in the event products are spilled or contained within a waste matrix.

SOLID WASTE ENGINEERING ANALYSIS

HAZARDOUS ANALYSIS SMART (HAS) SYSTEM
HAS SYSTEM REPORT FOR REQUEST # 24095CURRENT DATE -- 4/18/94
ANALYSIS DATE - 4/18/94
WASTE PHYSICAL STATE - SMATERIAL -- ANALYSIS OF K-DASIN SLUDGE
CONTAINER -
TC PHYSICAL STATE - S

pH -
 FLASHPOINT - °F
 DENSITY - g/cc

PAGE - 1
 DESIGNATOR - RSL
 WASTE WEIGHT - K
 WASTE STATUS - O

CONSTITUENT LIST FOR ITEM #S3-032-01

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC #	PERS/ LDR	IARC	SOURCES		PRODUCT	40 CFR			TOXICITY CHARACTERISTIC	GENERAL INFORMATION
							Use-Code	cls		D1	D2	D3	Code-DW conc.-EHW conc.-LDR conc.	
7429-90-5	ALUMINUM (METAL)	2.4300	N	0.0000			-	-	CODE - CLASS - LDR -				- - -	RQ-45.4 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		2.4300												
7439-89-6	IRON METAL	28.5000	N	0.0000			-	-	CODE - CLASS - LDR -				- - -	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		28.5000												
7439-92-1	LEAD	.0618	N	0.0000			-	-	CODE - CLASS - LDR -				D008-0.01% -1% -0.01%	RQ-.454 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0618												
7439-93-2	LITHIUM	.0004	N	0.0000			-	-	CODE - CLASS - LDR -				- - -	RQ- °F K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0004												
7439-95-4	MAGNESIUM METAL	.1070	N	0.0000			-	-	CODE - CLASS - LDR -				- - -	RQ-5 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.1070												
7439-96-5	MANGANESE	.0363	N	0.0000			-	-	CODE - CLASS - LDR -				- - -	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0363												
7439-98-7	MOLYBDENUM	.0046	N	0.0000			-	-	CODE - CLASS - LDR -				- - -	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0046												
7440-00-8	NEODYMIUM	.0187	N	0.0000			-	-	CODE - CLASS - LDR -				- - -	RQ-NONE K FP- °F RD-6/3/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0187												
7440-02-0	NICKEL	.0114	N	0.0000			-	-	CODE - CLASS - LDR -				NICKEL-N/A -N/A -0.268%	RQ-45.4 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0114												

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MHC-EP-0830 REV 0, VOL. III

CURRENT DATE -- 4/18/94 MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
 ANALYSIS DATE - 4/18/94 CONTAINER -
 WASTE PHYSICAL STATE - S TC PHYSICAL STATE - S

HAS SYSTEM REPORT FOR REQUEST # 24095

PAGE - 2
 DESIGNATOR - RSL
 FLASHPOINT - °F WASTE WEIGHT - K
 DENSITY - g/cc WASTE STATUS - O

CONSTITUENT LIST FOR ITEM #S3-032-01

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC #	PERS/ LDR	IARC	SOURCES		PRODUCT	40 CFR			TOXICITY CHARACTERISTIC			GENERAL INFORMATION
							Use-Code-cls	LDR (WV/OT)		D1	D2	D3	Code-DW conc.-ENW conc.-LDR conc.			
7440-09-7	POTASSIUM	.0200	N	0.0000			- - - -		CODE - CLASS - LDR- -	F	X	X	- - - - - -			RQ- K FP- °F RD-12/09/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0200														
7440-19-9	SAMARIUM	.0665	N	0.0000			- - - -		CODE - CLASS - LDR- -				- - - - - -			RQ-NONE K FP- °F RD-11/11/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0665														
7440-21-3	SILICON	.1430	D	.0000			- - - -		CODE - CLASS - LDR- -				- - - - - -			RQ-NONE K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.1430														
7440-23-5	SODIUM	.0150	C	.0000			- - - -		CODE - CLASS - LDR- -	F	X	X	- - - - - -			RQ-4.54 K FP- °F RD-12/09/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0150														
7440-24-6	STRONTIUM	.0045	N	0.0000			- - - -		CODE - CLASS - LDR- -				- - - - - -			RQ-NONE K FP- °F RD-11/12/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0045														
7440-28-0	THALLIUM	.0217	N	0.0000			- - - -		CODE - CLASS - LDR- -				THLM N/A -N/A -0.26% L.26%			RQ-454 K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0217														
7440-32-6	TITANIUM POWDER	.0174	N	0.0000			- - - -		CODE - CLASS - LDR- -				- - - - - -			RQ-45.4 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0174														
7440-36-0	ANTIMONY METAL	.0318	N	0.0000			- - - -		CODE - CLASS - LDR- -				- - - - - -			RQ-2270 K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0318														
7440-38-2	ARSENIC	.0041	D	.0000			- - - -		CODE - CLASS - LDR- -				D004-0.01% -1% -0.01% L.01%			RQ-.454 K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0041														

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PAGE - 3
 DESIGNATOR - RSL
 WASTE WEIGHT -
 WASTE STATUS - 0
 pH -
 FLASHPOINT -
 DENSITY -
 *F
 8/CC

HAS SYSTEM REPORT FOR REQUEST # 24095
 MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
 CONTAINER -
 TC PHYSICAL STATE - S

CONSTITUENT LIST FOR ITEM #S3-032-01

CAS# FSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC X	PERS/ LDR	IARC	SOURCES Use-Code-cis	PRODUCT	40 CFR D1 D2 D3	TOXICITY CHARACTERISTIC Code-DW conc.-EHW conc.-LDR conc.	GENERAL INFORMATION
7440-39-3	BARIUM	.0116	N	0.0000			- - -	CODE - CLASS - LDR -		D005-0.2X -20X -0.2X	RQ-454 FP- RD-10/24/91
TOT. X OF CHEMICAL IN WASTE MATRIX		.0116									
7440-41-7	BERYLLIUM (METAL)	.0004	C	.0000			- - -	CODE - P015 CLASS - A1M LDR - LDR no copy		- - -	RQ-4.54 FP- RD-7/01/92
TOT. X OF CHEMICAL IN WASTE MATRIX		.0004									
7440-43-9	CADMIUM	.0096	C	.0000			- - -	CODE - CLASS - LDR -		D006-0.002X -0.2X -0.002X	RQ-4.54 FP- RD-10/24/91
TOT. X OF CHEMICAL IN WASTE MATRIX		.0096									
7440-47-3	CHROMIUM	.1180	N	0.0000			- - -	CODE - CLASS - LDR -		D007-0.01X -1X -0.01X	RQ-4.54 FP- RD-11/11/91
TOT. X OF CHEMICAL IN WASTE MATRIX		.1180									
7440-48-4	COBALT METAL	.0030	N	0.0000	N/A		- - -	CODE - CLASS - LDR -		- - -	RQ-NONE FP- RD-10/5/93
TOT. X OF CHEMICAL IN WASTE MATRIX		.0030									
7440-50-8	COPPER	.0369	N	0.0000			- - -	CODE - CLASS - LDR -		- - -	RQ-2270 FP- RD-11/01/91
TOT. X OF CHEMICAL IN WASTE MATRIX		.0369									
7440-61-1	Uranium Compounds	10.9000	N	0.0000			- - -	CODE - CLASS - LDR -		- - -	RQ- FP- RD-5/29/92
TOT. X OF CHEMICAL IN WASTE MATRIX		10.9000									
7440-62-2	VANADIUM	.0527	N	0.0000			- - -	CODE - CLASS - LDR -		- - -	RQ-NONE FP- RD-11/11/91
TOT. X OF CHEMICAL IN WASTE MATRIX		.0527									
7440-66-6	ZINC	.1250	N	0.0000			- - -	CODE - CLASS - LDR -		- - -	RQ-454 FP- RD-11/11/91
TOT. X OF CHEMICAL IN WASTE MATRIX		.1250									

CURRENT DATE -- 4/18/94
ANALYSIS DATE - 4/18/94
WASTE PHYSICAL STATE - S

MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
CONTAINER -
TC PHYSICAL STATE - S

HAS SYSTEM REPORT FOR REQUEST # 24095

pH -
FLASHPOINT -
DENSITY -

DESIGNATOR - RSL
WASTE WEIGHT -
WASTE STATUS - O

PAGE - 4

K

CONSTITUENT LIST FOR ITEM #S3-032-01

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC X	PERS/ LDR	IARC	SOURCES Use-Code-clc LDR (WV/OT)	PRODUCT	40 CFR D1 D2 D3	TOXICITY CHARACTERISTIC Code-DW conc.-EHW conc.-LDR conc.	GENERAL INFORMATION
7440-67-7	ZIRCONIUM	.0222	N	0.0000			- -	CODE - CLASS - LDR -	<i>not</i>	- - -	RQ-45.4 K FP- *F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0222									
7440-70-2	CALCIUM METAL	.4380	N	0.0000			- -	CODE - CLASS - LDR -	<i>not</i>	- - -	RQ-4.54 K FP- *F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.4380									
7704-34-9	SULFUR	.0344	N	0.0000			- -	CODE - CLASS - LDR -	<i>not</i>	- - -	RQ-NONE K FP- *F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0344									
7723-14-0	PHOSPHORUS	.0502	X	.0502			- -	CODE - CLASS - LDR -	<i>not</i>	- - -	RQ-.454 K FP- *F RD-7/02/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0502									
GCH000	No constituents given	56.4038	N	0.0000			- -	CODE - CLASS - LDR -		- - -	RQ- FP- *F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		56.4038									

WT01-EHW WT02-DW Total ECX .05024
No Data or ECX < 0.001 X Non-Regulated X
WAC-173-303-101

HH > 1.0X, WP01-EHW 0.01X < HH ≤ 1.0X, WP02-DW
Non-regulated X
WAC-173-303-102 (LDR-Land Ban HH > 1000 ppm If Fed. Regulated)

> 0.01X single carcinogen or > 1.0X total carcinogens DW-WC02
Non-regulated X
WAC-173-303-103

NOTES: 1-Notification Made To RLA
2nd-Notification Not Req; Ref to Tbl C

Flashpoint (FP) < 100°F FLAMMABLE (F)
100°F ≤ FP < 140°F COMBUSTIBLE (C)
OXIDIZER (O)
WAC-173-303-090, 5 (Always LDR) D001-DW

pH ≤ 2 or pH ≥ 12.5 D002-DW
WAC-173-303-090, 6 (All Liquids Are LDR)

WAC-173-303-090, 7 (Always LDR) D003-DW

TC Codes D006, D007, D008
EHW DW X
LDRs D006, D007, D008
WAC 173-303-090, 8

WASTE SHIPPING SUMMARY

DOT Reg. Is Waste RQ? D0
TSCA Reg. RCRA Reg. State Reg.

DESIGNATION INFORMATION FOR ITEM # S3-032-01

OF REQUEST #24095

APPLICABLE WASTE CODES

WASTE CLASS

LDR CODES

PROPER SHIPPING NAME

HAZARD CLASS

DOT ID NO

LABELS

PACKAGING REQUIREMENTS

PG

SHIP TO

CELL (IF APPLICABLE)

MHC-EP-0830 REV. 0, VOL. III

HAZARDOUS ANALYSIS SMART (HAS) SYSTEM
HAS SYSTEM REPORT FOR REQUEST # 24095

MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
CONTAINER -
TC PHYSICAL STATE - S

•F
R/CC

PAGE - 1
DESIGNATOR - RSL
WASTE WEIGHT - K
WASTE STATUS - O

PAGE - 1

[illegible]

—

WHC-EP-0830 REV 0, VOL. III

CURRENT DATE -- 4/18/94 MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
 ANALYSIS DATE - 4/18/94 CONTAINER --
 WASTE PHYSICAL STATE - S TC PHYSICAL STATE - S

PAGE - 2
 DESIGNATOR - RSL
 WASTE WEIGHT - K
 WASTE STATUS - O
 pH -
 FLASHPOINT - °F
 DENSITY - g/cc

CONSTITUENT LIST FOR ITEM #S3-032-02

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC X	PERS/ LDR	IARC	SOURCES Use-Code-cla	LDR (W/OT)	PRODUCT	40 CFR D1 D2 D3	TOXICITY CHARACTERISTIC Code-DW conc.-EHW conc.-LDR conc.	GENERAL INFORMATION
7440-09-7	POTASSIUM	.0121	N	0.0000			- - - -		CODE - CLASS - LDR- -	X X X	- - - - - -	RQ- K FP- °F RD-12/09/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0121										
7440-19-9	SAMARIUM	.0280	N	0.0000			- - - -		CODE - CLASS - LDR- -	not	- - - - - -	RQ-NONE K FP- °F RD-11/11/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0280										
7440-21-3	SILICON	.1410	D	.0000			- - - -		CODE - CLASS - LDR- -	in	- - - - - -	RQ-NONE K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.1410										
7440-23-5	SODIUM	.0084	C	.0000			- - - -		CODE - CLASS - LDR- -	X X X	- - - - - -	RQ-4.54 K FP- °F RD-12/09/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0084										
7440-24-6	STRONTIUM	.0022	N	0.0000			- - - -		CODE - CLASS - LDR- -	Str	- - - - - -	RQ-NONE K FP- °F RD-11/12/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0022										
7440-28-0	THALLIUM	.0071	N	0.0000			- - - -		CODE - CLASS - LDR- -	from	THLM H/A -H/A -0.26X 2.76%	RQ-454 K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0071										
7440-32-6	TITANIUM POWDER	.0108	N	0.0000			- - - -		CODE - CLASS - LDR- -		- - - - - -	RQ-45.4 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0108										
7440-36-0	ANTIMONY METAL	.0115	N	0.0000			- - - -		CODE - CLASS - LDR- -		- - - - - -	RQ-2270 K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0115										
7440-38-2	ARSENIC	.0046	D	.0000			- - - -		CODE - CLASS - LDR- -		D001-0.01X -1X -0.01X 2.01%	RQ-.454 K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0046										

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WMC-EP-0830 REV 0, VOL. III

CURRENT DATE -- 4/18/94
ANALYSIS DATE - 4/18/94
WASTE PHYSICAL STATE - S

MATERIAL -- ANALYSIS OF K-DASIN SLUDGE
CONTAINER -
TC PHYSICAL STATE - S

HAS SYSTEM REPORT FOR REQUEST # 24095

pH --
FLASHPOINT - °F
DENSITY - g/cc
DESIGNATOR - RSL
WASTE WEIGHT -
WASTE STATUS - O

PAGE - 3

CONSTITUENT LIST FOR ITEM #53-032-02

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC %	PERS/ LDR	IARC	SOURCES		PRODUCT	40 CFR			TOXICITY CHARACTERISTIC			GENERAL INFORMATION
							Use-Code	cls		D1	D2	D3	Code-DW	conc.-EHW	conc.-LDR	
7440-39-3	BARIUM	.0067	N	0.0000			-	-	CODE - CLASS - LDR -				D005-0.2X -20X -0.2X			RQ-454 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0067														
7440-41-7	BERYLLIUM (METAL)	.0003	C	.0000			-	-	CODE - P015 CLASS - LDR -				-	-	-	RQ-4.54 K FP- °F RD-7/01/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0003														
7440-43-9	CADMIUM	.0058	C	.0000			-	-	CODE - CLASS - LDR -				D006-0.002X -0.2X -0.002X			RQ-4.54 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0058														
7440-47-3	CHROMIUM	.0671	N	0.0000			-	-	CODE - CLASS - LDR -				D007-0.01X -1X -0.01X			RQ-4.54 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0671														
7440-48-4	COBALT METAL	.0014	N	0.0000	N/A		-	-	CODE - CLASS - LDR -				-	-	-	RQ-NONE K FP- °F RD-10/5/93
TOT. % OF CHEMICAL IN WASTE MATRIX		.0014														
7440-50-8	COPPER	.0202	N	0.0000			-	-	CODE - CLASS - LDR -				-	-	-	RQ-2270 K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0202														
7440-61-1	Uranium Compounds	4.0400	N	0.0000			-	-	CODE - CLASS - LDR -				-	-	-	RQ- °F FP- °F RD-5/29/92
TOT. % OF CHEMICAL IN WASTE MATRIX		4.0400														
7440-62-2	VANADIUM	.0212	N	0.0000			-	-	CODE - CLASS - LDR -				-	-	-	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0212														
7440-66-6	ZINC	.0737	N	0.0000			-	-	CODE - CLASS - LDR -				-	-	-	RQ-454 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0737														

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MHC-EP-0830 REV 0, VOL. III

CURRENT DATE -- 4/18/94
ANALYSIS DATE - 4/18/94
WASTE PHYSICAL STATE - S

MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
CONTAINER -
TC PHYSICAL STATE - S

HAS SYSTEM REPORT FOR REQUEST # 24095

pH -
FLASHPOINT -
DENSITY -

*F
g/CC

PAGE - 4
DESIGNATOR - RSL
WASTE WEIGHT -
WASTE STATUS - O

K

CONSTITUENT LIST FOR ITEM #S3-032-02

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC 1	PERS/ LDR	IARC	SOURCES Use-Code-c1s LDR (WH/OT)	PRODUCT	40 CFR D1 D2 D3	TOXICITY CHARACTERISTIC Code-DW conc.-EHW conc.-LDR conc.	GENERAL INFORMATION		
7440-67-7	ZIRCONIUM	.0081	N	0.0000			- - - -	CODE - CLASS - LDR- -	F	- - - - - -	RQ-45.4 K FP- *F RD-10/24/91		
TOT. % OF CHEMICAL IN WASTE MATRIX		.0081											
7440-70-2	CALCIUM METAL	.2460	N	0.0000			- - - -	CODE - CLASS - LDR- -	F	- - - - - -	RQ-4.54 K FP- *F RD-10/24/91		
TOT. % OF CHEMICAL IN WASTE MATRIX		.2460											
7704-34-9	SULFUR	.0303	N	0.0000			- - - -	CODE - CLASS - LDR- -		- - - - - -	RQ-NONE K FP- *F RD-11/11/91		
TOT. % OF CHEMICAL IN WASTE MATRIX		.0303											
7723-14-0	PHOSPHORUS	.0327	X	.9827			- - - -	CODE - CLASS - LDR- -		- - - - - -	RQ-.454 K FP- *F RD-7/02/92		
TOT. % OF CHEMICAL IN WASTE MATRIX		.0327											
GCN000	No constituents given	73.8525	N	0.0000			- - - -	CODE - CLASS - LDR- -		- - - - - -	RQ- K FP- *F RD-10/24/91		
TOT. % OF CHEMICAL IN WASTE MATRIX		73.8525											
WT01-EHW _____ WT02-DW _____ Total ECX .03273 No Data _____ or ECX < 0.001 ☒ Non-Regulated ☒ WAC-173-303-101							NOTES: 1-Notification Made To RLA 2nd-Notification Not Req; Ref to Tbl C					TC Codes <u>0006, 0007</u> EHW _____ DW <u>X</u> LDRs <u>0006, 0007</u> WAC 173-303-090, 8	
HH > 1.0%, WFO1-EHW _____ 0.01% < HH ≤ 1.0%, WFO2-DW _____ Non-regulated ☒ WAC-173-303-102 (LDR-Land Ban HH > 1000 ppm If Fed. Regulated)							Flashpoint (FP) < 100°F FLAMMABLE (F) _____ 100°F ≤ FP < 140°F COMBUSTIBLE (C) _____ OXIDIZER (O) _____ WAC-173-303-090, 5 (Always LDR) D001-DW _____					WASTE SHIPPING SUMMARY	
> 0.01% single carcinogen or > 1.0% total carcinogens DW-WC02 Non-regulated ☒ WAC-173-303-103							pH ≤ 2 or pH ≥ 12.5 D002-DW _____ WAC-173-303-090, 6 (All Liquids Are LDR) _____ WAC-173-303-090, 7 (Always LDR) D003-DW _____					DOT Reg. _____ Is Waste RQ? ☒ TSCA Reg. _____ RCRA Reg. _____ State Reg. _____	
DESIGNATION INFORMATION FOR ITEM # S3-032-02 OF REQUEST #24095													
APPLICABLE WASTE CODES <u>0006, 0007, 0008</u> WASTE CLASS <u>DW</u> LDR CODES <u>0006, 0007, 0008</u>													
PROPER SHIPPING NAME _____ HAZARD CLASS _____ DOT ID NO _____													
LABELS _____ PACKAGING REQUIREMENTS _____ PG _____													
SHIP TO _____ CELL (IF APPLICABLE) _____													

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MHC-EP-0830 REV 0, VOL. III

SOLID WASTE ENGINEERING ANALYSIS

HAZARDOUS ANALYSIS SMART (HAS) SYSTEM
HAS SYSTEM REPORT FOR REQUEST # 24095CURRENT DATE -- 4/18/94
ANALYSIS DATE -- 4/18/94
WASTE PHYSICAL STATE - SMATERIAL -- ANALYSIS OF K-BASIN SLUDGE
CONTAINER -
TC PHYSICAL STATE - SPAGE - 1
DESIGNATOR - RSL
WASTE WEIGHT - K
WASTE STATUS - O
pH -
FLASHPOINT - °F
DENSITY - g/cc

CONSTITUENT LIST FOR ITEM #S3-032-03

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC 1	PERS/ LDR	IARC	SOURCES		PRODUCT	40 CFR			TOXICITY CHARACTERISTIC				GENERAL INFORMATION
							Use-Code-cls	LDR (WM/OT)		D1	D2	D3	Code-DW	conc.-EHW	conc.-LDR	conc.	
7429-90-5	ALUMINUM (METAL)	2.0800	N	0.0000			- - - -		CODE - CLASS - LDR- -	F	X		- - - - - -	- - -	- - -		RQ-45.4 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		2.0800															
7439-89-6	IRON METAL	7.3500	N	0.0000			- - - -		CODE - CLASS - LDR- -				- - - - - -	- - -	- - -		RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		7.3500															
7439-92-1	LEAD	.0195	N	0.0000			- - - -		CODE - CLASS - LDR- -				D008-0.01% - - - -	-1% - -	-0.01% - -		RQ-.454 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0195															
7439-93-2	LITHIUM	.0001	N	0.0000			- - - -		CODE - CLASS - LDR- -	F	X		- - - - - -	- - -	- - -		RQ- °F K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0001															
7439-95-4	MAGNESIUM METAL	.0300	N	0.0000			- - - -		CODE - CLASS - LDR- -	F	X		- - - - - -	- - -	- - -		RQ-5 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0300															
7439-96-5	MANGANESE	.0156	N	0.0000			- - - -		CODE - CLASS - LDR- -				- - - - - -	- - -	- - -		RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0156															
7439-98-7	MOLYBDENUM	.0015	N	0.0000			- - - -		CODE - CLASS - LDR- -				- - - - - -	- - -	- - -		RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0015															
7440-00-8	NEODYMIUM	.0067	N	0.0000			- - - -		CODE - CLASS - LDR- -				- - - - - -	- - -	- - -		RQ-NONE K FP- °F RD-6/3/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0067															
7440-02-0	NICKEL	.0040	N	0.0000			- - - -		CODE - CLASS - LDR- -				NICK-N/A - - - -	-N/A - -	-0.268% - -		RQ-45.4 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0040															

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MHC-EP-0830 REV 0, VOL. III

CURRENT DATE -- 4/18/94
 ANALYSIS DATE - 4/18/94
 WASTE PHYSICAL STATE - S

MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
 CONTAINER -
 TC PHYSICAL STATE - S

HAS SYSTEM REPORT FOR REQUEST # 24095

pH -
 FLASHPOINT -
 DENSITY -

*F
 g/cc

PAGE - 2
 DESIGNATOR - RSL
 WASTE WEIGHT -
 WASTE STATUS - O

CONSTITUENT LIST FOR ITEM #S3-032-03

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC 1	PERS/ LDR	IARC	SOURCES		PRODUCT	40 CFR			TOXICITY CHARACTERISTIC			GENERAL INFORMATION
							Use-Code	cls		D1	D2	D3	Code-DW	conc.-EMW	conc.-LDR	
7440-09-7	POTASSIUM	.0050	N	0.0000			-	-	CODE - CLASS - LDR- -	X	X	X	-	-	-	RQ- K FP- *F RD-12/09/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0050								nd						
7440-19-9	SAMARIUM	.0225	N	0.0000			-	-	CODE - CLASS - LDR- -				-	-	-	RQ-NONE K FP- *F RD-11/11/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0225								in						
7440-21-3	SILICON	.1990	D	.0000			-	-	CODE - CLASS - LDR- -	X			-	-	-	RQ-NONE K FP- *F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.1990								present						
7440-23-5	SODIUM	.0044	C	.0000			-	-	CODE - CLASS - LDR- -	X	X	X	-	-	-	RQ-4.54 K FP- *F RD-12/09/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0044														
7440-24-6	STRONTIUM	.0011	N	0.0000			-	-	CODE - CLASS - LDR- -				-	-	-	RQ-NONE K FP- *F RD-11/12/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0011								form						
7440-28-0	THALLIUM	.0100	N	0.0000			-	-	CODE - CLASS - LDR- -				THM-N/A	N/A	-0.26X	RQ-454 K FP- *F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0100											1.263			
7440-32-6	TITANIUM POWDER	.0045	N	0.0000			-	-	CODE - CLASS - LDR- -	X			-	-	-	RQ-45.4 K FP- *F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0045														
7440-36-0	ANTIMONY METAL	.0088	N	0.0000			-	-	CODE - CLASS - LDR- -				-	-	-	RQ-2270 K FP- *F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0088														
7440-38-2	ARSENIC	.0017	D	.0000			-	-	CODE - CLASS - LDR- -				D004-0.01X	-1X	-0.01X	RQ-.454 K FP- *F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0017											1.087			

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WMC-EP-0830 REV 0, VOL. III

CURRENT DATE -- 4/18/94 MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
 ANALYSIS DATE - 4/18/94 CONTAINER -
 WASTE PHYSICAL STATE - S TC PHYSICAL STATE - S

HAS SYSTEM REPORT FOR REQUEST # 24095

PAGE - 3
 DESIGNATOR - RSL
 WASTE WEIGHT - K
 WASTE STATUS - O
 pH -
 FLASHPOINT - °F
 DENSITY - g/cc

CONSTITUENT LIST FOR ITEM #S3-032-03

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC %	PERS/ LDR	IARC	SOURCES		PRODUCT	40 CFR			TOXICITY CHARACTERISTIC			GENERAL INFORMATION
							Use-Code-cls	LDR (WW/OT)		D1	D2	D3	Code-DW conc.	EHW conc.	LDR conc.	
7440-39-3	BARIUM	.0054	N	0.0000			- -		CODE - CLASS - LDR -				D005-0.2X	-20X	-0.2X	RQ-454 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0054														
7440-41-7	BERYLLIUM (METAL)	.0025	C	.0000			- -		CODE - P015 CLASS - AHW LDR - LDR				-	-	-	RQ-4.54 K FP- °F RD-7/01/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0025														
7440-43-9	CADMIUM	.0059	C	.0000			- -		CODE - CLASS - LDR -				D006-0.002X	-0.2X	-0.002X	RQ-4.54 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0059														
7440-47-3	CHROMIUM	.0238	N	0.0000			- -		CODE - CLASS - LDR -				D007-0.01X	-1X	-0.01X	RQ-4.54 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0238														
7440-48-4	COBALT METAL	.0009	N	0.0000	N/A		- -		CODE - CLASS - LDR -				-	-	-	RQ-NONE K FP- °F RD-10/5/93
TOT. % OF CHEMICAL IN WASTE MATRIX		.0009														
7440-50-8	COPPER	.0213	N	0.0000			- -		CODE - CLASS - LDR -				-	-	-	RQ-2270 K FP- °F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0213														
7440-61-1	Uranium Compounds	3.5000	N	0.0000			- -		CODE - CLASS - LDR -				-	-	-	RQ- °F FP- °F RD-5/29/92
TOT. % OF CHEMICAL IN WASTE MATRIX		3.5000														
7440-62-2	VANADIUM	.0165	N	0.0000			- -		CODE - CLASS - LDR -				-	-	-	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0165														
7440-66-6	ZINC	.0353	N	0.0000			- -		CODE - CLASS - LDR -				-	-	-	RQ-454 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0353														

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MHC-EP-0830 REV 0, VOL. III

CURRENT DATE -- 4/18/94
ANALYSIS DATE - 4/18/94
WASTE PHYSICAL STATE - S

MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
CONTAINER -
TC PHYSICAL STATE - S

HAS SYSTEM REPORT FOR REQUEST # 24095

PAGE - 4
DESIGNATOR - RSL
WASTE WEIGHT - K
WASTE STATUS - O
FLASHPOINT - °F
DENSITY - g/cc

CONSTITUENT LIST FOR ITEM #S3-032-03

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC X	PERS/ LDR	IARC	SOURCES Use-Code-cls LDR (WH/OT)	PRODUCT	40 CFR D1 D2 D3	TOXICITY CHARACTERISTIC Code-DW conc.-EHW conc.-LDR conc.	GENERAL INFORMATION
7440-67-7	ZIRCONIUM	.0148	N	0.0000			- - - -	CODE - CLASS - LDR- -	<i>not in form</i>	- - - - - - - - -	RQ-45.4 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0148									
7440-70-2	CALCIUM METAL	.0693	N	0.0000			- - - -	CODE - CLASS - LDR- -	<i>present</i>	- - - - - - - - -	RQ-4.54 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0693									
7704-34-9	SULFUR	.0214	N	0.0000			- - - -	CODE - CLASS - LDR- -	<i>form</i>	- - - - - - - - -	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0214									
7723-14-0	PHOSPHORUS	.0191	X	.0191			- - - -	CODE - CLASS - LDR- -		- - - - - - - - -	RQ-.454 K FP- °F RD-7/02/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0191									
GCN000	No constituents given	86.4994	N	0.0000			- - - -	CODE - CLASS - LDR- -		- - - - - - - - -	RQ- FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		86.4994									

WT01-EHW _____ WT02-DW _____ Total ECX .01913
No Data _____ or ECX < 0.001 ☒ Non-Regulated ☒
WAC-173-303-101

HH > 1.0X, WF01-EHW _____ 0.01X < HH ≤ 1.0X, WF02-DW _____
Non-regulated ☒
WAC-173-303-102 (LDR-Land Ban HH > 1000 ppm If Fed. Regulated)

> 0.01X single carcinogen or > 1.0X total carcinogens DW-WC02
Non-regulated ☒
WAC-173-303-103

NOTES: 1-Notification Made To RLA
2nd-Notification Not Req; Ref to Tbl C

Flashpoint (FP) < 100°F FLAMMABLE (F) _____
100°F ≤ FP < 140°F COMBUSTIBLE(C) _____
OXIDIZER (O) _____
WAC-173-303-090, 5 (Always LDR) D001-DW _____

pH ≤ 2 or pH ≥ 12.5 D002-DW _____
WAC-173-303-090, 6 (All Liquids Are LDR) _____
WAC-173-303-090, 7 (Always LDR) D003-DW _____

TC Codes D006, D007, D008
EHW D008 LDR D006, D007, D008
WAC 173-303-090, 8

WASTE SHIPPING SUMMARY
DOT Reg. _____ Is Waste RQ? _____
TSCA Reg. _____ RCRA Reg. _____ State Reg. _____

DESIGNATION INFORMATION FOR ITEM # S3-032-03

OF REQUEST #24095

APPLICABLE WASTE CODES

D006, D007, D008

WASTE CLASS

DW

LDR CODES

D006, D007, D008

PROPER SHIPPING NAME

HAZARD CLASS

DOT ID NO

LABELS

PACKAGING REQUIREMENTS

PG

SHIP TO

CELL (IF APPLICABLE)

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MHC-EP-0830 REV 0, VOL. III

SOLID WASTE ENGINEERING ANALYSIS

HAZARDOUS ANALYSIS SMART (HAS) SYSTEM
HAS SYSTEM REPORT FOR REQUEST # 24095CURRENT DATE -- 4/19/94
ANALYSIS DATE - 4/19/94
WASTE PHYSICAL STATE - SMATERIAL -- ANALYSIS OF K-BASIN SLUDGE
CONTAINER -
TC PHYSICAL STATE - S

pH -
 FLASHPOINT - °F
 DENSITY - g/cc

PAGE - 1
 DESIGNATOR - RSL
 WASTE WEIGHT - K
 WASTE STATUS - 0

CONSTITUENT LIST FOR ITEM #S3-032-04

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC 1	PERS/ LDR	IARC	SOURCES Use-Code-cln LDR (WH/OT)	PRODUCT	40 CFR D1 D2 D3	TOXICITY CHARACTERISTIC Code-DW conc.-EHW conc.-LDR conc.	GENERAL INFORMATION
7429-90-5	ALUMINUM (METAL)	.5970	N	0.0000			- - - -	CODE - CLASS - LDR- -	☒ ☒ ☒	- - - - - -	RQ-45.4 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.5970									
7439-89-6	IRON METAL	1.9200	N	0.0000			- - - -	CODE - CLASS - LDR- -	☒ ☒ ☒	- - - - - -	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		1.9200									
7439-92-1	LEAD	.0076	N	0.0000			- - - -	CODE - CLASS - LDR- -	☒ ☒ ☒	D008-.01% -1% -0.01% /C.01%	RQ-.454 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0076									
7439-93-2	LITHIUM	.0003	N	0.0000			- - - -	CODE - CLASS - LDR- -	☒ ☒ ☒	- - - - - -	RQ- °F FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0003									
7439-95-4	MAGNESIUM METAL	.0365	N	0.0000			- - - -	CODE - CLASS - LDR- -	☒ ☒ ☒	- - - - - -	RQ-5 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0365									
7439-96-5	MANGANESE	.0430	N	0.0000			- - - -	CODE - CLASS - LDR- -	☒ ☒ ☒	- - - - - -	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0430									
7439-98-7	MOLYBDENUM	.0002	N	0.0000			- - - -	CODE - CLASS - LDR- -	☒ ☒ ☒	- - - - - -	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0002									
7440-00-8	NEODYMIUM	0.0000	N	0.0000			- - - -	CODE - CLASS - LDR- -	☒ ☒ ☒	- - - - - -	RQ-NONE K FP- °F RD-6/3/92
TOT. % OF CHEMICAL IN WASTE MATRIX		0.0000									
7440-02-0	NICKEL	.0029	N	0.0000			- - - -	CODE - CLASS - LDR- -	☒ ☒ ☒	NIKL N/A -N/A -0.268% /C.268%	RQ-45.4 K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0029									

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CURRENT DATE -- 4/19/94
 ANALYSIS DATE - 4/19/94
 WASTE PHYSICAL STATE - S

MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
 CONTAINER -
 TC PHYSICAL STATE - S

HAS SYSTEM REPORT FOR REQUEST # 24095

pH -
 FLASHPOINT -
 DENSITY -

PAGE - 2
 DESIGNATOR - RSL
 WASTE WEIGHT -
 WASTE STATUS - O

CONSTITUENT LIST FOR ITEM #S3-032-04

CAS# HSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC 1	PERS/ LDR	IARC	SOURCES Use-Code-cls LDR (WM/OT)	PRODUCT	40 CFR D1 D2 D3	TOXICITY CHARACTERISTIC Code-DW conc.-EHW conc.-LDR conc.	GENERAL INFORMATION
7440-09-7	POTASSIUM	.0165	N	0.0000			- -	CODE - CLASS - LDR -	/ X /	- - -	RQ- K FP- *F RD-12/09/91
	TOT. % OF CHEMICAL IN WASTE MATRIX	.0165									
7440-19-9	SAHARIUM	.0094	N	0.0000			- -	CODE - CLASS - LDR -	not	- - -	RQ-NONE K FP- *F RD-11/11/92
	TOT. % OF CHEMICAL IN WASTE MATRIX	.0094									
7440-21-3	SILICON	.0897	D	.0000			- -	CODE - CLASS - LDR -	in	- - -	RQ-NONE K FP- *F RD-11/01/91
	TOT. % OF CHEMICAL IN WASTE MATRIX	.0897									
7440-23-5	SODIUM	.0116	C	.0000			- -	CODE - CLASS - LDR -	/ X /	- - -	RQ-4.54 K FP- *F RD-12/09/91
	TOT. % OF CHEMICAL IN WASTE MATRIX	.0116									
7440-24-6	STRONTIUM	.0013	N	0.0000			- -	CODE - CLASS - LDR -	present	- - -	RQ-NONE K FP- *F RD-11/12/92
	TOT. % OF CHEMICAL IN WASTE MATRIX	.0013									
7440-28-0	THALLIUM	.0040	N	0.0000			- -	CODE - CLASS - LDR -	for	THLL N/A -N/A -0.26X L.262	RQ-454 K FP- *F RD-11/01/91
	TOT. % OF CHEMICAL IN WASTE MATRIX	.0040									
7440-32-6	TITANIUM POWDER	.0049	N	0.0000			- -	CODE - CLASS - LDR -	/	- - -	RQ-45.4 K FP- *F RD-10/24/91
	TOT. % OF CHEMICAL IN WASTE MATRIX	.0049									
7440-36-0	ANTIMONY METAL	.0033	N	0.0000			- -	CODE - CLASS - LDR -		- - -	RQ-2270 K FP- *F RD-11/01/91
	TOT. % OF CHEMICAL IN WASTE MATRIX	.0033									
7440-38-2	ARSENIC	.0003	D	.0000			- -	CODE - CLASS - LDR -	L.01%	D004 0.01X -1X -0.01X L.01%	RQ-.454 K FP- *F RD-11/01/91
	TOT. % OF CHEMICAL IN WASTE MATRIX	.0003									

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CURRENT DATE -- 4/19/94
ANALYSIS DATE - 4/19/94
WASTE PHYSICAL STATE - S

MATERIAL -- ANALYSIS OF K-BASIN SLUDGE
CONTAINER -
TC PHYSICAL STATE - S

HAS SYSTEM REPORT FOR REQUEST # 24095

FLASHPOINT -
DENSITY -

PAGE - 3
DESIGNATOR - RSL
WASTE WEIGHT - K
WASTE STATUS - O

CONSTITUENT LIST FOR ITEM #S3-032-04

CAS# MSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC %	PERS/ LDR	IARC	SOURCES Use-Code-cls LDR (W/OT)	PRODUCT	40 CFR D1 D2 D3	TOXICITY CHARACTERISTIC Code-DW conc.-EHW conc.-LDR conc.	GENERAL INFORMATION
7440-39-3	BARIUM	.0050	N	0.0000			- - - -	CODE - CLASS - LDR- -	✓	D005-0.2% -20% -0.2% C.20%	RQ-454 K FP- *F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0050									
7440-41-7	BERYLLIUM (METAL)	.0008	C	.0000			- - - -	CODE - P015 CLASS - AHW LDR-LDR no per to active	not	- - - - - -	RQ-4.54 K FP- *F RD-7/01/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0008									
7440-43-9	CADMIUM	.0080	C	.0000			- - - -	CODE - CLASS - LDR- -	in	D006-0.002% -0.2% -0.002% C.0%	RQ-4.54 K FP- *F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0080									
7440-47-3	CHROMIUM	.0061	N	0.0000			- - - -	CODE - CLASS - LDR- -	present	D007-0.01% -1% -0.01% C.0%	RQ-4.54 K FP- *F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0061									
7440-48-4	COBALT METAL	.0004	N	0.0000	N/A		- - - -	CODE - CLASS - LDR- -		- - - - - -	RQ-NONE K FP- *F RD-10/5/93
TOT. % OF CHEMICAL IN WASTE MATRIX		.0004									
7440-50-8	COPPER	.0152	N	0.0000			- - - -	CODE - CLASS - LDR- -	form	- - - - - -	RQ-2270 K FP- *F RD-11/01/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0152									
7440-61-1	Uranium Compounds	1.3100	N	0.0000			- - - -	CODE - CLASS - LDR- -	✓	- - - - - -	RQ- *K FP- *F RD-5/29/92
TOT. % OF CHEMICAL IN WASTE MATRIX		1.3100									
7440-62-2	VANADIUM	.0061	N	0.0000			- - - -	CODE - CLASS - LDR- -		- - - - - -	RQ-NONE K FP- *F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0061									
7440-66-6	ZINC	.0252	N	0.0000			- - - -	CODE - CLASS - LDR- -	✓	- - - - - -	RQ-454 K FP- *F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0252									

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WMC-EP-0830 REV 0, VOL. III

CURRENT DATE -- 4/19/94
ANALYSIS DATE -- 4/19/94
WASTE PHYSICAL STATE -- S

MATERIAL -- ANALYSIS OF K-DASIN SLUDGE
CONTAINER --
TC PHYSICAL STATE -- S

HAS SYSTEM REPORT FOR REQUEST # 24095

PAGE - 4
DESIGNATOR - RSL
WASTE WEIGHT -
WASTE STATUS - O
pH --
FLASHPOINT - °F
DENSITY - g/cc

CONSTITUENT LIST FOR ITEM #S3-032-04

CAS# HSDS#/RGN	CHEMICAL NAME	WEIGHT PERCENT	TOX	EC %	PERS/ LDR	IARC	SOURCES		PRODUCT	40 CFR			TOXICITY CHARACTERISTIC			GENERAL INFORMATION
							Use-Code-cla	LDR (HW/OT)		D1	D2	D3	Code-DW	conc.-EHW	conc.-LDR	
7440-67-7	ZIRCONIUM	.0030	N	0.0000			-	-	CODE - CLASS - LDR -				-	-	-	RQ-45.4 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0030														
7440-70-2	CALCIUM METAL	.0953	N	0.0000			-	-	CODE - CLASS - LDR -			X	-	-	-	RQ-4.54 K FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0953														
7704-34-9	SULFUR	.0331	N	0.0000			-	-	CODE - CLASS - LDR -				-	-	-	RQ-NONE K FP- °F RD-11/11/91
TOT. % OF CHEMICAL IN WASTE MATRIX		.0331														
7723-14-0	PHOSPHORUS	.0201	X	.0201					CODE - CLASS - LDR -				-	-	-	RQ-.454 K FP- °F RD-7/02/92
TOT. % OF CHEMICAL IN WASTE MATRIX		.0201														
GCN000	No constituents given	96.0000	N	0.0000			-	-	CODE - CLASS - LDR -				-	-	-	RQ- FP- °F RD-10/24/91
TOT. % OF CHEMICAL IN WASTE MATRIX		96.0000														

WT01-EHW _____ WT02-DW _____ Total ECX .02013
No Data _____ or ECX < 0.001 ☒ Non-Regulated ☒
WAC-173-303-101

III > 1.0X, WP01-EHW _____ 0.01X < III ≤ 1.0X, WP02-DW _____
Non-regulated ☒
WAC-173-303-102 (LDR-Land Ban III > 1000 ppm If Fed. Regulated)

> 0.01X single carcinogen or > 1.0X total carcinogens DW-WC02
Non-regulated ☒
WAC-173-303-103

NOTES: 1-Notification Made To RLA
2nd-Notification Not Req; Ref to Tbl C

Flashpoint (FP) < 100°F FLAMMABLE (F) _____
100°F ≤ FP < 140°F COMBUSTIBLE (C) _____
OXIDIZER (O) _____
WAC-173-303-090, 5 (Always LDR) D001-DW _____

pH ≤ 2 or pH ≥ 12.5 D002-DW _____
WAC-173-303-090, 6 (All Liquids Are LDR)

WAC-173-303-090, 7 (Always LDR) D003-DW _____

TC Codes D006

EHW _____ DW ☒
LDRs D006

WAC 173-303-090, 8

WASTE SHIPPING SUMMARY

DOT Reg. _____ Is Waste RQ? No
TSCA Reg. _____ RCRA Reg. _____ State Reg. _____

DESIGNATION INFORMATION FOR ITEM # S3-032-04 OF REQUEST #24095

APPLICABLE WASTE CODES D006 WASTE CLASS DW LDR CODES D006

PROPER SHIPPING NAME _____ HAZARD CLASS _____ DOT ID NO _____

LABELS _____ PACKAGING REQUIREMENTS _____ PG _____

SHIP TO _____ CELL (IF APPLICABLE) _____

4404

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ATTACHMENT C

QUESTIONS USED IN THE INTERVIEW MEETINGS FOR THE FOUR ALTERNATIVES

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SNF Interview Questions

Alternative: _____ Date: _____

1. Regarding technical performance of each function, describe the function in terms of the general processes involved, including any radiological or hazardous materials or operations.
 - a. Is there further degradation of fuel associated with the function? If so, how much and what type?
 - b. Is there potential for technology development and transfer associated with the function? What is its value in \$FY95.
 - c. Is waste generated during this function? If so, how much of what type?
 - d. Have the technologies required by this function been demonstrated? Are new technologies required?
 - e. What is the potential impact on NRC licensing?
 - f. What is the potential impact on final disposition?

2. Concerning schedule and cost uncertainties
 - a. Any approvals and/or external reviews required as part of this task that will impact schedule/costs?
 - i. Do we understand what they are and who will impose them?
 - ii. Have the requirements been applied elsewhere?
 - iii. What experience do we have regarding the types and duration of delays that could be generated
 - iv. How will technical issues/precedent impact the process?
 - b. What can go wrong during the task that will impact feasibility, schedule, and/or cost of completing it?
 - i. What are the estimated frequency of occurrence and physical consequences?
 - ii. What additional actions would be required to recover to a status quo physical condition?
 - iii. What types of additional external influences will it generate? (DOE, NRC, State and local governments, Public/intervenors)
 - iv. How can the above influence the expected duration of this task provided to Dave Harris? Four out of 5 times it would not increase the duration more than (provide either a factor or a duration).
 - v. Does this produce significant additional costs?

- c. What is your most optimistic estimate of duration/cost (provide factor if necessary)?

3. Concerning Health Risks

- a. What hazardous materials are used in each activity?
- b. How much of the material is at risk?
- c. What types of upset conditions might occur? (fuel drop, react chemicals, furnace run-away, etc.)
 - i. How often might they occur? (based on experience, near misses, etc.)
 - ii. How might radioactive or hazardous material be released?
 - iii. What safety features will limit the extent or consequences? (Passive, automatic, active human response required)
 - iv. How often could the safety function fail?
 - v. What are the consequences of the release? (with/without safety features)

4. Impact on Stakeholders

- a. How many tons of SNF will be shipped off-Site?
- b. How far from the river will fuel be stored in the pre-interim facility?
- c. Are the potential long-term economic benefits to the region associated with the function? If so, what are they and what is the estimated value in \$FY95.

ATTACHMENT D

**WESTINGHOUSE HANFORD COMPANY BASIS DOCUMENT FOR PRIORITY
PLANNING GRID APPLICATION OF THE
RISK RANKING TECHNIQUE**

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12/1/90
GJW

CORRESPONDENCE

DISTRIBUTION

COVERSHEET

Author

Addressee

Correspondence No.

J. O. Honeyman

J. D. Wagoner

90043468 R1

Subject: DEVELOPMENT OF A PRIORITY PLANNING SYSTEM

INTERNAL DISTRIBUTION

Approval	Date	Name	Location	w/att
		Correspondence Control		X
		R. J. Bliss	B3-04	X
		N. C. Boyter	R2-52	X
		J. G. Burk	B3-25	X
		J. R. Cassady	B3-07	X
		B. P. Dole	A2-50	X
		A. D. Gadeken	B4-52	X
		K. L. Hoewing	B3-06	X
X JH	11/21/90	J. O. Honeyman	B1-41	X
		J. R. Knight	B4-52	X
		R. J. Kobelski	L0-24	X
X MKK	11/21/90	M. K. Korenko	B3-08	X
		C. M. Kronvall	R2-96	X
		D. C. Lini	R3-63	X
		H. E. McGuire	B2-35	X
		E. J. Murphy	B1-41	X
		D. J. Newland	N1-35	X
		S. M. O'Toole	B2-20	X
		W. G. Ruff	R2-53	X
		D. E. Simpson	B3-51	X
		J. E. Truax	N2-51	X
		E. P. Vodney	B3-50	X
		G. R. Wilson	B1-41	X
		M. D. Zentner	H0-31	X
		President's Office	B3-01	X

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NOV 27 1990

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Westinghouse
Hanford Company

P.O. Box 1970
Richland, WA 99352

Roger C Nichols
President

November 26, 1990

9004346B R1

Mr. J. D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office
Richland, Washington 99352

Dear Mr. Wagoner:

DEVELOPMENT OF A PRIORITY PLANNING SYSTEM

Reference: Letter, J. D. Wagoner, DOE-RL, to R. C. Nichols, WHC,
"Development of Priorities For FY 1991 Workslope," SED:RAH,
dated September 26, 1990.

Westinghouse Hanford Company (WHC) was tasked by the Department of Energy-Richland Operations Office (DOE-RL) to perform a reassessment of the FY 1991 workslope. This reassessment was to be based on (1) a set of strategic alternatives for key Hanford facilities; and, (2) FY 1991 workslope priorities - particularly those that impact the Tiger Team findings. Concurrence on the strategic alternatives has been reached. The first major element of the effort is the "Key Assumptions, Priorities and Options" document which serves as a basis for both this effort on the Tiger Team Corrective Action Plans, and the "Hanford - The Next 7 Years" options study. We have informally received DOE-RL's comments on the key assumptions document and are using those comments as the basis for budget reassessment and scheduling of the Tiger Team Corrective Action Plans.

This letter addresses the second key element of the prioritization approach under development by WHC. The risk-based Priority Planning Grid (PPG) is based on state-of-the-art decision-making techniques. While application of the grid to real world decision-making is relatively straight forward, it is based on a complex set of regulatory concepts and management weighing that require careful consideration.

Enclosed is a draft of the "Westinghouse Hanford Company Basis Document for Site Priority Planning Grid Application of the Risk Ranking Technique" for your review and comment. This document provides the technical basis for the risk-based PPG which has been discussed with members of your staff. In addition, it is intended that the PPG, in

Mr. J. D. Wagoner
Page 2
November 26, 1990

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its current form, will be used to assess and establish priorities for the work elements of the Tiger Team Findings Corrective Action Plan. The PPG has been applied to the Tiger Team findings and early indications are that the process will be a valuable tool in providing relative risk rankings for these types of issues.

Your review and comments on the basis document, specifically the PPG, are needed by November 30, 1990. Incorporation of DOE-RL's comments and concurrence of the draft document will be needed by December 4, 1990, for the final application to the Tiger Team Corrective Action Plan to support the draft action plans' submittal to DOE-Headquarters (DOE-HQ) by January 31, 1991.

Westinghouse Hanford Company is considering this approach for broader application to programmatic workscope. In addition to the Tiger Team findings, this prioritization technique has been applied to a series of "pilot" program elements and a "lessons learned" effort is underway. We intend to evolve and refine the prioritization approach recognizing that both the DOE-HQ Environmental Restoration and Waste Management programs are developing different prioritization schemes for use in FY 1992 budget and 5-year plan development. Considering the nature and complexities associated with any prioritization process, we believe that risk-based prioritization will continue to be an evolutionary process. As we proceed through this evolutionary/refinement process, we will work closely with the DOE-RL staff.

If you have any questions regarding this basis document or the PPG, please contact Mr. J. O. Honeyman on 376-7402.

Sincerely,

ER
R. C. Nichols
President

dkb

Enclosure

DOE-RL - J. J. Keating
R. O. Puthoff (w/o enclosure)

PREDECISIONAL

WESTINGHOUSE HANFORD COMPANY

BASIS DOCUMENT FOR
PRIORITY PLANNING GRID
APPLICATION OF THE
RISK RANKING TECHNIQUE

NOVEMBER 20, 1990

DEVELOPED FOR WESTINGHOUSE HANFORD COMPANY

BY

J. J. RITTS, SENIOR CONSULTANT

TENERA, L. P.

DEVELOPMENT OF THE PRIORITY PLANNING GRID

The application of the risk based decision-making techniques developed by Tenera, L.P. was completed by the sustained efforts of a multi-disciplined team of senior Westinghouse Hanford managers and technical staff, with the assistance of J. J. Ritts, Senior Consultant, Tenera, L.P. Major contributors for this activity included:

J. O. Honeyman	Manager, Strategic Planning and Systems Integration
D. J. Newland	Manager, Advanced Reactor Operations
J. E. Truax	Manager, FFTF Special Projects and Administration
A. D. Gaden	Manager, Support Services Programs
S. M. O'Toole	Manager, Environmental Planning and Analysis
C. M. Kronvall	Manager, CP Planning and Technology Programs
R. J. Kobelski	Manager, SQS Planning
M. D. Zentner	Manager, Risk Assessment Technology
D. C. Lini	Principal Engineer, Process Systems Analysis
G. R. Wilson	Manager, Modernization
E. J. Murphy	Staff Assistant, Strategic Planning and Systems Integration
J. J. Ritts	Senior Consultant, Tenera, L.P.

This document represents the technical basis for the Priority Planning Grid, and incorporates lessons learned from the pilot Hanford applications, as well as lessons learned in the application of this technique in commercial NRC licensed facilities, at Oak Ridge, and at Rocky Flats.

PREDECISIONAL

developed for the Hanford Site from a combination of the previous DOE work and the Priority/Severity Matrix. These consequences have been grouped under seven general attributes:

1. Public Safety (PS)

This attribute addresses adverse impacts on the health and safety of the surrounding population (ie., anyone outside the Hanford Site boundaries).

2. Worker Safety (WS)

This addresses adverse impacts on the health and safety of the workers and any other individuals who are voluntarily inside the site boundary.

3. Environmental Protection (EP)

This includes physical degradation of the eco-system both on- and off-site and harmful effects on wildlife. This includes irreparable as well as reparable impacts.

4. Regulatory Compliance (RC)

This includes the risk of fines and imprisonment and loss of confidence in management by DOE, other regulatory agencies, such as OSHA, due to failure to abide by laws, regulations, or agreements with regulatory agencies. It also encompasses confidence levels associated with management effectiveness as reflected by its anticipation of and response to directives and internal audit findings and adherence to industry good practices.

5. Mission Impact (MI)

This includes negative impacts on the ability of the Hanford Site to carry out its various missions. Mission impacts can include failure to meet mandated programmatic directives from DOE, and failure to meet DOE goals and objectives, mission imperatives (such as environmental cleanup, etc), and shutdown of research reactors.

6. Investment Protection (IP)

This attribute includes adverse consequences to the Hanford Site from capital losses or equipment damage (due to fires or other advertable consequences), impacts that significantly increase production costs or prevent cost savings (lost opportunity to reduce production costs), lawsuits, or other investment impacts.

PREDECISIONAL

The investment dollar limits are based generally on limits employed in DOE Order 5480.7, "Fire Protection".

7. Public Perception (PP)

This attribute includes the loss of confidence by members of the public in the ability of Westinghouse Hanford Company (WHC) to operate the site in a safe and environmentally sound manner. It includes potential public disruption and economic impact caused by panic or evacuation whether or not public life is endangered (i.e., by releases of hazardous material).

Specific averted consequences for each of these attributes were developed and are displayed in the PPG (Table 1). Security concerns associated with projects being evaluated have not been assigned separate averted consequences because their impacts can be included as part of the cost of existing consequences.

To be able to determine the relative "averted risk" of a project, one must establish a probability of the event which the project is designed to eliminate, mitigate or avert. If a probability of occurrence is known, it should be used (eg., probability of equipment failure, earthquake, or other initiating event of an undesired occurrence which the project would mitigate). For those occurrences where the probability has not been determined, a probability scale was established and divided into four discrete segments. The first (most likely or high probability) segment covers those consequences which are pre-existing (probability of 1 of occurring) or are expected to occur in the next two years (probability of 0.5/year). Subsequent segments cover increasingly less likely events, down to probabilities of less than one in ten thousand/year. These probability segments are shown in Table 2. Guidelines are presented in the table to help in the choice of the probability to be applied. The representative value in the probability scale is used only when the probability of the event or accident which the project is designed to mitigate or eliminate is not known.

III. DETERMINATION OF RELATIVE RANKING OR WEIGHTS OF AVERTED CONSEQUENCES

In considering the justification of various weights assigned for severity of risks, it is important to consider the manner in which those weights are determined. Weights for early versions of risk based prioritization at DOE facilities were established by the "consensus" method. In this method, a number of upper managers are asked to rank consequences relative to each other. The results of each of these "rankings" were then compiled and a consensus determined (average, etc). However, a review of the literature

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suggests that a more logical and defensible method might be adopted. Fischhoff, et. al.¹ advanced a sophisticated approach to the numerical representation of risks by proposing the use of vectors to characterize the risks associated with different technologies. Each component of the vector, per Fischhoff, represents the expectation value (or some other numerical representation) of one particular type of consequence, such as the expected number of deaths in the general public, the expected number of person days of incapacity, etc. This approach can be extrapolated to various Hanford Sites risks by assignment of a cost of death, cost of injury or exposure of a certain level, cost of investment loss, cost of noncompliance, etc. and, then applying a vector composed of two factors to each of the costs according to the extent [number of persons (workers) involved and hazard level (of radiation or hazardous material)] and the unwillingness of the public or the business concern to accept those risks. The weights are then a function of three components: 1) the value of the specific consequence (ie., cost of a death, injury, investment loss, noncompliance, etc.); and, 2) an extent factor which relates to the hazard level and number of persons involved; and, 3) a factor related to the unwillingness to accept the risks. Those factors are multiplied together to give the final weights. The positive aspect of this approach is that the costs can be justified based on established usage or actual losses and the factors, although still somewhat subjective, can be justified by rational means. The following paragraphs describe the justifications for the costs and factors proposed for Hanford Site use in the risk ranking technique. This approach is one of many which could be adopted. It is a reasonable method to characterize risk and should be defensible in negotiations with DOE.

IV. COSTS OR VALUES OF AVERTED CONSEQUENCES

The first component of the averted consequence weights is the value or cost assigned to the averted consequence. Specific details on determination of these values for radiation exposure-to-individuals related consequences are discussed below. Key aspects of the consequence values include:

Costs for exposures to hazardous or radioactive materials were developed by using a linear relationship for the probability of death due to a given exposure.

Prompt or early fatalities were assigned a "cost" of \$1 million each and latent cancer/leukemia fatalities, \$500,000 due to the anticipated longer life. Although, an argument may be made that a "death is a death" and should be valued at the same level regardless of when it occurs, it is reasonable to assign a lower cost to a fatality which will occur 30 to 40 years later than one which occurs within 6 months of an event (accident).

¹ B. Fischhoff, S. R. Watson, and C. Hope, "Defining Risk," Policy Sciences 17, 123-139 (1984).

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TABLE 2
PROBABILITY RANGES FOR PROJECT PRIORITIZATION

PROBABILITY RANGE (/YR)	REPRESENTATIVE VALUE	CONDITIONS
HIGH 1.0 to 0.5	1.0	Existing conditions or those which are expected to occur within two years. For example: System failure is guaranteed or has fatal design errors. Training, procedures, or assurance activity are wrong and will result in failure if followed.
MEDIUM <0.5 to 0.05	0.1	Occurrence is expected in the lifetime of the upgrade (20 year maximum). For example: The system could be predicted to fail or has design flaws that cause frequent failure or significant reduction in safety margins. Procedures, training, or assurance activity are such that errors leading to system failure could occur.
LOW <0.05 to 10^{-3}	0.01	Occurrence is possible but not expected during life of plant. For example: System is within the range of typical mechanical system reliability and has no known flaws or minor reduction in safety/environmental margins. Procedures, training, and assurance activities seem adequate.
VERY LOW < 10^{-3} to 10^{-6}	10^{-4}	Highly unlikely to happen in the plant lifetime. For example: System is within the range of typical passive system reliability or better and has no known design flaws.

Note: If a probability of an event is known or can be calculated or estimated, the known, calculated, or estimated value should be used.

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Loss of life is the most severe Health and Safety concern whether it be off-site (to the Public) or on-site (to workers). Many dollar values are used for loss of life.^{2,3,4,5} In these references they range from a low of \$260,000 in Reference 5 to \$5,000,000, the "high" value in Reference 2. The high value was drawn from the safety goal proposed by the Advisory Committee on Reactor Safeguards in NUREG-0739. For our risk matrix, a median value of \$1,000,000 was chosen as the value for "early fatalities" (ie., versus delayed due to cancer, etc.). A primary consideration was that the median value agrees with values used for planning by the Consumer Product Safety Commission (Ref. 4). The value chosen also corresponds to the "medium" value in Reference 2. This does not imply that a death due to an incident in the Defense Industry is "worth" more or less than one in nuclear power production. It is simply an attempt to quantify risk levels on a relative scale based on acceptability.

Delayed loss of life due to cancer or leukemia is valued in the NRC Indian Point Testimony² from a low of \$100,000, medium value of \$300,000 to a high of \$5,000,000. A value of \$500,000 which is slightly higher than the medium value was chosen.

Other injuries involving visits to a hospital emergency room are valued at \$5000 to be consistent with extrapolated values for radiation exposures based on the probability of a latent cancer death. This value is equal the Reference 4 statistics for 1985 (86,000 emergency room treated All-Terrain Vehicle injuries for total cost of \$421 million including \$275 for pain and suffering or roughly \$5,000 per injury). This cost is employed to place injuries in their proper position on the PPG relative to exposures to hazardous materials (see Table 3, wherein overexposures to 200% of limit had a cost of \$5,000).

Exposures to hazardous materials and/or radiation are valued based on a linear model (according to exposure) of the probability of radiation exposures resulting in cancer or leukemia deaths. For radiation exposures, the linear model agrees very well with recent cancer estimates (see Reference 6). Table 3 shows the values chosen for exposures to hazardous material for the attributes PS and WS. The last column in this table is the exposure ratio times cost and is the value used for determining the consequence weight.

² NRC Staff Testimony Presented to the Atomic Safety and Licensing Board Special Proceeding on Indian Point, April 1983. "Direct Testimony of F. H. Rowsome and Roger Blond on Commission Question 5."

³ Timothy L. McDaniels, "Comparing Expressed and Revealed Preferences for Risk Reduction: Different Hazards and Question Frames," February 22, 1988, Risk Analysis, Volume 8, No. 4, 1988.

⁴ Gregory B. Rogers and Paul H. Rubin, "Cost-Benefit Analysis of All-Terrain Vehicles at the CPSC," May 31, 1988, Risk Analysis, Volume 9, No. 1, 1989.

⁵ Philippe Hubert and Pierre Pages, "Risk Management for Hazardous Materials Transportation: A Local Study in Lyons," April 4, 1989, Risk Analysis, Volume 9, No. 4, 1989.

TABLE 3. RELATIVE COSTS FOR RADIATION EXPOSURES

Exposure Level	Value Used (REM)	Exposure Ratio	Fatality Cost (thousands)	Cost (thousands)
Extreme Exposures	1,000	1.0	\$1,000 (prompt death)	\$1,000
Serious Overexposures	100	0.1	\$500 (delayed cancer/ leukemia fatality)	\$50
Over-Exposures (To 200% of Limits)	10	0.01 ⁶	\$500	\$5
Low Level Exposures	2	0.002	\$500	\$1

Consequence values or costs for the attributes of Environmental Protection, Regulatory Compliance, Mission Impact, Investment Protection and Public Perception are estimates of the direct monetary loss due to the occurrence. For example, noncompliance with a Federal Regulation is assumed to require extensive management involvement for resolution. Corresponding lesser amounts were assigned for lower level noncompliances or audit findings. Loss of investment values are the top values from the loss range except for the highest range (> \$25 million) which was assigned \$50 million. Mission Impacts are assumed to cost approximately half a million dollars per day of vital program interruption.

V. DETERMINATION OF FACTORS USED

The more subjective part of the risk determination is choice of the factors to be applied in the weight assignment process. Two factors are used: 1) a factor for the "extent" or magnitude of the consequence (impact factor), and, 2) a factor for the "unwillingness" of the public, worker, or corporation to accept the consequence. The extent factor should represent the expected number of deaths or injuries due to a particular incident or some measure of the hazard level and number of people exposed to the hazard. The "unwillingness" factor is related to the willingness of individuals to accept an involuntary risk versus their willingness to accept a voluntary one. In a classic treatise published in Science, "Social Benefit versus Technological Risk," Chauncey Starr pointed out that the average person will accept roughly 1000 times as much risk voluntarily as he or she will involuntarily. Starr's premise was validated a number of ways, and in all cases, the risk of voluntary activities exceeded that of involuntary ones by 1000 times. He also showed that people can

⁶ National Research Council Report, BIER V, December 19, 1989 as reported in the Knoxville News Sentinel, byline by Robert Engleman, Scripps Howard News Service. Reported 790 additional cancer or leukemia deaths per 100,000 persons exposed to a one-time dose of 10 Rem. This results in a probability of 0.008 additional chance of cancer/leukemia death (80 percent of the value used here).

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be paid to take voluntary risks up to roughly 1000 times those they would accept on an involuntary basis.

In establishing the weight factor for "unwillingness" to accept "Public Safety" (PS) risks, we applied Starr's factor of 1000 to public acceptance of risks from accidents. The impact factor was chosen as 10 to represent the number of individuals killed, injured or otherwise seriously affected by a release of hazardous material.

For WS, the impact factor is 10 (the same as for PS) but the unwillingness factor is reduced by 50 percent from that of PS (to 500) to account at least partially for the compensation, site personnel receive to accept the risk of working at the facility.

Purely environmental concerns in the Environmental Protection attribute were assigned a factor value of 1 for the extent of the damage (which is totally accounted for in the cost) and unwillingness factors of 100 because this type of damage could possibly lead to long-term public health concerns which are not quantified at this time.

The Regulatory Compliance (RC) unwillingness factors are estimates of relative weights of corporate desires to not experience the consequence. As such, they are somewhat subjective in nature and could be revised if corporate goals, risks or values change.

Factors for Mission Impact (MI) and Investment Protection (IP) are all 1.0 reflecting that the impact of the consequence is fully accounted for in the monetary loss assigned.

The unwillingness factors for Public Perception vary from 250 down to 10 to reflect the desire of WHC to not experience events which cause great public outcry or panic.

Averted consequences, consequence costs, factors and their effective weights are shown in Table 4. In this table the costs, impact factor, and unwillingness factor are multiplied together to give the effective weight. The weights are then divided by 10^{-6} to yield more manageable numbers. This information was used with the consequence list and probability ranges to develop the PPG (Table 1). Table 4 does not discuss minor consequences in Column VIII for attributes A, B, or C which were added for "minor" events or effects.

VI. UNCERTAINTIES

As with any method adopted to assess risk, there are uncertainties associated with the results. These uncertainties may be attributable to the options available in choosing the consequences, estimating the probabilities, and in the nature of the weights themselves.

TABLE 4. CONSEQUENCE WEIGHTS FOR HANFORD MODIFICATIONS

ATTRIBUTE		FACTORS			
AVERTED CONSEQUENCE		Cost (\$)	Impact	UW	Eff Wt
A.	PUBLIC HEALTH AND SAFETY:				
I&II.	Loss of Life	1,000,000	10	1,000	10,000
II.	Disablement (Assumed 50% Cost of I)	500,000	10	1,000	5,000
III.	Excessive Exposure/Injury	50,000	10	1,000	500
IV.	Moderate Exposure	5,000	10	1,000	50
VI.	Low Level Exposure	1,000	10	1,000	10
B.	SITE PERSONNEL SAFETY:				
II.	Loss of Life or Permanent Disablement (Loss of Limb or Organ)	1,000,000	10	500	5,000
IV.	Serious Over-Exposure or Serious Injury with Significant Lost Time	50,000	10	500	250
V.	Exposure Which is Near/Over Limits, Contaminated Wound, or Injury Requiring Emergency Room Treatment	5,000	10	500	25
VII.	Exposure 1% to 20% of Limits, Significant Removable Skin Contamination, and Injury Requiring First Aid	1,000	10	500	5
C.	ENVIRONMENTAL PROTECTION:				
III.	Uncontained Contamination Off-Site	5,000,000	1	100	500
IV.	Uncontained Contamination On-Site	2,500,000	1	100	250
V.	Moderate Contamination On or Off-Site	250,000	1	100	25
VII.	Measurable Ecological Damage (Reparable)	50,000	1	100	5
	REGULATORY COMPLIANCE				
D.IV.	Violation of Law Leading to Civil or Criminal Penalty	1,000,000	1	250	250
D.V.&E.V.	Non-Compliance with DOE Order to Protect Public or Violations of Law with Moderate Fines	500,000	1	50	25
E.VI.	Noncompliance with DOE Order to Protect Worker or Environment	200,000	1	50	10
D.VII.&E.VII.	Minor Technical or Administrative Non-Compliance with Laws, Orders, or Agreements	200,000	1	25	5
F.VII.	Significant Deviation From Good Practice	200,000	1	25	5
F.VIII.	Minor Deviation from Good Practice or Slow Implementation	100,000	1	10	1

TABLE 4. CONSEQUENCE WEIGHTS FOR HANFORD MODIFICATIONS
(CONTINUED)

ATTRIBUTE		FACTORS			
AVERTED CONSEQUENCE		Cost(\$)	Impact	UW	Eff Wt
G.	MISSION IMPACT:				
IV.	Serious Negative Impact on Site Mission Accomplishment (>180 Days of Vital Protection Interruption [VPI])	100,000,000	1	1	100
V.	Moderate Negative Impact on Mission (VPI from 30 to 180 Days)	25,000,000	1	1	25
VII.	Failure to Meet DOE-HQ Milestone	1,000,000	1	5	5
VIII.	Failure to Meet Contractor Milestone (Non-DOE)	200,000	1	5	1
H.	INVESTMENT PROTECTION				
IV.	Equipment Damage or Increased Operations Cost (>\$25 Million)	50,000,000	1	1	50
V.	Equipment Damage or Increased Operations Cost (>\$5M to \$25M)	25,000,000	1	1	25
VII.	Equipment Damage or Increased Operations Cost (>\$1M to \$5M)	5,000,000	1	1	5
VIII.	Equipment Damage or Increased Operations Cost (<=\$1 Million)	1,000,000	1	1	1
I.	PUBLIC PERCEPTION				
II.	Public Panic/Evacuation (Traffic Fatality)	1,000,000	1	1000	1000
V.	Public Demonstrations	500,000	1	50	25
VI.	Major News Event	200,000	1	50	10
VII.	Some Public Concern	100,000	1	50	5
VIII.	Little Public Concern	100,000	1	10	1

Note: UW = "Unwillingness" Factor

If the consequences and probabilities are chosen in a logical and consistent manner, the final averted risks are still not accurate to the third significant digit or possibly even the second. It is probable that the first digit does give a reasonably accurate measure of risk averted relative to other projects, but the uncertainty in the application of the method from one person to another makes the second digit less accurate. As a rough guide, if a project/program has an averted risk over 100, it is or should be a critical project/program; over 50, a serious one; over 10, needs attention; and under 5, less severe. However, one should not evaluate a project/program with relative risk of 31.4 as being significantly more important than one at 31.0 or even one at 28.

It is important to recognize that the weights (Table 1, probability = 1.0) which were chosen for each consequence are important only relative to each other. Changes in these weights (e.g., changing major mission impact from 100 to 200) will generally have little effect on the final ranking. This "little affect" is because the important projects (those with high averted risks) generally have high probabilities of occurrence and will have corresponding high risks associated.

VII. USE OF THIS METHOD FOR RANKING PROJECTS

To compile the information necessary to prioritize each of the projects via the PPG, a worksheet was developed. The procedure in Appendix A describes how the Worksheet (Table A-1 of Appendix A) must be completed. The primary input to the worksheet is the grid location of each averted consequence (from Table 1) along with its probability (as calculated or from Table 2) and additional project information (description, number, costs, etc.).

The information on this worksheet will serve as input to a dBase file which will calculate the total relative averted risk for each project. The calculated risks will be used to rank the projects along with the benefit/cost ratios (risk divided by total project cost).

APPENDIX A

USERS GUIDE FOR
PROJECT DATA DEVELOPMENT TO
PRIORITIZE PROJECTS
BY USE OF THE PRIORITY PLANNING GRID -
RISK RANKING TECHNIQUE

PREDECISIONAL**I. PROCEDURE OBJECTIVES**

The purpose of this procedure is to provide background and guidance for choice of averted consequences and probabilities from the Priority Planning Grid (PPG) so that various projects at Hanford Site can be prioritized or ranked on a relative "Risk Averted" basis. Two rankings will be developed from this program: 1) ranking of projects by risk averted (benefit); and 2) ranking of projects by benefit/cost ratios. These rankings will allow management to develop schedules for project completion using priorities related to the relative risk or the relative risk averted per unit cost expended.

II. PROCEDURAL GUIDANCE - FOR CONSEQUENCE AND PROBABILITY DETERMINATION**1.0 DETERMINATION OF PROJECT SIZE FOR EVALUATION**

Project size is a crucial consideration in project evaluation. The primary criterion is that the project be chosen large enough so that its completion represents a defined objective which has an associated reduced risk.

However, the project size should be limited so that it cannot be broken into smaller portions which have different risk levels. For instance, if the objective of a large project is to install step off pads at various places around the site to meet DOE monitoring requirements, the project should be subdivided into smaller projects which might include all step off pads on the perimeter of building X (which has high level contamination potential), all step off pads exiting area Y (an area of relative low contamination potential), etc.

In general, broad, site-wide projects should be subdivided into smaller, manageable units. A range of \$50,000 to \$1,000,000 is about right for project size. It is conceivable, although, for major projects to be much larger and some to be smaller (i.e., \$10,000).

Equipment projects should address resolutions of root causes, not correction of individual equipment failures unless they are major budget items (i.e., if monitors are failing periodically, the project to be evaluated should address correction of root causes; not fixing two monitors).

Project should include costs and work through end result. Do not evaluate milestone steps.

2.0 DETERMINING APPLICABLE CONSEQUENCES

The first step in ranking improvement projects is to determine which averted consequences apply to that project and the probability of those consequences occurring. It is important to keep in mind that the consequence chosen should represent an avoidable or avertable

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consequence which either would not occur if the project work is completed or its likelihood would be reduced substantially. It is likely that most projects will avert more than one consequence (eg., one from Public Safety, one from Regulatory Compliance and one from Investment Protection, etc.). In some cases, two or more consequences from the same general grouping (such as Site Personnel Safety) might apply but with different probabilities of occurrence because they represent independent risks from different scenarios. Guidance on important considerations for consequence choices is given in Attachment A-1. Once the most likely consequences have been determined, then the probability of each of those consequences must be estimated.

3.0 PROBABILITY GUIDANCE

A best estimate of the probability of occurrence of the averted consequence should be made assuming normal failure modes (ie., not assuming multiple failures if single failure will result in the consequence). For radiation protection issues, many are existing conditions which must be "fixed" and for which the probability (of radiation exposures of some type and level) can be assumed to be 1.0. Those situations which are tied to potential accident situations (such as upgrades to the ventilation system to allow for system or room isolation following an accident) may not utilize the Table 2 values, but instead are calculated from the probability of the accident occurring (see the example below). Just because a piece of equipment is faulty, it does not imply that the consequence to be avoided has a probability of 1.0 (eg., a faulty airborne radiation monitor will only prevent radiation exposure to a worker if contamination is released to the area. Therefore, the probability of averting radiation exposures is related to the frequency of release of contamination of the type monitored). If a calculation of the probability has not been performed (ie., a known accident probability), a best estimate of the probability range from Table 2 should be made in assigning probabilities of averted consequences and the representative probability in the range used.

For training projects, generally more credit is given to training than it deserves. People, even if well trained, will make mistakes. Try to estimate the specific reduction in errors directly attributable to training.

In making a determination of probability, ask yourself what occurrences are necessary for something "bad" to happen. Estimate probability for each occurrence required.

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Example: Probability of leakage of contamination to off-site (low level impact) if ventilation fans are not upgraded.

	<u>Probability</u>
1) Have to have vent fan outage (loss of HVAC)	(0.5)
	x
2) With contamination incident in progress in rooms in question	($10^{-1}/\text{yr}$)
	x
3) And leakage path from rooms to atmosphere (5 rooms each with 5 percent change of leak path)	(~ 0.25)
	x
4) Chance of room with leak path being the one with contamination incident	(0.2)

Total Probability of leak to atmosphere if vent fans are not upgraded	2.5×10^{-3}
---	----------------------

If upgrading vent fans only reduce chance of outage by a factor of 5, then remaining probability (leading to change in risk) is	5×10^{-4}
---	--------------------

As shown above, in some cases, a project will not eliminate the risk entirely but only reduce it to some lower level or it might incur a risk in another area (eg., a fire protection upgrade of doors might be in conflict with OSHA or radiation protection standards). For those projects, a negative probability for the lower or newly created risk should be input so that the risk equation below is met:

Net Risk Averted = Sum of Averted Risks - New Risks Created or Remaining Risks

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III. PROJECT PRIORITIZATION TECHNIQUE

1.0 RANKING BY TOTAL AVERTED RISK

The primary ranking option is to sum the risk values from all the consequences/probability pairs which apply to the project. This approach yields a good value for averted risk. This ranking is important for management to ensure that the projects with the highest level of risk reduction are targeted for resources. This listing provides the primary management tool for ranking projects.

2.0 BENEFIT/COST RATIO DETERMINATION AND RANKING

Benefit/Cost ratios for each project are determined by dividing the total averted risk sum by the total project cost. The project total cost includes the cost of all capital expenditures, recurring cost times the number of years of the recurring cost. The final risk benefit/cost ratio may be compared for different projects to determine the dollar value of risk averted for various projects (ie., "more bang for the buck"). This approach shows the areas where the greatest benefit can be realized and is important to identify those lower cost projects which have a high benefit and those higher cost projects with extremely low relative benefits.

IV. PROCEDURAL STEPS - COMPLETING THE PPG ASSESSMENT FORM

The Worksheet (Table A-1) must be completed in the following manner:

Step Instruction

1. Enter source of issue (e.g., Tiger Team Report, FFTF, Criticality Safety Assessment, etc.)
2. Enter unique project number assigned, issue number or finding number.
3. Enter brief description.
4. Enter location of project (building, area, etc.)
5. Enter subject category
6. Names of Evaluators - Sign and date upon completion of evaluation.
7. Nature of risk - Determine the location of the applicable consequences from the position in the PPG (Table 1). Example: If multiple exposure > limit applies, location is A-III.

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Either estimate the probability of occurrence of each averted consequence chosen and enter the estimate or choose its most likely range from Table 2 and use the representative probability from the range.

Enter pairs of consequence number and probability in Blocks A through I, where applicable (e.g., A-III, 10⁻⁴; B-IV, 0.1; B-VII, 0.01). Note that up to three separate risks may be determined for public safety, worker safety and environmental protection, if they apply. It is not necessary to enter a consequence number for an attribute which clearly does not apply (e.g., Failure to meet life safety code has no affect on public or environment).

Note: Input negative probabilities for the final level to which a risk is lowered (if not eliminated entirely) or for new risks which are caused by the project.

8. Project Cost - Insert cost of implementation (equal to total initial cost and total yearly recurring cost times the number of years of the recurring cost). If as project is considered to be low cost/no cost due to inclusion in other budgets, assign a cost of \$1,000.

Note: Operational cost savings which will be realized due to implementation of the project should be subtracted from the initial cost before input.

TABLE A-1
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PRIORITY PLANNING GRID ASSESSMENT FORM

1. Source of issue: _____
2. Issue/Finding/Concern identifier or number: _____
3. Brief description of issue: _____

4. Location (Building Number, Sitewide, etc.) _____
5. Subject category (groundwater, rad. protection, etc.): _____
6. Assessment conducted by: _____ Date: _____
Assessment reviewed by: _____ Date: _____

7. Nature of Risk:

Priority Planning Grid Subject:	Grid Box:	Prob.	Rel. Risk	Grid Box	Prob.	Rel. Risk	Grid Box:	Prob.	Rel. Risk
A. Public Safety									
B. Worker Safety									
C. Environmental									

Total of all Relative Risk Values for Hazards: _____

D. Laws & Agrmnts.				#	_____
E. DOE Orders				#	_____
F. Best Mgmt Prac.					

The single highest Relative Risk Values for Compliance: _____

G. Mission Impact				Relative Risk Value:	_____
H. Investment Prot				Relative Risk Value:	_____
I. Public Prtcpn.				Relative Risk Value:	_____

TOTAL OF ALL APPLICABLE RELATIVE RISK VALUES (A-I): _____

8. Estimated cost (annual or one-time) of corrective actions (\$'s) _____
- Relative risk/cost ratio (Total relative risk/cost) _____

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ATTACHMENT A-1

HELPFUL QUESTIONS AND COMMENTS ON ATTRIBUTES

A. PUBLIC SAFETY (PS)

Can this issue/project reduce the chance of loss of life, injury, or chemical or radiation exposure to the general public (off-site)?

- 1) Can contamination reach site boundary or be carried off site by workers? What levels of contamination are involved?
- 2) Is a hazardous material involved which could affect someone off-site? Liquid pathway? Gaseous release?
- 3) Is process totally enclosed in building such that normal building filtration/isolation process will mitigate releases? Will the exhaust structure still function? (If so, the consequence is low). Is there bypass to the atmosphere? (If not, the consequence is low).
- 4) Off-site impacts are generally low unless hazardous chemicals are involved outside buildings. Even criticality events generally have low off-site impacts because they are contained in buildings.

B. WORKER SAFETY (WS) - REDUCTION OF RISK TO WORKERS AND OTHER ON-SITE INDIVIDUALS

Can this issue/project reduce the chance of loss of life, injury, or chemical or radiation exposure to site personnel (deaths, injuries, chemical or radiation exposures, significant skin contamination or otherwise endanger a worker)?

- 1) People on site from the general public accept the risk of being there, and, therefore, are included as part of site personnel in determining the WS consequences.
- 2) What is the level of injury or exposure possible to worker(s) which can be reduced?
 - a) Is there a high probability of minor injuries?

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- b) Is there a low(er) probability of more significant injuries from different accident types?
- 3) The lowest consequence in this category includes "significant" skin contamination from (generally) transuranics. A 2-minute wash-off to acceptable levels is not significant unless it is an amount which is required to be reported or documented under DOE Order 5480.11, etc.
- 4) Often the consequence to site personnel is higher than off-site (PS) consequences for accidents or incidents with the same probability. For instance, a project involving reducing the change of a criticality event on site could, if a criticality occurred, lead to a worker's death but have low off-site consequence. However, the probability of both occurrences are the same.

C. ENVIRONMENTAL PROTECTION

Can this issue/project reduce the chance of loss of life, injury, or chemical or radiation contamination spread beyond the site boundary, chemical or radiation contamination damage inside the site boundary, but outside of a containment structure or building?

D., E., & F. COMPLIANCE WITH REGULATIONS AND GOOD PRACTICE

Can this issue reduce the chance of noncompliance with Federal or State laws, contracted agreements, administrative laws, DOE Orders, environmental regulations or best management practices (industry good practices)?

- 1) Major items of noncompliance include best judgment as to the risk to WHC of any noncompliances.
- 2) If the question of compliance is that the site may be interpreted as being in noncompliance, then the probability is lower (~medium) of being termed, "noncompliant."
- 3) If compliance issue is a disagreement between site and the regulator, the probability of noncompliance can be considered to be lower (~low).

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- 4) External concerns which are not considered valid should not be assigned full weight. Reasons for this should be documented. However, do not be "defensive" in determining if an external concern is valid. Adopt the general approach that, if someone has a concern, it is valid unless logical reasoning indicates otherwise.
- 5) Do not assume because the regulator does not know of the situation now, that he is not going to cite you for being in noncompliance. If you can, use plant history for determining if a citation would be made.

G. MISSION IMPACT QUESTIONS

Can the issue/project reduce the chance of an inability to complete DOE mission imperatives, negative mission impact, failure to meet DOE milestones, or failure to meet contractor milestones?

- 1) Mission impact applies when failure to complete a project will significantly delay an operation vital to producing the plant product (whether it be plutonium parts, research products, tritium from reactor production, SMUs from uranium enrichment enterprises, etc.).
- 2) The mission impact is serious when the total site production is impacted or a major (DOE defined) site mission is seriously delayed (>180 days).
- 3) The mission impact is moderate or low according to the length of delay and the importance of the operation itself. If the delay is relatively short or the operation has a lower level priority with DOE, the consequence should be chosen as moderate to low.

H. INVESTMENT PRODUCTION AND PRODUCTIVITY QUESTIONS

Can this issue/project reduce the chance of facility or equipment damage over \$10,000, increased operations cost over \$5,000/year or lost opportunity to reduce operational production cost of \$5,000/year?

- 1) The investment concerns in this attribute are usually indicative of preventable fires or additional damage (from earthquake, internal flooding, etc.) which could be prevented by completing activities to mitigate the damage from the incident.

PREDECISIONAL

- 2) Productivity costs also covers the risk of lawsuits against the company of varying amounts due to failure to correct an OSHA hazard and an injured worker sues (asbestos hazards and beryllium hazards if not corrected could fall in this category).

I. PUBLIC PERCEPTION

Can this issue/project reduce the chance of public panic, public demonstrations, or public concern to the extent that a press release will be made by the site or DOE?

- 1) The Public Perception attribute, in general, should not be used for issues/projects which have high potential for violation of a law without a release or incident. If the issue is not a direct violation of a law or order, but the public would likely be or have been (highly) upset if knowledge of the situation were made public, then this attribute applies.
- 2) Public panic includes the probable loss of life due to traffic accident in evacuation (as happened at Three Mile Island where there were three deaths due to traffic accidents).

ATTACHMENT E

REVIEW OF DRY STORAGE OPTION FOR HANFORD K BASINS FUEL

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Westinghouse Idaho
Nuclear Company, Inc.

From: L. F. Ermold
Phone: (208) 526-4628 MS-3422
Date: September 23, 1994
Subject: Review of Dry Storage Option for Hanford K Basins Fuel

LFE-94-071

John C. Fulton, Director
Spent Nuclear Fuel Project

Attached for your information is the report regarding the review of a dry storage option for Hanford K Basins Fuel developed by an Independent Technical Assessment (ITA) Team. The report has been prepared, at your request, by an independent review team with the defined objective of focusing on two major areas associated with the feasibility of dry storage of fuel from the Hanford K Basins. The two major areas evaluated by the review were: (1) technical adequacy of the proposed dry storage program, and (2) management feasibility of the proposed program.

The scope of the review was limited to the proposed dry storage option developed by the ITA team and did not review or compare this proposal with other storage options.

The ITA Team:

- Made a convincing case, including foreign experience, that the transition from wet to dry storage can be done safely.
- Has recommended an attractive approach by selection of the multi-canister overpack (MCO), consistent with commercial experience, which is the container for transportation, processing, and storage.
- Has proposed a conditioning process that exposes the fuel to physical conditions which provide a high level of confidence that the fuel will be stable during long term storage.

The report primary conclusions are:

- The proposed ITA dry fuel storage concept as presented is technically feasible. No insurmountable safety, environmental, or engineering technology gaps were identified.
- Sludge removal from the fuel canisters and fuel conditioning processes will require additional development and demonstration.

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- Several items such as ALARA, accountability, contamination levels, recovery from process abnormalities, waste handling, etc. could significantly influence the cost and schedule estimates presented by the ITA Team.
- The concept can be implemented from a management and institutional perspective under existing rules and regulations.
- The program to implement this concept as presented is unrealistic from a cost and schedule perspective, and therefore, does not provide a basis for comparison with alternate options for meeting TPA milestones for removal of spent fuel and sludge from K Basins.

The attached report has been reviewed and concurred with by review team members. The review team would like to extend our thanks to you and your staff for logistical support and accommodations associated with the review and preparation of the report. Efforts of Linda Huston, Marlene Paris and Bob Tiller were particularly noteworthy.

L. F. Ermold
L. F. Ermold, Chairperson
Dry Storage Option Review Team

Attachment

cc: W. T. Alumkal	L. L. Humphreys
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REVIEW OF DRY STORAGE OPTION
FOR
HANFORD K BASINS FUEL

SEPTEMBER 1994

REVIEW TEAM

Len Ermold, Chairperson
Frank Baranowski
John Honekamp
Al Hoskins
Larry Humphreys
Nick Kaufman
Marty Plys
Jay Pride

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Review of Dry Storage Option for Hanford K Basins Fuel

Executive Summary

The feasibility of a program for dry storage of fuel from the Hanford K Basins was evaluated by an independent review team. The scope of the review was limited to the proposed dry storage option developed by the Independent Technical Assessment (ITA) team and did not review or compare this proposal with wet storage options. Sludge handling and storage were also not reviewed except as sludge removal was necessary as preparation for fuel conditioning prior to storage. The dry storage program concept involves drilling drainage holes in existing canisters followed by desludging of the canister with water. The canisters are then stacked in a multi-canister overpack (MCO). The loaded MCO is raised into a transfer cask, sealed, and shipped full of water by rail to an on-site conditioning facility. At the conditioning facility the MCO is transferred into a conditioning station, where water is drained and replaced with an argon atmosphere. Fuel conditioning is then performed by heating to remove water, and passivation to oxidize uranium hydride. Finally, an inert filler gas is added and the sealed MCO is placed in a storage facility. Two areas were evaluated by the review group: (1) technical adequacy of the proposed dry storage program, and (2) management and institutional feasibility of the proposed program.

The ITA Team:

- Made a convincing case, including foreign experience, that the transition from wet to dry storage can be done safely.
- Has recommended an attractive approach by selection of the multi-canister overpack (MCO), consistent with commercial experience, which is the container for transportation, processing, and storage.
- Has proposed a conditioning process that exposes the fuel to physical conditions that provide a high level of confidence that the fuel will be stable during long term storage.

The primary conclusions resulting from the review are:

Conclusions:

- The proposed ITA dry fuel storage concept as presented is technically feasible. No insurmountable safety, environmental, or engineering technology gaps were identified.

- Sludge removal from the fuel canisters and fuel conditioning processes will require additional development and demonstration.
- Several items such as ALARA, accountability, contamination levels, recovery from process abnormalities, waste handling, etc. could significantly influence the cost and schedule estimates presented by the ITA Team.
- The concept can be implemented from a management and institutional perspective under existing rules and regulations.
- The program to implement this concept as presented is unrealistic from a cost and schedule perspective, and therefore, does not provide a basis for comparison with alternate options for meeting TPA milestones for removal of spent fuel and sludge from K Basins.

Introduction

In April 1994 an Independent Technical Assessment (ITA) Team was selected by the U.S. Department of Energy (DOE) management at Headquarters and the Richland Operations Office (RL) to examine the feasibility of dry storage for N-Reactor spent nuclear fuel (SNF) which is currently stored underwater in the Hanford Site K-Basins. The ITA was requested to produce its formal feasibility report by September 15, 1994.

On June 3, 1994, the U.S. Department of Energy, Richland Operations Office and Westinghouse Hanford Company (WHC) provided an overview of the Hanford Spent Nuclear Fuel Project to Mr. Thomas P. Grumbly, EM-1. During the presentation the possibility of expedited fuel and sludge removal from the K Basins was discussed using continued wet fuel and sludge storage in a new or existing on-site facility.

A review team was assembled to evaluate the technical adequacy, and management and institutional feasibility of the proposed wet expedited fuel and sludge removal program option. The results of this review are documented in a July 1994 report titled "Review of Expedited Movement of Fuel From Hanford K-Basins". Subsequently the review team was requested to perform a similar review of the ITA dry storage program.

The ITA dry storage program concept involves drilling drainage holes in existing canisters followed by desludging with water. The canisters are then stacked in a multi-canister overpack (MCO). The loaded MCO is raised into a transfer cask, sealed, and shipped by rail to an on-site conditioning facility. At the conditioning facility the MCO is transferred into a conditioning station, where water is drained and replaced with an argon atmosphere. Fuel conditioning is then performed by using a heating and pressure cycle to remove water, and to oxidize accessible uranium metal and hydride. Finally, an inert filler gas is added and the MCO is placed in a storage facility. Two areas were evaluated by the review group: (1) technical adequacy of the proposed dry storage program, and (2) management and institutional feasibility of the proposed program.

The scope of the review was limited to the proposed dry storage option developed by the ITA team and did not review or compare this proposal with other storage options. Sludge handling and storage were also not reviewed except as related to removal from existing fuel canisters. The on-site review was performed the week of September 19, 1994, and the review report is provided herein.

Background

The Hanford spent nuclear fuel (SNF) inventory is dominated by N-Reactor fuel accumulated in the K Basins from 1978 through 1987, the year N-Reactor was shutdown. Storage at K Basins was planned to be only as needed to sustain operation of N-Reactor while PUREX was closed for refurbishment and restart. Although PUREX did process much N-Reactor fuel as planned, the decision in December 1992 to deactivate the facility left over 2,000 metric tons of

zircalloy-clad N-Reactor spent fuel in the K East (KE) and K West (KW) Reactor Storage Basins.

The fuel has been stored in the basins for an extended period, and little or no definitive information is available regarding the degree of degradation, physical integrity, condition of canisters, in-canister sludge, etc. In KW Basin the fuel has been placed into sealed containers with a corrosion inhibitor and the basin water is relatively clean. The fuel in KE Basin is in open containers and the fuel is corroding and releasing fission products to the basin water. The KE Basin contains approximately one million gallons of water contaminated with tritium, fission products, and fuel corrosion products in the form of sludge. The sludge composition is uncertain and probably varies with location. Problems associated with fuel relocation in KE Basin include decreased pool visibility (due to sludge suspension) and radiation exposure. As previously indicated, the conditions of the pool and water in KW where the fuel is in sealed canisters are much better; however, the specific condition of the fuel inside the containers is unknown, since the containers have not been sampled since 1983.

The DOE Spent Fuel Working Group released the Spent Fuel Vulnerability Assessment in December 1993. This assessment listed the K Basins among the DOE SNF facilities given the highest priority to resolve environmental, health, and safety vulnerabilities. Negotiations in January 1994 with signatories of the Hanford Consent Decree defined a milestone to achieve fuel removal from the K Basins by 2002.

As a result of dynamic analysis, the seismic qualification of the K Basins was questioned, and an Unresolved Safety Question (USQ) was declared in April 1994. The basis of the USQ was due to the possibility of post-seismic leakage through a construction joint between the KE Basin and reactor building structures. This leak, currently postulated to be capable of emptying the basin in a very short time (days or less), could result in soil contamination, and uncovering and dryout of the fuel and sludge. The drying of fuel raises concerns about the pyrophoric nature of uranium hydride. Sludge dryout could lead to dispersal of radioactive materials. A large release of contamination could be postulated to reach the nearby Columbia River.

The Defense Nuclear Facility Safety Board conducted reviews of fuel storage facilities within the DOE Complex, and on May 26, 1994, issued Recommendation 94-1. Item 7 of Recommendation 94-1 states, "That the program be expedited to place the deteriorating reactor fuel in the KE Basin at the Hanford site in a stable configuration for interim storage until an option for ultimate disposition is chosen. This program needs to be directed towards storage methods that will minimize further deterioration."

Independent Review Team

An independent review team was assembled by WHC to review both the expedited fuel and sludge removal, and ITA dry storage programs and consisted of the following individuals:

Frank Baranowski
Independent Consultant

Leonard Ermold
Westinghouse Idaho Nuclear Company

John Honekamp
Science Applications International Corporation

Alan Hoskins
Westinghouse Idaho Nuclear Company

Larry Humphreys
Independent Consultant

Nick Kaufman
Sciencetech, Incorporated

Marty Plys (ITA program only)
Fauske and Associates

Jay Pride
Scientific Ecology Group Incorporated

A brief background summary for each of the team members is provided in the appendix.

Technical Items Evaluation

This section of the report deals with the review team's evaluation of the technical adequacy of the proposed ITA dry storage option. It is organized into three parts:

Fuel Overpackaging and Transportation
 Fuel Conditioning
 Dry Storage

Each part provides a brief description of the items considered or reviewed by the team, and a summary of the team's conclusions. These three parts were selected due to technology differences and the stage of maturity between the phases. The regulatory considerations of each phase are also different as are safety considerations, surveillance requirements, operability/maintainability considerations, and potential accidents.

● Fuel Overpackaging and Transportation

This phase includes:

- preparing the canister;
- loading the MCO;
- transferring the MCO into the transfer cask;
- welding the shield plug; and
- transferring the cask to a rail car and transporting to the conditioning facility.

The canister preparation involves the removal of the canister lids; clamping a canister into a fixture; drilling holes in the bottom of the canisters; and injecting water into the top of the canister to flush the internal sludge from the fuel. At K West, the sludge will be captured. The operation is monitored by an underwater camera. The removal of sludge is desirable to assure the conditioning and passivation of the canister contents. The concern is that with large quantities of sludge remaining in the MCO it will be difficult to adequately dry the material. Radiolytic decomposition of this water over the intended storage period could result in undesirable quantities of hydrogen and the formation of hydrides during storage.

The loading of the MCO involves the use of long handled tools to place two canisters per level times five levels high. Since each canister typically contains 14 elements, a fully loaded MCO contains 140 elements or about 3 tons of SNF.

Transfer of the MCO into the Cask involves lowering the cask (with both top and bottom end doors open) to near the water level and using a crane, connected through the cask to the MCO, to lift the MCO into the cask. High pressure water spray will be use for decontamination during the removal of the MCO from the water.

The welding of the shield plug is performed with automatic welding equipment after removing enough water to allow the installation of the plug. Non Destructive Examination (NDE) is then performed.

The cask is then lifted onto the existing rail cars for transport to the conditioning facility.

Four new transportation casks will be designed and constructed in accordance with 10 CFR 72 and computer analyzed in accordance with 10 CFR 71. (One constructed for the initial demonstration). All transportation will be performed on site with roads blocked and manned by security at public intersections. A Safety Analysis Report for Packaging (SARP) will be prepared. The existing rail cars will be utilized.

Critical path operation is considered to be one MCO per day with a capability to support 1.3 MCO in a 24 hour day. Contingency is provided by simultaneous shipping from both KE and KW; the immediate availability of another cask following loading; and backlogging full MCOs. There are about 7500 Canisters which will require about 750 MCOs. One MCO per day would require roughly a two year operation schedule.

This phase is similar to the wet alternative in the review team's first report except for drilling the holes, removal of the canister sludge accumulated in the N-Fuel canisters stored in both K-Basins, and capture and handling of the in-canister sludge at the KW Basin. In the wet alternative, the canister with sludge and N-Fuel is transferred wet to a container for transport to a new location at Hanford away from the river. In the dry option the plan is to remove the sludge through holes in the bottom of each canister prior to transport to a new location away from the river.

The review team has the following comments on the overpack/transportation phase of the technical approach:

- There is no new technology required but there will be engineering challenges.
- At the time of the review, a specification on allowable residual sludge content and methods to assure that they were achieved were not available. Test data from the development and demonstration program discussed later in the report will be required to prepare the specifications and QA procedures for adequate sludge removal. The sludge removal process should be demonstrated to provide assurance that the sludge is adequately removed from the canister and to assure that the basin turbidity will remain satisfactory. Specifications for allowable residual sludge would be developed during the demonstration for the conditioning phase.

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- The concept selected for removal of the sludge from canisters requires drilling holes in the bottom of each canister. The test effort will need to select an optimal design for the number and size of the holes as well as the hostile operating environment in the basins.
- An ALARA evaluation and plan was not presented to the review team. The review team recommends that an ALARA evaluation and Plan be performed against the conceptual design and later modified for the final design. This plan will provide assurance that adequate staffing is planned to support total dose.
- We agree with the development of a new cask for transport of the fuel designed to 10 CFR 72 requirements and to the intent of 10 CFR 71 requirements. The cask would not be submitted to the NRC for licensing. A Hanford SARP would be developed for the new cask design.
- A cask or shielded MCO may be required to contain the sludge (dewatered sludge) removed from the canisters at KW.
- We agree with overpacking the canisters. However, the geometry (2 per level - five high) should not be considered fixed to allow for final design optimization.
- MCO decontamination needs to be monitored and verified by taking wet swipes and using a high pressure spray. A liquid processing system will need to be added to allow use of the pool water for decontamination purposes. Occasionally in commercial application millions of dpm of contamination can be encountered upon opening a loaded cask. Due to the damaged fuel, consideration of potential TRU contamination is required.
- Rail should be the principal transport path but truck transport should not be excluded. New rail cars should be considered in lieu of trying to modify the existing rail cars.
- Qualification of the MCO for certain impact energies such as the drop height for the maximum credible accident should be performed.
- An evaluation of the use of existing NRC-certified (or previously certified) Type B casks should be performed since many copies of these casks may already be available.
- In the wet option, the canisters with spent fuel and sludge were transferred, therefore, maintaining SNM accountability by direct transfer. The separation of the sludge and SNF proposed in the dry option will increase the level of uncertainty in N-Fuel SNM accountability. Therefore, a detailed plan addressing SNM accountability is needed.

- The elimination of K-basins as a safety risk requires a solution to the disposal of the large quantities of sludge at the bottom of the basins. Although not within the ITA scope, quantification of the technique, cost and schedule for sludge removal is required for consistent evaluation of dry storage with other options.

⊙ Fuel Conditioning

Process Design

The conditioning process presented by the ITA is generally viable, and similar processes in the UK and France were cited by the ITA and used in the present process development. Nonetheless, there are clear issues of scaling, conditioning efficacy, and effluent gas processing which impede the direct application of the British and French processes to processing of K basin fuel. Engineering development will be required to design and prove the process (discussed below) but success is considered likely.

Some examples of technical inconsistencies requiring resolution provide a perspective on our judgement. Process gases are expected to flow at a rate of 160 CFM (75.5 liters/sec). However, since a 1" (2.5 cm) line is employed to the MCO, the resulting gas velocity is half the speed of sound in air. Consequently, larger inlet ports or lower gas flow rates must be factored into the design, with resulting tradeoffs. The tradeoff involved with larger ports is the larger flow area through a severed connection. Lower gas flowrates may imply longer process durations because the nature of the process requires low partial pressures of water vapor and hydrogen when these gases are removed from the fuel.

Scaling of the process is a major issue for the drying heatup schedule. The heatup schedule is directly borrowed from that of the French, and according to the ITA concept heating will be accomplished by heated inlet process gas assisted by peripheral heaters. A 10 hour heatup duration to the maximum process temperature of 300 C requires about 10 kW net power input to the MCO. If the peripheral heater serves as a guard heater the gases cannot perform the net heating, which may be shown as follows. The maximum gas inlet temperature would be constrained to about 400 C so that the inlet end of the MCO does not exceed its design specification. Using the ITA design gas flowrate (which implies undesirably high velocities) only about 4 kW may be delivered by the gas. The peripheral heater must really perform the heatup itself, so it must be sized to about 25 kW. Heating the fuel interior to 300 C by conduction and radiation in the radial direction requires the MCO wall to reach about 400 C so that the heatup rate is reasonable, and again this reduces the process margin to the MCO design temperature. Similar considerations during the cooldown cycle indicate that time durations presented are possibly optimistic, and impacts on specified throughput rates could result.

The process gas composition, temperature, and pressure schedule must also be tailored for K Basin fuel. The conditioning process is mainly designed to remove free and bound water so that the pressure increase from long-term radiolysis is acceptable. Another objective is to passivate the fuel against

potential exothermic oxidation by oxidizing the fuel surface, including interior portions accessible by microcracks and possible interior inclusions of uranium hydride. To this end, the process gas pressure will be cycled between 1 and 10 atmospheres so that fresh oxygen is forced into microcracks and into portions of the fuel otherwise inaccessible by convective flows. Here the K basin fuel differs from that of the French because the interior of annular fuel elements may be inaccessible to convective flow due to corrosive swelling. Therefore, more pressure cycles may be required for conditioning of K basin fuel.

The process gas flowsheet will require further development to demonstrate adequate capacity for fission product release during processing, particulate release, and effluent composition monitoring. Fission product release rates are expected to be low, but they have simply not been quantified, and their impact has not been addressed by the ITA. For example, fission products could be filtered prior to offgas chemical composition monitoring -- but the filters must now remain at the process gas temperature so that water vapor is not condensed, and the filters must also not adsorb hydrogen in great quantity. It is necessary to monitor the water vapor content of the effluent with precision so that the operators will know when the drying step is complete, and it is necessary to monitor the hydrogen and oxygen content of the gas to know when the passivation is complete. Assembly of a process gas train consisting of filters, mass spectrometers, condensers and hydrogen traps is feasible but nontrivial, and thus requires qualification.

Particulate was not addressed by the ITA but it is an issue. The sludge removal process must be assumed imperfect. Particulate adhering to the canisters or fuel may become loose during the heatup and drying step, and therefore may be entrained by the process gas due to the small particle size characteristic of corrosion products. Corrosion products that still adhere to the fuel after desludging may be sloughed off during handling or MCO drainage and this represents an inherent mechanism for generating new particulate in the MCO.

Technical and Safety Basis

The technical and safety bases for the conditioning process are not completely developed but we believe they are defensible given additional effort and qualification as discussed below.

Removal of chemically bound water is a significant challenge due to the high temperature required and the tradeoff to keep the MCO below a design limit. The ITA proposes drying in a vacuum at 300 C, which should work if transport paths exist for water vapor. The method must be shown to work for highly corroded fuel inner elements which may have little free flow area due to swelling of the corroded fuel. One solution to this problem is to continually flush the MCO with dry inert gas, since it is only the partial pressure of the water vapor which matters. Similarly, passivation of the hydride and any metal fines formed by hydride decomposition must be demonstrated.

The safety basis appears to rely upon bounding scenarios and timely intervention. For example, unanticipated runaway reactions would be detected and quenched with inert gas within five minutes. In fact, such intervention may be moot because the worst-case extent of oxidation for the MCO is that which would react its gas contents. Any oxidation excursion will likely be over before action could therefore be taken, but the consequences are bounded. Reactions that occur during either the process step at 10 atmospheres with 2% oxygen, or during a containment breach accident during drying in vacuum, result in a temperature rise of only 8 C. Even if fission product release fractions typical of 600 C are used (0.01% of the oxidized material) only about 1 millicurie would be released to the MCO gas (this assumes a 10,000 Ci inventory in an MCO).

The ITA has presented sound theoretical reasons why only limited quantities of uranium hydride would be present in K basin fuel. Process steps are designed to limit the availability of reactants, and therefore the potential for extensive fuel reactions is adequately addressed.

Contamination Control

More subtle events may really drive the safety basis. If the MCO exterior is not fully decontaminated, then contamination will be released inside the conditioning station. Such contamination may become airborne when an MCO is inserted or withdrawn. Radioactive corrosion particulate inside an MCO may be entrained during the drying process. Impaction and settling would occur in the process line upstream of any filters, and contamination could be released as MCOs are detached.

Process Qualification

Process qualification will be required to (1) Provide non-proprietary, domestic information on the efficacy of drying and passivation during the contemplated process temperature history, (2) Optimize the process variables such as temperature and number of pressurization cycles, and (3) Quantify the release rate and chemical species for fission products evolving during the process in order to design the offgas train. The latter step must by its nature be undertaken with actual K basin fuel.

Conditioning End-point Trade-offs

The design of the MCO and the conditioning process parameters were selected by the ITA to meet the following goals

- maintain a high degree of confidence in the structural integrity of the MCO over the expected interim storage time, and
- provide passive storage and minimize interventions

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To achieve these goals the ITA approach depends heavily on the conditioning process to limit the quantity of residual water. Alternate MCO and storage system designs which permit higher pressures in the MCO and/or provide venting may be more optimal in terms of costs and schedule.

Systems and Facility Design Bases

The ITA concept for the conditioning facility relies on local shielding, temporary enclosures and a HEPA filtered confinement structure to achieve ALARA goals and minimize releases to the environment. The review team believes a more robust design will be required to:

- Minimize worker exposure during off normal operations, routine and corrective maintenance,
- Provide for recovery from process abnormalities,
- Provide for treatment, packaging and temporary storage of process waters, and
- Provide containment control for TRU materials.

While it is not clear that a hot cell will be needed, the review team believes it is likely that the process equipment will need to be located in pits or trenches that are HEPA filtered and at a pressure that is negative with respect to the operating floor and rail car lock. Temporary enclosures (plastic, tents) are not considered adequate. This judgement is based on the following considerations:

- With eight process lines in various stages of loading, operation, unloading, and maintenance it will be very difficult to control contamination unless each process line is separately contained.
- The external surfaces of the MCO and the internal surfaces of the conditioning station are likely to be contaminated given the activity levels in the K Basin water. Without adequate control simply lowering an MCO into the furnace will spread contamination to the operating floor, rail car, etc.
- Liquid effluent filters, process gas filters and chillers could easily exceed contact maintenance limits if significant quantities of particulate material are released from an MCO. Parallel filters which can be switched on line and replaced or backflushed may be necessary.

Location of the Conditioning Facility

It is not possible for the review team to provide specific recommendations on the location of the conditioning facility without more information on the Hanford Site Plan and intended uses for various areas and existing facilities.

However, the Team is aware of the capabilities of such facilities and was not convinced that the arguments presented by the ITA make a compelling case that a new facility is either quicker or cheaper. This is particularly true if one considers that existing facilities might also provide contingency or lag storage for half of the K Basin fuel if such a contingency were needed to meet the TPA milestones. The ITA evaluated the FMEF, which already exists, apparently has no urgent mission and is sufficiently robust and flexible. The annual costs quoted to maintain the facility seem inordinantly high and should be re-visited.

☉ Dry Storage

The review team agrees that dry storage should be pursued. While some aspects of the ITA plan for processing are questioned herein, the concept for dry storage appears attractive. The process for preparing SNF for storage, the locations of processing and storage, and any monitoring required, probably have many proposals and proponents. There is clearly an early focus on removal of the fuel from near the river, for selecting the specific process and facility to be used, and developing any necessary data for process control or safety.

Given that thrust, the committee supports a project strategy which expedites removal, evaluates all processing options (systems approach), performs any needed testing in hot cells and optimizes project decisions (location, containers, criteria, etc.). To balance these needs, the committee believes that development of "lag storage" or "surge capacity" should be considered as a means to improve the ability to move fuel early without jeopardizing the systems approach to future options.

Management Feasability Evaluation

This section of the report, which deals with the team's evaluation of management feasibility of the proposed fuel movement and dry storage program, is organized into several specific areas considered by the team. Each area provides a brief description of the items considered or reviewed by the team, and the conclusions.

☉ Applicability of DOE Policies and Practices

The plan presented implicitly makes a number of assumptions regarding changes in the DOE culture as related to required approvals, durations, and decision making. Although we applaud the initiative to move institutional processes toward those more typical of private industry, we believe that it is unrealistic to forecast such large scale change in the near term and/or use the product of such assumptions as the basis for decision making when comparing alternatives or assuring compliance with regulatory requirements. Specifically, the proposed plans assume durations for contract award, readiness review, safety analysis preparation and review, and NEPA approvals which appear significantly less than those currently experienced throughout the DOE. Moreover, the plans are not sensitive to the interplay between safety and NEPA approvals and

budgetary authority and approval. Finally, the plans reviewed imply a consensus of approach and technical design basis sufficient to launch a number of parallel activities within the next few months, which belies resolution of a number of technical issues with this approach, as well as selections between this option and others for removal of fuel from the K Basins.

The combination of these aggressive assumptions and a lack of contingent paths results in a schedule, project logic, and cost which we consider unrealistic. Determination and early action by DOE to implement the indicated improved durations for procurement (6 mo. total duration), readiness review (less than 1 mo.), and safety analysis and approval (less than 2 yrs.) will be most helpful to expediting this or any other selected fuel removal alternative and are clearly achievable based on commercial analogs. Such aggressive action would expedite fuel removal from the basins.

☉ Process Development and Demonstration

The "Demonstration" as described by the ITA, involves full-scale operations and accomplishes a first-phase of the overall project. In this approach, control parameters, flowrates, and design criteria must be well established to ensure success for the relatively large-scale demonstration. The review team concluded that smaller scale tests to provide proof of principle confirmation of process design parameters, control features, scaling factors, effluent control, safety basis, and recovery from abnormal events is needed.

Process steps of particular concern relative to the need for testing/demonstration prior to full-scale design and construction include:

- Sludge Removal Efficiency and Verification
- Heating Methods/Cycle Times
- Control Parameters
- Monitoring Techniques and Sample Points

As discussed in the fuel conditioning process design section of the report, the degree to which the sludge is removed during loading operations is viewed as important to the success of subsequent conditioning and storage. Demonstrations of sludge removal techniques combined with sludge behavior and/or bounding analyses are needed to establish the maximum amount of sludge allowable in an MCO. Methods to verify sludge removal to meet the criteria will need to be established and validated.

Demonstrations of methods, controls, cycle times, and uniformity (temperature variations) associated with the heating cycles proposed to dry, dehydride, and passivate the fuels is needed to establish the safety basis and design information to ensure specifications for the stored N-Reactor fuel are satisfied.

The issue of process control will likely need to be the subject of demonstrations. Presumably, the drying process must reach a specified criteria. The ability to measure moisture in the off-gas and correlate the effluent moisture to a state of dryness in the MCO will be needed for development of the safety basis for the process.

The dehydride step in the process must be monitored by the hydrogen gas evolved into the off-gas, or would be based on an abundance of data demonstrating adequate dehydring is achieved by specified operating conditions. Either of these scenarios require demonstration prior to final design of the process.

Passivation of the metals is based on oxidation of exposed metal surfaces/diffusion of oxygen through microcracks to occluded surfaces. While a limited amount of non-passivated metals or residual hydride is not viewed as a serious threat, some method is needed to determine that oxidation of the bulk of the exposed metal is complete. This control will need to be demonstrated.

A small-scale test/demonstration of process sampling points, sample methods, and monitoring techniques should be performed to confirm design uncertainties and minimize rework following process construction and full-scale tests.

⊗ Regulatory Approach

The plans presented to the review team assume that required NEPA approvals will be made within the context of the national NEPA effort regarding spent fuel and within the subsequent Hanford effort to deal with those issues as they apply to Hanford fuels. These plans further assume that it will prove desirable to proceed with an Interim NEPA Action which allows an early demonstration run of the conditioning facilities, processing a small portion of the N Reactor fuel.

It is our opinion that a better approach might be to carry out the proposed activities as a NEPA action to close the K Basins and in the course of that action to remove the spent fuel from the vicinity of the river and render it all into a suitably stored and stable condition to await longer term decisions as to disposition and treatment for all spent fuels at Hanford. The differences are potentially significant since, in the proposed plan, the overall spent fuel issue will pace the schedule of this project, with project delays if the overall NEPA effort is delayed. The suggested approach to focus instead on the K Basin concern per se and the appropriate interim disposition of fuel will allow focus on removal of an environmental concern at the earliest date, and secure time to resolve ultimate fuel disposition issues. We believe that whatever hard fought NEPA approvals are obtained, they should be sufficient to carry the effort through to a disposition of all of the fuel currently in the K Basins, rather than a small portion thereof.

We believe that insufficient attention has been given to the design and safety requirements to be demonstrated in order to obtain required safety and operational approvals. Examples include development of data on fuel condition and drying/passivation behavior to support bounding analyses, the treatment of

sludge dust in operations, ALARA concerns in basin and facility operations. Moreover, although there are precedents, domestic and foreign; for conditioning and for dry storage, none is directly comparable to the treatment and dry storage of large quantities of seriously failed metallic fuel stored for long durations in water. These issues will likely result in schedule extension as the unique issues are defined and debated, decision makers briefed, and operations are ultimately approved.

④ Schedule

In other sections of this report, a number of issues are raised regarding the certainty of assumed institutional processes, such as procurement safety analysis reviews, and readiness review durations. Because we believe that the schedule would be challenging even in the commercial arena, these institutional uncertainties are sufficient that we believe that the proposed plan will neither meet the TPA milestone, nor prove useful in comparing with other alternatives. For such comparisons, a schedule based on a common set of assumptions needs to be created for each alternative, with comparable degree of schedule confidence.

We believe that there are two fundamental deficiencies in the logic of the plan presented: Fuel removal from the basin is paced by operation of the conditioning facility, and the interim NEPA approval proposed would permit processing of only a small quantity of the basin fuel. First, the plan should be re-examined from the view of removing the basin fuel at the earliest date. This will probably lead to some sort of lag storage sequence such that fuel removal is not paced by completion of the conditioning equipment. Second, the NEPA strategy should be oriented to successful completion of all fuel disposition in a stable configuration once operations begin as the result of approved safety and operational analyses and reviews.

④ Cost

With the schedule uncertainties noted above, there are of course cost uncertainties. Again, for the purpose of comparing alternatives, a normalization process is required. Beyond the cost uncertainties driven by schedule uncertainties, we are concerned that the cost estimate for MCOs (approximately 20% of the total cost) and their engineering and testing is low. Because we believe that a more robust building is required to house the conditioning equipment, that estimate also appears too low.

We also believe that the estimates are incomplete in terms of addressing the totality of the task to exit the K Basins, including particularly those required to address sludge, conditioning facility wastes, and operational savings upon exit of the basins.

Appendix

Leonard F. Ermold

Education

- Ph.D. Engineering Mechanics, Virginia Polytechnic Institute & State University - 1965
- M.S. Engineering Mechanics, Virginia Polytechnic Institute & State University - 1963
- B.S. Mechanical Engineering, Drexel Institute of Technology - 1962

Experience

Twenty-six years with Westinghouse that included assignments ranging from senior engineer to department manager with responsibilities for up to 650 employees and annual budgets of \$90 million. Experience includes both the government and private sectors in functional areas of design and engineering, projects, operations, maintenance, procurement, research and development, and teaching. Recent DOE experience includes seven years at the Idaho National Engineering Laboratory Chemical Processing Plant as Vice President and Manager, Engineering and Plant Projects (1987), Vice President and Manager, Production (1987-1992), and Vice President and Director, Applied Technology (1992-Present).

Frank P. Baranowski

Education

- M.S. Chemical Engineering, University of Tennessee - 1954
- B.S. Chemical Engineering, New York University - 1943

Experience

Forty-six years in nuclear related activities. Since the Manhattan Project involved in the U.S. Nuclear Program in various assignments with Oak Ridge National Laboratory, the Atomic Energy Commission (AEC) and its successor agency, the Energy Research and Development Administration (ERDA). The last assignment was as Director of Production and Nuclear Fuel Cycle for the AEC and ERDA, which covered direction of total fuel cycle development and production activities, supplying materials to meet government defense and non-defense and commercial requirements. Since retirement in 1976, continued as management consultant in nuclear activities, was a member of DOE Energy Research Advisory Board (1983-1987), and recently served on a number of committees most involving study of integrated operations - New Production Reactors and Accelerator for tritium production, disposition of weapon grade plutonium and enriched uranium, waste management and reconfiguration of the weapon complex.

John R. Honekamp

Education

- B.S. Chemical Engineering, University of Dayton, 1956
- M.S. Chemical Engineering, Iowa State University, 1958
- PhD Chemical Engineering, Iowa State University, 1960

Experience

Thirty-four years experience in the nuclear power field, including management of technical activities related to development, design, analysis, construction, and testing of nuclear power plants. Managed development and testing programs for both the Department of Energy (DOE) and U.S. Navy. Established and managed independent design and construction quality verification programs in the commercial sector, served on corporate safety review boards, and managed resolution of technical and licensing issues. Led or participated in performance assessments and evaluations at 11 nuclear power plants.

Alan P. Hoskins

Education

- B.S. Chemical Engineering, Montana State University, 1973
- Post-graduate studies in corrosion engineering, Idaho State University

Experience

Over 20 years experience in spent fuel handling and storage, fuel reprocessing, and high-level waste management. Experience includes technology development, project engineering, plant startup, facility management, and program management. Current management responsibilities include spent fuel conditioning and materials technology for Westinghouse Idaho Nuclear Company, and technical support to the DOE EM-37 Office of Spent Nuclear Fuel and Special Projects.

Lawrence L. Humphreys

Education

- M.S. Physical Chemistry, Oregon State University

Experience

Direct experience managing research and development, engineering, design, construction, start-up, operations, program control, planning, finance, administration, safety, quality, regulatory compliance, human relations, marketing, and external relations. Responsible for several NRC dockets as the "Engineer in Charge", site decommissioning to NRC requirements, and performed as an "Independent Reviewer" for other NRC regulated projects.

Directly responsible for operation of "Class A" DOE reactor, technical basis, safety and quality programs, 2500 employees and company policy within the DOE regulatory and administrative systems. This senior management experience spans both large and small organizations, nuclear and fossil operations, technical organizations, major engineering and construction projects and product development. Responsibilities have included regulatory compliance in both NRC and DOE regulatory programs, financial planning, working with organized labor (local and national), public and media relations and profitability.

N. C. Kaufman

Education

- B.S. Physics, Stanford University
- M.S. Engineering Science, Stanford University

Experience

More than 30 years of diverse experience in industries and companies characterized by high tech, safety and regulatory concern, and quality production. Mr. Kaufman has served as President of four companies and senior responsible executive for seven other companies, all in the nuclear, defense, and environmental marketplace. Strong technical, financial, and people skills have produced a record of profitable growth of managed companies, operations to high standards, and on-time, below budget completion.

Martin G. Plys

Education

- Sc.D. Nuclear Engineering, Massachusetts Institute of Technology, 1984
- M.S. and B.S. Nuclear Engineering, Massachusetts Institute of Technology, 1981

Experience

10 years experience in nuclear and chemical accident analysis with Fauske and Associates, Inc. Recently at Hanford, consulting on chemical hazards of high level waste including experiments and analyses, and consulting on accident phenomena and consequences for K basin fuel. As Vice President of Methods Development, managed development, experimental validation, and maintenance of severe reactor accident computer programs for the nuclear industry. Created or contributed to models for flammability, combustion, aerosols, fission product chemistry, core melt progression and material properties, and heat and mass transfer.

Jay T. Pride

Education

- B.S. Engineering Physics, University of Tennessee
- Graduate School in Physics, Vanderbilt University
- U.S. Navy Nuclear Power School and Prototype School

Experience

Over 25 years in nuclear startup, operations, reactor engineering, decommissioning, waste management, and transportation aspects of nuclear facilities. Experience has been in progressively higher positions to the current position of Executive Vice President of the Scientific Ecology Group (SEG). Responsibilities have included wet waste, decontamination, decommissioning, as well as engineering and quality assurance. Officer in U.S. Navy Nuclear Power Program and instructor at the U.S. Naval Academy.

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ATTACHMENT F

REVIEW OF EXPEDITED FUEL REMOVAL FROM HANFORD K BASINS

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8/29

Westinghouse Idaho
Nuclear Company, Inc.

LFE-063-94

From : L. F. Ermold
Phone : (208) 526-4628 MS-3422
Date : July 25, 1994
Subject: Review of Expedited Fuel Removal From Hanford K. Basins

To : John C. Fulton, Director
Spent Nuclear Fuel Project

Attached for your information is the report on review of expedited movement of fuel from Hanford K Basins. The report has been prepared, at your request, by an independent review team with the defined objective of focusing on two major areas associated with the feasibility of an expedited program for removal of fuel and sludge from the Hanford K Basins. The two major areas evaluated by the review were: (1) technical adequacy of the proposed expedited fuel movement program, and (2) management feasibility of the proposed program.

The scope of the review was limited to wet options only and did not review or compare dry storage options.

The report conclusions relative to the two major areas are:

- The expedited overpack concept as presented is technically feasible. No safety, environmental, or engineering technology gaps were identified.
- The schedule as presented for the expedited overpack concept is achievable from an engineering and construction point of view. The decision/approval process will require a high priority to meet the proposed schedule.

During the review, a hybrid of the expedited wet options being considered was identified by a review team member and the attached report recommends:

- A possible schedule improvement should be evaluated by using an FMEF cell to store some fuel on an interim basis.

Mr. J. C. Fulton
Page 2
LFE-063
July 25, 1994

The attached report has been reviewed and concurred with by all review team members. The review team would like to extend our thanks to you and your staff for logistical support and accommodations associated with the review and preparations of the report. Efforts of Mary Rosen and Bob Tiller were particularly noteworthy.

L. F. Ermold
L. F. Ermold, Chairperson
Expedited Fuel Removal Review Team

Attachment

cc: F. P. Baranowski	L. L. Humphreys
M. J. Bonkoski	J. R. Hunter
J. L. Daily	N. C. Kaufman
J. L. Gallagher	W. C. Moffitt
E. W. Gerber	J. T. Pride
J. R. Honekamp	R. E. Tiller
A. P. Hoskins	A. L. Trego

**REVIEW OF EXPEDITED
MOVEMENT OF FUEL FROM
HANFORD K BASINS**

JULY 1994

REVIEW TEAM

Len Ermold, Chairperson
Frank Baranowski
John Honekamp
Al Hoskins
Larry Humphreys
Nick Kaufman
Jay Pride

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Review of Expedited Fuel Removal from Hanford K Basins

Executive Summary

The feasibility of an expedited program for removal of fuel and sludge from the Hanford K Basins was evaluated by an independent review team. The scope of the review was limited to wet options only and did not review or compare wet storage options to dry storage options. The expedited program concept involves placing existing K Basin fuel containers in an overpack, placing sludge in containers and then into an overpack, and moving the overpacks to either a new or existing on-site facility, located away from the river, for near-term (order of ten years) storage. Throughout this process, the fuel material would remain wet. Two areas were evaluated by the review group: (1) technical adequacy of the proposed expedited fuel movement program, and (2) management and institutional feasibility of the proposed program.

The choice of an overpack concept for repackaging spent fuel in a water environment does not invoke new technology. Although the time spent by Westinghouse on the expedited removal of spent fuel from K Basins has been short, a sufficient technical basis is available to proceed with engineering and construction on a priority basis. The keys to achieving rapid fuel removal are policy and organizational commitments. Program efforts must be expedited to achieve the stated goal of early removal of fuel and sludge from K Basins.

The primary conclusions and recommendations resulting from the review are:

Conclusions:

- The expedited overpack concept as presented is technically feasible. No safety, environmental, or engineering technology gaps were identified.
- The schedule as presented for the expedited overpack concept is achievable from an engineering and construction point of view.
- The decision/approval process will require a high priority to meet the preferred schedule. Specific areas requiring focus are:
 - Budget validation and funding
 - NEPA approvals as presented
 - Funding approval and expenditures in parallel with the NEPA process
 - Selection of the final approach (wet overpack, dry storage, etc.) and facility location

- Expedited removal as presented does not pre-judge alternatives for final disposition.
- The expedited overpack concept when compared to the baseline case (encapsulation) provides:
 - An improved schedule if a timely decision is made to proceed
 - Comparable costs
 - Reduced personnel exposure
 - A path forward for achieving a Tri-Party Agreement (TPA) milestone

Recommendations:

- A possible schedule improvement should be evaluated by using an FMEF cell to store some fuel on an interim basis.
- The planned Pilot Run should be utilized as an opportunity to gather schedule and exposure data to facilitate planning and provide a basis for proceeding with overpacks.
- Sampling of the KW Basin canisters for corrosion inhibitor and condition of the fuel should occur as soon as possible.
- The team recommends that a clear plan addressing SNM accountability be prepared.

Introduction

On June 3, 1994, the U.S. Department of Energy, Richland Operations Office and Westinghouse Hanford Company (WHC) provided an overview of the Hanford Spent Nuclear Fuel Project to Mr. Thomas P. Grumbly, EM-1. During the presentation the possibility of expedited fuel removal from the K Basins was discussed. This effort would conceptually involve placing fuel in an overpack and transporting it to either a new or existing on-site facility for near-term (order of ten years) storage. WHC initiated a more in-depth evaluation concerning feasibility of expedited fuel movement, and identified a review group to assess two major areas: (1) technical adequacy of the proposed expedited fuel movement program, and (2) management and institutional feasibility of the proposed program. The scope of the review was limited to wet options only and did not review or compare to dry storage options. The on-site review was performed the week of July 18, 1994, and the review report is provided herein.

Background

The Hanford spent nuclear fuel (SNF) inventory is dominated by N-Reactor fuel accumulated in the K Basins from 1978 through 1987. Storage at K Basins was planned to be only as needed to sustain operation of N-Reactor while PUREX was closed for refurbishment and restart. Although PUREX did process much N-Reactor fuel as planned, the decision in December 1992 to deactivate the facility left over 2,000 metric tons of zircalloy-clad N-Reactor spent fuel in the K East (KE) and K West (KW) Reactor Storage Basins.

The fuel has been stored in the basins for an extended period, and little or no definitive information is available regarding the degree of degradation, physical integrity, condition of canisters, in-canister sludge, etc. In KW Basin the fuel has been placed into sealed containers with a corrosion inhibitor and the basin water is relatively clean. The fuel in KE Basin is in open containers and the release of fission products to the basin water is occurring. The KE Basin contains approximately one million gallons of water contaminated with tritium, fission products, and fuel corrosion products in the form of sludge. The sludge composition is uncertain and probably varies with location. Problems associated with fuel relocation in KE Basin include decreased pool visibility due to sludge suspension and radiation exposure. As previously indicated, the conditions of the pool and water in KW where the fuel is in sealed canisters are much better; however, the specific condition of the fuel inside the containers is unknown, since the containers have not been sampled since 1983.

The DOE Spent Fuel Working Group released the Spent Fuel Vulnerability Assessment in December 1993. This assessment listed the K Basins among the DOE SNF facilities given the highest priority to resolve

environmental, health, and safety vulnerabilities. Negotiations in January 1994 with signatories of the Hanford Consent Decree defined a milestone to achieve fuel removal from the K Basins by 2002.

As a result of dynamic analysis, the seismic qualification of the K Basins was questioned, and an Unresolved Safety Question (USQ) was declared in April 1994. The basis of the USQ was due to the possibility of post-seismic leakage through a construction joint between the KE Basin and reactor building structures. This leak, currently postulated to be capable of emptying the basin in a very short time (days or less), could result in soil contamination, and uncovering and dryout of the fuel and sludge. The drying of fuel raises concerns about the pyrophoric nature of uranium hydride. Sludge dryout could lead to dispersal of radioactive materials. A large release of contamination could be postulated to reach the nearby Columbia River.

The Defense Nuclear Facility Safety Board conducted reviews of fuel storage facilities within the DOE Complex, and on May 26, 1994, issued Recommendation 94-1. Item 7 of Recommendation 94-1 states, "That the program be expedited to place the deteriorating reactor fuel in the KE Basin at the Hanford site in a stable configuration for interim storage until an option for ultimate disposition is chosen. This program needs to be directed towards storage methods that will minimize further deterioration."

Independent Review Team

As requested by DOE, an independent review team was assembled by WHC and consisted of the following individuals:

Review Team Chairperson

Leonard F. Ermold
Westinghouse Idaho Nuclear Company

Technical Sub-Team

John Honekamp
Science Applications International Corporation

Alan Hoskins
Westinghouse Idaho Nuclear Company

Jay Pride
Scientific Ecology Group Incorporated

Management Sub-Team

Frank Baranowski
Independent Consultant

Larry Humphreys
Independent Consultant

Nick Kaufman
Independent Consultant

A brief background summary for each of the team members is provided in the appendix.

Technical Items Evaluation

This section of the report deals with the review team's evaluation of the technical adequacy of the proposed expedited fuel movement program. It is organized into a set of topical areas that were considered during the review. Each topical area provides a brief description of the items considered or reviewed by the team, and a summary of the team's conclusions and/or recommendations associated with the topical area.

● Alternatives

The comparison of alternatives differ in the location of storage facilities on the Hanford Site. The canisters containing the spent fuel are common to all alternatives. The repackaging of the K Basin fuel in a wet condition, the need to transfer the fuel as quickly as possible, and transfer being only a temporary solution limited the study to on-site alternatives. In its review, the team placed emphasis on the following factors: readiness to receive spent fuel, safety (seismic and radiation), environment, capabilities, costs, and institutional. The main factor was early transfer of spent fuel since it will reduce both the current and potential exposure situation in K Basin and the handling of spent fuel in operations prior to disposition.

The locations of the alternatives in order of increasing distance from Columbia River are:

Facility	Elevation above water table (ft)	Distance from river (miles)
WNP-4 Spray Pond	70	2.5
New 400 Area Basin (Adjacent to FMEF)	160	4.5
Purex Canyon, 200 Area	310	11
New 200 Area Basin	310	11

WHC prepared pros and cons for each alternative studied. The team agrees with WHC's decision to eliminate the WNP-4 Spray Pond and the Purex Canyon from further consideration.

There are no apparent advantages in operating cost or unique advantages to use of WNP-4 Spray Pond. The DOE has sites, excess facilities, and infrastructure necessary to meet an expedited schedule. Further, the potential institutional problems associated with transfer of property are disadvantages of this

site.

The Purex Canyon has an apparent advantage of a facility that has been used in processing of radioactive materials. It has a versatility in processing equipment replacement through the use of connecting jumpers. However, modifying its receiving facility and canyon to hold storage basins will subject personnel to radiation exposure significantly greater than other options. Further, current seismic design criteria can not be met. There is also a cost and time penalty for its use.

The team review of the alternatives of separate basin facilities in the 200 Area and adjacent to FMEF in the 400 Area indicate both are capable of performing the storage task. The FMEF Basin will utilize the existing receiving and shipping facility within the FMEF. Both facilities will be designed to meet all DOE requirements with special attention to leak detection and protection of the environment and the D/D operations on decommissioning.

In the FMEF alternative, the availability of large hot cells adjacent to the Basin and receiving facility within FMEF that meets current standards provides considerable flexibility in management of the spent fuel program by providing space for temporary storage of canisters, development, testing, and repackaging. The team's experience in management of complex programs handling radioactive materials notes this additional flexibility is important for responding to unforeseen events especially with a program of this nature that is required to respond to programs still maturing.

In discussing with WHC the above alternatives and exploring possible others that may further accelerate the transfer of K basin fuel, the temporary use of cell capacity in FMEF to receive K fuel was identified. Early shipment of fuel to FMEF, the overpacking of KE fuel and relocation, and the design and construction of the FMEF basin in parallel could improve the schedule for movement of fuel and sludge out of K Basins. This alternative should be evaluated in more depth by WHC. At this early phase of the study it is clear that alternatives do exist which would empty the K Basins well before 2002.

● Material Condition

A list of material condition and behavior considerations was prepared prior to the review that encompassed the following topical areas:

- Criticality

- Mobility of radioactive species
- Transportation
- Continued wet storage
- Stabilization/conversion to final waste form
- Unique K-Basin SNF material condition issues

The review focused on assessing the potential impacts of these considerations on expedited removal, the extent to which they have been addressed by the Project and whether or not they are unique to expedited removal. The team concluded that the Project has considered the appropriate material condition and behavior issues and that most of these issues as related to wet transfer and storage are well within established practice. Further, the only departure from established practice relates to the degree of corrosion (sludge) and the potential extent of fuel hydriding. While these changes need to be accounted for they are not considered to represent technology gaps or major engineering challenges. Finally, it was concluded that most, if not all, of these material condition and behavior issues are common to the base case (encapsulation) or other disposition options for the K Basin fuel.

The material characterization program is still in its early stages and is focused on visual documentation of the existing conditions, establishing the capability for detailed hot cell examinations and developing data quality objectives for the characterization measurements. The team believes that the data quality objective process outlined by the Project is an excellent approach to assure that the appropriate information is obtained. Further, the safety analyses required to ship hydrided uranium fuel to the hot cell for examination will provide a timely test of the adequacy of the data and methods needed to establish the safety basis for wet shipment. In this regard, if expedited removal is to be pursued further, it is recommended that a separate task be initiated to assess the impacts of scale (if any) on the transportation safety issues in order to provide early input to the design of the storage package and cask needed for the actual removal operation.

The team agrees that it is highly desirable to inspect the fuel in some of the sealed canisters in KW at the earliest possible date. This examination should include sampling the canister water prior to opening to determine the condition of the corrosion inhibitor. If the corrosion inhibitor is still present in sufficient concentration, and the fuel is in good condition, this would add confidence that fuel in the remaining intact canisters should be

in good condition. It would also provide valuable experience on the performance of the corrosion inhibitor for wet storage durations comparable to that envisioned for the expedited removal initiative.

● Accountability

Details on Special Nuclear Material (SNM) accountability were not included in the formal presentations by WHC. The following write-up summarizes discussions between the SNF Project Management personnel and the team.

SNM material accountability for K Basin fuel is complicated by fuel corrosion, sloughing of material from the fuel to the basin sediments, and documented wide variation for material conditions within the KE Basin. Technical evaluations have shown that SNM accountability is not a controlling factor for criticality safety in the expedited containerization, transportation, or relocation of K Basin fuels. Therefore, SNM accountability could be simply documentation of the physical movement of the fuels and sludge from K Basin to the new location. This documentation would record the loading of fuel units from particular storage locations in the K Basins to transfer casks and new storage configuration/locations. This documentation would account for the combined movement of all materials from K Basins to alternate storage. Determination of the need for detailed assay of the Special Nuclear Materials contained in each overpack, if necessary, could be deferred to the new fuel storage location or at a subsequent facility used to condition the fuel.

This approach appears feasible and desirable. The existing level of SNM accountability is preserved for the fuel. SNM accountability, if needed for the sludge, could be initiated as the material is containerized to a defined volume, specified storage locations, and documented. The team recommends that a clear plan addressing SNM accountability be prepared.

● Safety

This topic considered the safety envelope for operation of K Basin fuel storage facilities, anticipated fuel and sludge handling and near-term storage safety issues, interim measures, criticality control, expected changes to the existing safety envelope and how they are being integrated into the fuel relocation planning, and contingencies provided for response to the unexpected.

The current safety envelope for the K Basins is defined by WHC-SD-WM-SAR-062, Rev. 1, "Safety Analysis of Irradiated N Reactor Fuel," and WHC-SD-WM-OSR-006, Rev. 0, "Operations Safety

Requirements - 100-KE and 100-KW Fuel Storage Basins." This safety envelope includes shipping to and from the basins, in-pool fuel handling and storage, decapping of canisters, and re-encapsulation. A range of accident scenarios are considered involving both criticality and non-criticality-related accidents.

Current information in the following areas are being analyzed:

- Degraded fuel condition
- Potential presence of uranium hydride
- Potential for exothermic chemical reactions

Analysis of these aspects and incorporation into an on-going revision to the safety documentation is required to support characterization of the N-Reactor fuels and basin sludge and a pilot run to verify engineering aspects of fuel movement and packaging.

A new Safety Analysis Report for expedited removal of fuel and sludge will build upon current documentation as many of the engineering and operational aspects for a replacement wet storage facility are similar to those in the current facilities. The issues related to fuel condition, uranium hydrides, and potential exothermic chemical reactions are expected to be resolved through the normal design and analysis process.

● Final Disposition Impact

The continued wet storage of all K Basin spent fuel in canisters in a new facility does not change the nature of the fuel to be stabilized.

The WHC process to establish canister specifications includes consideration of subsequent follow-on steps to final disposition of spent fuel. The selection of wet overpack as the storage form provides DOE with a number of advantages for final disposition, such as:

- Improved characterization of spent fuel and sludge
- Lower exposure of personnel than current storage in K Basin
- Time to develop treatment and storage options

● Shipping

The expedited fuel relocation concept employs the existing K Basin casks or newly designed casks or use of commercial casks along with the special rail cars originally designed to transport irradiated fuel from N Reactor to an on-site reprocessing facility.

There is an on-site SARP for the N-Fuel cask. The proposed payload is not in compliance with SARP payload description as significant amounts of breached cladding, corroded fuel, and sludge are not addressed.

On-site shipments were historically made in non-NRC certified containers which do not approach the containment security required by current DOE, DOT, or NRC regulations and policies. The regulatory environment at both the state and federal levels has moved towards requiring NRC-approved or "equivalent" shipping containers for on-site (within reservation boundaries) shipments, particularly if a state or federal highway is used or crossed in transit.

This "equivalent" alternative, at the DOE's discretion, may warrant an agreement with the NRC regarding the extent and manner of use. Concurrence by appropriate state health officials would be advantageous. This agreement would likely take the form of a limited, conditional use certification issued by the DOE and defined in a site SARP. The conditional use would be limited to those situations when on-site shipments require travel on or across state or federal highways. Conditions may bound aspects such as maximum speed, escorts, maximum transport time, hours of operation (e.g., daylight), site-specific payload limits, on-site use only, etc. Shipments conducted strictly on DOE property may be even less limited. The cask units used for on-site shipment should be permanently marked and/or tagged to ensure against use for off-site or out-of-compliance transportation.

The team felt that in the short term, modification may be performed to the existing casks to allow their use with changes made and approved to the existing SARP. Consideration would be given in the SARP for the amounts and nature of the damaged fuel. Since this system does not comply with Title 10, Code of Federal Regulations, Part 71 (10 CFR 71), the transport route would be barricaded under transport conditions. Several modifications, such as cask drainage, will need to be incorporated into the existing cask.

If schedule considerations permit, the team prefers the WHC proposal of a new cask designed to the intent of the NRC rules (10 CFR 71), but the cask would not be submitted for licensing to that criteria. In any case, the team recommends the continued use of modified casks in the short term. Performance of the drop test and fire test may not be required for a cask used only on-site. A Hanford SARP would be developed for the new cask design.

The equivalence evaluation also could, in the case of the containment evaluation under normal and hypothetical accident conditions, take into account the integrity of the primary container or overpack. This can be done by qualifying the primary containers themselves for certain impact energies such as DOT Type A. Consideration and credit should be given to all conditions that would tend to mitigate the release of activity in the event the cask leak tightness was degraded.

The team agrees that rail will be the primary transport path with truck transportation also allowed. The project should also thoroughly evaluate the use of existing NRC-certified (or previously certified) Type B and LSA-restricted casks, since many copies of these models may already be available in the commercial nuclear fuel and waste transport industry.

These units may also be presently under-utilized due to regulatory changes in the commercial industry. For example, at least three Type B radwaste cask designs which previously were NRC certified, but for which the certifications were allowed to lapse for economic reasons, are available and should be considered for reapplication to the fuel shipments. Copies of each of these casks are known to exist. These casks could be obtained at a fraction of their replacement cost, new copies could be built at much less than a new NRC-current design, or these designs could serve as the basis for a modified design tailored to meet the project's requirements.

- Worker Exposure and Safety

The review team drew several conclusions regarding worker exposure and safety, not necessarily restricted to expedited fuel removal, but certainly inclusive of such action. None of these conclusions preclude the viability of expedited removal, but worker exposure limits and ALARA will require significant attention at the KE Basin.

- In review of the current planning for alternatives to expedite fuel and sludge removal (draft report and presentations), the team found no technical nor management feasibility issues.

- Worker exposure and fuel integrity will be significantly different between KE and KW basins. The working exposure, water contamination, sludge quantity, and storage state of fuel at KW appears to present relatively few challenges.
- Both industrial safety and readiness reviews will be less challenging at KW due to fewer hazards, fewer encumbrances required for contamination control, more recent operation, recent shipping status, and generally newer fuel.
- The difficulties of performing work in KE basin, as regards exposure, safety and support, will be better defined by the planned Pilot Run Operational Readiness Review (ORR) in KE Basin. The team believes that some information in support of overpacking should be obtained through pursuit of the Data Quality Objective (DQO) process as the Pilot Run is completed. It appears that overpacking KE Basin canisters could significantly reduce exposure and time requirements as compared to piece-by-piece handling for re-encapsulation, but data must be available for planning to minimize exposure.
- It would appear that shortening the time during which KE basin must be maintained (by years) should reduce total exposure and improve safety. The current WHC plan for expedited removal incorporates improvements deemed necessary for personnel safety requirements.
- The Operational Readiness Review process, while not yet detailed, has been accounted for in planning the Pilot Run and the expedited removal case. This process, as required by WHC policy and procedures, would include readiness to support exposure minimization, personnel safety, and training.
- The alternative evaluated for adapting the shut-down PUREX facility would require significantly higher exposures due to the higher radiation fields during installation.

● Waste Generation and Effluent Emission

Waste generation was not discussed in detail. However, the waste stream types are not expected to be unusual and should be similar to other sludge removal and clean up actions. A sludge and debris removal plan was addressed.

The expedited removal reduces the total amount of waste generated by reducing time spent in K Basins. Similarly, overpacking should reduce the potential for spread of contamination and waste generation.

A spectrum of disposal options for the treated water was discussed, but no preferred path was identified. It was also stated that water cleanup is coupled to fuel and sludge removal by agreements in the TPA. Specifically, if fuel and sludge are not removed by 1996 a feed-and-bleed must be initiated. As a result, the longer the fuel and sludge remain, the larger the volume of contaminated water generated.

The only expected new emissions, other than possible disposal of tritiated water, was air discharges that would be required for construction and operation of a new storage facility. The facility air emissions would be conditioned by HEPA filters that should result in emissions below the allowed release levels.

The team found:

- No major concerns on emissions as a result of expedited action.
- The amounts of waste generated for the expedited action should be less than the amounts of waste generated compared to the baseline case.
- A Waste Certification Plan should be developed for all wastes expected to be generated during the expedited action.
- Classification of sludge should be carefully considered.
- Technology Gaps

The planned approach utilizes available technology, but will require some new engineering designs and applications in the area of shielding, retrieval, packaging and transportation. The expedited overpack concept as presented is technically feasible. No safety, environmental, or engineering technology gaps were identified.

Management Items Evaluation -

This section of the report, which deals with the team's evaluation of management feasibility of the proposed expedited fuel movement program, is organized into topical areas considered by the team. Each topical area provides a brief description of the items considered or reviewed by the team, and, as appropriate, the conclusions and/or recommendations associated with the topical area.

● Regulatory and Regulation Requirements

The plan presented to the team contains four critical regulatory assumptions:

- NEPA approval within 15 months
- Transportation within a safety envelope similar to but not in full compliance with DOT and NRC regulations
- Safety approval of the new basin within DOE Orders only
- No constraints from the application of RCRA to planned spent fuel activities

Obtaining NEPA approvals within 15 months is very aggressive but is feasible with high priority attention and expeditious processing, review, and approval by the DOE, the contractor, and the stakeholders. Treatment of the proposed activity as an Emergency Removal Action under CERCLA may provide an alternate, faster way to meet this goal, provided that DOE will accept such activity as an acceptable alternative to NEPA.

Transportation within a safety envelope that is similar to but not in full compliance with DOT regulations appears acceptable for this on-site action.

Use of DOE Orders for the licensing of the new basin appears a reasonable choice. However, comparability with NRC criteria and policy should be considered to the maximum extent possible to minimize potential future problems.

The assumption that fuel and sludge are not RCRA waste and that there are thus no RCRA constraints on the proposed expedited plan appears reasonable, given the continuing national discussions as to RCRA applicability and the importance of proceeding with this effort to reduce storage of fuel near the Columbia River.

It is the judgement of the team that the proposed expedited fuel movement initiative will not prejudice future decisions on ultimate disposition.

The plans presented for the construction of the new fuel facility appear to appropriately acknowledge the need to consider state and federal regulations for air and water discharges.

In summary, the regulatory assumptions in the plan are reasonable and feasible provided that the expedited fuel effort receives the highest priority by involved parties to expedite reviews, decisions, and approvals. Without such emphasis, the schedule is probably optimistic. Without agreed regulatory criteria, plans will be uncertain.

● Facility Strategy

In developing alternatives for expedited removal, the WHC evaluation includes infrastructure and support requirements. WHC has expressed that the two most favorable alternatives (FMEF plus basin addition or a new facility in 200 Areas) can be or are sited to take advantage of existing capabilities. The procedural systems, administrative systems, control systems, and support systems required for expedited removal do not appear to be any more demanding than other existing programs or operations. These will be assessed through the scheduled Operational Readiness Review, but the requirements/challenges should not tax either technological nor operational norms. The activities are very similar in nature to past and current operations (fuel shipping, fuel encapsulation, fuel sorting).

● Schedule

Although the schedule presented to the team was summary in nature and not fully or consistently developed, the plan appeared to include all essential schedule elements for evaluation of the expedited fuel removal initiative. The proposed schedule would appear to meet the TPA milestone for removal of fuel from K Basin. Schedule success will depend critically on high priority attention and expedited action by the DOE, the contractors, and the stakeholders, to obtain necessary NEPA approvals and confirmation of applicable regulations, both of which are on the critical path. Additionally, the schedule presumes that capital (construction) monies will be made available in the near-term to begin design and construction of the new basin and that such design can proceed in parallel with obtaining final NEPA approval. Such actions are certainly feasible if DOE places high priority on them. A critical schedule activity is an early decision to use overpacks

for transportation and storage, since this decision controls the development of the transportation effort and schedule, and hence, initiation of shipments. Earliest project completion will occur if no detailed characterization is required at the time of loading and shipment and if overpacks are used.

The team notes that the proposed schedule might be improved if shipping of material from the KW Basin were to begin as soon as possible to FMEF in parallel with construction of the new basin and overpacking and cleaning of the KE Basin. This approach begins to reduce risk at the earliest time and enables earliest exit of the basins with attendant reduction of costs and personnel exposure. This would also keep the critical path focused on early fuel transfer from the river, which is the objective of the plan. Alternatively, FMEF could be considered as an interim storage for KE material until additional space is developed for storage of material from the KW Basin.

Although the plan is very aggressive with regard to institutional decisions, the plan is considered achievable in its assumed durations for engineering and construction activity. The design and construction effort for the new basin might be improved, recognizing that construction of fuel storage basins is a standard nuclear industry activity with several suppliers and standard designs. Such schedule improvement would require focused and timely identification and approval of design and safety criteria.

In summary, the team believes that the schedule presented represents a feasible plan provided that regulatory activities receive priority attention and capital monies can be made available in the near-term to begin basin design and construction. The team suggests that the use of FMEF be evaluated to expedite fuel removal.

● Budget

A tentative budget for the baseline and the expedited shipment plan were presented to the team with the caveat that such costs were preliminary and developed by several persons with varying assumptions. These estimates appear adequate for scoping purposes.

The essential cost trade-offs presented involve savings from early exit of the K Basins versus the capital cost of constructing a new basin. This tradeoff indicates that these costs are about the same, with earliest exit of the K Basins favored and savings becoming progressively greater as decisions on ultimate fuel disposition become delayed. The expedited fuel movement can not, of course, begin until funding is available. Since savings become

greater the earlier the expedited action is completed, the financial desirability of the proposed plan increases with earliest funding and budget validation.

The expedited fuel transfer plan will likely result in some increased costs and budgets in the first years to be off-set in later years. However, the annual incremental differences between baseline and expedited action are believed to be relatively small (less than 20%), particularly considering the high visibility and priority that this effort will likely enjoy.

In summary, budget estimates suggest that the incremental costs of expedited fuel shipment are modest and that over a few-year period, expedited action will be financially favored due to reduced operating costs of the K Basins and then early transition to D&D.

Appendix

Leonard F. Ermold

Education

- Ph.D. Engineering Mechanics, Virginia Polytechnic Institute & State University - 1965
- M.S. Engineering Mechanics, Virginia Polytechnic Institute & State University - 1963
- B.S. Mechanical Engineering, Drexel Institute of Technology - 1962

Experience

Twenty-six years with Westinghouse that included assignments ranging from senior engineer to department manager with responsibilities for up to 650 employees and annual budgets of \$90 million. Experience includes both the government and private sectors in functional areas of design and engineering, projects, operations, maintenance, procurement, research and development, and teaching. Recent DOE experience includes seven years at the Idaho National Engineering Laboratory Chemical Processing Plant as Vice President and Manager, Engineering and Plant Projects (1987), Vice President and Manager, Production (1987-1992), and Vice President and Director, Applied Technology (1992-Present).

Frank P. Baranowski

Education

- M.S. Chemical Engineering, University of Tennessee - 1954
- B.S. Chemical Engineering, New York University - 1943

Experience

Forty-six years in nuclear related activities. Since the Manhattan Project involved in the U.S. Nuclear Program in various assignments with Oak Ridge National Laboratory, the Atomic Energy Commission (AEC) and its successor agency, the Energy Research and Development Administration (ERDA). The last assignment was as Director of Production and Nuclear Fuel Cycle for the AEC and ERDA, which covered direction of total fuel cycle development and production activities, supplying materials to meet government defense and non-defense and commercial requirements. Since retirement in 1976, continued as management consultant in nuclear activities, was a member of DOE Energy Research Advisory Board (1983-1987), and recently served on a number of committees most involving study of integrated operations - New Production Reactors and Accelerator for tritium production, disposition of weapon grade plutonium and enriched uranium, waste management and reconfiguration of the weapon complex.

John R. Honekamp

Education

- B.S. Chemical Engineering, University of Dayton, 1956
- M.S. Chemical Engineering, Iowa State University, 1958
- PhD Chemical Engineering, Iowa State University, 1960

Experience

Thirty-four years experience in the nuclear power field, including management of technical activities related to development, design, analysis, construction, and testing of nuclear power plants. Managed development and testing programs for both the Department of Energy (DOE) and U.S. Navy. Established and managed independent design and construction quality verification programs in the commercial sector, served on corporate safety review boards, and managed resolution of technical and licensing issues. Led or participated in performance assessments and evaluations at 11 nuclear power plants.

Alan P. Hoskins

Education

- B.S. Chemical Engineering, Montana State University, 1973
- Post-graduate studies in corrosion engineering, Idaho State University

Experience

Over 20 years experience in spent fuel handling and storage, fuel reprocessing, and high-level waste management. Experience includes technology development, project engineering, plant startup, facility management, and program management. Current management responsibilities include spent fuel conditioning and materials technology for Westinghouse Idaho Nuclear Company, and technical support to the DOE EM-37 Office of Spent Nuclear Fuel and Special Projects.

Lawrence L. Humphreys

Education

- M.S. Physical Chemistry, Oregon State University

Experience

Direct experience managing research and development, engineering, design, construction, start-up, operations, program control, planning, finance, administration, safety, quality, regulatory compliance, human relations, marketing, and external relations. Responsible for several NRC dockets as the "Engineer in Charge", site decommissioning to NRC requirements, and performed as an "Independent Reviewer" for other NRC regulated projects.

Directly responsible for operation of "Class A" DOE reactor, technical basis, safety and quality programs, 2500 employees and company policy within the DOE regulatory and administrative systems. This senior management experience spans both large and small organizations, nuclear and fossil operations, technical organizations, major engineering and construction projects and product development. Responsibilities have included regulatory compliance in both NRC and DOE regulatory programs, financial planning, working with organized labor (local and national), public and media relations and profitability.

N. C. Kaufman

Education

- B.S. Physics, Stanford University
- M.S. Engineering Science, Stanford University

Experience

More than 30 years of diverse experience in industries and companies characterized by high tech, safety and regulatory concern, and quality production. Mr. Kaufman has served as President of three companies and senior responsible executive for seven other companies, all in the nuclear, defense, and environmental marketplace. Strong technical, financial, and people skills have produced a record of profitable growth of managed companies, operations to high standards, and on-time, below budget completion.

Jay T. Pride

Education

- B.S. Engineering Physics, University of Tennessee
- Graduate School in Physics, Vanderbilt University
- U.S. Navy Nuclear Power School and Prototype School

Experience

Over 25 years in nuclear startup, operations, reactor engineering, decommissioning, waste management, and transportation aspects of nuclear facilities. Experience has been in progressively higher positions to the current position of Executive Vice President of the Scientific Ecology Group (SEG). Responsibilities have included wet waste, decontamination, decommissioning, as well as engineering and quality assurance. Officer in U.S. Navy Nuclear Power Program and instructor at the U.S. Naval Academy.