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		ECN No.

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SEP 29 1994

STN #19
24

ENGINEERING DATA TRANSMITTAL

Page 1 of 1 JKB 4/24/94

1. EDT 602987

2. To: (Receiving Organization) Basin Integrity Task Team, K Basins	3. From: (Originating Organization) Technical Safety, K Basins Engineering	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: K Basins, Spent Nuclear Fuel Project	6. Cog. Engr.: R. H. Meichle	7. Purchase Order No.: N/A
8. Originator Remarks: This document provides the safety evaluation for preparation and installation of discharge chute isolation barrier at KE and KW for USQ and readiness review categorization.		9. Equip./Component No.: N/A
11. Receiver Remarks:		10. System/Bldg./Facility: KE/KW Basins
		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: N/A

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-SNF-SARR-002	N/A	0	Safety Assessment of Discharge Chute Isolation Barrier Preparation and Installation	SQ	1	1	1

16. KEY			
Approval Designator (F)	Reason for Transmittal (G)		Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information	4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)										(G)	(H)
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RELEASE AUTHORIZATION

Document Number: WHC-SD-SNF-SARR-002, REV 0

Document Title: SAFETY ASSESSMENT OF DISCHARGE CHUTE ISOLATION
BARRIER PREPARATION AND INSTALLATION

Release Date: September 28, 1994

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This document was reviewed following the
procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

* * * * *

WHC Information Release Administration Specialist:

Kara Broz
(Signature)

September 28, 1994
(Date)

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SUPPORTING DOCUMENT

1. Total Pages **4024**
JUL 9 1994

<p>2. Title</p> <p>SAFETY ASSESSMENT OF DISCHARGE CHUTE ISOLATION BARRIER PREPARATION AND INSTALLATION</p>	<p>3. Number</p> <p>WHC-SD-SNF-SARR-002</p>	<p>4. Rev No.</p> <p>0</p>
<p>5. Key Words</p> <p>K Basins, fuel storage basins, N fuel, KE and KW fuel storage basins, irradiated fuel, fuel storage canisters, encapsulated fuel, safety analysis, isolation barrier, seismic</p> <p style="text-align: center;">APPROVED FOR PUBLIC RELEASE</p> <p><i>KMB 9/29/94</i></p>	<p>6. Author</p> <p>Name: R. H. Meichle</p> <p><i>R H Meichle</i> Signature</p> <p>Organization/Charge Code 2A340/KK4DC</p>	
<p>7. Abstract</p> <p>The safety assessment is made for the activities for the preparation and installation of the discharge chute isolation barriers. The safety assessment includes a hazard assessment and comparison of potential accidents/events to those addressed by the current safety basis documentation. No significant hazards were identified. An evaluation against the USQ evaluation questions were made and the determination made that the activities do not represent a USQ. Hazard categorization techniques were used to provide a basis for readiness review classification.</p>		
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<p>9. Impact Level SQ</p>		

SAFETY ASSESSMENT OF DISCHARGE CHUTE ISOLATION BARRIER PREPARATION & INSTALLATION

1.0 INTRODUCTION

Dynamic seismic analysis, construction joint integrity projections and leak rate calculations for the K Fuel Storage have resulted in a post earthquake leak rate estimates in excess of the 1500 gph limit in the SAR. Expert and peer reviews have indicated that the complexity of the problem is such that a definitive value for leak rate is not possible. Estimates have been between 5000 and 25000 gph. This range, in addition to being higher than that used in the safety analysis, challenges the capability to adequately respond to the event to maintain fuel coverage.

Based on the foregoing, there is an increase in consequences of a previously evaluated event and reduced margin in OSRs. The discovery involves increase in the previously analyzed seismically induced leakage rather than a new basin malfunction, or new accident.

This report addresses and assesses the activities planned in 105 KE and 105 KW to resolve potential public safety and environmental impacts from postulated basin leakage following an earthquake, provides an evaluation of the risks associated with these activities, and identifies precautions which will be taken to manage these risks. Insights from this analysis are integrated with the Master Work Procedure (MWP) and detailed procedures for controlling field work.

In response to the safety issue raised concerning a potential seismic event in the K Basins, a corrective action plan has been developed. Seismically induced leakage in the discharge chute portion of the basin could result in significant water level reductions in the basin. The corrective action plan requires installation of isolation barriers (i.e., upgraded cofferdams) to separate the discharge chute from the rest of the basin. A sketch of the isolation barrier location is included (see Figure 1).

Figure 1 - Overview sketch of the basin showing the location of isolation barriers.

A cleanup system will be installed to treat the discharge chute water. Piping will be added that will introduce treated water from the Ion Exchange Module (IXM) into the chute via a pump, and an overflow weir slot is provided in the isolation barrier to return water from the discharge chute back to the main basin. Water quality in the discharge chute is then expected to improve over that in the main basin.

2.0 DISCUSSION OF ASSESSMENT METHODOLOGY OF POTENTIAL FOR PERSONNEL EXPOSURE, PERSONNEL INJURY OR AIRBORNE RELEASE RESULTING FROM ACTIVITIES

The Office of Safety & Health (EM-23) within the U.S. Department of Energy Office of Environmental Management (EM) is currently developing guidance on hazard baseline

documentation for EM facilities.¹ This guidance is still preliminary, but it provides useful insights on an appropriate methodology for addressing hazards assessment activities associated with this activity. It is particularly useful in addressing the evolving subject of worker protection, where it prescribes, "The principles and requirements of Process Safety Management (PSM) shall be integrated into the nuclear safety analysis process if the hazardous chemical thresholds established in 29 CFR 1910.119², are reached or exceeded. The principles and requirements of PSM are encouraged even for those facilities where the thresholds are not reached or exceed."

Although none of the planned activities use toxic materials which would trigger the threshold requiring it be addressed under 29 CFR 1910.119, WHC & RL have elected to follow a PSM style approach and provide safety assessments of direct use to the workers in managing the risk of activities.

Planned activities have been evaluated, using hazards analysis techniques, to identify potential risks and provide appropriate controls to manage these risks. The overall hazard checklist was developed by reviewing material in draft guidance on hazard baseline documentation for EM facilities.¹ Actual facility hazards were identified by systematically reviewing the planned activities and potential related accidents. Potential accidents can be divided into three major categories: accidents resulting in direct injury to people, radiation exposure from a field, and airborne radiation or toxic material exposure. Note that nuclear safety is embedded in these three for analysis purposes.

Industrial Safety - The first category, commonly referred to as industrial safety accidents, include electrical safety, fire safety, crane operations safety, and elements of ergonomics. Of these, the dominant risk results from improper crane operations or crane failures. These risks are minimized by utilizing trained operators and subjecting the involved cranes to maintenance and surveillance procedures.

Radiation Exposure - The second category, radiation exposure (from fields) can result from failure to plan work to minimize exposure, or from an activity which produces high fields in areas occupied by personnel. The first concern will be addressed by an As Low As Reasonably Achievable (ALARA) plan, which will be used to plan work to the lowest exposure possible, consistent with performing the work. The second area of concern, high radiation fields, was identified as possible only in the event of an unshielded inadvertent criticality or inadvertent removal of the fuel from the water. Both are precluded by design and by operating procedures.

Airborne material exposure (includes Industrial Hygiene) - The third category, airborne material exposure, will require careful management because it poses the greatest potential. No source of airborne toxic material has been identified, but airborne radionuclides are expected for some portions of the job. Airborne release can result from radionuclides in suspension or solution in the basin water, or from work in surface contamination zones.

All activities will be managed to minimize airborne releases. Consistent with practices established for the current air permit for KE encapsulation, a water sample will be obtained each shift and an analysis performed for Cs-137 activity. Any tasks involving above water work will be conducted consistent, where required) with the current encapsulation permit numerical limits. Continuous air monitors, where required, will be operated in the vicinity of the work to detect significant changes in airborne activity.

The potential for airborne release into KE (and potentially from KE) resulting from planned activities can be compared with encapsulation. The planned activities are

fewer, and they have limited potential to suspend radioactive particulate in the water (especially when compared with fuel and sludge encapsulation). The airborne release potential is well bounded by the airborne emissions forecast for encapsulation.¹

The activities in KW have a lower potential for airborne release than those in KE because the fuel is encapsulated, the concentration of waterborne radionuclides is at least an order of magnitude lower, and free sludge is limited.

Nuclear Safety - Nuclear Safety hazards deal with potential criticality, over exposure of personnel to radioactive material or over exposure of the public or personnel because of release of radioactive material. Criticality is controlled predominately by maintaining geometric control of fissionable material by canister and racks. Other controls are administrative limits on mass. Control of exposure is by maintaining the radioactive material under water, except for a very limited amount of airborne particulate radionuclides, by maintaining water level. The level is maintained by assuring structural integrity of the basin boundary. The SAR addresses events and accidents that deal with the above.

Table 1 provides a summary of the accidents/events addressed by the safety basis documentation, identifies which are applicable to the described activities and provides a determination of whether the activities are bounded by the accident/event addressed.

3.0 PLANNED ACTIVITIES

Activities for installation of the isolation barriers in 105 KE & KW can be categorized into four groups: 1) inspection and evaluation activities 2) relocation of equipment and fuel to support installation of the isolation barriers, 3) cleaning and surfacing of the discharge chute to limit the source term remaining in the chute, 4) installation of the barriers, and leak rate testing of the barrier seals.

3.1 INSPECTION AND EVALUATION ACTIVITIES

Prior to installation of hardware in the basin, detailed inspection and evaluation are necessary to support and assure and adequate design. Figure 2 illustrates the isolation barrier layout, and demonstrates the need for accurate dimension verification of the discharge chute entry way. Inspection and evaluation, common to many plant modification, can normally be performed with minimal intrusion in the basins. The most intrusive activity will be verifying the discharge chute openings dimensions using a video micrometer. The video micrometer camera will be moved underwater, filming the opening and verifying the dimensions which the isolation barriers must be built to.

Figure 2 - Top view of the isolation barrier illustrating the general configuration.

3.1.1 Safety Assessment Check sheet for activities.

<p style="text-align: center;">GENERAL CHECK SHEET HAZARDS IDENTIFICATION & MANAGEMENT of MAJOR ACTIVITIES ASSOCIATED WITH THE BASIN INTEGRITY TASK</p>		
Operation(s)	Potential Hazards	Assessment & Controls
Detailed inspection and evaluation are necessary to support design	Industrial Safety - Evaluate for electrical safety.	Camera power supplies are routinely used in the basins.
	Industrial Safety - Evaluate for fire safety.	Minimal change in fire loading.
	Industrial Safety - Evaluate for crane operations safety.	No crane operations required.
	Industrial Safety (Hygiene) - Evaluate for activities which result in worker physical stress because the equipment or tools do not fit the worker well (ergonomics).	None.
	Industrial Safety - Evaluate for other considerations based on operator experience and knowledge of the plant.	None.
	Industrial Hygiene - Evaluate for potential toxic material exposure or release.	No toxic materials used.
	Radiation Exposure - Evaluate for potential As Low As Reasonably Achievable (ALARA) considerations.	Specific ALARA plan & RWPs will be prepared for field work in each basin. Dominant exposure concerns result from activities in KE because of routine high fields.
	Radiation Exposure - Evaluate for high radiation fields unshielded inadvertent criticality or inadvertent removal of the fuel from the water .	No fuel will be moved. The equipment to be used (video cameras and associated cables) is light enough to preclude damage to fuel or movement of fuel.
	Airborne material exposure - Evaluate for airborne radionuclides from radionuclides in suspension or solution in the basin water.	Suspension of radionuclides in the water is not required as part of this activity, nor is it likely. The camera motion will be clear of sludge.
	Airborne material exposure - Evaluate for airborne radionuclides from work in surface contamination zones.	Standard ALARA plan & RWPs will be used for these activities consistent with other video camera work that has recently been conducted in KE and KW basins.
	Nuclear Safety - Evaluate the activity for the possibility that it exceeds the existing SAR (basis for USQ screening).	See Table 1 - Activities bounded by existing safety basis.

3.2 RELOCATION OF EQUIPMENT AND FUEL TO SUPPORT INSTALLATION OF THE ISOLATION BARRIERS

Installation of the isolation barriers requires fuel or equipment relocation. These changes are basin specific:

a) In 105 KW the location for installation of isolation barriers (see Figure 3) is currently close to existing fuel occupied storage. Some limited fuel relocation and storage rack modification (estimated to involve about 40 canisters) will be required. Because KW basin is relatively clean and the canisters are closed, this activity is not expected to be a large contributor to air emissions.

This represents a rather limited fuel move (1 to 2 shifts of activity). The equipment is designed to stress simple and safe operation. Individual fuel canisters are grappled, suspended by a lifting tool designed to preclude lifting the canisters from the water, with design features, (length of tool) which protects against operator error. The worst credible accident, dropping of fuel, is analyzed by the existing criticality analysis. The fuel drop would not result in any risk of criticality.

The 105 KW & KE isolation barrier sealing surfaces will also be modified by removing the existing inflatable seals and associated hardware. The removal of selected hardware in 105 KE & KW will be accomplished by using an underwater "side grinder" for cutting. Equipment used in these tasks will be surveyed before, during and after the work to ensure the spread of contamination is limited.

b) Some equipment must be relocated in the 105 KE discharge chutes to assure it does not interact with the barriers during an earthquake. This will be accomplished by moving the equipment to the center of the discharge chute, e.g., the old coffer dams currently located in the discharge chute will be moved to the center of the chute. In addition, it is prudent to move selected encapsulation equipment in KE out of the discharge chute into the main basin. Moving this equipment out of the chute will eliminate the necessity of removing the equipment from the water for reinstallation after the barriers are installed. For example, several empty canisters may be removed from the main basin storage racks and the packager relocated to storage, resting directly on the racks outside the chute. Additionally, one fuel element (inner) and portions of another are still located in the KE discharge chute. They will be removed.

All equipment will be moved underwater to minimize the air emissions. Hoisting equipment will be surveyed before, during and after the work. Decontamination or

replacement of the equipment will be done based on survey results. All these activities are similar to previously approved encapsulation activities

. 3.2.1 Safety Assessment Check sheet for 105 KW activities.

GENERAL CHECK SHEET HAZARDS IDENTIFICATION & MANAGEMENT of MAJOR ACTIVITIES ASSOCIATED WITH THE BASIN INTEGRITY TASK		
Operation(s)	Potential Hazards	Assessment & Controls
<p>Limited fuel relocation and storage rack modification (40 canisters) will be required.</p> <p>105 KW isolation barrier sealing surface will also be modified by removing the existing inflatable seals and associated hardware. The removal of hardware in 105 KE was formerly accomplished by using an underwater "side grinder" for cutting. Use of remotely controlled sidegrinders and similar cutting or surfacing tools is planned in both KE and KW.</p>	Industrial Safety - Evaluate for electrical safety.	None. No electrical modifications will be made to the facility. Existing facility outlets will be used for equipment.
	Industrial Safety - Evaluate for fire safety.	Minimal change in fire loading.
	Industrial Safety - Evaluate for crane operations safety.	Crane operations will be required for fuel movement and for storage rack modification. The worst postulated accident is a water drop of one fuel canister. See discussion below under Radiation Exposure for consequences. Crane operations will be treated as critical lifts if the lift is over fuel, or if it is over the basin and exceeds 800 lbs.
	Industrial Safety (Hygiene) - Evaluate for activities which result in worker physical stress because the equipment or tools do not fit the worker well (ergonomics).	None.
	Industrial Safety - Evaluate for other considerations based on operator experience and knowledge of the plant.	None.
	Industrial Hygiene - Evaluate for potential toxic material exposure or release.	No toxic materials used.
	Radiation Exposure - Evaluate for potential As Low As Reasonably Achievable (ALARA) considerations.	Specific ALARA plan will be prepared for field work in each basin. KW fields are routinely less than 2 mREM/hr and specific controls are not anticipated.
	Radiation Exposure - Evaluate for high radiation fields unshielded inadvertent criticality or inadvertent removal of the fuel from the water.	Fuel handling has been performed annually for the past 10 years, and crane usage is considered routine. the worst case crane failure would result in dropping a canister of fuel on other fuel. Such a crane failure has been analyzed for criticality safety and will not cause an unplanned criticality.
	Airborne material exposure - Evaluate for airborne radionuclides from radionuclides in suspension or solution in the basin water.	Suspension of radionuclides in the water is not required as part of this activity, nor is it likely. Past fuel handling has resulted in no increase. Standard ALARA procedures will be updated and used for these activities. Rack removal poses even less risk than fuel movement. Equipment used in these tasks will be surveyed before, during and after the work to ensure the spread of contamination is limited.
	Airborne material exposure - Evaluate for airborne radionuclides from work in surface contamination zones.	No work will be performed in surface contamination zones.

	<p>Nuclear Safety - Evaluate the activity for the possibility that it exceeds the existing SAR (basis for USQ screening).</p>	<p>See Table 1 - Activities bounded by existing safety basis.</p>
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3.2.2 Safety Assessment Check sheet for 105 KE activities.

<p style="text-align: center;">GENERAL CHECK SHEET HAZARDS IDENTIFICATION & MANAGEMENT of MAJOR ACTIVITIES ASSOCIATED WITH THE BASIN INTEGRITY TASK</p>		
Operation(s)	Potential Hazards	Assessment & Controls
<p>Some equipment must be relocated in discharge chute to protect the barriers from damage during an earthquake. This will be accomplished by moving equipment to center of chute. Selected encapsulation eqpt moves out of the discharge chute into the main basin. A single inner fuel element and portions of another will be removed from the discharge chute.</p>	Industrial Safety - Evaluate for electrical safety.	None.
	Industrial Safety - Evaluate for fire safety.	Minimal change in fire loading.
	Industrial Safety - Evaluate for crane operations safety.	Crane operations will be considered as critical lifts as added assurance that basin structure, racks, canisters and fuel will not sustain unacceptable damage.
	Industrial Safety (Hygiene) - Evaluate for activities which result in worker physical stress because the equipment or tools do not fit the worker well (ergonomics).	None.
	Industrial Safety - Evaluate for other considerations based on operator experience and knowledge of the plant.	None.
	Industrial Hygiene - Evaluate for potential toxic material exposure or release.	No toxic materials used.
	Radiation Exposure - Evaluate for potential As Low As Reasonably Achievable (ALARA) considerations.	Specific ALARA plan will be prepared for field work in each basin. Dominant exposure concerns result from activities in the main KE Basin because of routine high fields found there. Activities will center, as much as possible, around the discharge chute in a lower field region.
	Radiation Exposure - Evaluate for high radiation fields unshielded inadvertent criticality or inadvertent removal of the fuel from the water .	None anticipated. No fuel will be moved. The equipment to be used is light enough to preclude damage to fuel.
	Airborne material exposure - Evaluate for airborne radionuclides from radionuclides in suspension or solution in the basin water.	Suspension of radionuclides in the water is not required as part of this activity, nor is it likely. Several empty canisters may be removed from the main basin storage racks and the packager relocated to storage, resting on empty fuel storage racks. Dropping of equipment on canisters may damage fuel but additions to water would not be significant.
	Airborne material exposure - Evaluate for airborne radionuclides from work in surface contamination zones.	Standard ALARA procedures will be used for these activities consistent with other work that has recently been conducted in KE and KW basins. No work will be performed in surface contamination zones.
	Nuclear Safety - Evaluate the activity for the possibility that it exceeds the existing SAR (basis for USQ screening).	See Table 1 - Activities bounded by existing safety basis.

3.3 CLEANING AND SURFACING OF THE DISCHARGE CHUTE TO LIMIT THE REMAINING SOURCE TERM

Cleaning of the discharge chute in 105 KE will involve depositing activated hardware, debris, and fuel from the discharge chute into canisters and moving these canisters to other underwater locations in the main basin, as has been previously described as - encapsulation activities. The underwater cleaning of sealing surfaces (of the main basin walls at the entry to the discharge chute) for the barriers in both 105 KE and 105 KW will involve minor water jet cleaning or mild abrasives, such as wire brushing. All loose material must be displaced from these areas to ensure adequate sealing of the barriers. A basin water treatment system will be operational during these activities to minimize the levels of radionuclides present in the basin water.

3.3.1 Safety Assessment Check sheet for discharge chute cleanup activities.

GENERAL CHECK SHEET HAZARDS IDENTIFICATION & MANAGEMENT of MAJOR ACTIVITIES ASSOCIATED WITH THE BASIN INTEGRITY TASK		
Operation(s)	Potential Hazards	Assessment & Controls
Cleaning: 1) put activated hardware, debris and fuel from the discharge chute into canisters and moving these canisters to other underwater locations in the main basin 2) underwater cleaning of sealing surfaces	Industrial Safety - Evaluate for electrical safety.	None
	Industrial Safety - Evaluate for fire safety.	None
	Industrial Safety - Evaluate for crane operations safety.	Crane operations will be treated as critical lifts, if lift is over fuel or if it is over the basin and exceeds 800 pounds, to minimize damage potential to basin boundary and fuel.
	Industrial Safety (Hygiene) - Evaluate for activities which result in worker physical stress because the equipment or tools do not fit the worker well (ergonomics).	None
	Industrial Safety - Evaluate for other considerations based on operator experience and knowledge of the plant.	None
	Industrial Hygiene - Evaluate for potential toxic material exposure or release.	No toxic materials used
	Radiation Exposure - Evaluate for potential As Low As Reasonably Achievable (ALARA) considerations.	Specific ALARA plan to be prepared for field work in each basin. Dominant exposure will be from activities in the main KE Basin because of routine high fields found there.
	Radiation Exposure - Evaluate for high radiation fields unshielded inadvertent criticality or inadvertent removal of the fuel from the water .	Fuel handling has been performed annually for the past 10 years and crane usage is considered routine. Potential has been analyzed (see Table 1).
	Airborne material exposure - Evaluate for airborne radionuclides from radionuclides in suspension or solution in the basin water.	Some suspension of radionuclides in the water may occur but additions are not considered to be significant.
	Airborne material exposure - Evaluate for airborne radionuclides from work in surface contamination zones.	Standard ALARA procedures to be used for these activities consistent with other work that has recently been conducted in KE and KW basins. No work will be performed in surface contamination zones.

	<p>Nuclear Safety - Evaluate the activity for the possibility that it exceeds the existing SAR (basis for USQ screening).</p>	<p>See Table 1 - Activities bounded by existing safety basis.</p>
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3.4 INSTALLATION OF THE BARRIERS

The barriers will be moved outside of the basin along the reactor interface wall until they are above the entry location located in the discharge chute (see Figure 4). Once there, they will be lowered into the water in the discharge chute. They will then be suspended from the crane in an upright position, and moved through the discharge chute entry openings into the main basin. They will be moved only in an area from which fuel has been removed to assure that they are never over fuel canisters. They are then installed by attaching to Z-brackets which mate with the walls inside the discharge chute portion basin. (See Figure 2) At no point will the barriers or associated equipment be located above fuel.

Figure 4 - Sketch showing path which isolation barriers will follow during installation.

Water quality will be maintained in the discharge chute by continuous flow through the region. Piping will be provided to return treated water (less than 200 gpm) from the IXM to the chute. The water level will be allowed to rise several inches higher inside the discharge chute than in the main basin; it will overflow a weir (slot cut into the barrier) and return to the main basin. This system will be shut off during barrier installation to prevent difficulty in installing barriers across the entries, but will routinely operate there after.

Installation of the barriers will produce limited airborne emissions since the doors and hardware are uncontaminated prior to installation. The only potential source of emissions comes from filters and tools removed following installation. Normal practices (rinsing, bagging out, and monitoring) will be followed.

A leak rate test involving lowering the level in the discharge chute to effect a head across the barrier will be performed to confirm that leakage is within acceptable limits.

3.4.1 Safety Assessment Check sheet for barrier installation activities.

<p style="text-align: center;">GENERAL CHECK SHEET HAZARDS IDENTIFICATION & MANAGEMENT of MAJOR ACTIVITIES ASSOCIATED WITH THE BASIN INTEGRITY TASK</p>		
Operation(s)	Potential Hazards	Assessment & Controls
<p>1) Barriers moved near the basin until they are at entry location. Then lowered into the water and installed by attaching to brackets.</p> <p>2) Piping installed to return water from the IXM to the chute.</p> <p>3) Leak test establish head between main basin</p>	Industrial Safety - Evaluate for electrical safety.	None. No electrical modifications will be made to the facility. Existing outlets will be used for equipment.
	Industrial Safety - Evaluate for fire safety.	Minimal change in fire loading
	Industrial Safety - Evaluate for crane operations safety.	Crane operations required and will be treated as critical lifts, to minimize damage potential to basin boundary and fuel.
	Industrial Safety (Hygiene) - Evaluate for activities which result in worker physical stress because the equipment or tools do not fit the worker well (ergonomics).	None
	Industrial Safety - Evaluate for other considerations based on operator experience and knowledge of the plant.	A water safety protection program will be provided.
	Industrial Hygiene - Evaluate for potential toxic material exposure or release.	None
	Radiation Exposure - Evaluate for potential As Low As Reasonably Achievable (ALARA) considerations.	Specific ALARA plan to be prepared for field work in each basin. Dominant exposure will be from activities in the main KE Basin because of routine high fields found there. Some increase in field when discharge chute level is lowered, due to "bath-tub ring."
	Radiation Exposure - Evaluate for high radiation fields unshielded inadvertent criticality or inadvertent removal of the fuel from the water .	None, no fuel to be moved.
	Airborne material exposure - Evaluate for airborne radionuclides from radionuclides in suspension or solution in the basin water.	Because dropping of equipment on fuel canisters could damage fuel, fuel will be removed from the working areas prior to barrier installation. Additional airborne activity risk is not significant.
	Airborne material exposure - Evaluate for airborne radionuclides from work in surface contamination zones.	Standard ALARA procedures to be used for these activities consistent with other work that has recently been conducted in KE and KW basins. No work will be performed in surface contamination zones.
	Nuclear Safety - Evaluate the activity for the possibility that it exceeds the existing SAR (basis for USQ screening).	See Table 1 - Activities bounded by existing safety basis.

4.0 CONTINGENCY MANAGEMENT

It is expected that some changes to the above will be necessary as the work progresses. Such changes will be reviewed for impact to assess whether a) a major change in scope of work is involved, b) radioactive contaminants are being disturbed, c) the amount of hardware being inserted into or removed from the basin is affected,

and d) to determine whether the activity change poses an USQ.

5.0 SAFETY EVALUATION

The general check sheets identify general hazards resulting from identified activities. Table 1 identifies the accident/events addressed by the existing safety documentation, determines whether the accident/event is applicable to operations for described activities, and provides the basis for the determination that it is bounded by the existing safety basis.

Table 2 provides the response to the Unreviewed Safety Questions.

The hazard category of the activity is determined in accordance with DOE-SAD-1027-92, a supporting guide for DOE Order 5480.23, "Nuclear Safety Analysis Reports." This determination is based on a comparison of Threshold Quantities with the at-risk inventory consisting of the fuel, including transuranics and fission products, covered by the water in the basin. This form is used because all activities involving fuel or events/accidents on fuel are underwater. A conservative decontamination factor (DF) of 10⁴ is assumed. As allowed by DOE-SAD-1027-92, the threshold quantities provided by the standard can be divided by this value. The amount of fuel to reach the Cat 3 threshold is then calculated. The Cat 3 threshold quantity is 243 fuel assemblies (17 canisters). For fuel movement, only one canister is handled at a time and if drop would likely only damage the fuel in less than 4 other canisters. In addition there is no possible equipment drop that could impact 17 canisters. Hence, the amount of inventory of fuel that is at risk of contributing to airborne dose is less than the Cat 3 Threshold Quantities. Appendix A provides the calculations for this determination.

6.0 CONCLUSION

The hazard category of the activity has been as specified in DOE-SAD-1027-92, a supporting guide for DOE Order 5480.23, "Nuclear Safety Analysis Reports." is less than Cat 3.

The activities involved with installation of discharge chute isolation barriers to mitigate the seismic induced leakage from basin-reactor building construction joint have been reviewed for hazards. The identified hazards are controlled or mitigated by the existing systems or procedures or will be mitigated or controlled by implementation of existing administrative practices. No new hazards have been identified that have not been addressed by the existing safety basis documentation. The hazard category of the activity has been as specified in DOE-SAD-1027-92, a supporting guide for DOE Order 5480.23, "Nuclear Safety Analysis Reports." is less than Cat 3. The activities described, therefore, present no undo risk and also do not represent an unreviewed safety question.

7.0 REFERENCES

TABLE 1
SAFETY EVALUATION OF ACTIVITIES VS SAFETY BASES EVENTS/ACCIDENTS

Accident/Event (1)	Assumptions	Probability	Consequences (Remarks)	INVOLVES FUEL MOVE/BARRIER INSTALLATION (2)
1. Rail Car Fuel Spill - Criticality (SAR 8.1.1)	Contents of 3 casks spill and form a hemispherical configuration with optimal moderation and reflection.	10 ⁴ to 10 ⁴ "Not expected to occur during the lifetime of the facilities."	No criticality. Less than the necessary 169 elements for a criticality.	NO - FUEL NOT HANDLED OUT OF BASIN
2. Cask Fuel Spill - Criticality (SAR 8.1.2)	Contents of one cask spill into an optimally moderated and reflected hemisphere.	10 ³ to 10 ⁴ "Infrequent"	No criticality. Less than the minimum critical mass (169 elements).	NO - NO CASKS BEING USED
3. Canister Drop - Criticality (SAR 8.1.3)	1 over 3 storage configuration.	10 ³ to 10 ⁴ "Infrequent"	Spike fuel - Keff remains below 0.822. No criticality.	YES (for fuel movement only) - NO CHANGE
4. Broken Fuel Elements - Criticality (SAR 8.1.4)	Estimated 5% of total fuel is broken and 1% of the fuel has gone into solution immediately surrounding the fuel elements.	1 to 10 ³ "Anticipated"	No criticality.	YES - NO CHANGE
5. Water Loss and Partial Moderation - Criticality (SAR 8.1.5)	Loss of coolant water. Reduction in density of the cooling water.	10 ⁴ to 10 ⁴ "Not expected to occur during the lifetime of the facilities."	No criticality. The Keff for a partially moderated array is less than for a fully moderated array.	YES - NO CHANGE
6. Loss of Storage Array Geometry - Criticality (SAR 8.1.6)	Maximum storage array is 1 over 3. No storage of unirradiated fuel. No storage of Mark IA fuel in the west bays and no hanging fuel in the west bays.	10 ⁴ to 10 ⁴ "Not expected to occur during the lifetime of the facilities."	No criticality. The storage restrictions prevent a critical mass configuration.	No - NO HANGING FUEL
7. Well Car Drop Into the Fuel Storage Basin - Criticality (SAR 8.1.7)	Derailers, railstops and bumpers are utilized. Locomotive speed limited to 2 mph. No Mark IA and no hanging fuel in west bays.	< 10 ⁴ "Incredible"	No criticality. Measures noted in the Assumptions prevent critical mass formation.	NO - NO TRAIN AND WELL CAR REQUIRED, NO FUEL MOVEMENT OUT OF BASIN
8. Loss of Monitoring Instrumentation (SAR 8.2.1)	Annunciation of instrument loss in the Control Room	1 to 10 ³ "Anticipated"	No significant consequences. Immediate response procedures in place.	YES - NO CHANGE IN EVALUATION, WORK MAY NEED TO STOP BECAUSE OF RESPONSE PROCEDURES

TABLE 1
SAFETY EVALUATION OF ACTIVITIES VS SAFETY BASES EVENTS/ACCIDENTS

9. Liquid Waste Car Accident (SAR 8.2.2)	Spill from tank car loaded with low level waste water in transit to the 200 Area.	1 to 10 ⁴ From "Anticipated to Extremely Unlikely."	For low level waste release of a small quantity the consequences are minimal. For total release of a shipment, the consequences could be great. Not quantified.	NO - NO LIQUID WASTE GENERATED BY ACTIVITY
10. Crane Failure and Cask Dropped Into the Fuel Loadout Pit (SAR 8.2.3)	Fully loaded cask. Drop pulverizes the concrete beneath the cask. Percolation through the concrete slab and the soil are equal.	10 ³ to 10 ⁴ "Infrequent"	Leak of 2 gal. per min. to the soil. Environmental release is minimal due to under basin membrane and tile field.	YES - FOR LIFTS OF EQUIPMENT AND GATE CASK EVENT IS BOUNDING. (3)
11. Crane Failure and Cask Dropped Onto the Floor of Transfer Area (SAR 8.2.4)	Fully loaded cask (42 elements) drops 15 feet or more and overturns. The lid comes off and fuel spills out. Three broken elements per cask with break at a 45° angle. Fuel has been stored 150 days. 100% of the noble gases and 50% of the iodines are released as the only source term.	10 ³ to 10 ⁴ "Infrequent"	Site boundary dose: 7 X 10 ⁴ mrem whole body and 1.5 X 10 ⁴ mrem thyroid. (On-site dose - 16 mrem EDE 286 mrem limiting organ) (Off-site dose - 21 mrem EDE 386 mrem limiting organ)	NO - NO FUEL HANDLING OUT OF BASIN
11A. Crane Failure and Cask Dropped Onto the Floor of Transfer Area (Maximum Credible Accident) (SAR 8.2.4)	Cask fully loaded with broken fuel elements drops at least 15 feet, overturns and spills fuel out. Fuel is 150 days old. Only 100% noble gases and 50% iodines are released.	10 ⁴ to 10 ⁴ "Not expected to occur during the lifetime of the facility"	Offsite population exposure of 2 X 10 ³ mrem whole body and 4.5 X 10 ³ mrem thyroid doses. SEE ITEM 17 BELOW FOR A REANALYSIS OF THIS ACCIDENT.	
12. Loaded Canister Dropped from a Lifting Hoist to the Pool Floor (SAR 8.2.5)	Fully loaded canister dropped 3.5 feet.	10 ³ to 10 ⁴ (Not defined in SAR)	No leakage. There is no fracture of the cement slab.	YES (FOR FUEL HANDLING ONLY) - NO CHANGE CANISTER HANDLING WILL BE THE SAME
13. Fire and Explosion Hazard (SAR 8.2.6)	Noncombustible facilities. Adequate fire water supply. No ion exchange material regeneration.	TBD	None to very minimal. Hydrogen hazard in IXC and IXM being evaluated.	YES - NO CHANGE, NO UNUSUAL EXPLOSIVES OR COMBUSTIBLES

TABLE 1
SAFETY EVALUATION OF ACTIVITIES VS SAFETY BASES EVENTS/ACCIDENTS

14. Loss of Pool Coolant (SAR 8.2.7)	Total loss of pool water. Maximum of 5% of total fuel is damaged.	< 10 ⁴ "Incredible"	Release is less than 200 times that of the cask drop. (On-site dose - 3.1 mrem EDE 57.1 mrem limiting organ) (Off-site dose - 3.6 mrem EDE 77.1 mrem limiting organ)	YES - NO CHANGE
15. Uncontrolled Railroad Train (SAR 8.2.8)	Runaway train enters pool causing floor damage and leak of pool water. Derailers, railstops and bumpers in place and functional. Train speed controlled.	< 10 ⁴ "Incredible"	None since event is incredible. If credible, the leak would cause water loss and release of material.	YES - EQUIPMENT DELIVERY WILL BE BY VEHICLES MUCH LIGHTER THAN TRAIN AND CASK.
16. Sludge Criticality (SER 3.1.8)	0.95 fuel only stored in KE.	< 10 ⁴ "Cannot Occur"	Homogeneous sludge cannot become critical.	YES - BUT NO CHANGE
17. Crane Failure and Cask Dropped Onto the Floor of Transfer Area (Maximum Credible Accident) (SER 3.2.4 replaces SAR 8.2.4)	Cask contains 3 canisters (42 elements) of all broken fuel. Fuel is 10 years old and is 12% Pu fuel. On-site exposure is for 2 hours and the off-site exposure is 8 hours.	Maximum of 10 ⁴ "Not expected during plant lifetime."	On-site dose - 220 mrem EDE 4 rem limiting organ Off-site dose - 290 mrem EDE 5.4 rem limiting organ	NO - NO FUEL MOVEMENT OUT OF BASIN
17A. Cask Drop with 3 Canisters of Sludge	Sludge escapes ruptured canisters, dries and release radioactive materials. Sludge source term is 1985 sludge decayed 6 years.		On-site dose - 250 mrem EDE 4.7 rem limiting organ Off-site dose - 83 mrem EDE 1.6 rem limiting organ	
18. Loss of Off-site Power (SER 3.3.1 - SAR 5.3.3)	Total loss of power from offsite. Fuel handling operations cease with the power outage.	1 to 10 ⁴ "Infrequent to Anticipated"	Heating up of pool due to loss of cooling. Maximum temperature is 130°F after 60 hours. (Being re-evaluated for current fuel age)	YES - NO CHANGE

TABLE 1
SAFETY EVALUATION OF ACTIVITIES VS SAFETY BASES EVENTS/ACCIDENTS

19. Loss of Pool Cooling (SER 3.3.2 - SAR 5.3.3)	Loss of cooling with maximum heat load and no natural phenomena cooling. Initial temperature of 100°F and a maximum of 1.45 MW heat load.	1 to 10 ⁴ "Infrequent to Anticipated"	Heating up of pool to a maximum of 130°F after 60 hours. (Being re-evaluated for current fuel age)	YES - NO CHANGE
20. Design Basis Earthquake (SER 3.3.3 - SAR 2.5)	Maximum horizontal acceleration of 0.25 g with simultaneous vertical acceleration of 0.17 g.	2.0 X 10 ⁴	Basin leakage from either cracks in basin walls or at the construction joint between the basin and the reactor. Water loss is less than total. (See Item 44)	YES - CUTTING OF RACKS WILL NOT COMPROMISE SEISMIC CAPABILITY. (4)
21. Tornado (SER 3.3.4 - SAR 2.6)	Maximum wind speed of 175 mph.	6.82 X 10 ⁴	Failure of wall and roof panels. Steel frame remains intact.	YES - NO CHANGE
22. Floods (Probable Maximum Flood) (SER 3.3.5 - SAR 4.3)	Reaches 423 feet above mean sea level.	(SDC 4.1 Design Basis Flood)	Loss of raw water (pumps submerged).	YES - NO CHANGE
23. Ashfall (SER 3.3.6 - SAR 4.6)	Maximum depth of 6 inches followed by heavy rain.	1 to 10 ⁴ "Infrequent to Anticipated"	Roof loading of 25 lb/ft ²	YES - NO CHANGE
24. Low/No Flow of Service Water (SER 3.4.1)	Pipe break causes basin overflow at KE. Flow is 2000 gpm to the basin. 8 hours to respond.	Low probability	Discharge of 90,900 gal. to the river via 1908-K outfall and formation of a 5.4 acre shallow (3 in. deep) lake at KE. Total off-site dose of 4.1 E-1 mrem/yr. and 3.4 mrem/yr on-site dose at 100 meters.	YES - NO CHANGE
25. Fuel Storage Basin Water Level Low (SER 3.4.2)	See items 5 and 14.	10 ⁴ to 10 ⁴	See item #s 5 and 14	YES - NO CHANGE
26. Fuel Storage Basin Water Level Very Low or None; Fuel Storage Basin Leakage Catastrophic (SER 3.4.3)	See items 5, 14, 18, 19 and 20.	10 ⁴ to 10 ⁴	See item #s 5, 14, 18, 19 and 20.	YES - NO CHANGE

TABLE 1
SAFETY EVALUATION OF ACTIVITIES VS SAFETY BASES EVENTS/ACCIDENTS

27. Fuel Storage Basin Temperature Very High (SER 3.4.4)	See items 18 and 19.	10^3 to 10^4	See item #s 18 and 19.	YES - NO CHANGE
28. Fuel Storage Basin Leakage (SER 3.4.5)	See items 5 and 14	10^4 to 10^5	See item #s 5 and 14.	NO CHANGE TO 5 OR 14
29. Contaminated Building Atmosphere (SER 3.4.6)	Canister removed from basin with unnoticed fuel assembly. Hoist fails in "on" position. Evacuation of the basin and impacted areas.	$< 10^4$ "Not expected to occur during the life of the facility."	On-site dose: 5 mrem EDE 90 mrem limiting organ Off-site dose: 7 mrem EDE 130 mrem limiting organ	Yes - No change
30. Confinement of Gaseous Radiolysis Products (SER 3.4.7)	Radiolysis of sludge in basin and of canister contents.	Sludge - $< 10^4$ "Incredible" Canister-Not Defined	No consequences for sludge since it is incredible. Canister seal will leak at 100 psi and release gases.	Yes - No change
31. Nitrogen Cylinder Rupture (SER 3.4.8)	Rupture of cylinder and formation of missile impacting fuel.	$< 10^4$ "Incredible"	No longer credible. Bottles have been moved out of basin.	No - No pressurized gases required
32. Oxidation of Uranium Hydrides - Failure to Add Corrosion Inhibitor (SER 3.4.9)	Corrosion inhibitor not added to canister. Hydration of uranium has occurred.	$< 10^4$ "Incredible"	None, the event is incredible.	Yes - No change
33. Release of Chlorine (SER 3.5.1)	Chlorine released from KE Water Treatment Facility.	TBD	Being re-evaluated due to modification and upgrade of chlorine system.	Yes - No change
34. Release of Sulfuric Acid/Sodium Hydroxide (SER 3.5.2)		$< 10^4$ "Incredible"	None. Sources have been removed.	No - No acids/bases required
35. Sulfuric Acid or Sodium Hydroxide Solution Sent Directly to Basin (SER 3.5.3)		$< 10^4$ "Incredible"	None. Sources have been removed.	No - No acids/bases required
36. OSR Fissile Mass Limits - Addition of Sludge to Open Canisters (SER 3.6.1)	Sludge canister spill into a loaded fuel canister.	10^3 to 10^4 "Infrequent"	Reduces reactivity.	Yes - KW has closed canisters, no fuel canister movement at KE. Fuel movement in KE limited to 1 & 1/2 fuel slug plus limited sludge.

TABLE 1
SAFETY EVALUATION OF ACTIVITIES VS SAFETY BASES EVENTS/ACCIDENTS

37. Keff 0.98 vs 0.95 (SER 3.6.2)	NA	NA	Non concern. Evaluation and resolution sent to Tiger Team.	No -Issue resolved
38. DBE Basin Water Level (SER 3.6.3)	See item #s 14 and 20.	2 X 10 ⁴	See item #s 14 and 20.	Yes - Evaluated by #14 & # 20
39. Spent Ion Exchange Shipment for Burial (SER 3.6.4)	NA	NA	Tiger Team item - resolution submitted.	Yes - No change
40. Basin Leakage Monitoring (SER 3.6.5)	NA	NA	Tiger Team item - resolution submitted.	Yes - No change
41. Release of Ion Exchange Medium (SER 3.6.6)	Drop of one IXM from crane or drop of two IXC's from crane. Release of 1% of the radioactive inventory from the resin.	10 ³ to 10 ⁴ "Unlikely Event"	Being re-evaluated with revised source terms. Previous analysis had results of: On-site does: 1.9 mrem EDE 28 mrem limiting organ Off-site dose: 0.92 mrem EDE 8.6 mrem limiting organ	Yes - No change
42. Clearwell Integrity During DBE (SER 3.6.7)	Loss of clearwell due to DBE.	2 X 10 ⁴	Loss of coolant makeup water. No significant basin impact. (Credit no longer taken)	No - No credit for integrity of Clearwell during DBE
43. Ventilation Stack Failure (SER 3.6.8)	Stack failure due to aircraft striking it.	< 10 ⁷ "Incredible"	Upper part of stack impacts basin.	No - No affect on stack
44. Unsupported Basin Construction Joint (SER 3.6.9)	No rebar or doweling across joint.	2 X 10 ⁴	Leak rate less than the ability to makeup. Leak rate from failure of 17 sq. ft. area of the basin floor is 2 gpm. (Being re-evaluated in conjunction with DBE review.)	Yes - Until isolation barrier installed no change in potential affect on basin water level.

- (1) SAR - Safety Analysis Report Irradiated N Reactor Fuel, WHC-SD-WM-SAR-062 REV 1.

SER - Safety Evaluation of Fuel Encapsulation in the 105-KE Storage Basin, WHC-SD-TA-020 REV 0. Also contained in Addendum 1 of SAR.

N.N.N - Refers to section of SAR or SER.

- (2) Applicability is for all activities unless otherwise noted.

- (3) The existing accident analysis reference by the SAR, UNI-287, "Extreme Load Analysis of the 100K Fuel Storage Basins and Clearwells", evaluated the consequences of dropping a fully loaded fuel canister, 728 lbs, on the 2 ft thick basin floor from a height of 3.5 ft. The energy of the falling canister, just before impact, would be about 2290 ft-lb, allowing for bouyancy effects. The maximum impacting force would be 68,500 lb which is less than the punching shear resistance of the concrete of 291,320 lb. For this drop no damage to basin is sustained.

A 25 foot drop of a transfer cask which weighs 48,000 lb will result in fracture of the basin floor, however leakage would be limited such that water make up can be effected before there is significant reduction in water level.

For the activities involving isolation barrier installation the maximum weight object would be the gate portion of the barrier with a weight of less than 2700 lbs. Using the same velocity values as for the fuel canister the impacting force would be 0.87 of the resistance. The drop height of the gate could be higher but because of its shape would likely sustain deformation which would reduce the impact force. Therefore damage to fuel basin is not likely to be sustained by equipment drops and in any case any damage would be much less than that of a cask drop. In addition such lifts will be handled as critical lifts which makes the probability of drops very small.

Drops on the fuel in racks will damage fuel but would be limited to a few canisters. Such damage could result in additional spread of radioactive materials to the water. Because the corrosion rates are slow the amount added would not be significant to that already in the water. The additional airborne radioactivity would thus also not be significant.

- (4) Refer to ECN 610292/610293, Prepare Isolation Barrier Location for Doors KE/KW.

TABLE 2
USQ EVALUATION

1	Does the proposed activity increase the probability of occurrence of an accident previously evaluated in the safety basis?	NO
	Basis: The handling of the fuel is the same as was done in the past so there should be no difference in probability of canister drop or lifting of fuel to basin surface. The activity involving other equipment with the potential for damage to safety structures are one or two time activities with special lift requirements such that the probability of a drop should be vanishingly small ($> 10^4$). For other applicable accidents identified in Table 1 there is no change in operation thus no change in probability.	
2	Does the proposed change increase the consequences of an accident previously evaluated in the safety basis?	NO
	Basis: The drop accidents are all bounded by the existing safety basis as indicated in Table 1. For other applicable accidents there is no change.	
3	Does the proposed activity increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the safety basis?	NO
	Basis: The only potential malfunctions are to the basin structure and fuel racks that would be caused by drops. These were addressed by 1 above.	
4	Does the proposed activity increase the consequences of a malfunction of equipment important to safety previously evaluated in the safety basis?	NO
	Basis: The only potential malfunctions are to the basin structure and fuel racks that would be caused by drops. These were addressed by 2 above.	
5	Does the proposed activity create the possibility of an accident of a different type than any previously evaluated in the safety basis?	NO
	Basis: The general check sheets for hazard identification did not identify any different accidents.	
6	Does the proposed activity create the possibility of a malfunction of equipment important to safety previously evaluated in the safety basis?	NO
	Basis: Only mechanical damage to basin structure and fuel racks was identified and these are addressed by existing safety basis.	
7	Does the proposed activity reduce the margin of safety as defined in the basis for any Technical Safety Requirement?	NO
	Basis: No technical safety requirement(OSR) is impacted by the described activities.	

APPENDIX A
CALCULATION OF THRESHOLD QUANTITIES WITH WATER DF OF 10⁴

			Cat 3	Cat 2		
			Threshold	Threshold	Cat 2	Cat 3
Isotope	Ci/MTU	Ci/Element	Ci	Ci	Ratio	Ratio
Pu-236*	2.20e-04	4.99e-06	5.20e-01	5.50e+01	9.07e-08	9.60e-06
Pu-238	4.80e+01	1.09e+00	6.20e-01	6.20e+01	1.76e-02	1.76e+00
Pu-239	1.10e+02	2.49e+00	5.20e-01	5.60e+01	4.45e-02	4.80e+00
Pu-240*	5.80e+01	1.32e+00	5.20e-01	5.50e+01	2.39e-02	2.53e+00
Pu-241	4.40e+03	9.98e+01	3.20e+01	2.90e+03	3.44e-02	3.12e+00
Pu-242	2.10e+02	4.76e+00	5.20e-01	5.50e+01	8.66e-02	9.16e+00
Am-241	9.30e+01	2.11e+00	5.20e-01	5.50e+01	3.83e-02	4.06e+00
Cm-244*	4.60e+00	1.04e-01	5.20e-01	5.50e+01	1.90e-03	2.01e-01
Eu-154*	8.80e+01	2.00e+00	5.20e-01	1.10e+05	1.81e-05	3.84e+00
Cs-134	1.30e+02	2.95e+00	4.20e+01	6.00e+04	4.91e-05	7.02e-02
Cs-137	7.30e+03	1.66e+02	6.00e+01	8.90e+04	1.86e-03	2.76e+00
Ce-144	2.80e+01	6.35e-01	1.00e+02	8.20e+04	7.74e-06	6.35e-03
Pr-144*	2.80e+01	6.35e-01	1.00e+07	4.30e+05	1.48e-06	6.35e-08
Pr-144M*	3.30e-01	7.48e-03	1.00e+07	4.30e+05	1.74e-08	7.48e-10
Pm-147	2.00e+03	4.54e+01	1.00e+03	8.40e+05	5.40e-05	4.54e-02
Sb-125	1.20e+02	2.72e+00	2.10e+02	4.30e+05	6.33e-06	1.30e-02
Te-125M*	3.00e+01	6.80e-01	2.10e+02	4.30e+05	1.58e-06	3.24e-03
Ru-106	5.20e+01	1.18e+00	1.00e+02	6.50e+06	1.81e-07	1.18e-02
Sr-90	5.80e+03	1.32e+02	1.60e+01	2.20e+04	5.98e-03	8.22e+00
Y-90*	5.80e+03	1.32e+02	2.10e+02	4.30e+05	3.06e-04	6.26e-01
				Totals	2.56e-01	4.12e+01
Number of elements to exceed Hazard Category 2 or 3 Threshold					3.91	0.02
No of elements to Cat 2 Threshold with DF of 10,000					39130	
No of canisters to Cat 2 Threshold with DF of 10,000					2795	
No of canisters to Cat 3 Threshold with DF of 10,000						243

No of canisters to Cat 3 Threshold with DF of 10,000				17
Cat 2 Threshold from DOE-SAD-1027-92				
Cat 2 or 3 ratio is Ci/Element divided by Threshold Ci				