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7. Abstract <p>The purpose of this report is to provide an information summary for the 100-K Area fuel storage basins design change. The design change was made to resolve a USQ related to potential water leakage from the basin following a design basis earthquake.</p> <p>The design change consists of installing isolation barriers in the K-East and K-West Basins. The barriers are installed in each basin to isolate the fuel storage portion of the basin from the location of the potential seismic induced leak.</p> <p>The summary represented by this report provides information on the issue, the courses of corrective action, the technical work to support the corrective action, and the fabrication, installation, testing of the isolation barriers.</p> <p style="text-align: center;">DISCLAIMER</p> <p>This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.</p>		
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K BASINS ISOLATION BARRIERS

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Rev. 0

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NOTE

The initial release of this report as Rev. 0 is an interim issue. Although the purpose of this report is to document the total range of activities associated with the K Basin Isolation Barriers design modification, there are areas where further information is needed. This information is largely that which will become available when procurement, fabrication, and installation reports are finalized and released and post-installation testing is completed. Section 1.4 lists information that will be incorporated in a later revision of this report. The activities leading up to this point are documented in draft OE of the report. This information has received a "90-percent" completion independent technical review by a review committee chaired by John Dearing. The review committee comments have largely been incorporated into this Rev. 0 document. The current information in draft OE is considered to be sufficiently mature to issue the document as Rev. 0.

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TERMS

AEA	<i>Atomic Energy Act of 1954</i>
CFR	<i>Code of Federal Regulation</i>
DBE	design basis earthquake
DOE	U.S. Department of Energy
FR	<i>Federal Register</i>
IXC	ion exchange columns
IXM	ion exchange modules
KE	K-Reactor East Basin
KW	K-Reactor West Basin (collectively K Basins)
NRC	U. S. Nuclear Regulatory Commission
PUREX	Plutonium-Uranium Extraction (plant)
QAP	Quality Assurance Program
SAR	safety analysis report
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>
UOR	unusual occurrence report
USQ	unreviewed safety question
WHC	Westinghouse Hanford Company

K-BASINS ISOLATION BARRIERS SUMMARY REPORT

I. INTRODUCTION

This report provides an information summary for the 100-K Area fuel storage basins design change. The design change was made to resolve an unreviewed safety question (USQ) related to potential water leakage from the basins following a design-basis earthquake (DBE).

The design change consists of installing isolation barriers in the East and West K Reactors Basins (KE and KW). The barriers are installed in each basin to isolate the fuel storage portion of the basin from the location of the potential seismic-induced leak.

This summary provides information on the issue, the courses of corrective action, the technical work to support the corrective action, and the fabrication, installation, and testing of the isolation barriers.

1.1 SUMMARY OF ISSUE

Underwater storage of reactor irradiated fuel is provided by the KE and KW Basins. The basins' safety function is to maintain minimum water coverage over the irradiated fuel. The storage of spent fuel in the K Basins has been identified by the U.S. Department of Energy (DOE) as a priority safety concern. These basins were designed for interim storage of spent fuel following its discharge from their respective reactors until its transfer to the Plutonium-Uranium Extraction (PUREX) plant for chemical processing. The K West reactor was permanently shut down in February 1970, the K East reactor in February 1971. Except for a few loose pieces, fuel stored in the basins at that time was shipped to the 200 East Area for processing. The basins were then idle, but were kept filled with water. The basins were modified (KE in 1975 and KW in 1981) to provide for the storage and handling of N-Reactor fuel. The storage and handling of N-Reactor fuel was also viewed as interim storage. However, in December 1992, the DOE directed that the PUREX plant be shut down and deactivated because it was no longer needed to support the nation's weapons-grade plutonium production. With the closure of PUREX, fuel waiting for processing was returned to the K Basins for storage pending final disposition. The DOE has committed to remove all the fuel and sludge from the basins by the year 2002 (in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1994).

Until the fuel and sludge can be appropriately removed from the basins, the DOE is ensuring that the storage facilities are adequate to perform their safety function. Westinghouse Hanford Company (WHC), recognizing that the basins would now be used to store fuel for longer than originally envisioned, evaluated the structural integrity of the K Basin facilities. This evaluation involved reconsidering previous analyses performed to earlier standards against modern techniques.

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A recent series of dynamic seismic analyses performed on the reactor building/basin structures involved more stringent requirements than those in the original design evaluation and within the current facility authorization basis. From the results of these analyses, WHC determined that previous conclusions about the integrity of the K Basins following a design basis earthquake (DBE) did not take into account potential effects from the dynamic analyses.¹

Potential leakage from the basin is an evaluated accident in the safety analysis report (SAR) (Reference VII 7.2). Specifically, Section 5.3.3.2 of the K Basins SAR, establishes an upper limit leak rate of 5,680 liters per hour (lph) [1,500 gallons per hour (gph)]. This leakage is associated with a cask-drop event. This leak rate limit is stated to bound anticipated leak rates from other events.

The dynamic seismic analysis raised questions about the performance of the construction-joint water seal to restrict potential leakage to within this limit. The construction joint is located in the floor and walls of the discharge chute, an area adjacent to the fuel storage basin. The technical challenge to define the performance of the joint/flexible water seal under dynamic seismic conditions was found to be complex and the results were difficult to substantiate. It could not be shown with the necessary degree of assurance that a dynamic seismically induced leak through the discharge chute construction joint water seal would not exceed the SAR bounding leak of 5,680 lph (1,500 gph). Also, WHC concluded that further technical efforts to quantify the potential leak would not be conclusive. Estimated leakage for an assumed failure of the water seal was between 18,930 and 94,635 lph (5,000 and 25,000 gph). Even with makeup water capability, as assumed under the SAR accident analysis, this leak rate significantly challenges the basins' capability to maintain fuel coverage.

Consistent with DOE requirements, WHC evaluated this new information and determined that the dynamic seismic analysis results could indicate a condition that was outside the facility authorization basis. Pursuant to DOE Order 5480.21, *Unreviewed Safety Questions*, WHC evaluated the potential to experience a leak in excess of the SAR limit to determine whether an USQ existed. WHC concluded that, in addition to potentially exceeding the SAR limit, the accident scenario could challenge the capability of the system to maintain fuel coverage following the seismic event. Although the postulated seismic event has a low probability, its potential consequences could be high. Under these circumstances, and based on the guidance in DOE Order 5480.21, WHC determined that a USQ existed. WHC promptly advised the DOE of its determination through an unusual occurrence report (UOR).

¹ WHC considers a seismic event to have a low probability, but the damage from such an event would have potentially serious consequence.

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WHC then developed an action plan to resolve the USQ (Reference VII 7.3). The action plan included planning for short-term mitigation activities and long-term resolution of the issue. A value engineering team was assembled and numerous possible short- and long-term solutions were generated and evaluated. Short-term mitigation included arranging to provide materials that could be used to seal the opening in the construction joint immediately when a large leak was discovered, and arranging to provide makeup water from the Columbia River using portable diesel-powered generators and pumps. Of the possible long-term solutions, WHC chose to use isolation barriers to seal the two openings between each fuel storage basin and discharge chute. This involved fabricating two sets of barriers (one set each for KE and KW). Each set can survive a DBE. Cofferdams of similar design were used successfully several years earlier to allow work to be performed in the discharge chute area of the KW basin.

A safety assessment of the addition of the isolation barriers was performed and is included as Appendix D. The assessment concluded that installing the isolation barriers would introduce no new hazards. Consequently the activities associated with installing the barriers present no undue risk and do not represent an USQ.

Short-term mitigation actions were taken immediately and will remain in place until the isolation barriers have been installed. The final solution to issues relating to K Basin seismic integrity is to remove the irradiated fuel materials from the basins.

1.2 CONTENT OF SUMMARY REPORT

As documented in Reference VII 7.3, WHC developed an action plan to resolve the identified USQ. The plan consists of four key elements:

- Initiate immediate actions, as appropriate, to mitigate the consequences of an accident before final resolution
- Conduct appropriate detailed analyses to fully characterize the nature of the USQ
- Use outside experts to assist in the evaluation and validation of resolution actions
- Design, fabricate, and install the hardware modification.

The hardware design modification is to install isolation barriers in the entry channels between the discharge chute pit and storage basin area. The barriers are designed to survive not only the initial earthquake, but also the aftershocks. While installing the isolation barriers will not prevent the potential leakage from the discharge chute area, it will isolate the storage basin from the discharge chute so that if the construction joint opens, water will not be lost from the basin.

K-BASINS ISOLATION BARRIERS SUMMARY REPORT

The Summary Report provides documentation of the technical evaluations, design, analysis verification, fabrication, installation, and testing of the basin design modification.

1.3 ORGANIZATION OF SUMMARY REPORT

This summary report provides an overview of the design change implemented to resolve the K Basins construction joint seismically induced leak issue.

Section II describes the systems associated with the K Basins including the basin structure, the discharge chute, and supporting systems. The design and function of the isolation barriers are also described in this section.

Section III discusses the methods used to resolve the basin leakage issue. This section begins with a review of the regulatory requirements (upper tier requirements) that govern the basin design, maintenance, and operation and that would apply to the isolation barriers. Next, the section covers the methods used to develop and evaluate optional approaches to both the short- and long-term resolution of the issues and the process used to select the best option. The section also discusses the design criteria for the isolation barriers and how the design process ensures compliance with these criteria. Because two isolation barriers were fabricated to facilitate possible work on the KE discharge chute area before the USQ was identified, the acceptability of the existing isolation barriers had to be evaluated against the current criteria. This discussion also is found in Section III. Finally, Section III describes the process for fabricating the new isolation barriers.

Section IV explains the procedures used to install the isolation barriers and the post-installation testing performed to ensure that the barriers will fulfill their intended function. With the barriers installed, the basin systems will need to be operated differently because the barriers isolate the discharge chute area. Section IV also describes the operation of the systems, as well as the inspection and maintenance procedures that will be used during the life of the barriers to ensure that they continue to meet the leak integrity requirements.

Section V provides the conclusions arrived at regarding the long-term resolution of the USQ.

Section VI summarizes the technical tasks. Further details about these tasks are listed in the references, Section VII.

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1.4 Future Information to be Added to the Report

The summary report will be revised to include information that was not available at the time Rev. 0 was issued. This information covers:

- Finalization and signoff of the dedication program, materials procurement, and fabrication records
- Installation method and results
- Post-installation testing of the isolation barriers
- In-service inspection and facility operation.

The information to be available later corresponds with the following report sections:

- 4.2 Post-Installation Testing and In-Service Inspection of Isolation Barriers
- 4.3 Facility Operation
- 6.5.2 Shop Travelers
- 6.5.3 Fabrication Records
- 6.6.1 Installation Plan
- 6.6.2 ALARA Review
- 6.6.3 Installation Procedures
- 6.6.4 Baseline Leak Test Report
- 6.6.5 Baseline ISI Report.

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II. SYSTEM DESCRIPTIONS

Section II describes the K Basins structure and supporting systems in Paragraph 2.1. Paragraph 2.2 describes the isolation barrier system.

2.1 K BASIN STRUCTURE AND SYSTEMS

The KE and KW Basin facilities are designed to provide underwater storage for irradiated reactor fuel.

Main Basin

In the context of this system, the basin structure consists of the entire concrete pool that retains the water covering the fuel. Both the KE and KW fuel storage basins are rectangular, reinforced concrete basins located below ground level. The basins are approximately 38.1 m (125 ft) long, 20.4 m (67 ft) wide, and 6.4 m (21 ft) deep with a nominal 4.9-m (16-ft) water depth. The rectangular main basin is subdivided into three equal sections by two concrete walls that run north and south for most of the width of the basin. There are openings between the dividing walls and the basin wall at each end of the dividing wall. See Figure II-1.

The KE basin can only store fuel of lower enrichment while the KW basin can store fuels of both higher and lower enrichments. Fuel in the KE basin is stored primarily in open canisters but only fuel in sealed canisters is stored in the KW basin.

The main basin is constructed with a subbasin leak collection system that collects any water that may leak through the main basin floor.

The significant differences between the KW and KE basins are:

- The KW Basin is coated with an epoxy sealant that was pliable when installed
- The fuel elements stored in the KW Basin are encapsulated in closed canisters; the KE Basin storage racks contain open canisters of fuel elements
- The KW Basin has a canister decapping station located in the transfer canal between the load-out pit and the basin's west bay
- The walls of the KW Basin taper, thinning from bottom to top; KE has uniformly thick sidewalls.

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Figure II-1. Configuration of the K-Basins.

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Discharge Chute

An area known as the discharge chute is connected to the south side of the rectangular main basin. The discharge chute is the area where fuel elements discharged from the K reactor were collected. The discharge chute encompasses a region of basin water approximately 16.2 m (53 ft) long by 2.7 m (9 ft) wide. The discharge chute has been used for conducting fuel segregation work. See Figure II-2.

The discharge chute is separated from the main basin by a freestanding wall or island. The wall is approximately 12.8 m (42 ft) long and 1.8 m (6 ft) thick. The top of the wall is at the same elevation as the grating that forms the floor surface at the working level of the main basin. The north surface of the island is common with the surface of the main basin south wall. At the east and west ends of the island are channels or openings to provide access from the main basin to the area between the south surface of the island wall and the rear wall of the discharge chute. These openings provide for transport of discharged fuel from the reactor discharge chute to the basin for storage.

The discharge chute contains a construction joint between the basin structure and the reactor structure. This unreinforced joint between construction pours runs the length of the discharge chute. The construction joint has a neoprene water stop, which has leaked in the past. The drainage collection system for the basin does not extend below the discharge chute and associated construction joint. Leakage through this water stop would be released to the ground. See Figure II-3.

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Figure II-2. K-Basin Elevation.

K-Basin Elevation View

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Figure II-3. Fuel Storage Basin.

M94J9C21.3

Top view showing isolation of the discharge chute, which is the location of the construction joint, from the main basin. Isolation at this location would limit leakage in the event an earthquake opens the construction joint. The water level in the main basin would remain at normal levels, ensuring continued coverage of irradiated fuel in the basin.

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Basin Leakage Collection

Both basins have under-basin leak collection systems. Each collection system is composed of an asphalt membrane and a collection field. However, the asphalt membrane and collection field do not extend under the discharge pickup chute area. The contaminated effluents are routed from the collection field to a sump. This sump is at the bottom of a 20-cm- (8-in.)-diameter steel-lined caisson located on the outside of the building on the north side. The sump uses two 227-lpm (60-gpm) sump pumps located about 7.6 m (25 ft) below ground level. The sump pumps return collected drainage water to the basin or to a radioactive waste holding tank. The pumps are equipped with electrical controls that alternate the pumping cycle from one pump to the other. It can operate both pumps in the unlikely event that the demand exceeds the capacity of one pump. An epoxy sealant has been applied to the floor and walls of the KWBasin to further limit leakage. Leaks from the discharge chute area of the basins will not be intercepted by the under-basin collection system.

Water Makeup

A demineralized water system is used to treat service water for use as makeup water for the fuel storage basins. The system is a commercial ion anion and cation exchange package. Each basin has an identical unit. The rating of each system is 45 lpm (12 gpm). When the cation and anion material is saturated, the tanks are collected by the vendor and replaced with fresh tanks.

Another source of demineralized water is available when larger amounts of water are needed. Water can be delivered to the K Basins at 190 lpm (50 gpm) through existing piping from a 90,850 l (24,000-gal) storage reservoir in the 1706K Building.

A large underground storage structure, commonly called the clear well can supply 5,680 lpm (1,500 gpm) of filtered emergency makeup water to the cooling pool to recover from an abnormal reduction in water level. The clear well can contain approximately 3.4×10^7 l (9.0×10^6 gal) of treated water. If electrical power is lost to the area (only one source of power is available), portable pumps or fire trucks can be used to supply water from the clear well. Alternatively, if the clear well is unavailable, water can be drawn directly from the Columbia River.

Basin Water Recirculation System

Three 15-cm (6-in.) suction lines (one in each bay) are located along the north side of the basin. The suction lines reach to approximately 3.8 m (12 ft, 6 in.) above the basin floor.

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Each line has independent valving so the desired amount of water for recirculation can be selected from each bay. These lines manifold into a 20-cm (8-in.) line that goes to the suction sides of two self-priming 2,083-lpm (550-gpm) recirculation pumps. One pump is used during normal operation resulting in a recirculation flow of approximately 1,893 lpm (500 gpm).

Water is discharged from the pumps through a cartridge-type filter, then flows through the chillers and back to the south side of the basin. Each of the three bays has a discharge line equipped with a valve and a flow meter. The recirculation system also can provide water to the ion exchange columns to discharge into the east bay. Three ion exchange columns, each with 189 lpm (50 gpm) capacity, operate in parallel for a total flow capacity of 568 lpm (150 gpm).

Basin Cooling

Each basin has a forced-circulation cooling system to remove the decay heat generated by the irradiated fuel stored in the basin. The cooled water also reduces leaching of radioisotopes from the fuel elements and results in decreased airborne activity in the basin area.

A 60-hour quiescent cooling period (no forced circulation or addition of coolant) for a basin full of fuel was established as a design basis. The 60-hour period provides sufficient time to bring in emergency engine-driven pumps for make-up of level loss caused by evaporative cooling. This cooling period, established in 1977, was based on the 150-day-old fuel, and a maximum water temperature of 54.4 °C (130 °F). As of 1994, the fuel has decayed for from 7 to 23 years. Therefore, the current decay heat is several orders of magnitude less than the design-basis decay heat. Basin heat loads are such that the quiescent cooling period with the current basin water temperature limit of 37.8 °C (100 °F), is essentially infinite [test without cooling achieved an equilibrium temperature of lower than 21.1 °C (70 °F)].

The water cooling system is equipped with an air-cooled chiller. The air-cooled chiller is used during normal operation of the water cooling system. The basin water temperature is maintained at between 7 and 10 °C (45 and 50 °F).

The recirculation system draws water from the three cooling-pool sections through a common header to the suction side of the recirculation pumps. The water is then pumped through a 5- μ m disposable cartridge-type filter to the air-cooled chiller heat exchanger and returned to the cooling pool.

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Basin Water Cleanup System

The basin water cleanup system is designed to maintain water quality and clarity and to control the concentration of soluble and particulate radioactive material in the water. Controlling the radionuclide concentration helps to reduce personnel radiation exposure.

The basin water treatment system consists of the following components:

- Skimmer pump
- Sand filter
- Ion exchange modules (IXM)
- Ion exchange columns (IXC).

All these components, except the IXC, are supplied by water from the basin skimmer pump. The skimmer pump, sand filter, and IXMs are referred to as the IXM or skimmer pump system. This system treats the water that is drawn from the surface of the fuel storage basin.

Basin water enters the IXM system through three adjustable, screened weirs located along the north wall of the basin. The single skimmer pump with a capacity of 1,514 lpm (400 gpm) draws water from the weirs and pumps it to the sand filter. After passing through the sand filter, a portion of the water is routed through one or two of the IXMs [606 lpm (160 gpm) capacity each] before being returned to the basin. The IXMs are filled with ion exchange resin and are configured to operate in parallel with each other. The IXMs remain in service until their resins no longer effectively remove radionuclides from the basin water. At that time they are replaced. The spent IXMs are disposed of as a complete unit, which serves as its own disposal container.

The basin recirculation system includes the recirculation pumps, water-cooled or air-cooled chiller, ion exchange columns, cartridge filters, and the necessary valves and piping. The recirculation system draws water from the three cooling-pool sections through a common header to the suction side of the recirculation pumps. The water is then pumped through a 5- μ m disposable cartridge-type filter to the water-cooled or air-cooled chiller heat exchanger and returned to the cooling pool. Up to 568 lpm (150 gpm) of the discharge passes through the ion exchange columns before returning to the pool.

Water is supplied to the IXCs through a common header connected to the recirculation system. The IXCs are ASME tanks filled with ion exchange resin by plant personnel. The IXCs operate in parallel. Each column has a capacity of 190 lpm (50 gpm), providing a total capacity of 568 lpm (150 gpm) with all

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columns in operation. When the resin is depleted, the tanks can be removed individually and disposed of as a complete unit. Flow from the ion exchange system is discharged into the cooling pool through return piping.

Water for the second basin recirculating system is drawn from the cooling pool through the skimmer to the suction side of the skimmer pump, then pumped through the sand filter and the IXM, then back into the basin. A settling pit for backwash water is included with the sand filter system.

Basin Water Level and Temperature

Instrumentation is provided to measure the pool water level and to alarm on a high- or low-water-level condition. A high- or low-level alarm is annunciated in both facility control rooms.

Pool temperature is monitored and recorded in the facility operations offices. High temperature will cause an alarm to sound.

Shielding

With 2.4 m (8 ft) of water covering the irradiated fuel, the radiation dose rate from the fuel was calculated to be less than 10,000 Su/hr (1.0 Mr/hr). However, the irradiated N Reactor fuel is stored in the KE and KW basins with a nominal 4.9 m (16 ft) of water, which is twice the calculated coverage. The water provides scrubbing, which significantly reduces the release of radioactive materials to the environment, and shielding, which limits the radiation exposure in the work area.

Measured above the basin, radiation dose rates from all sources are approximately 200,000 Su/hr (20 mrem/hr) at K Basin East and less than 10,000 Su/hr (1 mrem/hr) at K Basin West.

Basin Ventilation

The basin ventilation system consists of four roof-mounted centrifugal exhaust fans and two evaporative coolers. The exhaust fans are controlled from a switch station located on the east side of the south wall of the basin. The nominal rating of the exhaust fans varies from 198 m³/min to 283 m³/min (7 to 10 Kft³/min). The two roof-mounted evaporative coolers have a nominal rating of 283 m³/min (10 Kft³/min) each. Two exhaust fans and two coolers are located above the basin and two exhaust fans are located above the fuel transfer area.

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Basin Water Sampling System

The basin water sampling system is used to take samples of basin water at various locations throughout the basin. The samples are used to test for different forms of radiation and to determine the water chemistry. The samples are taken weekly and put in a test bottle to be sent to the 200 Area laboratory.

2.2 ISOLATION BARRIERS

Barriers will be installed to isolate the discharge chute and associated construction joint water seal from the fuel storage basin. Two isolation barriers will be installed in each basin, one in each opening between the discharge chute and the basin. See Figure II-3. These isolation barriers are modeled after the coffer dams that were used successfully to isolate the basin when the construction joint was repaired. The isolation barriers will be part of the basin water boundary and are considered permanent installations. The isolation barriers are Safety Class 1 because they will mitigate potential post-earthquake leakage to within the level currently documented in the SAR. Limiting the leak rate and manual use of makeup water will maintain the water inventory within the limits established in the SAR. The isolation barriers are designed to survive the DBE shocks and aftershocks.

One installed barrier is shown conceptually in Figure II-4, which shows the fuel storage basin in the foreground. The discharge chute is in the upper left of the figure. The isolation barrier has a flat sealing surface with an installed flexible seal. The sealing area is compressed against the walls of the island and of the basin to seal in the water.

A top view of the isolation barrier installation is shown in Figure II-5. As shown in Figure II-5, 19 tie rods and their associated brackets compress the flexible seal against the face of the opening. The nuts on these threaded rods will be tightened to achieve uniform pressure and seal compression over the sealing face of the barrier. Figure II-6 shows the isolation barrier before installation. Figure II-7 illustrates the seal, barrier, and wall installation, showing the seal after it is compressed by tightening the tie rods nuts.

During normal operation, the water level in both the discharge chute and the basin will be approximately the same. Figure II-6 shows a slot (weir) through the isolation barrier. The weir, which will be at a water level of approximately 4.9 m (16 ft. 2 in.), provides for normal water inventory control during operation without interference from the presence of the isolation barriers. This slot will provide for water transfer between the two areas under normal conditions when the water level in the

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chute is slightly higher than the weir. In the unlikely event of a leak in the discharge chute that is large enough to reduce the water level, the level in the basin will not continue to drop once it reaches the weir level. Below that level passive isolation begins.

The operation of the basin auxiliary systems described in Section 2.1 is slightly changed by the installation of the isolation barriers. The demineralized make-up water and the recirculated water from the basin water cleanup skimmer system ICMs are delivered to the discharge chute rather than to the basin. With this method, the discharge chute water level would increase above the elevation of the weirs and would flow through them into the basin. This provides a clean-water purging effect for the discharge chute. Purging the discharge chute prudent and a good engineering practice, although not a requirement. In the unlikely event of a major leak in the chute, the water released is anticipated to be cleaner than the bulk water in the basin and, therefore, would reduce the environmental consequences.

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Figure II-4. General Layout of Basin.
(not to scale)

HS409021.10

The basin, where fuel is stored, is shown in the foreground. The discharge chute, where the construction joint is located, is in the upper left of the figure. The isolation barrier, which has a gasket facing the concrete basin wall and island, is drawn snug by tie rods. The tie rods, 2.5-cm (1-in.) steel rods, pass through the bracket assembly. They are threaded on the discharge chute side, allowing the 19 tie rods to draw the barrier up uniformly. This configuration allows isolation of the water covering the fuel from the construction joint in the discharge chute.

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Figure II-5. Top View of Basin Discharge Chute Isolation Barrier.

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Figure II-6. Side Views of Basin and Discharge Chute Isolation Barriers.

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Figure II-7. Isolation Barrier with Seal Compressed.

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III. APPROACH TO ISSUE RESOLUTION

This section discusses the evaluations leading to definitions of objectives and design requirements and to the selection of the design modification to resolve the USQ.

3.1 REQUIREMENTS GOVERNING BASIN DESIGN MODIFICATION

The DOE has established safety requirements for its nuclear facilities. The requirements are generally set forth in regulations and orders, with supplemental detail contained in DOE directives, notices, standards, and instructions. These safety requirements are made applicable to contractors, in whole or in part, through the contract negotiated with the DOE. The applicable requirements are, in turn, reflected in facility-specific documents such as the SARs and technical safety requirements. Together, all of the safety requirements applicable to a contractor constitute the facility authorization basis.

As an initial step in resolving the USQ, WHC reviewed the requirements that make up its authorization basis to identify those that would be directly affected by installing isolation barriers in the K-Basins. These requirements are documented in Appendix A. Safety analyses (including design analysis) were performed to support USQ resolution. Following final approval by the DOE, WHC will make appropriate revisions to the affected authorization-basis documents.

3.2 DEVELOPMENT OF DESIGN CRITERIA

In their installed configuration, the isolation barriers are considered to be Safety Class 1 structures and will form a continuation of the fuel storage basin walls. Therefore, the design criteria appropriate to apply to the isolation barriers are those that apply to the storage basin. The storage basin design criteria are contained in the facility SAR (WHC-SD-WM-SAR-062 Rev 1) (Reference VII 7.2).

As part of the design process, the storage basin design criteria were reviewed to identify those criteria that apply to the isolation barriers.

The two design criteria that are of greatest importance to the design of the isolation barriers are as follows:

- The ability to prevent leaks from the basin if the construction joint seal leaks in the discharge chute

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- The ability of the barriers to maintain their integrity during and following a DBE.

The DBE is a seismic event producing a maximum horizontal ground acceleration of 1.96 m/s^2 (0.20g) simultaneously with a maximum vertical ground acceleration of 1.27 m/s^2 (0.13g) at zero period. In addition to the initial seismic shock with equal levels of water in the basin and discharge pool, the isolation barriers must be capable of withstanding an aftershock when all water on the discharge chute side of the barrier has leaked out through the construction joint.

During normal operation, the water on both sides of the isolation barrier will be at approximately the same level. Following a DBE, it is assumed that the water on the discharge chute side all drains out through an open construction joint.

3.3 COMPLIANCE WITH DESIGN CRITERIA

The isolation barriers have been designed to comply with the design criteria applied to the fuel storage basins. Analyses were performed to ensure that the isolation barrier structure, as a complete unit, will withstand the design-basis loads and that each individual component will withstand the loads placed on it (letter report 8D420-MRL-94-005, Reference VII 7.4.3). The analyses confirm that the design criteria are met. The isolation barriers will maintain basin integrity under the worst case accident scenario (a seismic aftershock and no water on the discharge chute side of the barrier).

3.4 EVALUATION OF OPTIONAL APPROACHES FOR BASIN ISOLATION

Introduction

This section discusses the main design options that were considered to isolate the discharge chute in KE and KW from the main storage basins (Reference VI 7.3).

Background

During a value engineering study, more than 100 options, including filling the joint with concrete, were developed for consideration. These options were screened to identify final candidate solutions for the potential post-seismic leakage at the construction joint. Three major options (with two variations on one option) for isolation or limited isolation were identified for further evaluation.

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Evaluation of Final Options

- Option 1) FULL-HEIGHT BARRIERS. Barriers would extend above the current basin water level, effectively isolating the 2.3×10^5 l (60,000 gal) of discharge chute water from the main basin volume [assuming approximately 3.8×10^6 (1,000,000 gal)].
- Option 2) FULL-HEIGHT BARRIER with WEIR SLOT. Same as Option 1, except that a weir slot would be cut in the barrier.
- Option 2a) LOW SLOT. In this option, the slot would be cut below the water level at a height that ensures that the island would not be overstressed, even during an aftershock equal to the full initial shock and total drain of the discharge chute. The slot would be normally open, but would be closable for leak rate testing. A variation of this approach that was considered (but is functionally identical) is use of a normally open isolation valve at this level.
- Option 2b) HIGH SLOT. In this option, the slot would be cut above the current water level at a height that ensures that the island would not be overstressed, even in the event of an aftershock equal to the existing facility criterion [1.18m/s^2 (0.12g)], and total drain of the discharge chute. The slot would be normally open, but would be closable for leak rate testing. It would be sized to allow raising of the basin water level to allow for radiation field reduction if judged necessary as part of the dose reduction program.
- Option 3) HALF-HEIGHT BARRIERS. Partial barriers would extend 1.8 m (6 ft) above the basin floor, but not above the water surface, allowing continued passage of fuel or material above them into the discharge chute. Fuel coverage would be maintained with reduced shielding above the fuel elements. The 2.3×10^5 l (60,000 gal) of discharge chute water and the water in the main basin from a 4.9-m (16-ft) elevation to a 1.8-m (6-ft) elevation might overflow the top of the partial barrier [approximately 2.6×10^5 l (685,000 gal)] in the event of a severe leak in the discharge chute. Although a number of height variations were considered, they are represented well by this option.

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3.5 SELECTION OF FINAL ISOLATION BARRIER DESIGN

This section discusses the selection of the preferred design of full-height isolation barriers with weir slots from the options discussed in Section III.3.4.

Factors considered in the selection of the final design

Factors considered in reaching the final selection included public safety protection from airborne release, reversibility of change, cost, constructability, environmental protection capability, worker safety, seismic performance, and operational impacts. Although important in deselecting other options, the first four factors (public safety, reversibility of change, cost, and constructability) were essentially identical for these options. The following factors allow for differentiation between options:

- 1) Limiting environmental impact potential has three sub-elements:
 - a) limiting release of contaminated water to the surroundings
 - b) optimizing the quality of any water that might be released
 - c) providing the ability to detect, characterize, and isolate operational leaks from the construction joint.
- 2) Worker safety was divided into two sub-elements:
 - a) support for dose reduction measures
 - b) accessibility of the basin following a quake if additional emergency operator intervention is necessary.
- 3) Seismic performance had two sub-elements:
 - a) the ability to survive the main shock
 - b) the ability to survive aftershocks.
- 4) Operational impacts had three sub-elements:
 - a) capability to verify leak integrity of isolation barrier
 - b) vulnerability to errors from routine operation
 - c) impacts on other facility operations.

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Evaluation

As with all engineering problems, a number of approaches are viable. Once the top-level design requirements are met, selecting the optimum solution is often a tradeoff between various factors. Table III-1 summarizes the tradeoff analyses.

The option that was selected originally was Option 1, Full-Height Isolation Barriers. Option 2a, Full-Height Barrier with Low Weir Slot, was identified as the backup if adequate seismic capability of the full-height barriers in Option 1 could not be demonstrated. Moving from Option 1 to Option 2b is simple; structural analyses show that cutting a slot in the full-height barrier reduces structural capability insignificantly. Option 3, Half-Height Barriers, was not chosen for several reasons.

- a) The barrier is vulnerable to damage by movement of materials over it.
- b) Operators would be unable to perform tests that demonstrate leak integrity.
- c) The barrier provides relatively poor reduction of environmental impacts.

Option 2b, Full-Height Barrier with High Weir Slot, was selected when it became obvious that the barrier could survive the primary quake and, using reduced criteria for existing facilities, the aftershock. The primary problem identified with this solution was the restriction on use of the discharge chute for most future basin activities. After the evaluation discussed in Section III.3.3, it was concluded that precluding use of the discharge chute, although it upsets the current baseline for facility operations, is unlikely to dramatically delay final fuel removal from the basin.

Options 2a and 3, although seriously considered, were judged to allow for excessive post-earthquake environmental impact from water leakage. Of the two, 2a allowed for less water leakage; the "low slot" could be placed as high as 4.3 m (14 ft), providing for full seismic survival without invoking existing facility seismic criteria. This would limit leakage to 7.0×10^5 l (185,000 gal). Option 3 has the worst environmental impact from water leakage and poses additional difficulty because periodic leak testing cannot be performed to confirm that the seal will perform adequately when needed.

Design and fabrication of Option 2b are underway. Two issues remain to be resolved with implementation of Option 2b. The first is the acceptability of using existing-facility reduced criteria for aftershocks. This may become moot. In the KE Basin,

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the center island is attached to one of two basin dividing walls by a beam that was provided in the early 70s to reduce island seismic stresses with the discharge chute level drawn down. Preliminary assessments indicate that the effect of the beam is adequate to ensure that the island will not be overstressed by an aftershock equal to the main shock, even with the discharge chute drained. A design analysis including the effect of the beam has not been located. Consequently, attention is focused to characterize the installed beam and anchors and incorporate that effect into the basin analysis.

The second remaining issue is use of the discharge chute for other activities. The discharge chute has two primary advantages as a work location in KE:

- Low radiation fields
- A relatively large open work area.

The first is important because general radiation fields are high throughout KE, but are relatively low in the discharge chute. Although use of the discharge chute provides for lower exposures than working elsewhere in the basin, the optimum solution, which provides for the largest projected dose commitment reduction, comes from dose reduction measures such as raising the water level. Once dose reduction measures have been taken, a number of other areas become available for operational use; for example, large areas of empty racks can be consolidated and work platforms can be installed by setting them on pedestal mounts that match the existing rack canister configurations.

Conclusion

Full-height isolation barriers with weir slots above the current water level are the best option for satisfying all constraints.

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Table III-1. Comparison of Options

Option	1	2a	2b	3
Title	Full-height barriers	Weir slot low in barriers	Weir slot high in barriers	Half-height barriers
<p>Environmental Impact:</p> <p>a) limiting release of contaminated water to the surroundings</p>	Limited to 2.3×10^5 l (60 Kgals)	Depends on weir slot height. For 4.3 m (14 ft) above bottom 7.0×10^5 l (185 Kgals)	Limited to 2.3×10^5 l (60 Kgals), unless water height raised to support dose reduction.	For 1.8 m (6 ft) above bottom, 2.59×10^6 l (685 Kgals)
<p>Environmental Impact:</p> <p>b) optimizing the quality of any water that might be released</p>	Water quality improvement possible, minimizing impact	Water quality improvement not possible	Water quality improvement possible even for raised height, minimizing impact	Water quality improvement not possible
<p>Environmental Impact:</p> <p>c) providing ability to detect, characterize and isolate operational leaks from the construction joint.</p>	Leak detection easy. Isolation easy.	Leak detection and isolation possible if weir slot designed to be closed with plate or valve	Leak detection easy. Isolation easy.	Leak characterization not possible without adding top half of barrier

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Table III-1. Comparison of Options

Option	1	2a	2b	3
Title	Full-height barriers	Weir slot low in barriers	Weir slot high in barriers	Half-height barriers
Worker safety: a) dose reduction	Poor ability to support dose reduction by raising water level.	Good ability to support dose reduction by raising water level.	Good ability to support dose reduction by raising water level.	Good ability to support dose reduction by raising water level.
Worker safety: b) accessibility following a quake	Limited field increase expected.	Dose increase expected from exposed walls contamination and from reduced fuel shielding.	Limited field increase expected.	Dose increase expected from exposed wall contamination and reduced fuel shielding.
Seismic performance: a) main shock	Will survive same quake as basin.	Will survive same quake as basin.	Will survive same quake as basin.	Will survive same quake as basin.
Seismic performance: b) aftershocks	Will survive reduced aftershock quake magnitude. See Note 1.	Will survive same quake magnitude as primary shock.	Will survive reduced aftershock quake magnitude. See Note 1.	Will survive same quake magnitude as primary shock.
Operational impacts: a) leak integrity verification	Straightforward.	Requires sealing of weir slot. Then straightforward.	Straightforward.	No obvious method to verify seal performs as designed.

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Table III-1. Comparison of Options

Option	1	2a	2b	3
Title	Full-height barriers	Weir slot low in barriers	Weir slot high in barriers	Half-height barriers
Operational impacts: b) vulnerability to errors	Impact on the basin side is limited by normal crane routing.	Impact on the basin side is limited by normal crane routing.	Impact on the basin side is limited by normal crane routing.	Barrier protection from fuel canisters and components bump or drop must be added.
Operational impacts: c) impacts on facility operations.	Precludes use of discharge chute for handling contaminated equipment and fuel. Note 2	Precludes use of discharge chute for handling contaminated equipment and fuel. Note 2	Precludes use of discharge chute for handling contaminated equipment and fuel. Note 2	Would allow continued use of discharge chute for fuel and equipment handling if special tooling designed to allow raising canisters above the barriers.

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Table III-1. Comparison of Options

Option	1	2a	2b	3
Title	Full-height barriers	Weir slot low in barriers	Weir slot high in barriers	Half-height barriers

Note 1: In the KE Basin, the center island is attached to one of two basin dividing walls by a steel beam that was provided in the early 70s to reduce island stresses with the discharge chute water level drawn down. Preliminary assessments indicate that this beam is adequate to ensure that the island can survive an aftershock equal to the main shock, even with the discharge chute drained. Efforts to retrieve the design and analysis from storage have not been successful. Efforts currently focus on characterizing the installed beam and anchors and incorporating the beam in the basin analysis.

Note 2: The discharge chute has two primary advantages as a work location in 105KE: i) low radiation fields and ii) relatively large open work area. The first is important because general radiation fields are high throughout 105KE, but are relatively low in the discharge chute. Although use of the discharge chute provides for lower exposures than working elsewhere in the basin, the optimum solution providing for the largest projected dose commitment reduction, comes from dose reduction measures such as raising the water level. Once dose reduction measures have been taken, a number of other areas become available for operational use; for example, large areas of empty racks can be consolidated and work platforms can be installed by setting them on pedestal mounts that match the existing rack canister configurations.

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3.6 PROCUREMENT OF MATERIAL USED TO FABRICATE THE ISOLATION BARRIERS

The detailed design for the isolation barriers was developed by modifying an existing design for coffer dams intended for use as temporary isolation devices at K Basins. A detailed review of the design of these coffer dams was performed, and significant design changes made to satisfy requirements for installation as long term isolation barriers.

Two isolation barriers are required for each basin to complete isolation of the discharge chute area from the fuel storage pool area. Therefore, four isolation barriers must be fabricated.

Two coffer dams were fabricated for temporary use at K Basins, but never actually installed. A review was performed to determine the feasibility of modifying them to meet the requirements of the final design for the long-term isolation barriers. It was determined that this approach was feasible, and offered cost and schedule advantages over complete fabrication of four new isolation barriers. These two coffer dams were modified to meet the requirements of the final design and are referred to as the "modified" isolation barriers.

Two additional isolation barriers were constructed to meet the requirement of four barriers. These two barriers are referred to as the "new" isolation barriers.

WHC procedures identify two acceptable methods for procuring material for use in Safety Class 1 applications at Hanford. The first method is procurement of material as Safety Class 1 from a supplier approved for the specific scope of supply on the Evaluated Suppliers List (ESL). The second method is procurement of material as "commercial grade" from a supplier not on the ESL, followed by dedication of this material for use in its intended Safety Class 1 application. The dedication process includes application of quality assurance and quality control activities that provide a level of assurance that the material is suitable and equivalent to that obtained through procurement of the material as Safety Class 1 from an approver supplier.

These two methods for procuring material intended for use in Safety Class 1 applications are essentially identical to and, in large part, based on practices developed in the commercial nuclear power industry. Properly implemented, both methods meet applicable regulatory requirements of the NRC. A detailed discussion of the commercial-grade procurement and dedication process and justification for its use is provided in Appendix B to this report.

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Both methods of procuring material for Safety Class 1 applications were used in the fabrication of the K Basins isolation barriers. Both sets of isolation barriers contain parts procured using each method. A larger fraction of materials used in the modified coffer dams was qualified using the commercial-grade dedication process, as all of the materials used to construct the pre-existing coffer dams were procured as commercial-grade materials. A detailed discussion of material procurement for each set of isolation barriers is provided in Section 6.3. Detailed technical evaluations and documentation of the material quality for each set of isolation barriers are provided in Reference xxx.

3.7 FABRICATION OF THE ISOLATION BARRIERS

While the final configuration of both sets of barriers is identical and meets the same design requirements, each set's fabrication and material procurement history differs. These are discussed separately.

Fabrication of the Modified Set of Isolation Barriers

The existing coffer dams were originally fabricated in 1993 (?) by ICF Kaiser Engineers at the 2704 shops in the 200 West area at Hanford. This fabrication effort is documented in Fabrication Request 2H-9301132F. As these coffer dams were intended only for temporary use in support of maintenance of K Basins pools, the fabrication effort (including material procurement) was controlled to Safety Class 2 standards. Because the end use was identified as a Safety Class 2 application at the time of fabrication, fabrication methods and records might not have been adequate to support modification and use of the existing coffer dams as long-term isolation barriers. A thorough review of the fabrication records and procurement records was performed to determine whether it was feasible to modify and use these coffer dams. This review is discussed in detail in Section 6.4.

The review showed that the fabrication package provided adequate documentation of the fabrication effort on the existing coffer dams. Review of the specific materials which had been used in the coffer dams was also required to determine whether modification and use of the existing coffer dams was feasible. This review of the material acceptability is summarized in Section 6.4. This review indicated that, following completion of certain additional quality control activities, the materials used in the fabrication of the existing coffer dams were acceptable for use in the Safety Class 1 long term isolation barriers.

Fabrication efforts to modify the existing coffer dams to meet the requirements of the design of the long term isolation barriers was controlled under fabrication package 2H-9401278F.

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This work was also performed by ICF Kaiser at the 2704 shop in the 200 West area at Hanford. Additional materials needed to support modification of the existing coffer dams were procured in accordance with the WHC requirements for use in Safety Class 1 applications. The fabrication effort to modify the existing coffer dams was controlled as Safety Class 1 work throughout.

Fabrication of the New Set of Isolation Barriers

Two additional isolation barriers were fabricated by ICF Kaiser under fabrication package 2H-9400875. Materials for these barriers were procured in accordance with WHC requirements for Safety Class 1 applications. Fabrication was controlled as Safety Class 1 work throughout.

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IV. INSTALLATION, OPERATION, AND MAINTENANCE

4.1 INSTALLATION OF ISOLATION BARRIERS

The isolation barriers will be installed at each discharge chute opening in the KE and KW Basins. The barriers have been fabricated to Safety Class I standards from an upgrade of the design originally used to isolate the KE discharge chute in 1989. The installation process includes:

- Measuring the chute opening dimension
- Relocating 25 canisters of fuel at KW
- Relocating empty canisters and debris at KE
- Pumping sludge at KE
- Cutting fuel rack segments at each discharge chute opening
- Preparing sealing surface at each discharge chute opening
- Installing the isolation barriers at both basins
- Leak testing to verify acceptable installation at each basin.

Chute Opening Measurement

The chute openings were measured at the locations of the Z brackets to verify that the barriers would fit when installed. The measurements were obtained using an underwater camera and a video micrometer. While the measurements were performed, a video was made of the embedded angle at each opening.

Sealing Surface Tooling Work Space

A 1.5-m x 1.5-m (5-ft x 5-ft) working area must be cleared in front of each chute opening in both basins to provide sufficient space for the seal preparation tools. This involves relocating the loaded fuel canisters in KW and the empty fuel canisters in KE. This space also provides clearance to limit risk of fuel canister damage.

KW Basin.

Loaded fuel canisters will be relocated using approved procedures from KW east and west chute openings. Thirteen canisters are to be relocated from the KW east chute opening and 11 canisters from the KW west chute opening (Ref. letter 94-KBOS-001).

KE Basin

Jackstrawed empty fuel canisters and debris will be relocated from the front of the KE chute openings as

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required to provide the desired working space for the seal strip installation tool.

Pumping Sludge

After the area in front of the KE openings is cleared of debris, approximately 1 to 7 cm (0.4 to 2.75 in.) of sludge will be pumped from the cleared fuel racks. The sludge will be pumped to the weasel pit using the Wilton air pumps and new suction headers developed for the long-term sludge removal program. Remaining sludge inside the KE discharge chute will also be pumped to the weasel pit before the barriers are installed.

Cutting Fuel Racks

A segment of the fuel racks will be removed from in front of the chute opening to make room for the seal preparation tool. The racks will be cut by a remotely operated abrasive wheel saw designed by SONSUB, the seal preparation subcontractor. The rack saw will be precisely placed for each cut and will clamp to the rack to remain stationary. The actual cut will be controlled remotely and monitored using an underwater camera.

Preparation of Seal Surfaces

The sealing surface at each opening will be prepared with a remotely operated tool designed and built by SONSUB. Preparation of the surface will consist of the following steps:

- Cutting away the existing inflatable rubber seal.
- Removing the existing steel strips bordering the inflatable seal by shearing the cap screws holding the strip.
- Cleaning the surface of the embedded angle at the corner of each opening with a paint/rust stripper and a grinding wheel.
- Spreading a bead of epoxy along the cleaned angle surface.
- Positioning a prefabricated stainless steel sealing strip that will be held in place by the epoxy.

The individual tools performing the separate operations are mounted on a chain-drive carrier that follows a designed path on the seal preparation tool. The tool itself is positioned by hydraulic jacks that wedge the tool into the discharge chute opening.

The seal preparation tool will also be equipped with a suction pump/filtration system that will contain the debris

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generated during the cutting operation both above and under the water.

Isolation Barrier Installation

The isolation barriers will be installed by ICF Kaiser Hanford. The barriers will be rigged from the plant rail system using a 1,800 kg (2-ton) chain fall in accordance with a rigging plan developed by ICF Kaiser Hanford. The brackets that hold the barrier from the back will be attached with stainless steel tie rods tightened by 2.5-cm (1-in.) lock nuts. Final compression of the J-seal will be verified using an underwater camera from the discharge chute side.

Leak Testing

The barrier installation will be verified for each basin by a leak test involving a differential water level between the basin and the discharge chute and measurement of the change in water level between the discharge chute and the basin.

4.2 POST INSTALLATION TESTING OF ISOLATION BARRIERS

IDENTIFY ACTIONS TO BE TAKEN TO PROVIDE CONTINUED VERIFICATION OF THE ISOLATION BARRIERS TO PROVIDE WATER BOUNDARY INTEGRITY IN ACCORDANCE WITH THEIR DESIGN FUNCTION. SUMMARIZE ISI AND MAINTENANCE ACTIVITIES PLANNED, CRITERIA TO BE USED TO ESTABLISH CONTINUED ACCEPTABILITY OF THE ISOLATION BARRIERS. REFER TO REFERENCE LIST DOCUMENTS.

4.3 FACILITY OPERATION

4.4 IN-SERVICE INSPECTION AND MAINTENANCE OF ISOLATION BARRIERS

4.4.1 Introduction

In-Service Inspection will be provided for components of the Isolation Barrier Subsystem that may degrade from exposure to basin environmental conditions. The inspection is one element in ensuring acceptable performance of the barriers over their 15-year design life.

Corrosion has been identified as the only significant age-dependent phenomenon that could reduce the structural margins for the barrier. Measures have been taken to preclude corrosion. These include seal welding to isolate interior surfaces, painting to protect exterior surfaces, provision of adequate material to

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accommodate corrosion at 2 to 3 mils/year for key areas, and use of stainless steel in applications such as the hooks and threaded tie rods that cannot be protected by paint.

4.4.2 Inspection Criteria and Basis

Inspection will be performed either by use of underwater video camera or comparable methods. Dimensions can be verified either by comparison with the dimensions of structural members of the isolation barriers, or by use of video micrometry against a standard. Uncertainties of plus 100 percent are acceptable; Therefore, relatively simple inspection methods may be used. Final documentation may be by detailed inspection report, inspection summary and video tape, inspection summary and still photos, or other equivalent methods of documenting the results. Analysis need only be performed if acceptance criteria are exceeded.

Component	Inspection Criterion	Technical Basis
Frame		
Tubing - sides	Bare or corrosion covered spots less than 100 cm ²	Limit corrosion on structural member.
Tubing - cross pieces	Bare or corrosion covered spots less than 1 cm ²	Limit corrosion on member seeing maximum stress during empty discharge seismic event.
Welds - structural	Bare or corrosion covered spots less than 1 cm ²	Limit corrosion on member seeing maximum stress during empty discharge seismic event.
Welds - seal	Bare or corrosion covered spots less than 100 cm ²	Limit seal weld corrosion to prevent water incursion to interior of structure.
End plates	Unlimited corrosion	No structural requirements
Side stops	Bare or corrosion covered spots less than 100 cm ²	Limit corrosion structural material.
Plate	Unlimited corrosion	Adequate margin to take total corrosion allowance on both surfaces of plate.
Weir opening	Unlimited corrosion	No structural requirements

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Z brackets			
	Tubing	Bare or corrosion covered spots less than 1 cm ²	Limit corrosion on member seeing maximum stress during empty discharge seismic event.
	Welds - structural	Bare or corrosion covered spots less than 1 cm ²	Limit corrosion on weld seeing maximum stress during empty discharge seismic event.
	Welds - seal	Bare or corrosion covered spots less than 100 cm ²	Limit seal weld corrosion to prevent water incursion to interior of structure.
	End plates	Unlimited corrosion	No structural requirements
	Interior guide tubes	Unlimited corrosion	No structural requirements
	Interior tubing (painted segment)	Unlimited corrosion	Limited structural requirements - adequate margin to take total corrosion allowance on interior of tube.
	Tie rod-related structures		
	Hook	No inspection required	Stainless
	Rod	No inspection required	Stainless
	Seal	Inspect for signs of general degradation	Inspection is precautionary only. Seal life exceeds 15 years.

4.4.3 Frequency

Baseline inspection is performed following installation of the barriers into the basin.

The initial follow-up inspection will be held within 2 years (not to exceed 2 1/2 years). The basis for this inspection frequency is that maximum corrosion credible within this period with total paint failure would not significantly degrade any component.

Thereafter, inspection may be relaxed to every 4 years if epoxy paint performs as expected.

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4.4.4 Acceptance of Corrosion in Excess of Criteria

All corrosion areas are conservatively set. Actual corrosion, if in excess of acceptance criteria, may be accepted by analysis against the stress report to identify critical portions of members and critical thicknesses.

4.4.5 Repair Program

If acceptance criteria are exceeded and the acceptance analysis identifies a need for protection, any compatible underwater covering may be used. The in-service inspection program frequency should be reevaluated based on the material used.

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V. CONCLUSIONS

The identification of an USQ related to the K Basins seismic design prompted WHC to perform the appropriate reviews and evaluations in accordance with DOE requirements. In responding to the USQ, WHC developed a USQ Resolution Plan (Reference VII 7.3) that outlined immediate mitigating actions as well as long-term resolution. In developing both the immediate and long-term action plans, WHC used accepted engineering methods (value engineering study) to arrive at appropriate and cost-effective solutions.

The use of isolation barriers as a long-term solution to the USQ has been proven as an effective means of isolating the discharge chute area from the main basin. The design for the isolation barriers has been improved and strengthened from the coffer dam door design as a result of the detailed analysis performed to ensure survival during a DBE and other design loads. Application of techniques such as commercial-grade dedication allowed the process to move forward quickly, without having to scrap work that had already been accomplished, thus saving time and money.

Following installation and testing of the isolation barriers, the USQ will be satisfactorily resolved and operation of the K Basins will continue to be within the design basis as defined in the SAR and the Authorization Basis. Until the final installation and testing are complete, the interim actions taken provide reasonable assurance that mitigating actions can be taken to protect the safety and welfare of the public in the event of a DBE and opening of the construction joint.

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VI. SUMMARY DESCRIPTION OF REFERENCE DOCUMENTS

Section VII identifies numerous reference documents involved with the resolution of the K Basin Seismic Leak USQ. This section provides a summary description of the key reference documents. These references are record documents retrievable from the document control center for detailed review if desired.

6.1 OVERVIEW OF REQUIREMENTS RELEVANT TO USQ RESOLUTION

Under the Department of Energy Organization Act [of 1977], all functions of the Energy Research and Development Administration (ERDA) were transferred to the DOE. Section 107(a) of the Energy Reorganization Act of 1974 (ERA) authorized ERDA to perform certain functions set forth in the *Atomic Energy Act of 1954* (AEA). In particular, Section 161(b) of the AEA authorized ERDA, and now DOE, to control the use of special nuclear material through "rule[s], regulation[s], or order[s]." The authority given to DOE under Section 161 is broad and includes all aspects of assuring the safe management of nuclear facilities authorized by the AEA. See 59 *Federal Register* (FR) 15843 (Apr. 5, 1994) [final rule for 10 *Code of Federal Regulation* (CFR) Part 830].

Under this broad authority, the DOE (and its predecessors) has established safety requirements for its nuclear facilities. These requirements generally are contained in DOE orders. The orders provide minimum requirements to be followed in the design and operation of the facilities. The requirements in the various orders are supplemented by other DOE documents such as directives, notices, and instructions. These documents provide further detailed safety requirements. Augmenting these requirements are safety and implementation guides (i.e., similar to NRC regulatory guides) and technical standards (DOE's implementing documents for industry codes and standards).

Based on these generally applicable requirements, each contractor negotiates facility-specific safety requirements that are imposed through contract conditions. These requirements include such things as technical specifications and operational safety requirements and are relied on by the DOE to ensure safe management of its nuclear facilities. Together, all of the negotiated design and operational requirements are considered as the facility "authorization basis." The specific details of the authorization basis are typically described in documents such as the facility SAR, technical safety requirements, DOE-issued safety evaluation reports, and other documents containing facility-specific commitments made to comply with DOE orders and policies.

In the case of the K Basins, WHC performed a seismic analysis and leak rate assessment that indicated the projected

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leakage following an earthquake would likely exceed the current authorization basis established in the SAR. Applying DOE Order 5480.21, *Unreviewed Safety Questions*, WHC performed a safety evaluation to determine whether an USQ existed.

As the initial step, WHC reviewed its authorization basis to determine what requirements might be affected. Under its contract with the DOE, the following orders would be specifically applicable:

- 5400.5 -- *Radiation Protection of the Public and the Environment*
- 5400.11 -- *Radiation Protection for Occupational Workers*
- 5480.21 -- *Unreviewed Safety Questions*
- 5480.22 -- *Technical Safety Requirements*
- 5480.23 -- *Nuclear Safety Analysis Reports*
- 5480.24 -- *Nuclear Criticality Safety*
- 5480.31 -- *Startup and Restart of Nuclear Facilities*
- 5700.6C -- *Quality Assurance*²
- 5700.7C -- *Work Authorization*
- 6430.1A -- *General Design Criteria*

In addition, WHC reviewed the facility-specific documents that are part of its authorization basis.³ The following documents (and their specific sections) are affected by the USQ resolution:

- WHC-SD-WM-SAR-062, Rev. 1, *Safety Analysis Irradiated N Reactor Fuel*
 - § 2.3 -- "Radiological Control"
 - § 2.5 -- "Design Basis Earthquake"
 - § 5.3.3.1 -- "Availability and Reliability"
 - § 5.3.3.2 -- "Cooling Pool Dewatering"

² This DOE order has been superseded by 10 CFR § 830.120; however, the basic requirements of the two documents are identical so there is no substantive change. See 59 FR 15843, 15847 (Apr. 5, 1994).

³ Appendix A contains the specific language of the relevant authorization basis sections cited.

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- § 6.3.2 -- "Water Level Instrumentation"
- § 6.9 -- "Effects of Normal Operation"
- § 8.2.3 -- "Crane Failure and Cask Dropped Into
the Fuel Loadout Pit"
- § 8.2.7 -- "Loss of Pool Coolant"
- WHC-SD-NR-TA-020, Rev. 0, *Safety Evaluation of Fuel
Encapsulation in the 105KE Irradiated Fuel Storage Basin*
 - § 3.3.3 -- "Design Basis Earthquake"
 - § 3.6.7 -- "Clearwell Integrity During DBE"
 - § 3.6.9 -- "Unsupported Basin Construction Joint"
- WHC-SD-WM-OSR-006, Rev. 0, *Operations Safety Requirements
100-KE and 100-KW Fuel*
 - § 5.1 -- "Facility Cooling Pool"
 - § 3/4.2 -- "Bases"
 - § 5.8 -- "Seismology"
- WHC-SD-NR-HC-002, *Facility Hazard Classification N Reactor
and KE/KW Fuel Basins*

Based on this set of affected authorization basis documents, the next step by WHC was to perform a safety evaluation⁴ as specified in DOE Order 5480.21. This evaluation called for answering the seven questions provided below. If the answer to any one of the questions is "yes" then the proposed activity is considered a USQ, and steps must be taken to bring the facility back into conformance with its authorization basis.

1. Could the proposed activity increase the probability of occurrence of an accident previously evaluated in the Safety Analysis?
2. Could the proposed activity increase the consequences of an accident previously evaluated in the Safety Analysis?
3. Could the proposed activity increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the Safety Analysis?

⁴

A safety evaluation is somewhat more limited than a safety analysis (see DOE Order 5480.5). Its purpose is to serve as a benchmark for whether the authorization basis is being preserved. A safety analysis establishes the set of "limiting analyses" important for safe operation.

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4. Could the proposed activity increase the consequence of a malfunction of equipment important to safety previously evaluated in the Safety Analysis?
5. Could the proposed activity create the possibility of an accident of a different type than any previously evaluated in the Safety Analysis?
6. Could the proposed activity create the possibility of a malfunction of equipment important to safety of a different type than previously evaluated in the Safety Analysis?
7. Does the proposed activity reduce the margin of safety as defined in the basis for any technical safety requirement?

WHC's safety evaluation demonstrated that a USQ existed. The USQ resolution plan called for the design, fabrication and installation of isolation barriers to ensure that the authorization basis of the K Basins was maintained. These activities are controlled under the DOE orders listed earlier, in particular those dealing with quality assurance, work control and design criteria. On final approval by the DOE, appropriate revisions to the affected authorization basis documents will be implemented. Further detail is available in Appendix A.

6.2 Discussion of Technical Basis Documents

Various technical aspects of the design modification were evaluated and documented in the engineering process leading to the barrier installation. The documentation of these investigations is listed in Section VII. The following paragraphs provide a brief description of the information in the references.

6.2.1 Functions and Requirements Report

Section III discussed the WHC decision to install K Basin isolation barriers. The installation of the barriers involves various tasks. The tasks include providing working space in front of the barrier location, measurement and preparation of the sealing surfaces, barrier installation, and leak testing.

Functions and requirements were developed for the implementation of these tasks. That information is provided in Appendix C.

6.2.2 Stress Analysis Report

The KE and KW facilities were constructed between 1953 and 1955. Because of the age of these facilities, no historical documentation is available to demonstrate their structural

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adequacy. Also, criteria (especially seismic) have changed over the years such that additional analyses were warranted.

The primary objective of the seismic evaluation of the KE and KW facilities was to establish seismic adequacy of the water retention boundaries of the reinforced concrete fuel storage basins for an additional 20 years of service. If adequacy of the existing structures could not be demonstrated, modifications were to be identified that would bring the facilities into compliance with the appropriate requirements.

A second objective of the evaluation was to evaluate the seismic adequacy of the steel-frame superstructures immediately above the storage basins. The steel-frame superstructures are classified as Safety Class 3 facilities, but an evaluation for the Safety Class 1 DBE loading is necessary because of a three-over-one concern. That is, if a Class 3 superstructure collapses because of a Safety Class 1 DBE, significant damage to the Safety Class 1 basins and fuel canisters might occur.

An additional need for structural qualification arose with the requirement for the addition of the isolation barrier doors to both basins. These doors have also had structural evaluation.

Figure VI-1 summarizes the documentation for the structural qualification of the basin and the barrier isolation doors. The following paragraphs summarize the contents of the noted documents.

Document WHC-SD-NR-SA-024, Rev. 0

The results of the KE/KW fuel storage basin seismic evaluation is divided between the Safety Class 1 below-ground concrete basins and the Safety Class 3 above-ground superstructures.

The seismic member loads for the basin substructure were developed with a three-dimensional soil-structural interaction model using the SASSI computer code. These dynamic member loads were combined with static loads developed with the ANSYS computer code to obtain the total seismic demand. Demand/capacity comparisons for the critical sections of the basins were developed. The demand predictions are less than the capacities at all locations except for a local overstress at the northwest corner of the KW Basin. This local capacity exceedance was not predicted for the KE Basin because the walls in KE are thicker.

The corner bending moments are deformation limited and are therefore not associated with collapse. Conservatism in the code capacity requirements makes it likely that no actual damage would

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result from the predicted seismic demand. If structural damage did occur, it would be in the form of local corner cracking in the upper third of the corner, which could result in relatively slow leakage of the cover water. The leakage rate would likely be within the makeup flow capacity. Even without makeup water, the potential water level drop is predicted to remain above the 8-ft cover requirement stated in the storage basin SAR. Recommendations for resolving this corner-cracking issue are provided.

The superstructure interfaces with the basin substructure through support column attachments at the top of the basin concrete walls. The structure is also coupled to the reactor building through attachments to the reactor building north wall. This structural coupling of the superstructure resulted in the need for a coupled seismic model including the superstructure, concrete basin and reactor building. This was achieved through the development of three separate computer models using the ANSYS computer code: concrete-basin substructure model, steel-frame superstructure model, K Reactor building and reactor/shielding model. Because the focus of the evaluation was on the superstructure, the coupled model size was reduced by creating ANSYS superelements from the basin substructure and reactor building models.

The superstructure seismic loads were generated from the Safety Class 1, 0.2 g, DBE. The seismic member loads were combined with the static loads to obtain the total seismic demand. Demand/capacity margins of safety were calculated and provided in tabular form. Several local regions of overstress (mainly in the roof support structure) were indicated, but a general collapse of the superstructure is not expected. Recommendations for resolving the local overstress concerns are provided.

An independent third-party review of this document was provided by Advent Engineering Services, Inc. in WHC-SD-NR-SA-025.

Document WHC-SD-NR-SA-024, Rev. A (ECN 191290)

This revision made a minor correction to the calculated building response spectra and presented calculations to qualify the reactor building north wall against collapse during a seismic event.

An independent third-party review of this document was provided by Advent Engineering Services, Inc. in WHC-SD-N031-SA-004.

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Document WHC-SD-N031-SA-002

The steel superstructure analyses of WHC-SD-NR-SA-024 included only the steel superstructure over the basin and none of the adjoining above-grade steel structure. Therefore, some conservative assumptions were made regarding fixity in the east-west direction. The results indicated a number of overstressed members. Additional analyses were performed (described in WHC-SD-N031-SA-002) that included a more detailed model of the entire superstructure, i.e., added the office and transfer bay as a part of the model. The results indicated a significant reduction in stresses in the superstructure.

The primary cause for the reduced stresses was that the structure is more stable because of the addition of east- and west-side structures. The aspect ratio (length over breadth) is therefore reduced causing a redistribution of stiffness.

In spite of the reduction of overall stresses, some local areas are still overstressed. On the office side some north-south long-span beams supporting the distributing east-west beams are overstressed. The allowable stresses in flexure for these beams are small because of the long unsupported length and the unrestrained compression flange. The unrestrained compression flange results in an overstress condition for the dead weight and snow-load combination. This localized overstressing can be overcome by adding local stiffeners at suitable locations and by stiffening one of the bays with inclined horizontal braces at roof level, connecting the long span beams with the columns and thus restraining the compression flange of the beams and reducing the unsupported length.

Also, four welded connections between the roof girders and the columns on Column Line 7.1, on the storage-basin side, are overstressed. These joints need additional welds to sustain the seismic loads.

An independent third party review of this document was provided by Advent Engineering Services, Inc. in WHC-SD-N031-SA-004.

Document LLH-8D420-94-001

Structural analyses have been performed on the isolation doors described in Drawing H-1-42659 (WHC 1979). All members are structurally adequate provided that modifications are made to the tie-rod hook, mid lifting pad, lower lifting pad, and top lifting ring. It should also be noted that the maximum load in the tie rods that were assessed was 1,526 lb.

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Document 8D420-MRL-005

This document summarizes the analyses required to qualify the design changes to the isolation doors noted in Drawing H-1-80104. Major change is a redesign of the tie-rod hook. All components of the door are shown to have positive margins of safety. The margins of safety resulting from the structural analysis of the isolation barrier assembly components are shown in Table VI-1.

Document 8D420-BVW-94-002

This document presents an analysis of the divider wall or center island that includes the loading that occurs when the barrier doors are in place and water is lost in the discharge chute. It is concluded that the divider wall by itself is limited to a basin water height of 14 ft. 11 in. with the discharge chute empty and an earthquake level of 0.2g. By taking advantage of a reduced seismic criteria (0.12g) for limited life structures, the allowable water height increases to 16 ft. 9 in.

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Figure VI-1. K-Basins Structural Analysis

H9410011.1

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Margins of safety given in Table VI-1 are for barrier components that are affected by the change in J seal compression load addressed in these calculations. Margins of safety for other barrier components are as given in Reference 1.

Table VI-1. Structural Margin of Safety for K Basin Isolation Barriers
(tie rod load = 3,000 lb).

COMPONENTS (No corrosion allowance)				
Component Drawing H-1-80104	Material	Allowable Stress (kip/in ²)	Actual Stress (kip/in ²)	Margin of Safety Normal Loading
Door Assembly (Item 4) - tube steel frame	Carbon steel A500, GR. B	30.4	20.3	0.50
Bracket assembly (Items 5 through 14)	Carbon steel A500, GR. B	*	*	0.46
Pad eye (Item 60)	Carbon steel A36	14.4	2.9	>2.0
Tie-rod (Items 69 through 87)	Stainless steel 304L or 316L	*	*	0.68
WELDS (No corrosion allowance)				
Door assembly tube steel connections	-----	21.0	9.8	1.14
Bracket assembly welds	-----	21.0	12.6	0.66

Margin of safety = (Allowable Stress/Actual Stress) - 1

* Margin of safety is based on the interaction of axial load and bending moment or combined bending.

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6.2.3 Isolation Barrier Corrosion Analysis

Potential corrosion of the barriers over their lifetime was evaluated to ensure that corrosion would not interfere with their function. The K Basins have an ongoing corrosion monitoring program. See Reference VII 7.4.4. The coupons used in this program are 1018 low-carbon steel. The corrosion behavior of this material is typical or perhaps more pronounced than the behavior of the carbon steel used in the isolation barriers. Consequently, coupon material corrosion can be used to predict corrosion of the barriers.

Coupon examinations show uniform corrosion with minimal pitting. With the chemistry control and demineralization currently practiced at the K Basins, the evaluation concluded that a 2 or 3 mils/year corrosion rate of uncoated carbon steel would be appropriate to consider for the design. This predicted corrosion rate is conservative because the isolation barriers will have a protective coating.

6.2.4 Isolation Barrier Weir Sizing Analysis

The isolation barriers passively isolate the fuel storage basin water from the location of a potential leak in the discharge chute. The barriers are designed to also provide for water circulation from the chute to the basin and to maintain a common water level for normal operation. This is accomplished by a weir through the barrier to allow normal water inventory control during operation without interference from the presence of the isolation barriers. The weir will provide for water transfer between the two areas for normal conditions when the water level in the chute and the basin is higher than the weir. In the unlikely event of a leak in the discharge chute large enough to reduce the water level, the level in the basin will not drop below the weir. Below that level the passive isolation function becomes operable.

The weir must be sized to allow for future operation at higher water levels, such that, in the unlikely event of a major leak in the chute area, the basin water level reaches the weir elevation [4.9 m (16 ft 2 in.)] before the chute drains. This requirement supports the seismic aftershock analysis. A higher water level in the basin with the chute empty would increase the stress on the separating wall (island) between the basin and the chute.

The analysis, Reference VII 7.4.5, examined the water volume transfers and time for different opening sizes. The conclusion was that a flow area size of 146 cm² (22.6 in.²) would provide sufficient water transfer to meet the requirement. This flow area is the total for both basin barriers. The weirs were designed

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conservatively and provide 413 cm^2 (64 in.^2) of flow area for each basin by using two weirs, each 41 cm by 5 cm (16 in. by 2 in.), one in each barrier.

6.2.5 Seal Performance Analysis

The isolation barrier seal design was established after the design objectives were considered and a number of alternatives were evaluated. Details of the seal performance analysis are provided in Reference VII 7.4.6. The seal performance objectives include the following:

- Compressibility to conform to the surface of the basin wall
- Material suitable for a 15-year service life suitable to the water chemistry and the radiation field
- A configuration that fit the design characteristics of the basin wall and the discharge chute opening
- A seal design that could be tested after the barriers were installed and periodically during its design lifetime
- A seal with previous applications with similar environments
- A seal that would retain sufficient compression after a period of service following initial installation to minimize the need for later recompression.

The seal design selected is a compressible J cross-section seal. This is a hollow bulb seal made of ethylene propylene, with approximately 2.5 cm (1 in.) diameter of internal air space. The uncompressed external diameter is approximately 4.4 cm (1.75 in.).

The J seal is mounted to the barrier by a stainless steel clamping strip and bolts. The clamping strip holds the J seal in the proper position against the barrier to ensure that, when the barrier is positioned and the tie rods are tightened, the seal is in the proper position to be compressed against the sealing strip. The basin sealing surface is a 12.7-cm (5-in.)-wide strip that begins 5.5 m (18 ft) above the basin floor, drops to the bottom, then across the bottom of the opening, and up 5.5 m (18 ft) to the other side of the opening. The seal attached to the barrier fits against that sealing area. See Figures VI-2 and VI-3. The seal compression will be limited by the thickness of the seal clamping strip. With the barrier tightened to the point where the clamping strip is close to the wall surface, the seal will be compressed to approximately 41 percent.

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Figure VI-2. Isolation Barrier with J Seals in Place.

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Figure VI-3. Isolation Barrier Showing Detail of J Seal.

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Subjects that were investigated to decide on a seal that satisfied the listed criteria were as follows:

- Various alternate seal concepts
- Consideration for lateral motion
- Compressibility characteristics and forces
- Relaxation and fatigue
- Resistance to abrasion and side forces
- Determination of the physical dimension of the openings.

Alternative seal designs considered were a flat seal and a double J seal. The flat seal has less capability to conform to variations in the seal surface. The double J seal is easier to test for leaks, however the double J seal is too wide for the sealing surface.

Lateral motion during a seismic event was considered undesirable because the movement could alter the relationship between the seal and the sealing strip or cause abrasion of the seal, either of which could lessen the integrity of the seal. The decision was made to allow for small initial movement but to limit the movement using mechanical stops. The movement was limited to that which would allow the sides of the flexible seal to flex laterally but would not move the seal relative to the seal surface. This was accomplished by using a lateral motion limiter. See Figure VI-4.

Nineteen rods provide the compressive force on the seal. They are attached to the seal face of the barrier and when tightened by the nuts, hold the barrier seal against the sealing strip and compress the J seal. Compression tests were conducted and the tie rods were designed to accommodate the forces resulting from 41 percent seal compression. That is enough to allow the J seal to relax later, while accomplishing its function without being retightened during its design life.

To ensure that the barriers fit into the current openings, the deviation from plumb of the two vertical surfaces of each opening was determined. The openings were found to be uniform and to provide a suitable fit-up within the ability of the flexible seal.

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Detail Showing Lower Side Stops Which Restrain
Sideways Motion During Seismic Events

115409021.11

Figure VI-4. Isolation Barrier Showing
Lateral Motion Limiter

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6.2.6 Isolation Barrier Leak Rate Test Methodology

A post-installation leak test will be performed to verify that the isolation barriers control leakage from the basin to the chute within the safe limit specified in the SAR. The test will also be used to generate baseline data.

During the leak test, the water level in the chute will be lowered relative to the water level in the basin, which will generate a hydraulic head across the barriers. The basin water level will be recorded over a period of time. The basin water leak rate can be calculated by the water volume change over time. Because the water level can be influenced by evaporation, condensation, and temperature changes, these effects will be determined and compensated for in determining the leak rate.

The differential head established between the discharge chute and the basin for the test is limited by operational considerations. Water level measurements will be made over a small range of testable differential heights. However, in the postulated seismic leak, the differential height could increase to its maximum [approximately 4.9 m (16 ft 2 in.)] if the chute were to empty. To determine a leak rate for this hypothetical condition, a curve-fitting technique based on the available data will be used to apply the test results to leakage anticipated with full height differential across the barriers. The methodology is presented in detail in Reference VII 7.4.7.

6.3 MATERIAL PROCUREMENT

Ensuring the suitability of material procured and used in fabrication of the K Basins isolation barriers was an important task in the USQ resolution. This section describes the approach used to ensure suitability of the materials for use in the Safety Class 1 application of the K Basin isolation barriers. Detailed documentation that the materials used are of adequate quality is provided in Reference xx.

6.3.1 Procurement Methods

Two methods of material procurement for use in the Safety Class 1 applications are allowed under WHC procedures. These are:

- Safety Class 1 procurement from a supplier currently on the Evaluated Suppliers List (ESL) for the materials being procured
- Procurement of commercial-grade material, and dedication of that material for use in its specific Safety Class 1 application.

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These two methods of procuring material for safety-related applications are also used in the commercial nuclear power industry. When properly implemented, they are considered equivalent, and both meet the procurement-related regulatory requirements established by the NRC.

As part of the USQ resolution process, a review was performed to evaluate the feasibility of using the commercial-grade dedication method at the Hanford Site generally, and for procurement of the material for the K Basins isolation barriers specifically. The results of this review indicated that use of the commercial-grade procurement and dedication option was feasible under DOE regulatory requirements and implementing WHC procedures. A detailed report on this review is provided in Appendix B.

As noted in Section 3.6, two sets of isolation barriers were fabricated for use at K Basins. The modified set consists of two existing coffer dams, originally fabricated under Safety Class 2 controls, which were evaluated and then modified under Safety Class 1 controls to meet the requirements of the isolation barrier final design. The new set of isolation barriers was fabricated entirely under Safety Class 1 controls.

Both the Safety Class 1 method and the commercial-grade method of material procurement were used on both sets of isolation barriers. The procurement histories for the modified and new sets of barriers are discussed separately.

6.3.2 Procurement of Material for the Modified Set of Isolation Barriers

The modified set of isolation barriers include materials procured as commercial grade during fabrication of the coffer dams, materials procured as commercial grade to support modification of the coffer dams, and materials procured as Safety Class 1 to support modification of the coffer dams. Each of these materials is discussed.

Material Procured as Commercial Grade During Fabrication of the Existing Cofferdams

Before reaching a decision to modify the coffer dams, a thorough review of their fabrication and material records was performed to determine the feasibility of such an approach. The fabrication of the coffer dams was controlled to Safety Class 2 standards. The review was to determine whether adequate controls had been applied such that, when augmented with additional quality controls, adequate verification would exist that the materials used were of suitable quality for use in the isolation barriers. The key questions were whether material control and traceability

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to sources of supply had been maintained, and whether fabrication practices were commensurate with Safety Class 1 requirements. The review of the fabrication records for the coffer dams indicated the following:

- The fabrication effort had been controlled using the same procedures that would have applied if the work had been controlled as Safety Class 1.
- All steps in the fabrication effort were fully documented in the same manner as if the work had been Safety Class 1.
- Welder qualification and weld records were maintained in the same manner as if the work were Safety Class 1.
- Traceability was maintained on all materials used in fabrication, with the specific purchase orders used to obtain the material identified for each part.
- Quality control during fabrication generally met practices used for Safety Class 1 work, with the only significant exception being in the weld inspections performed.

Based on the results of the record review, a decision was made to evaluate the specific materials used and establish dedication requirements for use of these materials in the K Basins isolation barriers. The main steps in this evaluation were:

- Determining which materials were used in parts that perform safety functions in the final isolation barrier design, and which materials were only used in nonsafety-related parts
- Performing commercial-grade item dedication evaluations which identified the critical characteristics that, when verified, ensure that the materials are of adequate quality for their intended functions
- Obtaining and reviewing available quality documentation that provided assurance that the materials used were acceptable
- Identifying additional tests and inspections that must be performed to augment the available documentation to provide adequate assurance that the materials are acceptable.

In general, the critical characteristics that apply to the isolation barriers are of two basic types: fabrication related, such as material of proper dimensions (including angular dimensions where specified) and material related, such as chemical composition and physical strength of material. In general, dimensional characteristics were verified during fabrication of the isolation barriers. Some additional dimensional measurements

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were specified in the dedication evaluations as documented in Reference xxx.

Verification of chemical and physical composition of the materials can be obtained either by obtaining mill test reports for the material used, or by performing testing and analysis of material samples from the as-built structure. Use of mill test reports (when available) is preferred, as it avoids the need to select sample locations and evaluate the impact of removing such samples from the as-built structure. For this reason, a review of procurement records both in WHC files and from the material suppliers was performed to determine whether mill test reports traceable to the materials used to fabricate the coffer dams were available. As is often the case, these records were available in the supplier's files, even though they had not been required in the WHC purchase orders. Results of the physical and chemical test reports obtained were compared to the requirements of the applicable ASTM specifications identified in the isolation barrier design documents, and found to be within acceptable ranges in all cases. Copies of these mill test reports are included in Reference xxx.

Material Procured as Commercial Grade During Modification of the Existing Cofferdams

In several cases, materials required to modify the existing coffer dams to conform to the final isolation barrier design could not be procured as Safety Class 1. In these cases, dedication evaluations were prepared and necessary tests and inspections conducted to verify that the items so procured were of adequate quality for their intended Safety Class 1 applications. Dedication evaluations for these items and associated procurement records are included in Reference xx.

Material Procured as Safety Class 1 During Modification of the Existing Cofferdams

Wherever possible, materials used to modify the existing coffer dams were procured as Safety Class 1 from approved suppliers. Items procured Safety Class 1 for use in the modified isolation barriers are identified in Reference xx. Related procurement and receipt inspection records are also included.

6.3.3 Procurement of Material for the New Set of Isolation Barriers

Materials the new set of isolation barriers were procured as Safety Class 1 wherever possible. All structural steels that form the isolation barrier and the Z brackets that secure it in place were procured as Safety Class 1. Items procured as Safety Class 1

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and the associated procurement, receipt inspection, and fabrication records are included in Reference xx.

Some of the safety-related parts of the new isolation barriers were procured as commercial-grade items. Commercial-grade dedication evaluations were prepared for these items identifying tests and inspections required to ensure adequate quality. Procurement records, receipt inspection records, and commercial-grade dedication evaluations for these items are provided in Reference xx.

Materials used in nonsafety-related applications on the isolation barriers were procured as commercial items, and do not require completion of dedication evaluations. Justification for classification of these items as nonsafety-related are included in Reference xx.

6.3.4 Conclusion

Evaluation of the materials used in fabrication of both the modified and new isolation barriers resulted in the determination that all materials are of adequate quality for use in the K Basins isolation barriers.

6.4 Report on Fabrication of Isolation Barriers

SUMMARIZE OVERALL REPORT - OVERALL REPORT TO BE IN REFERENCE LIST

LATER

6.4.1 Summary of Fabrication Effort

The isolation barriers were fabricated at the 2704W shops at the 200 West area by ICF Kaiser Engineers. The material and the activities performed in constructing the barrier assemblies is contained in work packages identified as follows:

Task Package Control Number:	KK2E1X
Design Drawings;	H-1-80104, Sheets 1 through 5
Work Package	2H9400875, Sub-packages A through K

Material Procurement The material specifications are contained on Sheet 1 of the design drawings. The specifications were translated into purchase requisitions,

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which were reviewed by the cognizant Engineering and Quality Assurance organizations as part of the procurement process.

On receipt, the material was inspected for compliance with the purchase order by Procurement Quality Support (QS). Records of receipt inspection are retained by Procurement QS and in the work package records set. Material staged for fabrication was verified as that specified before being released to the process.

Isolation Barrier Assembly Hierarchy Each Isolation Barrier basin consists of the barrier, the Z-brackets and tie rods, and the fasteners that hold them together. When installed, the barrier assemblies are interlocked with and press against the concrete structure and reliably isolate the discharge chutes from the main storage basin.

Isolation Barrier

The components of a barrier assembly are:

Frame: made from welded sections of 8.9-cm x 8.9-cm x 0.64-cm (3.5-in. x 3.5-in. x 0.25-in.)-wall square, A36 square tubing. The interior of the tubing is closed to water. The frame provides rigidity to the Plate.

Plate: made from 1.3-cm (0.5-in.) A36 flat plate. The plate fills, and is sealed to, the concrete structure that forms a passway between the storage basin and the discharge-pickup chutes.

Vertical Lifting Bails: made of 2.5-cm (1-in.) flat plate welded and gusseted to the frame.

Pad Eyes: made of 1.3-cm (0.5-in.) A36 steel, they are welded to the plate and function as the attachment point for the tie rod hooks.

Lateral Motion Limiters: made from 5.1-cm- (2-in.)-thick 304 stainless steel and welded to the plate, they limit the possible side-to-side movement the barrier within the passway during a seismic event.

J Seal and Mounting Hardware: consists of the rubber J seal assembly, the threaded, 1.3-cm (0.5-in.) SS studs welded to the plate that will hold the seal in place, and the SS clamping strips and retaining nuts.

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Z Brackets

Each barrier assembly has 10 Z brackets. Each bracket is a welded assembly of 8.9-cm x 8.9-cm x 0.64-cm- (3.5-in. x 3.5-in. x 0.25-in.)-wall square steel tubing, with the interior of the tube closed to water entry.

Each pad eye level of a barrier has one bracket. The brackets stack on top of each other and bear on the opposite side of the concrete wall from the barrier. Each bracket has tie rod connection points that match the pad eyes on the barrier at that level. The bottommost bracket has one-tie rod connection to adapt to the horizontal run of the J seal at the bottom of the barrier.

Tie Rods

Each isolation barrier is secured to the concrete passway structure by tie rods connecting an eye pad with a corresponding Z bracket. Each tie rod is loaded in tension, and it is the pulling force of 19 tie rods that secures the isolation barrier to the concrete.

A tie rod consists of 2.5-cm- (1-in.)-diameter SS round rod welded to 2.5-cm- (1-in.)-thick SS plate stock with a hook shape. The hook shape engages the opening of a barrier pad eye. The overall length of a tie rod varies from 1.8 m to 0.46 m (5 ft 10 in. to 1 ft 6 in.), the length being dictated by location of the tie rod in the Z bracket. The outside 14 cm (5.5 in.) of each rod is threaded.

Spacers, SS washers, and a self-locking nut make up the remainder of a finished tie rod subassembly.

Barrier Assembly Fabrication

ISOLATION BARRIER ASSEMBLY. The following describes the fabrication sequence of the barrier:

Build the Frame: Square tubing is cut to length to make up the pieces for the frame. The pieces are clamped to the welding table and tack welded together. Upon verification of dimensions, the joints were finish welded, inspected, and the surfaces to butt against the plate ground flush.

Install Lifting Bails: Make tubing cut-outs per drawing and assemble/tack weld components. Verify dimensions, finish weld, and inspect.

Cut-out And Attach Plate: Cut out the 5.5-m x 110-cm- (18-ft x 43-in.)-, 1.3-cm- (0.5-in.)- thick plate. Straighten as required to fit flush to the frame. Align the frame on the cover and clamp

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parts together and to the weld table. Tack weld, verify dimensions, and finish weld.

Attach Pad Eyes and Lateral Motion Limiters: Cut out parts per drawing. Turn the barrier over, plate surface facing up. Locate each eye part per drawing and tack weld. Verify dimensions and finish weld. Inspect weld and dimensions. Deburr.

Weir: Locate and cut out the weir slot. Deburr.

Seal Weld/Isolate Tube Interiors: Cut out end caps and weld to open tube ends per drawing.

Attach Seal Retaining Studs: Lay out and locate attaching points studs. Verify locations. Weld threaded studs in place per location. Inspect.

Clean And Paint: Sand blast all surfaces. Paint using epoxy to thickness specified on the drawing.

Attach J Seal: Cut out holes on the J Seal to match stud layout. Install seal clamping strips, washers and lock nuts. Torque all nuts to specified amount.

Z BRACKET ASSEMBLIES. The following describes the fabrication process that produces the Z Brackets:

Cut Out Components in Accordance with Drawing: Cut out structural components from square tube stock and pad eyes from flat stock, per drawing. Verify dimensions.

Assemble and Weld Tube Parts: Using the tubing alignment fixture, assemble and tack weld components together. Verify alignment and finish weld. Inspect.

Locate and Weld On Pad Eyes: Locate pad eye on the bracket, tack weld, verify dimensions, finish weld. Inspect.

Seal Weld/Isolate Tube Interiors: Cut out and weld square tubing end caps to open tube ends per drawing. Seal weld balance plate hidden surfaces.

Balance Bracket Assemblies:

Clean and Paint: Sand blast all accessible surfaces. Clean and paint to drawing requirements. Inspect.

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TIE ROD HOOKS. The tie rods were fabricated in the following sequence:

Cut Rounds To Preliminary Length, Thread One End: Cut 2.5-cm (1-in.) round stock to drawing length. Machine threads per drawing on one end. Inspect.

Cut Out Hooks: Torch cut hook periphery, leaving adequate material for finish machined dimensions.

Machine Hook: Machine hook to drawing dimensions. Inspect.

Final Cut: Cut unthreaded end of round so that the rod/hook assembly matches the drawing length.

Weld Hook to Rod: Use alignment fixture and tack weld hook/rod together. Verify dimensions and finish weld. Inspect.

RECORDS

Records of procurement and fabrication are retained in the 712 Building. They are retrievable by Work Package Identity Number.

The finished packages are first reviewed by the shop then by QA for completeness and compliance to requirements. The reviewed packages are then sent to Records Retention at the 712 Building.

6.4.2 Shop Travelers

LATER

6.4.3 Fabrication Records

LATER

6.5 Installation and Post-Installation Test Results

SUMMARY OF PERTINENT POINTS FROM THE REPORT/DOCUMENTS IN THE REFERENCE LIST

LATER

6.5.1 Installation Plan

LATER

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6.5.2 ALARA Review

LATER

6.5.3 Installation Procedures

LATER

6.5.4 Baseline Leak Test Report

LATER

6.5.5 Baseline ISI Report

LATER

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VII. Reference Documents

- 7.1 K Basins Engineering System Assessment, 100 K Area, May 1994
- 7.2 SAR/Authorization Bases Documents
 - 7.2.1 WHC-SD-WM-SAR-062, R1. Safety Analysis, Irradiated N Reactor Fuel. June 6, 1994.
 - 7.2.2 WHC-SD-SNF-SARR-002 R1. Safety Assessment of Discharge Chute Isolation Barrier Preparation and Installation. September 22, 1994. (See Appendix D)
- 7.3 Unreviewed Safety Question Resolution Plan, Rev. 5, August 8, 1994
- 7.4 Technical Data
 - 7.4.1 Functions and Requirements
(See Appendix C)
 - 7.4.2 Final Design Drawings
 - WHC Drawing H-1-42659, R1, 2 sheets. Basin Discharge Chute Isolation Cofferdams, June 23, 1993.
 - WHC Drawing H-1-80104, R1, 6 sheets. Basin Discharge Chute Isolation Barriers, XXXXXXX, 1994.
 - WHC Drawing H-1-34730, R5, 2 sheets. Engineering Flow Diagram KW Storage Facility for N Reactor Fuel, June 20, 1984.
 - 7.4.3 Stress Analysis Reports
 - Hanford Plant Standard SDC 4.1 Standard Arch-Civil Design Criteria. Design Loads for facilities, 9/3/93.
 - WHC-SD-NR-SA-024, R0. 105-KE/105-KW Irradiated Fuel Storage Basin Seismic Qualification Final Report, Phase I of III, December 27, 1991.
 - ECN 191290 TO WHC-SD-NR-SA-024, April 18, 1994.
 - WHC-SD-NR-SA-024, ROA. 105-KE/105-KW Irradiated Fuel Storage Basin Seismic Qualification Final Report, Phase I of III, April 18, 1994.
 - WHC-SD-NR-SA-025. Independent Review of 105-KE/105-KW Irradiated Fuel Storage Basin Report, Phase I of III (WHC-SD-NR-SA-024), February 14, 1992.

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WHC-SD-N031-SA-001. 105-KW Irradiated Fuel Storage Basin Metal Roof Addition Seismic Qualification. Phase II of III, February 11, 1994.

WHC-SD-N031-SA-002. 105-KE/105-KW Irradiated Fuel Storage Basin Seismic Qualification, Phase III of III. February 25, 1994.

WHC-SD-N031-SA-004. Independent Review of 105KE/105KW Irradiated Fuel Storage Basins, Phase II and III Dynamic Structural Analyses. May 12, 1994.

LLH-8D420-94-001, Structural Calculation for K Basin Isolation Barriers. Internal Memo, September 6, 1994.

8D420-MRL-94-005, Structural Calculation of K Basin Isolation Doors. Internal Memo, June 23, 1994.

8D420-BVW-94-002, K Basin Divider Wall Allowable Water Height for Seismic Event.

7.4.4 Corrosion Analysis

DRAFT DOCUMENT NUMBER KE Basin Discharge Cofferdam Corrosion Allowance and Coating Recommendations. June 24, 1994

7.4.5 Isolation Barrier Weir Sizing Analysis

WHC-SD-NR-CN-001. Overflow from Basin to Discharge Chute. August 5, 1994.

7.4.6 Isolation Barrier Seal Performance Analysis

DRAFT WHC-SD-SNF-ER-002, R0. K Basin Isolation Barrier Seal, July 20, 1994.

Draft - Seal Compression Test Results

Draft - Tie Rod Tightening Procedure

7.4.7 Isolation Barrier Leak Rate Methodology Analysis

WHC-SD-SNF-TP-009 REV. 0, 105-K Isolation Barrier Leak Test Specification/Test Plan

7.5 Material Procurement Methodology Documentation

identify pertinent documents by traceable number/subject

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- 7.6 Isolation Barriers Fabrication Methodology Documentation
 - identify pertinent documents by traceable number/title
- 7.7 Identify installation plan documents/procedures. Include ALARA report. Identify documentation of baseline leak and ISI reports.
- 7.8 Identify documents for ISI and maintenance plans, procedures and criteria.

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APPENDIX A

Review of Upper Tier Requirements

On August 4, 1977, pursuant to the Department of Energy Organization Act (Pub. Law 95-91), all functions of ERDA as well as the functions of the Federal Energy Administration and Federal Power Commission were transferred to the DOE. Under Section 107(a) of the ERA (Pub. Law 93-438), ERDA had been authorized to perform certain functions specified in the AEA. In particular, Section 161(b) of the AEA authorized ERDA, and now DOE, to control the use of special nuclear material through "rule[s], regulation[s], or order[s]." The authority given to DOE under Section 161 is broad and includes all aspects of assuring the safe management of nuclear facilities authorized by the AEA. See 59 Federal Register (FR) 15843 (Apr. 5, 1994) (final rule for 10 CFR Part 830).

Based on its authority under the AEA, DOE has promulgated regulations and orders that establish the requirements under which contractors carry out their obligations.

[Working Outline Materials -- This will form the basis for Sect.III/3.1]

CONCEPTS FOR POTENTIAL USE IN UPPER TIER DISCUSSION AS PART OF OVERALL SUMMARY REPORT ON ISOLATION BARRIERS

DOE CREATED FROM ERDA

- On August 4, 1977, pursuant to the Department of Energy Organization Act (Pub. Law 95-91), all functions of ERDA as well as the functions of the Federal Energy Administration and Federal Power Commission were transferred to DOE. Selected responsibilities of the ICC, Departments of Navy, Interior, Commerce and HUD were also transferred.
- Section 107(a) of the Energy Reorganization Act of 1974 (Pub. Law 93-438) authorized ERDA to perform functions specified in the AEA (e.g., § 161).
- Section 161(b) of the AEA allows for control of the use of special nuclear material to be accomplished through "rule[s], regulation[s], or order[s]."

10 CFR 830 (59 FR 15843) (4/5/94)

- Section 161 of the Atomic Energy Act (AEA) of 1954, as amended (42 USC 2201) provides DOE with broad authority to carry out its responsibilities under the AEA, including the safe management of

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facilities authorized by the AEA. This authority is the basis for all the rules concerning the safe management of nuclear facilities that DOE intends to adopt in Part 830.

- §830.3 -- Definitions

Implementation Plan means a document prepared by a contractor that sets forth:

(1) When and how the actions appropriate to comply with the requirements of a section of this Part, including the requirements of a plan or program required by the section, shall be taken, and

(2) What relief will be sought if a contractor cannot attain full compliance with a requirement in a reasonable manner.

* [An implementation plan would be, for example, the QAP

- §830.120 -- Quality Assurance Requirements: includes procurement, design, records, etc.
- Subparts B, Design, & C, Operations, are reserved for promulgation later.

DOE Order 5480.21 (12/24/91), Unreviewed Safety Questions

§6 -- Definitions

- Authorization Basis. Those aspect of the facility design basis and operational requirements relied upon by DOE to authorize operation. These requirements are considered to be important to the safety of facility operations. The authorization basis is described in documents such as the facility Safety Analysis Report and other safety analyses; Hazard Classification Documents, the Technical Safety Requirements, DOE-issued safety evaluation reports, and facility-specific commitments made in order to comply with DOE Orders or policies.
- Safety Analysis. See DOE 5480.22, Safety of Nuclear Facilities.
- Safety Analysis Report (SAR). See DOE 5480.23, Safety of Department of Energy-Owned Nuclear Reactors.
- Technical Safety Requirements. Those requirements that define the bounding conditions for safe operation, and bases thereof, and the management or administrative controls required to ensure the safe operation of a nuclear facility.

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§10 -- Program Requirements

- When a contractor identifies a situation that indicates a potential inadequacy of previous safety analyses or a possible reduction in the margin of safety, the following basic actions, among others, are required:
 - conduct a safety evaluation to determine if a USQ exists
 - if a USQ exists, take action to place facility in safe condition pending resolution
 - prepare a resolution plan
 - obtain approval for resolution from Program Office
 - implement resolution plan
 - revise authorization basis document(s) to reflect resolution

Chapter III -- Implementation Guidance, §3

- Safety analyses are intended to define those aspects of design and operations that are important to safety and therefore those aspects that DOE relies upon to allow initial and continued operation.
- The authorization basis of a facility may not be reflected in total in the current facility SAR. This basis, depending upon the facility, may reside in several different type of documents. These may include not only the facility SAR, but historical commitments made by contractors to support modifications and the imposition of new DOE requirements or administrative changes. These may also include DOE safety evaluation reports that modify contractor-proposed changes or analyses.
- The contractor must define that population of documents comprising the various elements of the authorization basis and must use this defined population of documents as the basis for performing safety evaluations under the requirements of this Order.

DOE Order 5480.22 (2/25/92), Technical Safety Requirements

§6 -- Definitions

- Safety Analysis means documented processes: (1) to provide systematic identification of hazards within a given DOE operation, (2) to describe and analyze the adequacy of the measures taken to eliminate, control, or mitigate identified hazards; and (3) to analyze and evaluate potential accidents and their associated risks.

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- Safety Analysis Report (SAR) means that report which documents the adequacy of safety analysis for a nuclear facility to ensure that the facility can be constructed, operated, maintained, shut down, and decommissioned safely and in compliance with applicable laws and regulations.
- Technical Safety Requirements (TSRs) means those requirements that define the conditions, safe boundaries, and the management or administrative controls necessary to ensure the safe operation of a nuclear facility and to reduce the potential risk to the public and facility workers from uncontrolled releases of radioactive materials or from radiation exposures due to inadvertent criticality. A TSR consists of safety limits, operating limits, surveillance requirements, administrative controls, use and application instructions, and the basis thereof.

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Appendix B

Dedication of Existing Isolation Barriers

I. Background

Following the evaluation of the dynamic seismic analysis results and leak rate assessment for the spent fuel storage basin at the K Reactor K Basin, WHC determined that previous conclusions about the integrity of the K Basin following a not fully envelope all potential accident scenarios.⁵ Specifically, the safety analysis report (SAR) for the K Basin, Section 5.3.3.2, establishes an upper limit leak rate at 5,680 l/hr (1,500 gal/hr). The recent seismic analysis indicates that during a DBE the construction joint located in the discharge chute, an area adjacent to the main spent fuel basin, could fail causing leakage estimated between 18,930 and 94,635 l/hr (5,000 and 25,000 gal/hr). Even with makeup water capability, as assumed under the SAR accident analysis, this leakage rate significantly challenges the capability of maintaining fuel coverage.

Consistent with DOE requirements, WHC determined that the seismic analysis raised an Unreviewed Safety Question USQ. Subsequently, WHC developed an action plan for resolution of the USQ. Among the possible solutions, WHC chose to use isolation barriers (also referred to as coffer dams) to seal the two openings between the main spent fuel basin and the discharge chute. This resolution method involved fabrication of two sets of barriers (one set for K East and one for K West) each capable of surviving a DBE.

One set of isolation barriers had previously been fabricated for the purpose of facilitating repair of operational leaks. Thus, the barriers were purchased and built to Safety Class 2 standards, which means they were not designed to survive a DBE. In order to withstand such an accident, however, the barriers must be designed and fabricated to Safety Class 1 standards.⁶ WHC performed an extensive design review of using isolation barriers and determined this approach to be an appropriate resolution of the USQ. Starting from this design position, the question is whether the quality of the materials and the fabrication/installation work is considered acceptable.

⁵ WHC considers a seismic event of low probability, but the damage of such an event of potentially high consequence.

⁶ Safety class is defined in WHC-CM-1-3, "Management Requirements and Procedures," MRP 5.46, "Safety Classification of Systems, Components, and Structures."

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WHC contracted with Pacific Northwest Laboratories (PNL), to prepare a document which provided reasonable assurance of the qualification of the existing isolation barriers for use in a Safety Class 1 application. Assisting PNL in the effort was a team which included representatives from Winston & Strawn (W&S), for legal and regulatory matters, and from Sequoia Consulting Group, Incorporated (Sequoia), for technical matters.

Based on technical and financial considerations, as well as timeliness, WHC wanted to utilize a strategy that had a high potential for success when submitted to DOE for review. Therefore, the initial stage of the work involved determining whether the commercial-grade dedication methods utilized in the commercial nuclear reactor industry would be applicable to the USQ resolution plan. If not applicable, the alternative was to purchase and fabricate new isolation barriers to Safety Class 1 standards. On the other hand, if applicable, WHC believed that use of the reactor industry standards had a high probability of acceptance by DOE. Furthermore, application of the commercial-grade dedication methods would result in cost savings and timely resolution of the USQ.

A review of the dedication methods used in the commercial reactor industry, as specifically endorsed by the NRC, showed them to be state-of-the-art. Based on this position, the PNL team concluded that these methods would be applicable to the USQ resolution plan. This conclusion was confirmed during a preliminary analysis of the design and fabrication requirements for the isolation barriers.

WHC agreed with the PNL team's recommendation to proceed with commercial-grade dedication of the isolation barriers consistent with NRC standards. The text below provides a discussion of the methodology used to dedicate the isolation barriers.

II. Discussion

To properly dedicate the isolation barriers for use in a Safety Class 1 application, particularly in a non-commercial nuclear reactor setting, several basic questions must be addressed. The first question is what are the governing regulatory requirements. Since WHC is a M&O contractor for DOE, the procurement methods set forth in the applicable DOE regulations, orders, and WHC implementing procedures must be identified.⁷

The second question is whether the applicable DOE regulatory requirements and WHC implementing procedures are consistent with

⁷ There may be other independent requirements that relate to this matter, such as through the WHC contract with DOE. However, an evaluation of these requirements is not within the scope of this task.

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commercial-grade dedication standards routinely employed in the commercial reactor industry and endorsed by the NRC. Past focus by the federal government on procurement activities in the commercial aviation and nuclear power fields have resulted in significantly enhanced commercial-grade dedication practices in these industries. Because of the clear similarities between the commercial reactor and the DOE weapons reactor industries, the techniques and standards endorsed by the NRC provide the best template for dedicating the isolation barriers.

The final question is, on applying the NRC "standards," do the findings support dedication of the isolation barriers. As discussed in more detail later, the answer to this question depends on the amount of objective evidence available concerning the quality of the materials and fabrication activities involved (e.g., vendor certifications or test results).

Each of these questions is addressed in order below.

A. Applicable Requirements

The control of purchased items and services is a basic element of quality assurance (QA) programs for the design, construction, operation and decommissioning of nuclear facilities.⁸ As such, the design and material procurement processes are regulated under the substantive QA requirements contained in 10 C.F.R. Part 830. Sections 830.120(a) and (b) explicitly require that DOE contractors responsible for nuclear facilities develop and submit for approval to DOE a Quality Assurance Program (QAP) which contains, among other things, provisions for assuring the proper procurement of items and services used at DOE nuclear facilities.

Specifically, Section 830.120(c)(2)(iii) states that:

Procured items and services shall meet established requirements and perform as specified. Prospective suppliers shall be evaluated and selected on the basis of specified criteria. Processes to ensure that approved suppliers continue to provide acceptable items and services shall be established and implemented.

⁸

See ASME NQA-1-1989, "Quality Assurance Program Requirements for Nuclear Facilities." (This industry standard is endorsed as an acceptable means for complying with DOE QA requirements.) 59 Fed. Reg. 15843, 15849. (Apr. 5, 1994); see also DOE Implementation Guide for 10 C.F.R. Part 830.120, "Quality Assurance," G-830.120-Rev. 0 (Apr. 15, 1994).

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This provision includes commercial-grade procurement activities.⁹ It, along with several other provisions (*i.e.*, Sections 830.120(c)(1)(iv) and 830.120(c)(2)(iv) involving documentation and acceptance testing, respectively), form the base requirements for control of the overall material procurement process.

In the final rule promulgating 10 C.F.R. Part 830 (59 FR 15843), DOE contractors were required to submit their QAPs by November 1, 1994. The QAPs should be limited to a description of the proposed QA activities, with the details to be contained in the contractors' implementing procedures and policies. Until a contractor submits a new QAP, however, the existing QAP remains in effect. These existing QAPs are implemented pursuant to DOE Order 5700.6C, *Quality Assurance*. Although 10 CFR 830.120 is intended to supersede DOE Order 5700.6C, there should be no substantive change in contractors' existing QAPs since the basic requirements are identical.¹⁰

In this regard, WHC has implemented a Quality Assurance Manual, WHC-CM-4-2 (effective date May 31, 1991), to meet the requirements of DOE Order 5700.6C. Although the QA Manual contains a number of sections that address various aspects of the overall material procurement process, Quality Instruction (QI) 7.5, Rev. 0, *Control of Commercial Grade Items*, specifically addresses commercial-grade procurement. In addition, WHC-IP-1026, *Engineering Practice Guidelines*, in Engineering Practice Guide (EPG) 5.3, Rev. 0 (May 27, 1994), supplements the guidance in the WHC QA Manual. These two documents combine to form the WHC implementing requirements for the commercial-grade dedication of the isolation barriers.

B. Consistency Of WHC Implementing Requirements With NRC Regulations & Industry Guidance.

Appendix B to 10 C.F.R. Part 50 establishes the basic quality assurance requirements for safety related structures, systems and components (SSCs) used in commercial nuclear power plants regulated by NRC. Appendix B sets forth these requirements in the form of criteria. Criteria III, IV, VII, VIII and XV of Appendix B are applicable to the control of purchased SSCs.¹¹ However, the process of dedication (*i.e.*, assuring that an item meets its design requirements and can therefore perform its intended safety function) is principally controlled by the first four criteria listed.

In sum, from the standpoint of commercial-grade dedication, Criterion III concerns design control and involves the process of

⁹ 59 Fed. Reg. at 15848.

¹⁰ 59 Fed. Reg. at 15847.

¹¹ 54 Fed. Reg. 9229 (Mar. 6, 1989).

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determining the safety function and classification of an item. Criterion IV concerns document control and involves the process of assuring that the design specifications are properly translated into procurement documents, such as purchase orders. Criterion VII is largely directed at assuring the traceability of an item from the original equipment manufacturer, through a distributor if applicable, to the ultimate end-user. Finally, Criterion VIII involves the control of the item while being warehoused and during the processes of fabrication and installation. (Attachment A contains the text of the applicable Appendix B criteria.)

To satisfy the requirements of Appendix B, QA activities such as commercial-grade dedication must be shown to provide "adequate confidence" that an SSC will perform satisfactorily while in service. As recognized by the Atomic Safety and Licensing Appeal Board, this language means that proper Appendix B implementation requires "simply a finding of reasonable assurance that, as built, the facility can and will be operated without endangering the public health and safety."¹² The "reasonable assurance" standard implements the overarching statutory mandate to "provide adequate protection to the health and safety of the public" as required pursuant to Section 182(a) of the AEA (42 U.S.C. § 2232(a)).¹³

Of course, what constitutes "reasonable assurance" is within the discretion of the NRC to decide depending on the particular circumstances at the time. In the context of commercial-grade procurement, however, NRC Inspection Procedure 38703 (Attachment 2) provides some insight. Specifically, the procedure states that "reasonable assurance" consists of the "purchaser controlling or verifying the activities affecting the item's quality to an extent consistent with the item's importance to safety or ensuring that these activities are adequately controlled by the supplier."

In the context of commercial-grade dedication, the critical activities affecting an item's quality include:

- design process (includes evaluation of safety function);
- translating design requirements to procurement specifications;
- specifying critical characteristics;
- acceptance process (*i.e.*, utilizing methods to reasonably assure that the item specified is the item received);
- receipt inspection;
- fabrication; and
- installation & post-installation testing.

¹² See, *e.g.*, Wisconsin Electric Power Co. (Point Beach Nuclear Plant, Units 1 and 2), ALAB-739, 18 N.R.C. 335, 346 (1983).

¹³ Carstens v. Nuclear Regulatory Commission, 742 F.2d 1546, 1557 (1984).

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NRC has provided specific regulatory guidance concerning the control of these critical activities for SSCs used in safety related applications. This guidance is made available in a variety of ways (e.g., Regulatory Guides, generic communications, and technical reports). While a number of these guidance documents relate to the commercial-grade dedication process, the principal guidance on applying the above referenced Appendix B criteria in this context is contained in NRC Generic Letters 89-02 (Attachment 3) and 91-05 (Attachment 4), as well as in NRC Inspection Procedure 38703. Although not regulatory requirements themselves, these guidance documents provide the NRC's view of what is an acceptable means of complying with the applicable Appendix B requirements.

Generic Letter (GL) 89-02 in turn discusses relevant industry guidance established by the Electric Power Research Institute (EPRI). The GL conditionally endorses EPRI Report NP-5652, *Guidelines for the Utilization of Commercial Grade Items in Nuclear Safety Related Applications* (NCIG-07).¹⁴ Specifically, GL 89-02 states that those who "use methods similar to those described in EPRI NP-5652 . . . to verify the critical characteristics of commercial-grade items intended for safety-related applications have the basis for effective dedication programs. . . . Properly implemented, the EPRI guidelines . . . [as modified by GL 89-02] establish methods which satisfy existing requirements of Appendix B." Therefore, EPRI NP-5652 forms the backbone of the NRC's regulatory guidance for commercial-grade dedication.

NRC GL 91-05 builds on GL 89-02 by providing further guidance on several key elements of the dedication process. This guidance is furthered by NRC Inspection Procedure 38703. The procedure explicitly indicates that it is "consistent" with the nuclear industry's comprehensive procurement initiative adopted in July 1990. This initiative was developed in concert with the nuclear utilities by the Nuclear Management and Resources Council (NUMARC).

The NUMARC initiative, documented in NUMARC 90-13, references several other EPRI reports: (1) EPRI NP-6629, *Guidelines for the Procurement and Receipt of Items for Nuclear Power Plants* (NCIG-15) and (2) EPRI NP-6630, *Guidelines for Performance Based Audits*. While not specifically referenced by NUMARC, EPRI has developed additional guidance as a supplement to those reports already mentioned. This guidance is principally contained in EPRI Reports NP-6895, NP-6406, NP-5652 and TR-102260. Each of these EPRI guidance documents apply to the overall commercial-grade dedication process. For the task at hand, that is determining whether the isolation barriers meet their technical requirements, only the guidance included in Reports NP-6895, NP-6406, NP-5652 and TR-102260 apply.

¹⁴

The GL makes only minor modifications to the guidance concerning two of the four acceptance methods (i.e., Methods 2 and 4) discussed in EPRI NP-5652.

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In sum, EPRI Report NP-6895, *Guidelines for the Safety Classification of Systems, Components and Parts Used in Nuclear Power Plant Applications (NCIG-17)*, contains guidance for determining which portions of a nuclear power facility's equipment are to be considered safety related, and therefore subject to quality assurance program requirements applicable to SSCs. EPRI Report NP-6406, *Guidelines for the Technical Evaluation of Replacement Items in Nuclear Power Plants (NCIG-11)*, provides guidance for establishing technical and quality requirements for replacement items. EPRI Reports NP-5652 and TR-102260, *Supplemental Guidance for the Application of EPRI Report NP-5652 on the Utilization of Commercial Grade Items*, contain specific guidance on the process by which items normally available in the commercial market can be procured and approved for use in nuclear safety related applications.

The EPRI guidance was compared with QI 7.5 and EPG 5.3. In general, the details of the guidance are not incorporated into these documents. However, the documents do follow the basic guidance for commercial-grade dedication embodied in EPRI NP-5652. Therefore, the existing WHC procedures provide an adequate basis for the dedication of commercial-grade items. (A more detailed discussion of the EPRI guidance documents is provided in Attachment 5.)

C. Dedication of K Basin Isolation Barriers:

Application of NRC Standards

Although the technical details of the dedication process are contained in an engineering report (Attachment 6), the discussion below provides a summary of the dedication activities for the isolation barriers.

The first major step in the dedication process was to gather all available technical and procurement information concerning the isolation barriers. Consistent with the PNL team's industry experience, and the guidance in NRC Inspection Procedure 38703, various procurement documents (such as drawings, bills of material, and fabrication records) applicable to the K Basin isolation barriers were obtained through a review of the WHC records.

The gathered information was used in the next step to prepare preliminary dedication evaluations for each of the unique structural parts used in constructing the barriers. In preparing these preliminary evaluations, the safety function of the isolation barriers was compared with the procurement information gathered. In sum, the safety function, as described in the WHC USQ Plan, is to prevent or limit leakage from the main spent fuel basin in case of a DBE. To provide this function, the isolation barriers must maintain structural integrity and maintain an adequate seal at the surface between the barriers and the main fuel basin wall.

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The next step in the dedication process was to identify the critical characteristics for each unique part. Basically, the isolation barriers and their associated support brackets are fabricated from plate and tubular carbon steel materials, with stainless steel tie rods serving as fasteners to secure the overall structure in place.

Where possible, similar parts were grouped into a single evaluation package based on part function and material construction. Since EPG 5.3 did not include any forms for use with the procedure, the PNL team developed appropriate forms to document the dedication evaluations.

In general, the critical characteristics which apply to the isolation barrier parts are of two basic types: (1) fabrication-related, such as material of proper dimensions (including angular dimensions where specified); and (2) material-related, such as chemical composition and physical strength of material.

In principle, all of the required critical characteristics for each part of the isolation barriers could be verified through test and inspection activities. However, exclusive use of testing would be extensive, time-consuming and costly, in particular since a significant number of samples of the actual materials would be required. Further, the testing would require substantial engineering input and review to assure that the removal of samples from the affected parts allowed the isolation barriers to remain within design limits.

As an alternative, and consistent with the guidance contained in NP-5652 and commercial nuclear industry practice, a more detailed review of the fabrication and procurement records was undertaken to determine the extent to which existing documentation could be relied on to provide the required objective evidence of material acceptability. The following provides a summary of the PNL team's findings for this final step, that is determining whether the acceptance criteria are met for the two categories of critical characteristics:

1. Fabrication-Related Critical Characteristics

A review of the fabrication records for the isolation barriers indicated that this activity was, with the exceptions noted below, performed under quality controls which were essentially identical to those used for fabrication of Safety Class 1 SSCs at WHC. The records document the (1) materials used (including traceability to the procurement documents), (2) dimensional requirements and tolerances, (3) weld locations, (4) type of welds, (5) weld materials used, and (6) the in-process and/or post-work QC inspections performed.

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The specific exceptions are as follows:

- Verification of threading machined into the tie rods was waived during fabrication. Each tie rod will require inspection to verify threading is as specified in the design.
- Verification of dimensions on the barrier assembly pad eyes was not documented at a sufficient level of detail. Additional dimensional checks of the as fabricated pad eyes on the barrier assembly will be required.
- Weld inspections performed during fabrication of the barriers consisted of visual inspection only. It is our understanding that all final welds on the barriers and associated brackets are to be inspected using penetration testing, ultrasonic testing, or another test method approved for use on Safety Class 1 welds of this type prior to installation. Verification of one of these methods must be accomplished.

2. Material-Related Critical Characteristics

A review of the fabrication records for the K Basin isolation barriers indicated that all of the safety related structural steel materials were procured on two requisitions to Pacific Steel. Pacific Steel was contacted and they were able to provide MTRs for all of the material provided on the two requisitions. The MTRs were reviewed and determined to be applicable to the material supplied. In addition, the results of the physical and chemical tests performed by the mills who produced the materials were compared to the applicable ASTM specifications identified in the isolation barrier design documents. All of the results were found to be within acceptable ranges.

Pacific Steel is on the WHC evaluated suppliers list (ESL) for structural steels of the type provided, and has been continuously since 1989. Pacific Steel verified in writing that the two subject requisitions were procured and controlled under procedures used for Safety Class 1 purchase orders. These procedures are the same ones reviewed and approved by WHC as part of the process to place Pacific Steel on the ASL.

Based on the documentation gathered from Pacific Steel, there appears to be adequate objective evidence to demonstrate that the materials provided by Pacific Steel are of acceptable quality and meet the specified design requirements. Therefore, no further testing of these materials is required.

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III. Conclusion

A thorough review of the existing documentation indicates that the parts comprising the isolation barriers are of adequate quality to be used in the proposed Safety Class 1 application. This quality provides reasonable assurance that the isolation barriers can perform the intended safety function under a DBE.

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ATTACHMENT 1

III. DESIGN CONTROL

Measures shall be established to assure that applicable regulatory requirements and the design basis, as defined in §50.2 and as specified in the license application, for those structures, systems, and components to which this appendix applies are correctly translated into specifications, drawings, procedures, and instructions. These measures shall include provisions to assure that appropriate quality standards are specified and included in design documents and that deviations from such standards are controlled. Measures shall also be established for the selection of materials, parts, equipment, and processes that are essential to the safety-related functions of the structures, systems and components.

Measures shall be established for the identification and control of design interfaces and for coordination among participating design organizations. These measures shall include the establishment of procedures among participating design organizations for the review, approval, release, distribution, and revision of documents involving design interfaces.

The design control measures shall provide for verifying or checking the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program. The verifying or checking process shall be performed by individuals or groups other than those who performed the original design, but who may be from the same organization. Where a test program is used to verify the adequacy of a specific design feature in lieu of other verifying or checking processes, it shall include suitable qualifications testing of a prototype unit under the most adverse design conditions. Design control measures shall be applied to items such as the following: reactor physics, stress, thermal, hydraulic, and accident analyses; compatibility of materials; accessibility for in-service inspection, maintenance, and repair; and delineation of acceptance criteria for inspections and tests.

Design changes, including field changes, shall be subject to design control measures commensurate with those applied to the original design and be approved by the organization that performed the original design unless the applicant designates another responsible organization.

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IV. PROCUREMENT DOCUMENT CONTROL

Measures shall be established to assure that applicable regulatory requirements, design bases, and other requirements which are necessary to assure adequate quality are suitably included or referenced in the documents for procurement of material, equipment, and services, whether purchased by the applicant or by its contractors or subcontractors. To the extent necessary, procurement documents shall require contractors or subcontractors to provide a quality assurance program consistent with the pertinent provisions of this appendix.

VII. CONTROL OF PURCHASED MATERIAL, EQUIPMENT, AND SERVICES

Measures shall be established to assure that purchased material, equipment, and services, whether purchased directly or through contractors and subcontractors, conform to the procurement documents. These measures shall include provisions, as appropriate, for source evaluation and selection, objective evidence of quality furnished by the contractor or subcontractor, inspection at the contractor or subcontractor source, and examination of products on delivery. Documentary evidence that material and equipment conform to the procurement requirements shall be available at the nuclear power plant or fuel reprocessing plant site prior to installation or use of such material or equipment. This documentary evidence shall be retained at the nuclear power plant or fuel reprocessing plant site and shall be sufficient to identify the specific requirements, such as codes, standards, or specifications, met by the purchased material and equipment. The effectiveness of the contractors shall be assessed by the applicant or designee at intervals consistent with the importance, complexity, and quantity of the product or services.

VIII. IDENTIFICATION AND CONTROL OF MATERIALS, PARTS, AND COMPONENTS

Measures shall be established for the identification and control of materials, parts, and components, including partially fabricated assemblies. These measures shall assure that identification of the item is maintained by heat number, part number, serial number, or other appropriate means, either on the item or on records traceable to the item, as required throughout fabrication, erection, installation, and use of the item. These identification and control measures shall be designed to prevent the use of incorrect or defective material, parts, and components.

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ATTACHMENT 2

NRC Inspection Procedure 38703, Commercial Grade Dedication, 11/08/93

ATTACHMENT 3

NRC Generic Letter GL 89-02, Actions to Improve the Detection of Counterfeit and Fraudulently Marketed Products, March 21, 1989.

ATTACHMENT 4

NRC Generic Letter GL 91-05, Licensee Commercial-Grade Procurement and Dedication Programs, April 9, 1991.

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ATTACHMENT 5

EPRI Report NP-6895

This report provides detailed guidance for determining the safety classification of SSCs used in nuclear power plants. It primarily deals with issues related to identification of safety functions, determining system boundaries through proper consideration of isolation and single failure criteria, and recommends an approach which is most useful when analyzing complex, interconnected mechanical and electrical systems.

Currently, there is no WHC procedure that implements the guidance included in this EPRI report. This is not considered an impediment to the current task because the safety functions of the individual structural components for the isolation barriers are straightforward and not complex. Proper safety classification of these components does not require extensive use of the detailed guidance contained in NP-6895. The situation, of course, would be different if WHC were to undertake classification efforts involving complex electrical or mechanical plant systems and components. Under such circumstances, the development of a specific procedure based on NP-6895 would be strongly recommended.

EPRI Report NP-6406

This EPRI report provides guidance on a process for determining an item's safety function(s) and identifying the critical design characteristics needed to assure this safety function(s). Under the guidance, an replacement item which can provide the critical design characteristics of the original item is considered acceptable.

The guidance expressed in NP-6406 is not effectively incorporated into any current WHC procedure. This also is not a concern for the current task since the isolation barriers do not meet the definition of a "replacement item." A replacement item is one which is being procured to replace an original item already installed in the facility, such as an existing pump, valve or circuit breaker. The isolation barriers are not replacement items. The current design will provide a permanent barrier between the main fuel basin and the discharge chute -- as such, it is designed and built to provide a function not previously included in the original design of the K Basin fuel storage pools. Consequently, there is no need to perform a replacement item evaluation under the guidance in NP-6406 in this case. If, on the other hand, WHC intends to make greater use of the dedication process in the future for procuring commercial-grade replacements for installed safety related components or items, it is recommended that the current procedures be upgraded to better incorporate the guidance of NP-6406.

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EPRI Reports NP-5652 and TR-102260

These two EPRI reports contain detailed guidance for performing commercial-grade item dedication activities, in particular as it relates to the process of providing reasonable assurance that acceptance criteria have been met. NP-5652 provides the basic procedural guidance, and TR-102260 (written over five years later) includes lessons learned through implementation of NP-5652 at commercial nuclear power plants.

In sum, these two guidance documents set forth the following basic elements for dedication of commercial-grade items:

- An item must meet the definition of a "commercial grade" item included in 10 C.F.R. Part 21 in order to be procured commercial-grade and dedicated for use in safety related applications. Otherwise, the item must be procured as safety related from suppliers with an approved QA program.¹⁵
- "Dedication" is a process consisting of a technical evaluation and quality assurance control activities which, when properly implemented, provide reasonable assurance that the item received is the item ordered.
- A key aspect of the dedication process consists of selecting critical characteristics of the item. The critical characteristics are verified through various acceptance methods and support the reasonable assurance finding.
- Four acceptance methods are identified which can be used to verify that the item received is the item ordered. They are:
 - Special Tests and Inspections;
 - Source Verification;
 - Commercial-grade Supplier Surveys; and
 - Satisfactory Item and Supplier Performance History.

Procedures currently in place at WHC follow the general guidance included in EPRI Report NP-5652 for the dedication of commercial-grade items. Specifically, EPG-5.3 and QI 7.5 include provisions for dedication of commercial-grade items and

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A commercial grade item is one that is: (1) not subject to nuclear unique design or specification requirements; (2) used in applications other than nuclear facilities; and (3) ordered from the supplier based on specifications set forth in the supplier's published product description (e.g., product catalog). See 10 C.F.R. § 21.3(a-1) (1994).

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qualification of commercial-grade vendors. While these procedures could be improved to enhance efficiency of the dedication process, they appear to provide an adequate procedural basis for dedication of the isolation barriers.

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ATTACHMENT 6

Sequoia Consulting Co. Engineering Report (i.e., contains technical data for dedication of piece parts)

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Appendix C

**105K EAST AND WEST BASIN/DISCHARGE CHUTE ISOLATION BARRIERS
FUNCTIONS AND REQUIREMENTS**

SEPTEMBER 20, 1994

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105K EAST AND WEST BASIN/DISCHARGE CHUTE ISOLATION BARRIERS FUNCTIONS AND REQUIREMENTS

1.0 INTRODUCTION

1.1 DOCUMENT PURPOSE

The purpose of this document is to identify functions and requirements for the installation of isolation barriers in the discharge chute openings of the 105K EAST and WEST basins. Once installed, the barriers will permanently isolate the discharge chute from the main basin. This activity is being performed to resolve the Unresolved Safety Question associated with the potential post-design basis earthquake leak postulated for the discharge chute construction joint.

1.2 BACKGROUND

The 105K Basins store spent fuel, and DOE, recognizing that these facilities were not designed for long term storage, has committed to remove all the fuel and sludge by 2002. Because of the extended basin use, WHC has been systematically reevaluating analyses performed to earlier standards using modern techniques. These analyses have identified a potential vulnerability in K Basins following a major earthquake.

This vulnerability is due to potential severe leakage caused by separation of the storage basin/discharge chute construction joint, which, unlike other joints, is not reinforced, and the resultant storage basin leakage due to failed seals and other problems associated with the original isolation gates. The existing gates are not Safety Class I, and are inoperable. This leakage could be of sufficient magnitude to uncover the fuel causing significant airborne radioactive contamination, a large incremental addition to the 105K Basin soil contamination, and the introduction of a large Tritium inventory to the groundwater. To counter this threat, the immediate compensatory actions of procuring Bentonite clay pellets for leak mitigation, and providing for temporary make-up water from the Columbia river, have been accomplished. The interim compensatory action of providing an isolation barrier between the storage basins and the discharge chutes will be accomplished next. The final corrective action will be to remove the fuel and sludge from the basins.

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1.2.1 Physical Description

The 105K basins are unlined, rectangular concrete pools, built in the early 1950's. They are 125 feet long, 67 feet wide, and 20 feet deep, with a nominal water depth of 16 feet. The basins are provided with an asphaltic membrane lined leakage collection sump under most of their footprints. Several structures extend beyond the collection sump, including the construction joint.

1.2.2 Current Status

The basins were constructed to meet the requirements of the standards in effect during construction in the 1950's. A formal comparison between the existing construction and the DOE 6430.1A requirements has not been made, however, several areas of non-compliance have been identified. These areas of non-compliance include lack of HEPA filtration on exhaust; lack of storage pool integrity in the event of a cask drop accident; lack of water chemistry control; and the lack of a pool liner or leak detection.

The 105-KW basin is coated with an epoxy sealant and the stored fuel elements are encapsulated in closed canisters. The 105-KE storage basin contains open canisters of fuel elements. As a result, the radiation and contamination levels in the East basin are higher than those of the WEST basin. The KW basin also has a canister decapping station located in the transfer canal between the load out pit and the basin's WEST bay. The isolation gates between the storage basins and the discharge chutes are open at both locations.

2.0 SCOPE

- 2.1 The scope of this project is to install new isolation barriers, two at each basin, between the basin fuel storage pool and the discharge chutes at 105-KW and 105-KE. This project includes the following tasks:

105-KW

- * Measuring the chute opening dimensions.
- * Moving fuel canisters as necessary to allow removing fuel racks. Fuel rack removal is required to place seal preparation and isolation barrier installation equipment in the storage pool.

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- * Removing racks.
- * Preparing the seal surface, including moving tools and equipment into the area and removing grating and handrails.
- * Installing the new isolation barriers, including moving the barriers into the area.
- * Leak testing to verify acceptable installation.

105-KE

- * Measuring the chute opening dimensions.
- * Moving empty canisters from fuel racks in the work area to allow removing racks.
- * Moving the seal preparation tools and equipment from the WEST basin to the EAST basin, and moving the sludge pumping equipment into the area.
- * Pumping sludge from the work area into a pit area.
- * Relocating racks.
- * Preparing the seal surface, including removing grating and handrails.
- * Installing the new isolation barriers, including moving the barriers into the area.
- * Leak testing to verify acceptable installation.

3.0 FUNCTIONS AND REQUIREMENTS

3.1 OVERALL FUNCTION

The overall function of this project is to provide an isolation barrier between the K basin storage pools and their associated discharge chutes to prevent draining the storage pools after a large seismic event due to leakage in the storage pool/discharge chute construction joint. The new isolation barriers, two in each basin, will limit

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leakage from each storage pool into its discharge chute to less than 12.5 gallons per minute (gpm) total per basin. This limit is one half (1/2) the amount cited as part of the facility authorization basis in the Safety Analysis Report. This installation is semi-permanent (15 year design life) and the isolation barriers will become an integral part of the basin structure.

3.1.1 Overall Assumptions

- * The design life of the isolation barriers is based on the assumption that the fuel stored in the two K basins will be removed by the year 2002, or at the latest before 2010.
- * The isolation barriers are Safety Class I.
- * The DBE criteria is 0.2 g's and the criteria for the aftershock can be lowered from 0.2 g's to 0.12 g's using UCRL 15910.

3.1.2 Overall Requirements

In addition to general requirements already in place, this project shall satisfy the following requirements:

- * Work shall be performed in accordance with approved work packages and their associated rigging plans, ALARA plans, radiation plans, installation procedures, operations procedures, and Safety plans.
- * Procedures shall be written and/or developed to control all fuel and canister handling operations.
- * The public and Hanford Site workers shall be protected from offsite and onsite release of airborne radioactive materials, and from radiological exposure. Practically, this means maintaining sufficient water in the basin to ensure that the fuel and sludge remain covered for all credible events, and at a level to provide personnel shielding.
- * All activities proposed for the basins should be responsive to stakeholder expressed concerns for limiting the potential impact of leakage to the soil and the Columbia River. Practically, this means limiting airborne and water releases to within limits currently established with state and federal regulators.

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- * The safety classification shall be Safety Class I. Material certifications, procedure approvals, QA inspections, and other required activities and documentation shall be performed or provided as necessary.
- * Material selection and corrosion allowance shall be specified to provide a 15 year design life.
- * The installed isolation barriers, together with the center island shall be capable of withstanding a Design Basis Earthquake (DBE) of 0.2 g's with a full head of water (16'- 8") in both the discharge chute and the storage pool.
- * The isolation barriers and the center island shall be capable of withstanding an aftershock equal to 0.12 g's with a full head of water (16'- 8") in the storage pool and the discharge chute empty.
- * Installation of the isolation barriers shall be accomplished without divers.
- * The leak rate shall be less than 12.5 gpm total through both barriers, both routinely, and following a DBE.

3.2 105-KW

3.2.1 Chute Opening Measurement

3.2.1.1 Function

The function of measuring the chute opening locations is to ensure that the isolation barriers will fit properly when installed. Proper fit is necessary to achieve the required leak tightness.

3.2.1.2 Requirements

The measurements shall verify the discharge opening widths to within +/- 1/16 in. A video recording of the condition of the embedded angle shall also be made.

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3.2.2 Preparing Seal Surfaces

3.2.2.1 Function

The function of preparing the seal surfaces is to provide the necessary surface conditions to assure long-term seal performance.

3.2.2.2 Requirements

The sealing surface shall be regular and smooth (step discontinuities of less than 1/8 inch). The sealing surface shall be capable of withstanding the force applied by the barrier during maximum seal compression. It shall not provide crevices or leak paths which bypass the seal. It shall remain in place with no significant change in performance during the DBE or aftershock.

3.2.3 Install Barriers

3.2.3.1 Function

The function of installing isolation barriers is to isolate the discharge chute from the K WEST main basin.

3.2.3.2 Requirements

The new isolation barriers shall limit leakage into the discharge chute from the storage pool to less than 12.5 gpm. The design and installation shall conform to Safety Class I requirements because the barriers become part of the boundary which prevents exceeding the authorization basis of the facility.

3.2.4 Leak Testing

3.2.4.1 Function

The function of leak testing is to verify that the isolation barriers will limit leakage between the basin storage pool and the discharge chute to less than 12.5 gpm.

3.2.4.2 Requirements

The leak test shall have sufficient accuracy to assure that gross, including uncertainties, isolation barrier leakage can be established with 2 sigma

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confidence. The test shall be performable in less than 48 hours, and in the shortest time possible, consistent with obtaining satisfactory accuracy. The test shall provide for immediate field indications of unsatisfactory or satisfactory performance.

3.3 105-KE

3.3.1 Chute Opening Measurement

3.3.1.1 Function

The function of measuring the chute opening locations is to ensure that the isolation barriers will fit properly when installed. Proper fit is necessary to achieve the required leak tightness.

3.3.1.2 Requirements

The measurements shall verify discharge chute openings to within $\pm 1/16$ in. A video recording of the condition of the embedded angle shall also be made.

3.3.2 Move Equipment

3.3.2.1 Function

The function of moving equipment in the K EAST discharge chute is to minimize the missile risk during an earthquake. Various equipment will be relocated in the discharge chute. The packager will be relocated to the storage pool to provide access to it for future use.

3.3.2.2 Requirements

The equipment in the discharge chute shall be relocated in accordance with WHC-SD-WM-AP-030, latest revision.

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3.3.3 Pump Sludge and Remove Debris

3.3.3.1 Function

The function of pumping sludge and removing debris from the intended storage pool and discharge chute work areas is to minimize interference from these items during the seal preparation and barrier installation activities.

3.3.3.2 Requirements

Sludge and debris from the affected storage pool and discharge chute work areas shall be removed and relocated. The determination of "what is sufficiently clean" will be made by Operations and Engineering based on visual inspection.

3.3.4 Prepare Seal Surfaces

3.3.4.1 Function

The function of preparing the seal surfaces is to provide the necessary surface conditions to assure long-term seal performance.

3.3.4.2 Requirements

The sealing surface shall be regular and smooth (step discontinuities of less than 1/8 inch). The sealing surface shall be capable of withstanding the force applied by the barrier during maximum seal compression. It shall not provide crevices or leak paths which bypass the seal. It shall remain in place with no significant change in performance during the DBE or aftershock.

3.3.5 Install Barriers

3.3.5.1 Function

The function of installing isolation barriers is to isolate the discharge chute from the K EAST basin.

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3.3.5.2 Requirements

The new isolation barriers shall limit leakage into the discharge chute from the storage pool to less than 12.5 gpm.

3.3.6 Leak Testing

3.3.6.1 Function

The function of leak testing is to verify that the isolation barriers will limit leakage between the basin storage pool and the discharge chute to less than 12.5 gpm.

3.3.6.2 Requirements

The leak test shall have sufficient accuracy to assure that gross, including uncertainties, isolation barrier leakage can be established with 2 sigma confidence. The test shall be performable in less than 48 hours, and in the shortest time possible, consistent with obtaining satisfactory accuracy. The test shall provide for immediate field indications of unsatisfactory or satisfactory performance.

**K-BASINS ISOLATION BARRIERS
SUMMARY REPORT**

WHC-SD-SNF-FDR-001 REV. 0

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K-BASINS ISOLATION BARRIERS
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Appendix D

SAFETY ASSESSMENT OF DISCHARGE
CHUTE ISOLATION BARRIER PREPARATION & INSTALLATION

WHC-SD-SNF-SARR-002 REV. 2 (not issued)

THIS SAFETY ASSESSMENT IS CURRENTLY UNDERGOING REVISION
AS OF 10/21/94.

WHEN REV 2 IS APPROVED AND ISSUED, IT WILL BE INCLUDED IN
REV 1 OF THIS SUMMARY REPORT, APPENDIX D.