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MCO CLOSURE OPERATIONS LOCATION STUDY

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April 12, 1996

Louis Goldmann
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PO Box 1970 MSIN R3-86
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Subject: *Final Multi-Canister Overpack Closure Operations Location Study*
 under WHC Purchase Order No. TTS-SBW-045793 for task 604.

Dear Mr. Goldmann:

LATA is pleased to provide the attached final *Multi-Canister Overpack Closure Operations Location Study*. Since release of the second draft of this study April 5, 1996, modifications have been made to incorporate WHC comments at the meeting held Wednesday, April 10, 1996. The recommended option to perform all of MCO closure operations at the Cold Vacuum Drying Facility.

Questions and comments should be directed to me at 373-3775 or Don Scott at 946-2983.

Sincerely,

Larry Ulbricht
Engineer
BNFL

cc: T. Smith/WHC (w/o attachment)
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 WR604 Files

Multi-Canister Overpack Closure Operations Location Study

L. H. Goldmann

Westinghouse Hanford Company, Richland, WA 99352
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Abstract: The Multi-Canister Overpack Closure Operations Location Study provides a relative evaluation of location options at the K Basins and the CVD Facility and recommends that the MCO closure weld be performed, inspected, and repaired at the CVD Facility.

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Kara J. Brox
Release Approval

4/15/96
Date

Release Stamp

Approved for Public Release

**MULTI-CANISTER OVERPACK
CLOSURE OPERATIONS
LOCATION STUDY**

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

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April 1996

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ACRONYMS

ASME	American Society of Mechanical Engineers
CSB	Canister Storage Building
CVD	Cold Vacuum Drying
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIS	Environmental Impact Statement
GTAW	Gas Tungsten Arc Welding
HEPA	High-Efficiency Particulate Air (Filter)
IXC	Ion Exchange Column
IXM	Ion Exchange Module
KE	105K East Building
KW	105K West Building
MCO	Multi-Canister Overpack
NDE	Non-Destructive Examination
NRC	U.S. Nuclear Regulatory Commission
PT	Dye Penetrant Testing
SNF	Spent Nuclear Fuel
SPR	Single Pass Reactor
TAP	Toxic Air Pollutant
VT	Visual Testing

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MULTI-CANISTER OVERPACK CLOSURE OPERATIONS LOCATION STUDY

1.0 INTRODUCTION

1.1 BACKGROUND

Approximately 2100 metric tons of Spent Nuclear Fuel (SNF) is stored in the two K Basins in the 100 K Area at the Hanford Nuclear Reservation. The Spent Nuclear Fuel Path Forward Project (SNF Project) has been established to develop engineered methods for the expedited removal of the irradiated uranium fuel from the K East (KE) and K West (KW) Basins. As specified by the SNF Project, the SNF will be removed from the K Basins, conditioned for dry storage and placed in a long term interim storage facility located in the 200 East Area.

The SNF primarily consists of "Zircaloy-2" clad uranium fuel discharged from the N-Reactor. A small portion of the SNF is Single Pass Reactor (SPR) Fuel, which is aluminum clad uranium fuel. Approximately 1100 metric tons of N-Reactor fuel and less than half a metric ton of SPR fuel is stored underwater in the KE Basin. The bulk of this inventory consists of over 100,000 "Zircaloy-2" clad uranium fuel elements (50,000 assemblies) stored in 3574 open top canisters. The KW Basin contains approximately 958 metric tons of N-Reactor fuel and approximately 3.4 metric tons of SPR fuel in underwater storage. The bulk of the KW Basin inventory consists of over 106,000 "Zircaloy-2" clad uranium fuel elements (53,000 assemblies) stored in 3821 sealed canisters.

The SNF will be loaded into Multi-Canister Overpacks (MCOs) at the K Basins, transferred to the Cold Vacuum Drying (CVD) facility for initial fuel conditioning, and transported to the Canister Storage Building (CSB) for staging, final fuel conditioning, and dry storage. The MCO is a transportation, conditioning, and storage vessel.

The MCO consists of a 24 inch pipe with a welded bottom closure and a top closure that is field welded after the MCO is loaded with SNF. The MCO is handled and transported in the vertical orientation during all operations. Except for operations within the CSB, the MCO is always within the transportation cask which primarily provides radiological shielding and structural protection of the MCO.

1.2 OBJECTIVE

The objective of this study is to identify the preferred location for performing MCO closure activities based on safety, dose commitment, logistics/schedule, and cost issues.

1.3 SCOPE

Several optional locations for performing the MCO closure activities were identified for consideration in this study, including the K Basin Load Out Pit, the K Basin Transfer Area, and the CVD facility. MCO closure activities include all operations required to provide a sealed and verified MCO, including performance of the following: welding the MCO shield plug (top closure) to the MCO shell; inspection of the closure weld; weld repair; and containment verification. The study is confined to those operations required to provide a sealed and verified MCO with starting and ending points in the operational sequence that are common to all options; beginning with a loaded, decontaminated, MCO suspended above the loadout pit, and ending with the closed MCO staged within the CVD facility. Each option is evaluated on its relative merits associated with safety, dose commitment, logistics/schedule, and cost issues.

1.4 STUDY APPROACH

Each of the location options have associated safety issues that must be identified and evaluated. Resolution of the safety issues may either provide constraints that eliminate options or identify requirements that must be satisfied in order to implement that option. This study is based on the decision that the operations performed within the existing K Basin facilities are not required to provide equivalency to U.S. Nuclear Regulatory Commission (NRC) requirements, but are required to meet the requirements of the U.S. Department of Energy (DOE) Orders.

Other SNF Project operations (debris removal, sludge retrieval, SNF retrieval, MCO loadout, etc.) and K Basin maintenance operations will be performed simultaneously with the MCO closure activities. These other operations may impact MCO closure activities as they may be competing for space, crane utilization, utilities, and other K Basin resources. In addition, the other operations may impose additional dose fields or other radiological control requirements (i.e., on-mask) on the MCO closure operations. The configuration and anticipated operations of the MCO, the cask, and the conveyance will influence or drive the operations required to affect a closed MCO. Therefore, a baseline with supporting assumptions must be developed and defined in accordance with the best available information to establish the boundaries and foundation of the study.

The study was initiated with the identification of pertinent safety issues and establishment of baseline information. This information is used in a preliminary determination to eliminate options deemed unsuitable for further consideration based on either safety issues or logistics/schedule issues. Also, as it was not precluded by an evaluation of the safety issues, the location of the cold vacuum drying (CVD) facility is assumed to be located in a single CVD module, sited within the 100K Area as recommended by a white paper written by Rick Bradshaw (WHC 1995).

Those options not eliminated during the preliminary determinations are referred to the detailed evaluation phase of the study. Operations for each of the referred options are developed to produce operation time lines, dose commitment estimates, logistics/schedule

issues, safety issues, and qualitative cost estimates in sufficient detail to allow a relative comparison of options. The final recommendation identifies the location for performing the MCO closure weld, weld inspection, weld repair, and leakage rate testing of the closed MCO.

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2.0 OVERVIEW

2.1 OPTIONS

Three locations for performing the MCO closure activities were identified as basic options: over the loadout pit in the K Basins; within the K Basin Transfer Area either on the transport trailer or in a Weld Station; and in the Cold Vacuum Drying facility. Several additional options were identified as variations on the three basic options. The options considered in this study are briefly described below. Four MCO closure states are used in the following option descriptions to identify the interim status of the MCO during the operating scenario and prior to leakage rate testing. The four MCO closure states are defined as follows: MCO (closed) - the MCO closure weld and weld inspection and repair are complete; MCO (sealed) - only the root weld, inspection of the root weld are complete; MCO (clamped) - no welding has been performed, the MCO shield plug is mechanically restrained and temporarily sealed; and MCO (welded) - the MCO closure weld and weld pass inspection are complete but the final weld inspection has not been performed.

OPTION 1: Weld, Inspect, & Repair Over Pit

- Weld MCO Over Pit
- Inspect and Weld Repair MCO Over Pit
- Move Cask/MCO (closed) to Trailer
- Transfer Cask/MCO (closed) to CVD Facility

OPTION 2: Root Weld & Inspect Over Pit; Complete Weld, Inspect, & Repair at CVD

- Root Weld MCO Over Pit
- Inspect Root Weld and Weld Repair Over Pit
- Move Cask/MCO (sealed) to Trailer
- Transfer Cask/MCO (sealed) to CVD Facility
- Complete MCO Weld at CVD
- Inspect & Weld Repair MCO at CVD

OPTION 3: Weld, Inspect, & Repair at Weld Station

- Move MCO (clamped) to Weld Station
- Weld MCO in Weld Station
- Inspect and Weld Repair MCO in Weld Station
- Move Cask/MCO (closed) to Trailer
- Transfer Cask/MCO (closed) to CVD Facility

OPTION 4: Weld, Inspect, & Repair at CVD

- Move Cask/MCO (clamped) to Trailer
- Transfer Cask/MCO (clamped) to CVD Facility
- Weld MCO at CVD
- Inspect and Weld Repair MCO at CVD

OPTION 5: Weld, Inspect, & Repair on Trailer

- Move Cask/MCO (clamped) to Trailer
- Weld MCO on Trailer
- Inspect and Weld Repair MCO on Trailer
- Transfer Cask/MCO (closed) to CVD Facility

OPTION 6: Weld & Inspect Over Pit; Repair at Weld Station

- Weld MCO Over Pit
- Inspect Weld Over Pit
- Move Cask/MCO (welded) to Weld Station
- Weld Repair MCO in Weld Station
- Move Cask/MCO (closed) to Trailer
- Transfer Cask/MCO (closed) to CVD Facility

OPTION 7: Weld & Inspect Over Pit; Repair on Trailer

- Weld MCO Over Pit
- Inspect Weld Over Pit
- Move Cask/MCO (welded) to Trailer
- Weld Repair MCO on Trailer
- Transfer Cask/MCO (closed) to CVD Facility

OPTION 8: Weld & Inspect Over Pit; Repair at CVD

- Weld MCO Over Pit
- Inspect Weld Over Pit
- Move Cask/MCO (welded) to Trailer
- Transfer Cask/MCO (welded) to CVD Facility
- Weld Repair MCO at CVD

OPTION 9: Weld & Inspect at Weld Station; Repair on Trailer

- Move MCO (clamped) to Weld Station
- Weld MCO in Weld Station
- Inspect Weld at Weld Station
- Move Cask/MCO (welded) to Trailer
- Weld Repair on Trailer
- Transfer Cask/MCO (closed) to CVD Facility

OPTION 10: Weld & Inspect at Weld Station; Repair at CVD

- Move MCO (clamped) to Weld Station
- Weld MCO in Weld Station
- Inspect Weld in Weld Station
- Move Cask/MCO (welded) to Trailer
- Transfer Cask/MCO (welded) to CVD Facility
- Weld Repair at CVD

OPTION 11: Weld & Inspect on Trailer; Repair at CVD

Move Cask/MCO (clamped) to Trailer

Weld MCO on Trailer

Inspect Weld on Trailer

Transfer Cask/MCO (welded) to CVD Facility

Weld Repair MCO at CVD

2.2 TECHNICAL ISSUES

2.2.1 Fire Protection

The fuel within the MCO is flooded with water during MCO closure welding and during transportation of the MCO to the CVD facility. Currently, the K Basins do not have fire protection, and other planned activities are not expected to require fire protection. However, welding in either the loadout pit or the transfer area requires the addition of fire protection capability. The CVD facility, being a new facility, must have fire protection regardless of whether or not welding is performed in the facility.

2.2.2 Security

The security requirements for performing MCO closure operations in the K Basin transfer area and the CVD facility are the same. Both options require drivers with security clearances, security escorts, and protective forces for the protection of the Category II quantity of SNF materials. The security requirements do not impact the decision on where the MCO is to be welded.

2.2.3 Environmental

The Environmental Impact Statement (EIS) is not affected by the decision of where the MCO is to be welded.

Radiological air permits will have to be obtained for both facilities, whether or not welding is performed there. The CVD is a new facility that will incorporate High-Efficiency Particulate Air (HEPA) filtration of all of the building airspace, with each process bay having a system independent of the other bays. Obtaining air permits for the welding operations will be relatively straightforward since HEPA filtration is readily accepted by the regulatory agencies as the best available technology.

The K Basin facilities do not have a building airspace HEPA filtration system. Welding within the K Basins will require the use of local HEPA filtration systems to capture the welding off-gases. Obtaining the air permits for welding within the K Basins will be more difficult than for the CVD because the engineered local controls will have to be justified to the satisfaction of the regulatory agencies.

Also, the fumes from the welding process may require that a Toxic Air Pollutant (TAP) permit be obtained. The same factors, as presented above, will be applicable in obtaining the TAP permits.

2.2.4 Leak Test

The MCO shield plug weld (closure weld) will be helium leak tested by using either a helium sniffing probe or a vacuum enclosure method. Both methods require that the MCO be backfilled with helium. In order to qualify the leak test procedure, the concentration of helium within the MCO must be a known quantity. This necessitates that a known vacuum be established in the MCO prior to backfilling with helium. The presence of free liquid in the MCO will prevent a vacuum from being achieved, and the water may clog small leak paths which will invalidate the leakage rate test. Therefore, the leakage rate test must be performed in the CVD facility after the MCO has been cold vacuum dried.

2.2.5 Transportation Limitations

If welded at the K Basins, the sealed MCO provides the containment required for the transfer to the CVD, and the cask is only required to provide structural and thermal (fire) protection, radiological shielding, and confinement of the MCO within the cask. If the MCO is to be welded at the CVD, the temporarily sealed MCO does not provide the required containment, and therefore, the cask must provide the required containment in addition to providing structural, thermal, radiological and confinement functions.

Approval of the transfer operation is granted on risk based dose consequence analyses, which are dependent in part on packaging design, distances traveled, vehicle speeds during the transfer, and the presence of other administrative controls. Performing the MCO closure weld in the CVD imposes additional requirements on the design of the cask, and may require the implementation of additional administrative controls.

2.2.6 Multi-Canister Overpack Surface Contamination

The cask contamination control pail will prevent the exterior surfaces of the MCO (excluding the MCO shield plug) from becoming contaminated during normal SNF loading operations. The MCO shield plug will only be decontaminated as required to allow for the necessary downstream operations. Surface contamination may exceed the surface contamination level limitations specified in Table 2-2 of the *Hanford Site Radiological Control Manual* (HSRCM-1, Rev. 2).

2.2.7 Weld Process

The welding will be performed by an automatic welding machine operated from a remote control station. The welding machine will be manually installed and removed from the MCO. The MCO closure weld is a horizontal field weld around the perimeter of the MCO shell. The weld joint preparation is a full penetration double J-joint preparation (30 degrees inclusive). The entire weld joint preparation is welded, however, the only credited

purpose of the root weld is to seal the gap, thereby ensuring that the remainder of the weld can be successfully installed. Therefore, the weld is considered a partial penetration weld for structural and American Society of Mechanical Engineers (ASME) Code compliance purposes, and credit for the root weld is disallowed.

Using the gas-tungsten arc weld (GTAW) process, the MCO closure weld is installed in five passes: one root weld pass, three intermediate passes and one cover pass. Although it is the slowest of the applicable weld processes, the GTAW process has been selected because of its relatively low failure rate. Assuming a good clean weld preparation with adequate backing gases, one percent of the MCOs are expected to need weld repair due to some degree of weld defect in one of the five weld passes required.

The welding cover gas is assumed to be Argon. The use of argon in the K Basins will require that additional confined space monitoring be routinely performed or additional continuous monitoring be installed.

Welding within the K Basins must be performed within a radiological shield to prevent the personnel performing other K Basin activities from the additional dose emanating from the cask/MCO.

2.2.8 Weld Repair Processes

Using the GTAW process, the weld defects are expected to be less than two inches in length. The weld will be repaired by manual grinding and manual welding. After grinding out the defect, the base metal will be examined using the dye penetrant (PT) examination method to assure that the defect has been completely removed.

In order to prevent "on-mask" requirements for all operations within the facility, an enclosed hood with glove ports will be required for removal of the weld defect by grinding. Installation and removal of the weld repair enclosure will equally add to the cycle time for all options, and will unequally add to the dose commitment, depending on the background radiation fields (K Basins will have higher dose commitments). Failure of the weld repair enclosure has a greater impact at the K Basins than at the CVD facility because of the many other activities performed there (i.e., fuel retrieval, sludge retrieval, debris removal, maintenance, etc.).

The probability of ultimately rejecting an MCO due to unsuccessful weld repair that requires complete excavation of the weld is considered to be not credible and is not addressed in this study.

2.2.9 Code Compliance

The MCO closure weld satisfies the requirements of Section III, Subsection NB of the ASME Boiler and Pressure Vessel Code with the following exceptions: the closure weld is a partial penetration weld, volumetric inspection of the weld will not be performed,

and each MCO will not be pressure tested. The MCO design proposes to meet the intent of these requirements by performing tests and analyses that prove the design and the closure welding process and procedure.

2.2.10 Closure Weld Non-Destructive Examination

Non-destructive examination (NDE) of the closure weld consists of performing dye penetrant testing (PT) of the root and final weld passes. The PT examination of the root weld is not intended to qualify the weld, but is used only to verify that there is sound metal at the base of the partial penetration closure weld. Visual observation of the weld by video camera will be performed by the welder after the non-structural root pass and after each of the structural weld passes, but a formal visual (VT) examination is not required.

The proposed PT method uses a solvent free, water soluble dye penetrant with a fine fluorescent talc that requires the use of a blacklight to identify weld indications. Use of the blacklight requires that the background white light be less than 2 foot-candles. In the CVD facility, the facility lights can be turned off to easily accommodate the use of the blacklight. In the K Basins, a hood that blocks out the facility lighting would have to be deployed, as turning off the lights in the K Basins would present an unacceptable situation for the other operations being performed, and would require the suspension of other operations.

2.2.11 Contingencies

In selecting the location for performing MCO closure operations, the affect of contingency operations must be considered. The two contingencies identified as most applicable to this decision are weld repair requirements and the need for performing "on-mask" operations. Weld repair frequency and the timing of failed MCO closure welds unequally affect the overall logistics of each of the location options. Whereas an option might be able to absorb a one percent average failure rate into its cycle without affecting overall throughput, an increase in the average failure rate or having weld failures in two successive MCOs may result in an unacceptable impact to the overall throughput; possibly suspending other operations such as fuel retrieval and cold vacuum drying. For these reasons, it is desirable to perform MCO closure operations, especially off-normal weld repair operations, in a non-critical path location.

Great effort is being expended to reduce the potential of airborne contamination for all activities in the K Basins. However, the experience of prior K Basin campaigns show that unexpected airborne emissions resulted in the need to perform operations "on-mask." If "on-mask" operations are required, the time required to perform individual tasks increases due to reduced mobility and visibility, and the operator dress efficiency due to the work environment drops from approximately 75 percent to 50 percent. This situation will affect all operations within the K Basins, resulting in a reduced time allotted for performing MCO closure operations in order to meet overall throughput requirements. Therefore, the number of operations performed in a potentially airborne contamination environment needs to be considered in the option evaluations.

A third contingency is how to recover if an MCO is ultimately rejected after completing the weld inspection and failed weld repair attempts. This low probability event is not considered to be significant in the decision of where to perform the MCO closure weld.

2.2.12 Multi-Canister Overpack Thermal Limit

The corrosion rate of the SNF submerged in water is temperature dependent. Although the SNF does not have a high heat production rate, unacceptable MCO temperatures are prevented by establishing a time limit of that a flooded MCO can remain within the transportation cask without forced cooling. Scoping calculations indicate that the heat-up time is sufficiently greater than the predicted MCO closure cycle time, including one weld repair cycle, with sufficient margin and does not impact this study.

2.2.13 Throughput

The operating plan for the K Basins specifies a three shift approach, providing 24 hour operations per day and 250 days per year. Operating efficiency factors for the various operations were presented by *Development of Design Basis Capacity for SNF Project Systems* (WHC-SD-SNF-TI-016). The operating efficiency factors are extracted from the referenced document with the following exceptions: the predicted weld repair is only 1 percent as opposed to ten percent, and a work efficiency for operator dress is assumed to be 50 percent for operations performed while "on-mask." The operating efficiencies used in this study are as follows:

- 90 % for Process Efficiency
- 99 % for Weld Success Rate
- 75 % for Operator Dress in Normal Work Environment
- 50 % for Operator Dress in "On-Mask" Work Environment
- 80 % for Equipment Availability (20 % downtime)
- 99 % for Accountability

The total operating efficiencies are determined as follows:

Normal Operations: $0.9 (0.99) (0.75) (0.8) (0.99) = 0.53$

"On-Mask" Operations: $0.9 (0.99) (0.5) (0.8) (0.99) = 0.35$

Assuming that a total 200 MCOs processed out of each K Basin over the two year fuel removal campaign, with 2 years of operation in the KW Basin and 1.75 years of operation in the KE Basin, and with a 6 month learning curve in the KW Basin and a 3 month learning curve in the KE Basin, the required average throughput is 0.5 MCO per day. Factoring in operating efficiencies, the required cycle time for cask loadin/loadout, including MCO closure welding, is calculated as follows:

Normal Operations: $(0.5 \text{ MCO/av day}) / (0.53) = 0.94 \text{ MCO/day}$ -or- 25.4 hours per MCO.

"On-Mask" Operations: $(0.5 \text{ MCO/av day}) / (0.35) = 1.43 \text{ MCO/day}$ -or- 16.8 hours per MCO.

3.0 BASELINE AND ASSUMPTIONS

3.1 CONFIGURATION BASELINE

3.1.1 Multiple Canister Overpack

The MCO is as depicted in the drawings included in Appendix A. The MCO is a right circular cylindrical pressure vessel 24 inches in diameter by 160 inches long with flat heads meeting the requirements (with exceptions) of the ASME Boiler and Pressure Vessel Code, Section III, Subsection NB. All major components of the MCO are constructed of Type 304L stainless steel including: the shell, the bottom closure, the top closure (shield plug), the internal process piping, the bottom spacing components, and the top spacing components.

The MCO shell is constructed from a 24 inch, Schedule 20 XS (0.5 inch wall) pipe. The top closure is a 12 inch thick cylindrical forging with an outside diameter of 24 inches that is reduced by a 0.5 inch radial step at 3 inches below the top of the shield plug. Final closure of the MCO is provided by a partial penetration field weld around the outside perimeter of the shield plug and shell. Both the end of the shell and the step in the shield plug are machined during fabrication to provide the required weld joint preparation. There are four 1 inch penetration ports in the top of the shield plug: (1) a process port with a quick disconnect, leading to the long dip tube; (2) a process port with a quick disconnect, leading to the short dip tube; (3) a vent port with a connection for installation of a HEPA filter, leading to the short dip tube; and (4) an over pressurization protection port with an installed rupture disk, leading to the short dip tube. All ports access the MCO cavity through 1 inch double bend passages machined through the thickness of the shield plug. Each of the penetration ports are covered by a bolted blind flange, sealed via graphite and stainless steel compression seals, and attached with 5/8 inch bolts screwed into blind holes in the shield plug. The two process port covers are 8 bolt, 3 inch blind flanges; the rupture disk port cover is a 4 bolt, 2.5 inch blind flange; and the HEPA filter port cover is a 4 bolt, 2 inch blind flange (reference drawings H-2-826303, Rev. 0).

The MCO shield plug (top closure) provides radiological shielding. The MCO dose rate design criteria for the top of the shield plug are 30 mrem/hr average contact dose based on average SNF activity with a 100 mrem/hr average contact dose based on maximum SNF activity. Due to the availability of dose estimates, the dose study estimates are based on a solid steel thickness of 8 inches, rather than the ported shield plug with a design thickness of 12 inches. The use of an eight inch solid plug might be expected to result in conservatively high dose estimates due to lower shielding thickness, but because the effect of local increased dose rates due to penetrations in the shield plug and gaps between the MCO and the cask are not accounted for in the dose rate estimates for the eight inch solid plug, the estimated dose might be expected to be non-conservatively low. In the absence of detailed dose calculations for the cask/MCO assembly that include the affects of gaps and reduced shielding at the penetrations, the dose rates from an eight inch solid plug are used to provide the relative dose commitment estimates needed to evaluate the weld location options.

3.1.2 Transportation Cask

The baseline cask design is as shown in the drawings included in Appendix A. The cask is a right circular cylinder that provides physical protection of the MCO and radiological protection (shielding) from the MCO. There are a set of trunnions on the cask body; used for lifting the cask. The cask body is equipped with leak testable quick disconnect fittings in the vent and drain ports for effective removal and circulation of fluids within the cask cavity or within the annular gap between the cask and MCO. For the welded MCO, the cask lid confines the MCO within the cask, and for the non-welded MCO, the cask lid restrains the MCO shield plug and provides containment while being transferred between the K Basins and the CVD facility.

The cask lid is installed with bolts screwed into blind holes in the cask body. The cask is sealed by an elastomeric o-ring at the cask to cask lid interface. The location of the interface between the cask lid and the cask body allows the MCO shield plug closure weld to protrude above the cask body by 3 inches.

The fully assembled cask provides protective packaging meeting the intent of U.S. Department of Transportation (DOT) and U.S. Nuclear Regulatory Commission (NRC) requirements by providing a level of safety equivalent to DOT and NRC requirements accounting for the onsite transportation environment.

While within the K Basin south loadout pit, the cask is held within a sealed contamination control pail with a pail lid that seals against the outside perimeter of the MCO body. The contamination control pail prevents the contaminated basin water from contacting the exterior of the MCO, the interior of the cask, and the exterior of the cask. The pail/cask/MCO assembly is raised and lowered within the pit using the 30 ton crane in the K Basins. With the pail in the raised position, the top of the MCO is approximately 1 to 1.5 feet above the water surface. The cask/MCO is suspended in the raised position by the pail which is pinned to a supporting structure. An platform that is approximately one foot above the water surface provides emergency access to only one side of the cask/MCO.

While within the CVD, a processing seal ring is installed on the cask body and is sealed to the exterior perimeter of the MCO shell. The seal ring seals the annular gap between the MCO and the cask to allow for the circulation of water within the gap for heating and cooling during CVD operations.

Due to the availability of shielded dose calculations, the following dimensions for cask diameter and wall thicknesses are used instead of those identified by the concept drawings. The sides and integral bottom of the cask are modeled as 8 inches thick, and the internal diameter of the cask is modeled as 24.5 inches, resulting in a nominal radial gap of 1/4 inch between the MCO and cask walls.

3.1.3 Transportation Conveyance

The baseline design of the conveyance is shown in the drawings in Appendix A. The conveyance is a drop center trailer with supporting structure that provides for vertical shipment of the cask. The supporting structure and work platform provide for installation and removal of the cask from the side of the trailer.

3.1.4 Existing K Basin Equipment

The existing platforms and major equipment in the KE and KW Basin Transfer Areas is depicted by SK-1-80092 and SK-1-80091, respectively (Appendix A).

3.1.5 K Basin Transfer Area Space Availability

The following modifications of the equipment, platforms, and cranes in the KE and KW Basin Transfer Areas are assumed for all aspects of this study.

Referring to SK-1-80092, the ion exchange columns (IXCs) (item 4), the IXC shielding (item 5), and the sand filter (item 6) will not be in service but will be abandoned in place throughout the SNF removal campaign. Both of the ion exchange modules (IXMs) (items 1 and 2) will be removed, but their associated piping systems will be abandoned in place throughout the SNF removal campaign. The platform directly west of the south loadout pit (platform No. 3) and the cask guides mounted on top of the south loadout pit curb will be removed.

Referring to SK-1-80091, both IXMs (items 1 and 2), the filters (item 3), and the cask (item 7) will be removed. The IXCs (item 4), the IXC shielding (item 5), the sand filter (item 6), and the piping associated with the IXMs will not be in service and will be abandoned in place throughout the SNF removal campaign. The platform directly west of the south loadout pit (platform No. 3) and the cask guides mounted on top of the south loadout pit curb will be removed.

According to the Space Utilization Coordinator, other SNF removal subprojects are endeavoring to keep clear of the Transfer Area by identifying locations for equipment and operations in other places throughout the basin. One exception to this is the Debris Removal project, which has identified the truck loadout bay (north bay) for staging and removal of debris. Occupation of the north loadout bay is not expected to impact any of the options considered for MCO closure activities, because the loadout of debris is a batch operation and can be coordinated with the SNF removal operations.

3.1.6 Radiological Environment

The initial goal of the Dose Reduction Project is to reduce the average dose rate at the grating level above the pool in KE Basin to 5 mrem/hr. After reaching this goal, evaluation of further reductions will be completed, and other activities will commence to reduce location specific dose rates. An optimization study will provide input as to the

areas to be reduced. At this time there are no specific activities planned for KW Basin or for the loadout pits and Transfer Areas of either basin. The following background dose rates are assumed for this study: 10 mrem/hr above the KE loadout pit, 3 mrem/hr in the KE south loadout bay, 10 mrem/hr in the KE middle loadout bay, and ten percent of these values at the corresponding locations in the KW Basin.

Cold Vacuum Drying operations will be performed in a newly designed and constructed facility. The CVD facility will be designed such that the background radiation fields are minimized. A background radiation field in the CVD facility of 0.2 mrem/hr is used for this study.

Although all SNFP sub-projects endeavor to prevent airborne contamination, the potential for having airborne contamination problems exists, resulting in personnel performing the required operations while "on mask." This study evaluates the relative impact on each of the options due to "on-mask" operation requirements. This study assumes that monitoring for airborne contamination during all welding processes is required.

3.2 OPERATIONS BASELINE

3.2.1 K Basin Maintenance

The only identified K Basin maintenance activity that could unequally affect the considered options is the replacement of the ion exchange modules. However, because the current location of the IXMs will be abandoned with the modified water treatment system, there will be no impact to the presented options due to K Basin maintenance activities.

3.2.2 Spent Nuclear Fuel Retrieval

All SNF retrieval and reracking operations will occur within the west bay of the basin. The SNF retrieval subproject (retrieval, KW de-lidding, SNF desludging, SNF reracking, etc.) will be of sufficient distance or will provide adequate shielding such that SNF retrieval operations do not impose additional dose on the operators performing MCO closure operations.

3.2.3 Debris Removal

The debris removal subproject will remove emptied and cleaned canisters from the basin, transfer them to the truck bay (along north wall) in the Transfer Area, and package them in disposal boxes. After being cleaned in an underwater high-pressure wash station, the canisters are hoisted out of the pool into a greenhouse above the basin decking. The contaminated canisters will be removed in batch process operations such that no dose will be imposed on operators performing MCO closure activities. Use of any equipment in the

Transfer Area will be subject to the availability from other operations (i.e., MCO closure activities and MCO/cask handling). The Debris Removal Subproject will not impact the MCO closure activities.

3.2.4 Sludge Retrieval

Operations of the sludge retrieval subproject (in KE Basin only) will operate at the east end of the basin, using the Weasel Pit for sludge storage and loading out sludge in the northeast corner of the basin. Given the distance, the sludge retrieval equipment can be adequately shielded such that there will be no dose imposed on the MCO closure operations.

3.2.5 Water Treatment

The water treatment system will be modified prior to initiation of fuel retrieval. If used, new ion exchange modules and sand filters will be located outside of the basin facility. The existing IXMs will be removed and the sand filter with its associated piping systems and the IXM piping systems will be abandoned in place (in the K Basin Transfer Area). The modified water treatment system will provide discharged water with the following impurity levels: $Cs^{137} \leq 0.05 \mu\text{Ci/L}$; $Sr^{90} \leq 0.05 \mu\text{Ci/L}$; and $\alpha \leq 0.005 \mu\text{Ci/L}$.

The modified water treatment system will return the cleaned water to the basin via the south loadout pit, and will provide for a 3 hour south loadout pit flushing cycle, providing a decontamination factor of approximately 20 to mitigate surface contamination on the exposed cask and MCO components. The flushing cycle will provide cleaned water at a rate of 250 gallons per minute.

3.2.6 Cask/Multi-Canister Overpack/Conveyance Operations

For general information, the following list presents an abbreviated operating sequence of the transportation packaging system including those operations dependent on location of MCO closure activities within the K Basins and the CVD facility. The following sequence does not include all operations of the transportation packaging system, but includes those operations required to present a general understanding of the overall operating sequence.

- 3.2.6.1 At the CSB, an empty MCO (without the lid and internals) is loaded into the cask.
- 3.2.6.2 The cask is loaded onto the trailer and is transported in the vertical orientation to the appropriate K Basin.
- 3.2.6.3 The trailer is backed into the south loadout bay, which has previously had a contamination control liner applied to the floor.

- 3.2.6.4 The trailer is staged within the loadout bay, the tractor is removed, and the K Basin doors are closed.
- 3.2.6.5 The cask lid is removed and the cask lift fixture is installed.
- 3.2.6.6 The cask/MCO is removed from the trailer and placed into the contamination control pail within the south loadout pit.
- 3.2.6.7 The cask lift fixture is removed, and the top closure of the contamination control pail is installed.
- 3.2.6.8 The cask/MCO/pail assembly is lowered to the bottom of the south loadout pit.
- 3.2.6.9 The SNF in pre-loaded MCO baskets is loaded into the MCO, and the MCO shield plug with process piping is installed in the MCO.
- 3.2.6.10 The south loadout pit is purged with clean water (approximately 3 hours).
- 3.2.6.11 The cask/MCO/pail assembly is raised out of the pit passing through a decontamination spray of clean water, such that the top of the MCO is approximately 1 to 1.5 feet above the water surface.
- 3.2.6.12 The water level within the MCO is lowered to a few inches below the shield plug, the exposed surfaces of the MCO and cask are decontaminated, and the top closure of the contamination control pail is removed.
- 3.2.6.13 Operations Applicable to This Study - The basic operations required to achieve a closed MCO are nearly the same for each option, but vary in sequence according to the location for welding. The basic MCO closure operations, shown in no particular order, are as follows:
 - install cask lid
 - move the cask/MCO to the weld station and seismically restrain (by option)
 - move the cask/MCO to the trailer
 - weld the MCO root pass, dye penetrant inspect, and repair as required
 - weld the intermediate passes
 - weld the final pass, dye penetrant inspect, and repair as required
 - transfer the MCO to the CVD facility

- seismically restrain cask/trailer within the CVD facility, and remove cask lid
- install the cask's processing seal ring (see figures in Appendix A) to prepare the cask/MCO for the CVD process.

- 3.2.6.14 The MCO is dewatered and cold vacuum dried.
- 3.2.6.15 Leakage rate testing of the closure weld and penetration ports is performed.
- 3.2.6.16 The cask is closed, and the seismic restraints are removed.
- 3.2.6.17 The cask/MCO is transported to the CSB where the loaded MCO is removed from the cask.

3.3 ASSUMPTIONS

3.3.1 General Assumptions

- 3.3.1.1 The time for the MCO to exceed the temperature limit imposed to control the chemical reaction rate of the SNF in water is greater than the MCO closure cycle time, including one weld repair cycle, with sufficient margin such that it has no impact on this study. This assumption is based on preliminary scoping calculations performed in support of the transportation sub-project.
- 3.3.1.2 Verification of MCO containment is limited to helium leakage rate testing of the closure weld and the penetration covers after completing the CVD process; leakage rate testing of the entire MCO assembly is not required. The MCO body is leakage rate tested during fabrication activities.
- 3.3.1.3 For normal operations, the allowable design MCO closure cycle time is 25.4 hours per MCO. For "on-mask" operations, the allowable design MCO closure cycle time is 16.8 hours. These are based on the following: a two year fuel removal campaign; a total of 400 MCOs (200 MCOs from each K Basin); 250 working days per year; 24 hour operations per working day, a 2 year operating campaign in KW Basin with a 6 month learning curve, a 1.75 year operating campaign in KE Basin with a 3 month learning curve, a 53% total operating efficiency for normal operations; and a 35% total operating efficiency for "on-mask" operations.
- 3.3.1.4 The installed cask lid provides mechanical restraint of the MCO and unwelded MCO shield plug as required during handling and transportation.
- 3.3.1.5 The cask is transported vertically on the conveyance, and is handled in a vertical orientation at all times.

- 3.3.1.6 A HEPA filtered welding off-gas collection system will be required whether closure welding is performed in the K Basins or in the CVD facility.

3.3.2 Welding Assumptions

- 3.3.2.1 MCO closure welding is accomplished in five weld passes using the GTAW process: one non-structural root weld pass, three intermediate weld passes, and one final weld pass. The MCO closure weld is a partial penetration field weld of a full penetration (30° inclusive) double J-joint preparation; the root weld is not considered as part of the structural weld.
- 3.3.2.2 One percent of the MCOs require weld repair.
- 3.3.2.3 All weld repairs are performed by manual grinding and manual welding. Expected weld defects are less than 2 inches in length.
- 3.3.2.4 Weld examinations are limited to dye penetrant testing of the non-structural root weld and dye penetrant testing of the final pass of the closure weld.
- 3.3.2.5 Weld repairs require examination of the base metal by dye penetrant testing to assure the defect has been removed.

3.3.3 K Basin Assumptions

- 3.3.3.1 Operations within the existing K Basin facilities are governed by the DOE Orders. U.S. Nuclear Regulatory Commission (NRC) Equivalency is not applicable to operations within the existing K Basin facilities.
- 3.3.3.2 Use of the 30 ton cranes in the KE and KW Basins is not subject to safety imposed time limits.
- 3.3.3.3 In the event of a dropped cask accident in the K Basin Transfer Area, the MCO must be retained within the cask, and the SNF (elements & scrap) must be retained within the MCO. Unfiltered fluids (water and gases) are not required to be contained within the MCO.
- 3.3.3.4 The background radiation dose fields in the KE and KW Basin Transfer Areas are as follows: 10 mrem/hr above the KE loadout pit, 3 mrem/hr in the KE south loadout bay, 10 mrem/hr in the KE middle loadout bay, and ten percent of these values at the corresponding locations in the KW Basin.
- 3.3.3.5 The following existing equipment is removed from both K Basin Transfer Areas: Ion Exchange Modules (IXMs), and the platform (#3) directly west of the south loadout pit. The Ion Exchange Columns (IXCs), the IXC shielding enclosure, the Sand Filter, and the piping systems for the IXMs, IXCs, and sand filter are abandoned in place. Additional space within the K Basin

Transfer Area for equipment laydown area and use of the middle loadout bay can be made available by additional demolition and removal of existing equipment

- 3.3.3.6 Only the south loadout pit is available for SNF removal operations; the north loadout pit, currently used exclusively as a sand filter backwash pit, remains unavailable for SNF removal even with the abandonment of the sand filter.
- 3.3.3.7 If welding, weld inspection, or weld repair is performed within the K Basin Transfer Area (either in a Weld Station or on the trailer), the cask/MCO will be seismically restrained and the cask/MCO must be located within a radiological shield structure..
- 3.3.3.8 The implementation of any cask drop mitigation equipment or procedures will not adversely impact the cask/MCO handling operations within the loadout pit.

3.3.4 Transportation Assumptions

- 3.3.4.1 In the event of a transfer accident when moving from the K Basins to the CVD Module, the MCO must be retained within the cask, and the SNF (elements & scrap) must be retained within the MCO. Containment of the SNF, water, and gases must be provided by either the MCO (if welded) or the cask (if MCO not welded).
- 3.3.4.2 The cask lid is installed and sealed, providing containment while transferring the unwelded MCO to the CVD facility. The welded MCO provides the necessary containment for the transfer to the CVD facility and does not require the cask to be sealed.

3.3.5 Cold Vacuum Drying Facility Assumptions

- 3.3.5.1 The CVD process will be performed in a common module servicing both KE and KW Basins and located within the inner security compound of the 100K Area.
- 3.3.5.2 The CVD Module is designed such that the background radiation dose field is less than 0.2 mrem/hr.
- 3.3.5.3 The cask/MCO and the conveyance is seismically restrained such that the cask/MCO remains upright during all operations in the CVD Module.
- 3.3.5.4 If the closure weld is performed in the CVD facility, each CVD station will be a weld station and the welding equipment will be shared among the CVD stations; additional CVD stations will be required to accommodate the additional operating time at the CVD facility.

- 3.3.5.5 The design impacts to the CVD facility to accommodate welding of the MCO when considering the design basis tornado are not significant, and will not affect the selection of the location for performing the MCO closure weld.

4.0 SAFETY ISSUES

4.1 INTRA-FACILITY HANDLING

The following sections address the safety issues and requirements for handling the SNF transportation system within the K Basins and the CVD facility.

4.1.1 Cask Drop in Loadout Pit

Cask drop accidents while in the loadout pit are credible events. The K Basin loadout pit and basin structure will be qualified or other cask drop mitigation will be implemented such that there are no restrictions (time limits or otherwise) on the handling of the 30 ton cask/MCO within the K Basin load out pit. This study assumes that the implementation of any cask drop mitigation equipment or procedures will not adversely impact the cask/MCO handling operations within the loadout pit.

4.1.2 Cask Drop in Transfer Area

Cask drop accidents while handling within the transfer area are credible events. In the event of a cask drop accident, the MCO must be retained within the radiological shielding provided by the cask, the SNF must be retained within the MCO, and the configuration of the SNF within the MCO must remain subcritical.

The MCO must be retained in the cask to prevent loss of shielding. This requirement implies that the cask lid or other mechanical restraining device must be installed to restrain the MCO within the cask prior to removal from the loadout pit.

The SNF must be retained within the MCO to prevent loss of criticality configuration control and loss of shielding. To satisfy this requirement, either the shield plug must be mechanically restrained onto the MCO shell or the weld sufficiently verified to assure that no SNF (assemblies, elements, or scrap) is released from the packaging due to a cask drop accident. This study assumes that only a welded MCO with complete dye penetrant weld inspection meets the requirement for a sufficiently verified welded MCO, and assumes the MCO is retained within the cask by the installed cask lid.

Assuming the SNF is retained within the MCO, the requirement for subcritical configuration of the SNF is an MCO design requirement and is not within the scope of this study.

4.1.3 Seismic Considerations

Seismic restraints may or may not be required for the cask outside of the loadout pit, and will be determined by detailed evaluations. In the absence of detailed evaluations, the following identify the assumed requirements for seismic restraint of the cask/MCO throughout the MCO closure cycle:

- There are no requirements for seismic event mitigation while the cask is suspended from the K Basin 30 ton crane.
- While within the K Basin Transfer Area, the trailer only needs to be seismically restrained if welding, weld inspection, or weld repair operations are performed with the MCO on the trailer.
- Welding, weld inspection, or weld repair of the MCO in a weld station within the K Basin Transfer Area requires that the cask be seismically restrained.
- The cask and trailer must be seismically restrained for all operations within the Cold Vacuum Drying facility.

4.1.4 U.S. Nuclear Regulatory Commission Equivalency Requirements

Operations performed within the K Basin facility are not required to provide NRC equivalency. Operations are required to provide NRC equivalency when the cask is loaded on the conveyance and presented for transportation.

Operations within the CVD facility must satisfy the NRC equivalency requirements. This study assumes that the NRC equivalency requirements will not affect the decision on MCO closure operations location.

4.2 INTRA-AREA TRANSFER

If the MCO is welded in the K Basins, the sealed MCO provides the primary containment during the transfer from the K Basins to the CVD facility. The sealed cask provides confinement for all accident scenarios except the fire accident. The cask provides structural and thermal protection of the MCO, radiological shielding from the MCO, and retains the MCO within the cask.

If the MCO is to be welded at the CVD, the MCO provides neither containment nor confinement, and therefore the sealed cask must provide the primary containment for all accident scenarios, including the fire accident. The cask also provides structural, thermal, and radiological protection for this scenario.

5.0 PRELIMINARY DETERMINATIONS

5.1 EVALUATION CRITERIA

For the preliminary determinations, the optional locations for MCO closure activities are evaluated solely on safety, logistics/schedule, and dose commitment.

The evaluation of safety issues results in constraints that are deterministic, and are not tradeable. Failure to satisfy a constraint disallows the considered option. Therefore, for the preliminary determinations, each option is evaluated against the safety constraints to determine whether or not it is a viable option.

Each option not eliminated by a safety constraint is evaluated based on logistics/schedule considerations. Those options that do not present a reasonable operating scenario due to logistics/schedule considerations are eliminated from further consideration.

The remaining options are evaluated for dose commitment considerations, based on the information gained from the baselining effort, the initial investigation into welding and inspection methods and efficiencies, and the implications of the safety constraints. Dose commitment studies are not performed for the preliminary determinations, rather, the downselection of options is based on additional dose/uptake with no obvious benefit.

5.2 ELIMINATED OPTIONS

The MCO shield plug weld (closure weld) will be leak tested by a method that requires backfilling the MCO with helium. In order to qualify the leak test procedure, the concentration of the helium within the MCO must be a known quantity. This necessitates that a known vacuum be established in the MCO prior to backfilling with helium, which also requires that the MCO be free of water prior to performing the helium leakage rate test. Therefore, the leakage rate test must be performed in the CVD facility after the MCO has been cold vacuum dried.

Transferring an unwelded MCO to the CVD facility imposes additional safety requirements on both the cask and the CVD facility. An MCO that has been welded but contains a known weld defect and an MCO that only has the non-structural root weld installed do not represent a welded MCO and do not provide containment. Considering the safety requirements for the cask and the CVD facility, the options that suggest welding in the K Basins and weld repair at the CVD facility represent no advantage over the option to weld, inspect, and repair the MCO at the CVD facility, and would result in a greater dose commitment due to the operations performed in the K Basins. Therefore, the following options are eliminated from further consideration:

Option 2: Root Weld & Inspect Over Pit; Complete Weld, Inspect, & Repair at CVD

Option 8: Weld & Inspect Over Pit; Repair at CVD

Option 10: Weld & Inspect at Weld Station; Repair at CVD

Option 11: Weld & Inspect on Trailer; Repair at CVD

The critical path locations within the K Basins are the loadout pit and the trailer if only one loadout bay is in service. Performing the welding in the Weld Station and then moving to the trailer to perform weld repair will unnecessarily add handling of the cask/MCO and will put the repair in the critical path, assuming only one trailer bay is available. If two trailer bays are available, it would be preferable to perform both the weld and weld repair operations in either the Weld Station or on the trailer. Therefore, "Option 9: Weld and Inspect at Weld Station; Repair on Trailer" is eliminated from further consideration.

The identified weld inspection and weld repair methods require direct personnel access to the entire MCO closure weld. Having the cask/MCO in the loadout pit with the top of the MCO only 1 to 1.5 feet above the surface of the water and having access to only one side of the cask/MCO does not permit adequate access for weld inspection and repair. Therefore, the following options are eliminated from further consideration.

Option 1: Weld, Inspect, & Repair Over Pit

Option 6: Weld & Inspect Over Pit; Repair at Weld Station

Option 7: Weld & Inspect Over Pit; Repair on Trailer

5.3 VIABLE OPTIONS

As a result of the preliminary determinations the following options are determined to be viable options and are referred to the detailed evaluation phase of the study:

OPTION 3: Weld, Inspect, & Repair at Weld Station

OPTION 4: Weld, Inspect, & Repair at CVD

OPTION 5: Weld, Inspect, & Repair on Trailer

6.0 OPTION EVALUATIONS

6.1 EVALUATION METHODOLOGY

6.1.1 Evaluation Criteria

The three remaining options essentially consist of the same basic operations performed in a slightly different order and at different locations, resulting in variations in operations and required equipment. All options are technically feasible and exhibit adequate technical maturity. Selection of the recommended option is based on an evaluation of each option's performance in safety, dose commitment, logistics/schedule, and qualitative relative cost considerations.

Each of the options are evaluated for safety considerations associated with K Basin operations, transportation, and CVD operations components.

The dose commitment evaluation includes components for normal operations, off-normal operations, and installation and decommissioning. Additional consideration is given to the cumulative doses received by skilled technical operators.

The logistics/schedule evaluation includes components for normal operations, off-normal operations, and installation.

The cost evaluation is performed on a relative basis, qualitatively comparing each option against the others. The cost evaluation includes consideration for equipment capital costs, and equipment installation and decommissioning costs.

Each of the evaluation criteria is assigned a weight factor to account for the importance of the criteria in determination of the recommended option. The weight factors are a value from one to ten, with ten indicating the most importance. Each evaluation criteria component is similarly assigned a weight factor to represent the importance of that component.

Each of the options are evaluated for their performance in each of the identified criteria components. Each option is ranked from one to ten, with ten indicating that the evaluated option exhibits the most desirable performance for that criterion component. The weighted ranking for each of the criterion's components is then summed and multiplied by the criterion weight factor to generate the total weighted ranking for that evaluation criterion. The option's total weighted ranking is determined by summing the total weighted rankings of the associated evaluation criteria. The option with the highest overall weighted ranking is the preferred option.

6.1.2 Criteria and Component Weight Factors

Safety is the highest priority for all operations, and is therefore assigned a weight factor of ten. Also, each component of the safety evaluation criterion is assigned a weight factor of ten.

Limiting the personnel dose commitment is a high priority for all operations on the Hanford Site. This evaluation criteria is assigned a weight factor of nine. The dose commitment components are assigned weight factors as follows:

normal operations	component weight factor = 10; the dose/uptake is expected to occur throughout the fuel retrieval campaign.
off-normal operations	component weight factor = 3; weld repair and "on-mask" operations are the off-normal operations considered; weld repair is expected for only 1% of the MCOs, but because the need for "on-mask" operations cannot be quantified, a component weight factor of 3 is assigned.
installation and decommissioning	component weight factor = 3; due to the short duration of the fuel removal campaign, the dose commitment from installation and decommissioning cannot be considered as an insignificant portion of the dose commitment during fuel removal project.

The SNF Project is committed to a two year SNF removal campaign, having all the SNF removed from the K Basins by December, 1999. This commitment shows the high priority placed on logistics/schedule, and therefore this criterion is assigned a weight factor of 9. The logistics/schedule components are assigned weight factors as follows:

normal operations	component weight factor = 10; normal operations must satisfy the schedule requirements.
off-normal operations	component weight factor = 5; the off-normal operations may impact throughput and other sub-project operations.
installation	component weight factor = 4; many activities are required by the various subprojects for preparation of the fuel removal campaign. Additional installation requirements need to be limited to reduce impact to the schedule.

Costs are always an important consideration in any project, but do not override the other criteria; the cost criterion is assigned a weight factor of eight. The cost components are assigned weight factors as follows:

capital	component weight factor = 10; capital costs need to be minimized as they will only be used during the two year campaign.
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installation &
decommissioning component weight factor = 6; due to the short duration of the project, installation and decommissioning costs are a significant consideration.

6.2 EVALUATIONS

Detailed dose studies were performed for two of the three MCO closure operations location options (Options 3 and 4) and for the weld repair sequence. The dose study presents the step by step operations required to achieve a closed MCO for the two location options. Because all the options are comprised of similar operations that are performed in a different order or at a different location, a detailed dose study of the other option (Option 5) was not performed. The summary information for Option 5 presented in Tables 6-1 and 6-2 was derived from the detailed dose studies performed for Options 3 and 4. The detailed dose studies are included as Appendix B and are summarized in Table 6-1 and Table 6-2. Table 6-1 presents the closure cycle time and dose for normal operations, excluding the weld repair cycle. Table 6-2 presents the closure cycle time and dose for closure operations that include a weld repair cycle. The estimates presented in Tables 6-1 and 6-2 have not been adjusted for operating efficiencies.

The elapsed time portions of Tables 6-1 and 6-2 are broken down into closure cycle times and entire cycle times. Closure cycle time refers to the minimum number of operations in the K Basins and the CVD facility necessary to envelope the MCO closure operations for all options. Entire cycle time refers to all the MCO related operations within the K Basins plus those operations in the CVD facility required to stage the MCO for the CVD process. The basin total cycle time is eleven hours greater than the basin closure cycle time to account for the following: 2 hours for receiving the cask/MCO/trailer at the K Basin and staging the cask/MCO in the loadout pit; 3 hours for loading the SNF into the MCO; 3 hours for purging of the south loadout pit; and 3 hours for installing the shield plug, lifting the cask out of the pool, and decontaminating the MCO. The entire cycle time total includes one hour for transferring the MCO from the K Basin to the CVD facility.

The closure cycle dose portions of Tables 6-1 and 6-2 are subdivided into total dose, background dose, and cask/MCO dose in order to differentiate the dose uptake due to the background radiation fields from that emanating from the cask/MCO. The average total dose entry in the tables is the average of the total closure cycle doses from the KE and KW Basins. The average total dose is a valid comparison value, assuming that the same operations will be performed in each basin, and assuming that there are an equal number of MCOs shipped from each basin.

6.2.1 Safety

6.2.1.1 K Basin Operations. A dropped cask accident is a credible event for all cask handling operations in the K Basin Transfer Area. For all cask drop scenarios, the MCO must be retained within the cask to prevent loss of shielding. In addition, handling an MCO that does not have an accepted closure weld, requires that the MCO shield plug be

restrained on the MCO shell to prevent loss of shielding, loss of criticality configuration control, and loss of SNF. The potential for failure of the seismic restraints in a seismic event presents a greater risk to the unwelded MCO than the welded MCO.

For both normal and weld repair scenarios, the MCO is moved out of the loadout pit prior to any welding for Options 3, 4, and 5. Options 3 and 5 present a greater risk than Option 4, because of potential failure of seismic restraints during welding. Option 3 has an additional handling step after being welded and therefore presents a greater risk than Options 4 and 5. The rankings for these three options are as follows:

Option 3: Rank = 8
 Option 4: Rank = 10
 Option 5: Rank = 9

6.2.1.2 Transportation. For the selected options, there are two scenarios that apply during the transfer of the MCO to the CVD facility. In the case of a welded MCO, the MCO provides containment and the cask provides confinement. For an unwelded MCO, the cask provides containment, but the MCO provides neither containment nor confinement. Although both transfer operations satisfy the safety requirements, the risk for movement of an unwelded MCO is greater than that for a sealed MCO.

Options 3 and 5 provide a welded MCO for transfer from the K Basins to the CVD facility. These options provide the least transportation risk. Rank = 10 for Options 3 and 5.

Option 4 presents an unwelded MCO for transfer to the CVD facility, and therefore has a greater risk than the other options. Rank = 9

6.2.1.3 CVD Facility Operations. The potential for failure of the seismic restraints in a seismic event presents a greater risk to the unwelded MCO than the welded MCO. The cask/MCO remains on the conveyance throughout the operations at the CVD, and therefore there are no additional risks associated with handling.

Options 3 and 5 present the least risk for operations within the CVD as all these options provide a welded MCO. Rank = 10

Option 4, providing an unwelded MCO to the CVD facility, has an inherently greater risk than the other options. Rank = 9

6.2.2 Dose Commitment

6.2.2.1 Normal Operations. The estimated dose commitment of each option for normal operations is summarized in Table 6-1. The average total closure cycle dose is a valid comparison value when assuming the operations within each basin are the same and assuming that an equal number of MCOs are processed from each basin.

Table 6-1. Time and Dose per Normal Multi-Canister Overpack Closure Cycle .

Normal Closure Cycle	ELAPSED TIME (hours)					CLOSURE CYCLE DOSE (mrem-person)							
	CLOSURE CYCLE			ENTIRE CYCLE		TOTAL DOSE			BACKGROUND DOSE		CASK/MCO DOSE		
Option	Basin	CVD	Total	Basin	Total	Ave.	KE	KW	KE	KW	Basin	CVD	Total
3	17.3	1.0	18.3	28.3	30.3	1938.0	2130.1	1745.9	426.8	42.7	1571.8	131.5	1703.3
4	3.3	13.9	17.2	14.3	29.2	1577.0	1626.1	1527.8	109.2	10.9	458.0	1058.9	1516.9
5	16.3	1.0	17.3	27.3	29.3	1777.1	1953.8	1600.4	392.6	39.3	1398.7	131.5	1561.2

Table 6-2. Time and Dose per Multi-Canister Overpack Closure Cycle With Weld Repair

Closure Cycle With Weld Repair	ELAPSED TIME (hours)					CLOSURE CYCLE DOSE (mrem-person)								
	CLOSURE CYCLE			ENTIRE CYCLE		TOTAL DOSE				BACKGROUND DOSE		CASK/MCO DOSE		
Option	Basin	CVD	Total	Basin	Total	Ave.	KE	KW	CVD	KE	KW	Basin	CVD	Total
3	26.4	1.0	27.4	37.4	39.4	2992.8	3291.8	2693.8		664.3	66.4	2496.0	131.5	2627.5
4	3.3	23.0	26.3	14.3	38.3	2505.9	2555.0	2456.7		114.0	15.7	458.0	1983.0	2441.0
5	25.4	1.0	26.4	36.4	38.4	2831.9	3115.5	2548.3		630.1	63.1	2353.8	131.5	2485.3
Weld Repair Only			9.1		9.1		1161.7	947.9	928.9	237.5	23.8			924.1

Based on an average total closure cycle dose, Option 4 is the preferred option. For normal operations, the options are rated as follows:

- Option 3: Rank = 7
- Option 4: Rank = 10
- Option 5: Rank = 8

6.2.2.2 Off-Normal Operations. The estimated dose commitment of each option for operations including a weld repair sequence is summarized in Table 6-2. The average total closure cycle dose is a valid comparison value when assuming the operations within each basin are the same and assuming that an equal number of MCOs are processed from each basin.

Based on an average total closure cycle dose, Option 4 has the least dose commitment.

If the closure cycle operations within the K Basins are required to be performed "on-mask," the duration of each operation will be increased. This is of particular importance where operations are performed in close proximity to the cask/MCO (such as welding, weld inspection, and weld repair), as this condition will lead to significantly higher dose commitments. In this respect, Option 4 presents a clear advantage over the other options, because most of the operations performed in close proximity to the cask are performed at the CVD facility where "on-mask" operations are not expected, and thus operation durations are known. In addition, performing weld repair in the K Basins has a potential for creating an environment that requires "on-mask" operations that would affect all operations within the basin, including fuel retrieval, sludge retrieval, debris removal, and maintenance activities.

Based on off-normal operations, the options are ranked as follows:

- Option 3: Rank = 5
- Option 4: Rank = 10
- Option 5: Rank = 6

6.6.2.3 Installation and Decommissioning. The dose commitment for installation and decommissioning are the same for both normal and weld repair scenarios.

All equipment installations required at the CVD facility are performed in a new facility, requiring no removal of existing equipment. Therefore no dose will be received during the equipment installation at the CVD facility. The background radiation field in the CVD is lower than at the K Basins, and therefore, the least dose commitment from decommissioning activities at the CVD.

All K Basin welding options require the same installation of welding equipment and welding control systems. The welding equipment and control station is assumed to be located directly west of the south loadout pit, and therefore, all K Basin welding options require the same dose commitment for installation of the welding and weld control systems.

Due to cycle times, Option 5 is a valid option only if two trailer bays are available. Options 3 and 5 will require the installation of seismically qualified cask support structures and radiological shielding within the Transfer Area of each K Basin, and Option 5 will require these structures to be installed in two locations. Both options will require the removal of existing IXM piping and support systems from the middle loadout bay to accommodate either the Weld Station or the second transportation conveyance, with the installation being greater for Option 5 due to the additional area occupied by the trailer. Installation and decommissioning of the additional structures will be performed within the background radiation fields of the K Basin Transfer Areas. Based on installation and decommissioning, the options are rated as follows:

Option 3: Rank = 7
 Option 4: Rank = 10
 Options 5: Rank = 6

6.2.3 Logistics/Schedule

6.2.3.1 Normal Operations. The estimated cycle time of each option for normal operations is summarized in Table 6-1. As discussed in Section 2.2.13, when considering the total operating efficiency, the allowed design time for the entire closure cycle is 25.4 hours per MCO.

From Table 6-1, the entire cycle times for all of the options are approximately within one hour of each other. All options have an entire cycle time that exceeds the allowable design cycle time of 25.4 hours. The important aspect of the cycle times is the total time spent within the critical path locations which are the south loadout pit and the south loadout bay, assuming only one loadout bay is available. Considering this aspect, Option 4 shows the least amount of time spent in the basins. Option 5 is a viable option only if two trailer bays are available such that the closure activities are not performed in a critical path location. Given the assumption that two trailer bays are available, both Options 3 and 5 immediately move the cask/MCO out of the loadout pit, such that much of the basin time for Option 3 is in an off-line weld station and much of the basin time for Option 5 is on a trailer in one of the two available loadout bays. Therefore, Options 3, 4, and 5 are considered equal and represent the best options based on occupation time of the south loadout pit. Based on critical path cycle time for normal operations, the options are rated as follows:

Options 3, 4, and 5: Rank = 10

6.2.3.2 Off-Normal Operations. The estimated cycle time of each option for operations requiring weld repair is summarized in Table 6-2. As discussed in Section 2.2.13, when considering the total operating efficiency, the design time allowed for the entire closure cycle, including weld repair, is 25.4 hours per MCO. If "on-mask" operations are required throughout the entire closure cycle performed within the K Basins, the design time allowed is 16.8 hours. Assuming 100 MCOs are processed from each basin per year and assuming one percent of the MCOs will require weld repair, only one weld repair per basin per year is expected.

The entire cycle times listed in Table 6-2 exceed the allowable design cycle time of 25.4 hours when a weld repair operation is required. However, as previously described, the important aspect of the cycle time is the total time spent within the south loadout pit, assuming two trailer bays are available for Option 5. For Options 3, 4, and 5, the MCO is removed from the loadout pit prior to welding (after 14.3 hours). Therefore, considering the logistics within the K Basins, Options 3, 4, and 5, can all support the allotted 25.4 hour cycle time.

The entire cycle times for all options (both normal and weld repair sequences) exceed the allowable average cycle time of 16.8 hours for when "on-mask" operations are required within the K Basins. However, for "on-mask" operations, the important aspect of the cycle time is the total time spent within the K Basins. Only Option 4 can accommodate the 16.8 hour cycle time limit for "on-mask" operations, given the estimated cycle times.

Based on off-normal operations, the option rankings for schedule/logistics considerations are as follows:

Options 3 & 5: Rank = 3

Option 4: Rank = 10

6.2.3.3 Installation. All options require the installation of welding and weld control systems that may require that additional floor space be created for their installation, or additional facilities to support the MCO closure operations. In the K Basins, the welding and weld control systems are assumed to be installed in the space made available by the removal of the platform directly west of the south loadout pit, and will not have an impact on this study. In the CVD facility, the equipment will be installed in a new facility, and will not have an impact on this study.

The location of the Weld Station is assumed to be in the middle loadout bay. Options 3 and 5 require that the middle load out bay be cleared for either the installation of a Weld Station or for the access of a second cask conveyance. This will require that the IXM piping and support systems be removed. Due to the larger area required for the trailer, Option 5 will require more activities in preparation for installation than Option 3. For both Options 3 and 5, fire protection systems and inert gas supply systems will have to be installed. There are many activities that have to be performed in a relatively small window of opportunity for preparation of the K Basins for the fuel removal campaign.

For Option 4, a significant portion of the closure cycle time is performed in the CVD facility which will add to the total cycle time for CVD operations. This will require an increase in the number of CVD stations in order to maintain throughput capacity, but it is expected to have only a small impact to the design and construction schedule, especially when considering the delayed start of operations in the KE Basin.

Based on schedule impacts due to installation requirements, the options are ranked as follows:

- Option 3: Rank = 8
- Option 5: Rank = 7
- Option 4: Rank = 10

6.2.4 Cost

6.2.4.1 Capital Costs. Equipment procurement, facility upgrades, and new facility construction are included in the capital cost evaluation.

All options require the same number of welding and weld control systems and does not impact this study.

Option 5 requires the construction of a seismic restraint and radiological shielding system in the south and middle loadout bays. Option 3 requires the construction of a seismic restraint and radiological shielding system in the middle loadout bay. Both Options 3 and 5 require the installation of fire protection systems and inert gas supply systems. Option 4 requires no K Basin facility upgrades.

For Option 4, the number of CVD stations will have to be increased in order to maintain throughput due to the additional time required for MCO closure operations performed at the CVD facility.

Based on capital costs, the option rankings are as follows:

- Option 3: Rank = 10
- Option 4: Rank = 8
- Option 5: Rank = 9

6.2.4.2 Installation and Decommissioning Costs. The installation costs of the welding and weld control systems are not a consideration for any of the options, because all the equipment is portable and simply requires setting into position. Similarly, the decommissioning costs are a minor consideration, as all equipment is likely to be reassigned for other uses. Options 3 and 5 have installation and decommissioning costs associated with the seismic restraint, radiological shielding, fire protection, and inert gas supply systems. Option 4 does not have any significant installation costs associated with the MCO closure operations, but has decommissioning costs due to the additional CVD stations required to support MCO closure operations.

Based on installation and decommissioning costs, the options are rated as follows:

- Option 3: Rank = 10
- Option 4: Rank = 8
- Option 5: Rank = 9

6.3 EVALUATION SUMMARY

The option evaluation scores are summarized in Table 6-3.

Table 6-3. Evaluation Summary. (2 sheets)

		OPTION					
		3		4		5	
CRITERIA	WEIGHT FACTOR	Rank	Weighted Rank	Rank	Weighted Rank	Rank	Weighted Rank
SAFETY	10						
K Basin Ops	10	8	80	10	100	9	90
Transfer	10	10	100	9	90	10	100
CVD Ops	10	10	100	9	90	10	100
Weighted Component Total			280		280		290
Weighted Criterion Total			2800		2800		2900
DOSE COMMITTED	9						
Normal Ops	10	7	70	10	100	8	80
Off-Normal Ops	3	5	15	10	30	6	18
Install & Decom	3	7	21	10	30	6	18
Weighted Component Total			106		160		116
Weighted Criterion Total			954		1440		1044
LOGISTICS/SCHED	9						
Normal Ops	10	10	100	10	100	10	100
Off-Normal Ops	5	3	15	10	50	3	15
Install	4	8	32	10	40	7	28
Weighted Component Total			147		190		143
Weighted Criterion Total			1323		1710		1287
COSTS	8						
Capital	10	10	100	8	80	9	90
Install & Decom	6	10	60	8	48	9	54

Table 6-3. Evaluation Summary. (2 sheets)

		OPTION					
		3		4		5	
CRITERIA	WEIGHT FACTOR	Rank	Weighted Rank	Rank	Weighted Rank	Rank	Weighted Rank
Weighted Component Total			160		128		144
Weighted Criterion Total			1280		1024		1152
WEIGHTED OPTION TOTALS			6357		6974		6383

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7.0 RECOMMENDATIONS

7.1 RECOMMENDED MULTI-CANISTER OVERPACK CLOSURE OPERATIONS LOCATIONS

Option 4, performing all MCO closure operations at the CVD facility, is the preferred option.

The MCO closure weld must be leakage rate tested after the free water has been removed from the MCO. Therefore, the only place to perform the leakage rate test is in the CVD facility.

7.2 RECOMMENDATIONS FOR FURTHER STUDY

This study is based on preliminary design information for the MCO, cask, trailer, and MCO closure equipment. Operational and safety requirements used in this study are based on the best available information. As such, many assumptions were made to enable development of the study. As the design details, operational requirements, safety requirements, and production rates are refined, this study should be revisited and evaluated for continued applicability.

Although the background radiation fields in the K Basins are not insignificant, the largest contributor to cumulative dose uptake is the MCO. Additional shielding in the cask or employment of auxiliary shielding during MCO closure operations will greatly reduce overall cycle doses. These dose mitigation measures should be evaluated further.

If all of the MCO closure cycle operations within the K Basins are required to be performed "on-mask," only Option 4 (the preferred option) allows throughput to be maintained, given the assumed operating efficiencies and estimated operation cycle times. Because the probability of requiring "on-mask" operations for all MCO closure operations within the K Basins has not been quantified, no options were eliminated based on failure to maintain throughput due to "on-mask" operations. All of the subproject operations within the K Basins should be reviewed to determine the probability or expected percentage of operations that will be required to be performed "on-mask" to validate this assumption.

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APPENDIX A
DRAWINGS

TN-WHC Cask Transportation System

LOADING CONFIGURATION
BEFORE IMMERSION PAIL IS SUBMERGED

MCO DRYING CONFIGURATION
(DRYING ON TRAILER)

TN-WHC Transport Cask
Loading/Drying Configurations

TRANSNUCLEAR, INC.

EXISTING HANFORD "J" HOOKS, REF.

TN-WHC Transport Cask
Cask Lifting Arrangement

DETAIL :
SCALE: NONE

177

[illegible]

ASSEMBLY

BEST AVAILABLE COPY

Equipment

[illegible]

61

$\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$
 $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$
 $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$

• *in situ* storage, distribution

$\frac{1}{2} \log \frac{1}{2}$

Calcium 9156 ± 1.5
Calcium 9156 ± 1.5
Calcium 9156 ± 1.5

$$\text{Lindgren } (1975): \quad \sigma^2 = \frac{1}{n} \sum_{i=1}^n (x_i - \bar{x})^2$$

Case note: 10/1/01

6544. *Utricularia* *subsp. nov.* 1955. —

Shareholder's Equity

[illegible]

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U.S. DEPARTMENT OF JUSTICE

10/1/01	10/1/01
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FIELD VEHICLE
CRANE
A BASSIN 10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38-39-40-41-42-43-44-45-46-47-48-49-50-51-52-53-54-55-56-57-58-59-60-61-62-63-64-65-66-67-68-69-70-71-72-73-74-75-76-77-78-79-80-81-82-83-84-85-86-87-88-89-90-91-92-93-94-95-96-97-98-99-100-101-102-103-104-105-106-107-108-109-110-111-112-113-114-115-116-117-118-119-120-121-122-123-124-125-126-127-128-129-130-131-132-133-134-135-136-137-138-139-140-141-142-143-144-145-146-147-148-149-150-151-152-153-154-155-156-157-158-159-160-161-162-163-164-165-166-167-168-169-170-171-172-173-174-175-176-177-178-179-180-181-182-183-184-185-186-187-188-189-190-191-192-193-194-195-196-197-198-199-200-201-202-203-204-205-206-207-208-209-210-211-212-213-214-215-216-217-218-219-220-221-222-223-224-225-226-227-228-229-230-231-232-233-234-235-236-237-238-239-240-241-242-243-244-245-246-247-248-249-250-251-252-253-254-255-256-257-258-259-260-261-262-263-264-265-266-267-268-269-270-271-272-273-274-275-276-277-278-279-280-281-282-283-284-285-286-287-288-289-290-291-292-293-294-295-296-297-298-299-300-301-302-303-304-305-306-307-308-309-310-311-312-313-314-315-316-317-318-319-320-321-322-323-324-325-326-327-328-329-330-331-332-333-334-335-336-337-338-339-340-341-342-343-344-345-346-347-348-349-350-351-352-353-354-355-356-357-358-359-360-361-362-363-364-365-366-367-368-369-370-371-372-373-374-375-376-377-378-379-380-381-382-383-384-385-386-387-388-389-390-391-392-393-394-395-396-397-398-399-400-401-402-403-404-405-406-407-408-409-410-411-412-413-414-415-416-417-418-419-420-421-422-423-424-425-426-427-428-429-430-431-432-433-434-435-436-437-438-439-440-441-442-443-444-445-446-447-448-449-450-451-452-453-454-455-456-457-458-459-460-461-462-463-464-465-466-467-468-469-470-471-472-473-474-475-476-477-478-479-480-481-482-483-484-485-486-487-488-489-490-491-492-493-494-495-496-497-498-499-500-501-502-503-504-505-506-507-508-509-510-511-512-513-514-515-516-517-518-519-520-521-522-523-524-525-526-527-528-529-530-531-532-533-534-535-536-537-538-539-540-541-542-543-544-545-546-547-548-549-550-551-552-553-554-555-556-557-558-559-560-561-562-563-564-565-566-567-568-569-570-571-572-573-574-575-576-577-578-579-580-581-582-583-584-585-586-587-588-589-590-591-592-593-594-595-596-597-598-599-600-601-602-603-604-605-606-607-608-609-610-611-612-613-614-615-616-617-618-619-620-621-622-623-624-625-626-627-628-629-630-631-632-633-634-635-636-637-638-639-640-641-642-643-644-645-646-647-648-649-650-651-652-653-654-655-656-657-658-659-660-661-662-663-664-665-666-667-668-669-670-671-672-673-674-675-676-677-678-679-680-681-682-683-684-685-686-687-688-689-690-691-692-693-694-695-696-697-698-699-700-701-702-703-704-705-706-707-708-709-710-711-712-713-714-715-716-717-718-719-720-721-722-723-724-725-726-727-728-729-730-731-732-733-734-735-736-737-738-739-740-741-742-743-744-745-746-747-748-749-750-751-752-753-754-755-756-757-758-759-760-761-762-763-764-765-766-767-768-769-770-771-772-773-774-775-776-777-778-779-780-781-782-783-784-785-786-787-788-789-790-791-792-793-794-795-796-797-798-799-800-801-802-803-804-805-806-807-808-809-810-811-812-813-814-815-816-817-818-819-820-821-822-823-824-825-826-827-828-829-830-831-832-833-834-835-836-837-838-839-840-841-842-843-844-845-846-847-848-849-850-851-852-853-854-855-856-857-858-859-860-861-862-863-864-865-866-867-868-869-870-871-872-873-874-875-876-877-878-879-880-881-882-883-884-885-886-887-888-889-890-891-892-893-894-895-896-897-898-899-900-901-902-903-904-905-906-907-908-909-910-911-912-913-914-915-916-917-918-919-920-921-922-923-924-925-926-927-928-929-930-931-932-933-934-935-936-937-938-939-940-941-942-943-944-945-946-947-948-949-950-951-952-953-954-955-956-957-958-959-960-961-962-963-964-965-966-967-968-969-970-971-972-973-974-975-976-977-978-979-980-981-982-983-984-985-986-987-988-989-990-991-992-993-994-995-996-997-998-999-1000-1001-1002-1003-1004-1005-1006-1007-1008-1009-1010-1011-1012-1013-1014-1015-1016-1017-1018-1019-1020-1021-1022-1023-1024-1025-1026-1027-1028-1029-1030-1031-1032-1033-1034-1035-1036-1037-1038-1039-1040-1041-

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
1	2	3	4	5	6	7	8	9	10	11	12	13																																																																																							

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APPENDIX B
DOSE STUDY

Notes on Dose Estimate Spreadsheets

The attached spreadsheets were used to estimate the doses for the two remaining potential welding scenarios for the MCO shield plug. The first scenario assumes all welding operations take place in the middle load out bay area, somewhere in the vicinity of the current IXM location. Depending on available space, two or more welding and inspection stations can be set up. The other scenario assumes all welding, inspection and repair activities take place in the CVD, reducing background exposures, and freeing the pit, crane and load out bay for continued operations. A third viable option, welding and repairing on the trailer, is nearly the same as welding in the bay (slightly lower background and one less cask move), and is not separately analyzed for dose. The weld repair dose calculations are included as a separate spreadsheet, since weld failure is considered an off-normal event, estimated to occur on one out of 100 MCOs.

Each of the sheets are divided into the steps required to complete the welding, inspection and repair operations. Each step is subdivided by craft involvement with an estimate of time and manpower required, provided by experienced personnel (eg, K and N Basin Operators, welding and NDE engineers, transportation, etc). The cask dose rates are from estimates generated by J.S. Lan (DSI, 10-16-95), based on where the workers are likely to be, relative to the cask, during the performance of each step. Lan's estimates are based on Mark IV fuel and eight inches of bulk steel shielding. The estimates do not account for the process port penetrations through the MCO shield plug, nor do they account for gap streaming, both significant contributors to the total dose. Although the dose fields used in these spreadsheets are not current, the relative ranking of the two scenarios will remain the same. Estimated background dose rates are based on RSR #226487 for KE, and RSR # 228364 for KW (included as Appendix C); the CVD estimate is a somewhat arbitrary non-zero number, assuming process piping will generate a background field after extended use. Dose rates and durations are used to generate projected doses for an individual, for each craft, for each step, and a grand total, summarized on the last page of each scenario. Total times are calculated by summing the longest duration tasks from each step. For example, if a given step takes an Operator twenty minutes, the PIC five minutes and an HP five minutes, twenty minutes is selected as the total duration of the step.

Assumptions:

1. Five weld passes are required for each MCO.
2. Crane load time limits are eliminated.
3. The cask lid serves as the MCO retaining device for the transfer to the CVD. A gas/water tight seal between the MCO and the shield plug is not required.
4. The intake part of the HEPA filtered weld off gas system is an integral part of the welding machine. An additional system will be required for manual weld repairs.
5. NRC equivalence requirements are not invoked for K Basins operations.
6. General background dose rates.
 - KE: 10.0 mR/hr around the load out pit, 10.0 mR/hr in the middle bay area (near IXM's), and 3.0 mR/hr around the South load out bay (Values from RSR #226487, Feb 13, 96).
 - KW: 1.0, 1.0, and 0.3, respectively for the same areas (Values from RSR # 228364, Apr 11, 96).
 - CVD: 0.2 mR/hr, from process piping after extended use.
7. The worst case weld failure assumes one repair required for every 100 MCOs welded, based on WHC welding engineer's experience and TIG-stainless steel welding history at Duke Power.
8. Spreadsheets assume normal, routine operations and do not model equipment maintenance or repair. Therefore, electricians, instrument techs, painters and other crafts are not represented.
9. Scenario starting point is after the cask/MCO has been lifted until the top is out of the water. The end point is the start of the cold vacuum drying sequence.
10. Equipment is assumed to be designed with lifting attachments and other devices to minimize rigger requirements.
11. Welding equipment is operated from remote operating stations (greater than three meters).
13. Cask dose rates are based on Mark IV fuel and assume 8" of bulk steel shielding on the top and sides of the cask.
14. Dye penetrant testing is assumed to be a full hands on operation (worst case). Efforts are underway to make part of this operation remote.

Scenario III: Weld, Inspect and Repair at Load Out Bay Welding Station

4/11/96

Step	Who	#	ET min	Background Doserates				Cask from KW		Cask from KE	
				Cask mR/hr	KE mR/hr	KW mR/hr	CVD mR/hr	Total/per mrem/per	Total/crew mrem-per	Total/per mrem/per	Total/crew mrem-per
1 Install cask lid and cask lift fixture.	O	2	30.0	57.1	10.0	1.0	0.0	29.1	58.1	33.6	67.1
	M	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
	H	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
	P	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
Step Totals (mrem-pers):								145.3		167.8	
2 Lift cask/MCO out of the water and allow to drip into pit.	O	2	15.0	14.7	10.0	1.0	0.0	3.9	7.9	6.2	12.4
	H	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9	6.2	6.2
Step Totals (mrem-pers):								11.8		18.5	
3 Decontaminate, dry and survey to verify there is no external contamination.	O	2	60.0	45.8	10.0	1.0	0.0	46.8	93.6	55.8	111.6
	H	2	30.0	45.8	10.0	1.0	0.0	23.4	46.8	27.9	55.8
	P	1	10.0	45.8	10.0	1.0	0.0	7.8	7.8	9.3	9.3
Step Totals (mrem-pers):								148.2		176.7	
4 Lift cask and position on trunnion cradles at load out bay weld station. Secure trunnion caps & seismic restraints.	O	2	20.0	14.7	10.0	1.0	0.0	5.2	10.5	8.2	16.5
	H	1	20.0	14.7	10.0	1.0	0.0	5.2	5.2	8.2	8.2
	P	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9	6.2	6.2
Step Totals (mrem-pers):								19.6		30.9	
5 Remove cask lid and cask lift fixture, if it interferes with welding	O	2	30.0	57.1	10.0	1.0	0.0	29.1	58.1	33.6	67.1
	M	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
	H	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
	P	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
Step Totals (mrem-pers):								145.3		167.8	

Scenario III: Weld, Inspect and Repair at Load Out Bay Welding Station

4/11/96

Step	Who	#	Background Doserates				Cask from KW		Cask from KE	
			ET	Cask	KE	KW	Total/per	Total/crew	Total/per	Total/crew
			min	mR/hr	mR/hr	mR/hr	mR/hr	mR/hr	mR/hr	mR/hr
6 Visually inspect joint for dryness and debris	O	1	15.0	45.8	10.0	1.0	0.0	11.7	14.0	14.0
	H	1	15.0	45.8	10.0	1.0	0.0	11.7	14.0	14.0
	W	1	15.0	45.8	10.0	1.0	0.0	11.7	14.0	14.0
	P	1	5.0	45.8	10.0	1.0	0.0	3.9	4.7	4.7
Step Totals (mrem-pers):							39.0		46.5	
7 Remove short tube cover flange, connect purge gas, and activate.	O	1	15.0	57.1	10.0	1.0	0.0	14.5	16.8	16.8
	H	1	15.0	57.1	10.0	1.0	0.0	14.5	16.8	16.8
	Step Totals (mrem-pers):						29.1		33.6	
	O	1	15.0	14.7	10.0	1.0	0.0	3.9	6.2	6.2
Step Totals (mrem-pers):							3.9		6.2	
8 Lower welding machine onto MCO with aux. crane & unrig	O	1	15.0	14.7	10.0	1.0	0.0	3.9	6.2	6.2
	H	1	15.0	14.7	10.0	1.0	0.0	3.9	6.2	6.2
	W	1	15.0	14.7	10.0	1.0	0.0	3.9	6.2	6.2
	Step Totals (mrem-pers):						11.8		18.5	
9 Set up weld off gas system & activate. System may be part of weld machine or separate system.	O	1	15.0	0.0	10.0	1.0	0.0	0.3	2.5	2.5
	H	1	15.0	0.0	10.0	1.0	0.0	0.3	2.5	2.5
	W	1	15.0	0.0	10.0	1.0	0.0	0.3	2.5	2.5
	Step Totals (mrem-pers):						0.5		5.0	
10 Inspect joint with CCTV; verify machine, TV, and light systems. Also verify off gas sys, if part of welder.	W	1	5.0	0.0	10.0	1.0	0.0	0.1	0.8	0.8
	P	1	5.0	0.0	10.0	1.0	0.0	0.1	0.8	0.8
	Step Totals (mrem-pers):						0.2		1.7	
	W	1	5.0	0.0	10.0	1.0	0.0	0.1	0.8	0.8
	P	1	5.0	0.0	10.0	1.0	0.0	0.1	0.8	0.8
	Step Totals (mrem-pers):						0.2		1.7	

Scenario III: Weld, Inspect and Repair at Load Out Bay Welding Station

4/11/96

Step	Who	#	ET min	Cask mR/hr	Background Doserates			Cask from KW		Cask from KE	
					KE mR/hr	KW mR/hr	CVD mR/hr	Total/per mrem/per	Total/crew mrem-per	Total/per mrem/per	Total/crew mrem-per
12 Start welding root pass. Monitor weld progress by CCTV & adjust parameters as required. HP monitors for airborne.	H	1	10.0	0.0	10.0	1.0	0.0	0.2	0.2	1.7	1.7
	W	1	45.0	0.0	10.0	1.0	0.0	0.8	0.8	7.5	7.5
	P	1	10.0	0.0	10.0	1.0	0.0	0.2	0.2	1.7	1.7
	Step Totals (mrem-pers):							1.1		10.8	
13 Visually inspect root pass by CCTV.	H	1	10.0	0.0	10.0	1.0	0.0	0.2	0.2	1.7	1.7
	W	1	5.0	0.0	10.0	1.0	0.0	0.1	0.1	0.8	0.8
	E	1	30.0	0.0	10.0	1.0	0.0	0.5	0.5	5.0	5.0
	P	1	5.0	0.0	10.0	1.0	0.0	0.1	0.1	0.8	0.8
	Step Totals (mrem-pers):							0.8		8.3	
14 Remove and secure welding machine, off-gas, purge gas, and related support equipment. (if req'd)	O	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9	6.2	6.2
	H	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9	6.2	6.2
	W	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9	6.2	6.2
	P	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9	6.2	6.2
	Step Totals (mrem-pers):							15.7		24.7	
15 Allow weld to cool to <125F			60.0	0.0	10.0	1.0	0.0	1.0	0.0	10.0	0.0
	Step Totals (mrem-pers):							0.0		0.0	
16 Clean root pass of weld in preparation for PT. Capture drips for disposal.	O	2	30.0	45.8	10.0	1.0	0.0	23.4	46.8	27.9	55.8
	H	1	20.0	45.8	10.0	1.0	0.0	15.6	15.6	18.6	18.6
	E	1	5.0	45.8	10.0	1.0	0.0	3.9	3.9	4.7	4.7
	P	1	5.0	45.8	10.0	1.0	0.0	3.9	3.9	4.7	4.7
	Step Totals (mrem-pers):							70.2		83.7	

Scenario III: Weld, Inspect and Repair at Load Out Bay Welding Station

4/11/96

Step	Background Doserates				Cask from KW		Cask from KE	
	Who	#	ET min	Cask mR/hr	KE mR/hr	CVD mR/hr	Total/per mrem/per	Total/crow mrem-per
17 Apply penetrant and allow to dry per mfg's instructions. Capture drips for disposal.	O	2	20.0	45.8	10.0	1.0	15.6	31.2
	H	1	10.0	45.8	10.0	1.0	7.8	7.8
	E	1	10.0	45.8	10.0	1.0	7.8	7.8
	P	1	5.0	45.8	10.0	1.0	3.9	3.9
Step Totals (mrem-pers):								50.7
18 Remove excess penetrant and clean per mfg's instructions. Capture drips for disposal.	O	2	20.0	45.8	10.0	1.0	15.6	31.2
	H	1	10.0	45.8	10.0	1.0	7.8	7.8
	E	1	10.0	45.8	10.0	1.0	7.8	7.8
	P	1	5.0	45.8	10.0	1.0	3.9	3.9
Step Totals (mrem-pers):								50.7
19 Apply developer and wait for reaction per mfg's instructions. Capture drips for disposal.	O	2	30.0	45.8	10.0	1.0	23.4	46.8
	H	1	20.0	45.8	10.0	1.0	15.6	15.6
	E	1	10.0	45.8	10.0	1.0	7.8	7.8
	P	1	5.0	45.8	10.0	1.0	3.9	3.9
Step Totals (mrem-pers):								74.1
20 Interpret root pass PT results.	H	1	20.0	45.8	10.0	1.0	15.6	15.6
	E	1	30.0	45.8	10.0	1.0	23.4	23.4
	W	1	10.0	45.8	10.0	1.0	7.8	7.8
	P	1	5.0	45.8	10.0	1.0	3.9	3.9
Step Totals (mrem-pers):								50.7
21 Clean up weld and area. Capture drips for disposal.	O	2	30.0	45.8	10.0	1.0	23.4	46.8
	H	1	20.0	45.8	10.0	1.0	15.6	15.6
	P	1	5.0	45.8	10.0	1.0	3.9	3.9
Step Totals (mrem-pers):								66.3

Scenario III: Weld, Inspect and Repair at Load Out Bay Welding Station

4/11/96

Step	Background Doserates				Cask from KW		Cask from KE	
	Who	#	ET min	Cask mR/hr	KE mR/hr	CVD mR/hr	Total/per mem/per	Total/per mem/per

22 *** Weld repair, as required. See attached weld repair sequence.

23 Re-set welding machine (if removed earlier) and Repeat Steps 11 thru 13 for the second thru fourth passes.

58.3

O	1	30.0	0.0	10.0	1.0	0.0	5.0	5.0
H	1	30.0	0.0	10.0	1.0	0.0	5.0	5.0
W	1	200.0	0.0	10.0	1.0	0.0	33.3	33.3
E	1	60.0	0.0	10.0	1.0	0.0	10.0	10.0
P	1	30.0	0.0	10.0	1.0	0.0	5.0	5.0

5.8

O	1	30.0	0.0	10.0	1.0	0.0	0.5	0.5
H	1	30.0	0.0	10.0	1.0	0.0	0.5	0.5
W	1	200.0	0.0	10.0	1.0	0.0	3.3	3.3
E	1	60.0	0.0	10.0	1.0	0.0	1.0	1.0
P	1	30.0	0.0	10.0	1.0	0.0	0.5	0.5

Step Totals (mrem-pers):

24 Weld final pass and visually inspect by CCTV.

0.8

W	1	30.0	0.0	10.0	1.0	0.0	0.5	0.5
E	1	10.0	0.0	10.0	1.0	0.0	0.2	0.2
P	1	5.0	0.0	10.0	1.0	0.0	0.1	0.1

Step Totals (mrem-pers):

25 Remove and secure welding machine, off-gas, purge gas, and related support equipment

24.7

O	1	15.0	14.7	10.0	1.0	0.0	6.2	6.2
H	1	15.0	14.7	10.0	1.0	0.0	6.2	6.2
W	1	15.0	14.7	10.0	1.0	0.0	6.2	6.2
P	1	15.0	14.7	10.0	1.0	0.0	6.2	6.2

15.7

O	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9
H	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9
W	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9
P	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9

Step Totals (mrem-pers):

26 Allow weld to cool to <125F

0.0

O	1	60.0	0.0	10.0	1.0	0.0	10.0	0.0
---	---	------	-----	------	-----	-----	------	-----

0.0

O	1	60.0	0.0	10.0	1.0	0.0	1.0	0.0
---	---	------	-----	------	-----	-----	-----	-----

Step Totals (mrem-pers):

Scenario III: Weld, Inspect and Repair at Load Out Bay Welding Station

4/11/96

Step	Who	#	ET min	Cask mR/hr	Background Doserates			Cask from KW		Cask from KE	
					KE mR/hr	KW mR/hr	CVD mR/hr	Total/per mrem/per	Total/crew mrem-per	Total/per mrem/per	Total/crew mrem-per
27 Clean final pass of weld in preparation for PT. Capture drips for disposal.	O	2	30.0	45.8	10.0	1.0	0.0	23.4	46.8	27.9	55.8
	H	1	20.0	45.8	10.0	1.0	0.0	15.6	15.6	18.6	18.6
	E	1	5.0	45.8	10.0	1.0	0.0	3.9	3.9	4.7	4.7
	P	1	5.0	45.8	10.0	1.0	0.0	3.9	3.9	4.7	4.7
Step Totals (mrem-pers):								70.2		83.7	
28 Apply penetrant and allow to dry per mfg's instructions. Capture drips for disposal.	O	2	20.0	45.8	10.0	1.0	0.0	15.6	31.2	18.6	37.2
	H	1	10.0	45.8	10.0	1.0	0.0	7.8	7.8	9.3	9.3
	E	1	10.0	45.8	10.0	1.0	0.0	7.8	7.8	9.3	9.3
	P	1	5.0	45.8	10.0	1.0	0.0	3.9	3.9	4.7	4.7
Step Totals (mrem-pers):								50.7		60.5	
29 Remove excess penetrant and clean per mfg's instructions. Capture drips for disposal.	O	2	20.0	45.8	10.0	1.0	0.0	15.6	31.2	18.6	37.2
	H	1	10.0	45.8	10.0	1.0	0.0	7.8	7.8	9.3	9.3
	E	1	10.0	45.8	10.0	1.0	0.0	7.8	7.8	9.3	9.3
	P	1	5.0	45.8	10.0	1.0	0.0	3.9	3.9	4.7	4.7
Step Totals (mrem-pers):								50.7		60.5	
30 Apply developer and wait for reaction per mfg's instructions. Capture drips for disposal.	O	2	30.0	45.8	10.0	1.0	0.0	23.4	46.8	27.9	55.8
	H	1	20.0	45.8	10.0	1.0	0.0	15.6	15.6	18.6	18.6
	E	1	10.0	45.8	10.0	1.0	0.0	7.8	7.8	9.3	9.3
	P	1	5.0	45.8	10.0	1.0	0.0	3.9	3.9	4.7	4.7
Step Totals (mrem-pers):								74.1		88.4	
31 Interpret final pass PT results.	H	1	20.0	45.8	10.0	1.0	0.0	15.6	15.6	18.6	18.6
	E	1	30.0	45.8	10.0	1.0	0.0	23.4	23.4	27.9	27.9
	W	1	10.0	45.8	10.0	1.0	0.0	7.8	7.8	9.3	9.3
	P	1	5.0	45.8	10.0	1.0	0.0	3.9	3.9	4.7	4.7
Step Totals (mrem-pers):								50.7		60.5	

Scenario III: Weld, Inspect and Repair at Load Out Bay Welding Station

4/11/96

Step	Who	#	ET min	Background Doserates				Cask from KW		Cask from KE	
				Cask mR/hr	KE mR/hr	KW mR/hr	CVD mR/hr	Total/per mrem/per	Total/crew mrem-per	Total/per mrem/per	Total/crew mrem-per
32	Clean up weld and area. Capture drips for disposal.										
	O	2	30.0	45.8	10.0	1.0	0.0	23.4	46.8	27.9	55.8
	H	1	20.0	45.8	10.0	1.0	0.0	15.6	15.6	18.6	18.6
	P	1	5.0	45.8	10.0	1.0	0.0	3.9	3.9	4.7	4.7
	Step Totals (mrem-pers):							66.3		79.1	
33	*** Weld repair, as required. See attached weld repair sequence.										
34	Install cask lid and cask lift fixture (if removed earlier). Remove trunnion caps & seismic restraints										
	O	2	30.0	57.1	10.0	1.0	0.0	29.1	58.1	33.6	67.1
	H	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
	P	1	10.0	57.1	10.0	1.0	0.0	9.7	9.7	11.2	11.2
	M	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
	Step Totals (mrem-pers):							125.9		145.4	
35	Lift cask and position on trunnion cradles on trailer										
	O	2	15.0	14.7	3.0	0.3	0.0	3.8	7.5	4.4	8.9
	H	1	15.0	14.7	3.0	0.3	0.0	3.8	3.8	4.4	4.4
	P	1	10.0	14.7	3.0	0.3	0.0	2.5	2.5	3.0	3.0
	Step Totals (mrem-pers):							13.8		16.2	
36	Secure trunnion caps										
	O	1	5.0	14.7	3.0	0.3	0.0	1.3	1.3	1.5	1.5
	P	1	5.0	14.7	3.0	0.3	0.0	1.3	1.3	1.5	1.5
	Step Totals (mrem-pers):							2.5		3.0	

Scenario III: Weld, Inspect and Repair at Load Out Bay Welding Station

4/11/96

Step	Who	#	ET min	Cask mR/hr	Background Doserates			Cask from KW		Cask from KE	
					KE mR/hr	KW mR/hr	CVD mR/hr	Total/per mrem/per	Total/crew mrem-per	Total/per mrem/per	Total/crew mrem-per
37 Remove cask lift fixture.	O	2	30.0	57.1	3.0	0.3	0.0	28.7	57.4	30.1	60.1
	H	1	10.0	57.1	3.0	0.3	0.0	9.6	9.6	10.0	10.0
	P	1	10.0	57.1	3.0	0.3	0.0	9.6	9.6	10.0	10.0
	Step Totals (mrem-pers):							76.5		80.1	
38 Install and secure all cask tie-downs	O	1	10.0	14.7	3.0	0.3	0.0	2.5	2.5	3.0	3.0
	M	1	10.0	14.7	3.0	0.3	0.0	2.5	2.5	3.0	3.0
	H	1	10.0	14.7	3.0	0.3	0.0	2.5	2.5	3.0	3.0
	P	1	10.0	14.7	3.0	0.3	0.0	2.5	2.5	3.0	3.0
	Step Totals (mrem-pers):							10.0		11.8	
39 Survey and release conveyance.	O	1	15.0	45.8	3.0	0.3	0.0	11.5	11.5	12.2	12.2
	H	2	30.0	45.8	3.0	0.3	0.0	23.1	46.1	24.4	48.8
	P	1	10.0	45.8	3.0	0.3	0.0	7.7	7.7	8.1	8.1
	Step Totals (mrem-pers):							65.3		69.1	
40 Transfer to CVD for cold vacuum drying.	O	1	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	D	1	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	P	1	15.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Step Totals (mrem-pers):							0.0		0.0	
41 Install seismic tie-downs	O	2	15.0	4.6	0.0	0.0	0.2	1.2	2.4	1.2	2.4
	P	1	10.0	4.6	0.0	0.0	0.2	0.8	0.8	0.8	0.8
	Step Totals (mrem-pers):							3.2		3.2	

Scenario III: Weld, Inspect and Repair at Load Out Bay Welding Station

4/11/96

Step	Who	#	ET	Cask	Background Doserates			Cask from KW		Cask from KE	
					KE	KW	CVD	Total/per	Total/crew	Total/per	Total/crew
			min	mR/hr	mR/hr	mR/hr	mR/hr	mrem/per	mrem-per	mrem/per	mrem-per
42 Close CVD doors. Remove cask lid and install cask sealing device for CVD processing.	O	2	40.0	57.1	0.0	0.0	0.2	38.2	76.4	38.2	76.4
	H	1	40.0	57.1	0.0	0.0	0.2	38.2	38.2	38.2	38.2
	P	1	15.0	57.1	0.0	0.0	0.2	14.3	14.3	14.3	14.3
Step Totals (mrem-pers):								128.9		128.9	

** Start CVD operations **

O - Operators
D - Drivers
M - Millwrights
H - Health Physics
R - Riggers
W - Welder/Welding Engineer
E - Non-Destructive Evaluation Tech
P - Person in Charge

Total Dose, Scenario III, KE: 2130.1 mrem-person

Total Dose, Scenario III, KW: 1745.9 mrem-person

Total Time: 18.3 hrs.

Cask Doserates used in this Table:

Top:	Side:
57.1 mR/hr @ 2"	45.8 mR/hr @ 2"
9.9 mR/hr @ 1m	14.7 mR/hr @ 1m
3.3 mR/hr @ 2m	7.6 mR/hr @ 2m
1.7 mR/hr @ 3m	4.6 mR/hr @ 3m

Time	KW	KE
49.50	42.68	426.83
manhrs	mrem-per	
Dose from background		

4/11/96

Step	Who	#	ET	Cask	Background Dose/rates			Cask from KW		Cask from KE	
					KE	KW	CVD	Total/per mrem/person	Total/crew mrem-person	Total/per mrem/person	Total/crew mrem-person
			min	mR/hr	mR/hr	mR/hr	mR/hr				
1 Install cask lid and cask lift fixture.	O	2	30.0	57.1	10.0	1.0	0.0	29.1	58.1	33.6	67.1
	M	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
	H	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
	P	1	30.0	57.1	10.0	1.0	0.0	29.1	29.1	33.6	33.6
	Step Totals (mrem-pers):							145.3		167.8	
2 Lift cask/MCO out of the water and allow to drip into pit.	O	2	15.0	4.6	10.0	1.0	0.0	1.4	2.8	3.7	7.3
	H	1	15.0	4.6	10.0	1.0	0.0	1.4	1.4	3.7	3.7
	Step Totals (mrem-pers):							4.2		11.0	
3 Decontaminate, dry and survey to verify there is no external contamination.	O	2	60.0	45.8	10.0	1.0	0.0	46.8	93.6	55.8	111.6
	H	2	30.0	45.8	10.0	1.0	0.0	23.4	46.8	27.9	55.8
	P	1	10.0	45.8	10.0	1.0	0.0	7.8	7.8	9.3	9.3
	Step Totals (mrem-pers):							148.2		176.7	
4 Lift cask and position on trunnion cradles on trailer	O	2	15.0	14.7	10.0	1.0	0.0	3.9	7.9	6.2	12.4
	H	1	15.0	14.7	10.0	1.0	0.0	3.9	3.9	6.2	6.2
	P	1	10.0	14.7	10.0	1.0	0.0	2.6	2.6	4.1	4.1
	Step Totals (mrem-pers):							14.4		22.6	
5 Secure trunnion caps	O	1	5.0	14.7	10.0	1.0	0.0	1.3	1.3	2.1	2.1
	P	1	5.0	14.7	10.0	1.0	0.0	1.3	1.3	2.1	2.1
	Step Totals (mrem-pers):							2.6		4.1	
6 Remove cask lift fixture	O	2	30.0	57.1	10.0	1.0	0.0	29.1	58.1	33.6	67.1
	H	1	10.0	57.1	10.0	1.0	0.0	9.7	9.7	11.2	11.2
	P	1	10.0	57.1	10.0	1.0	0.0	9.7	9.7	11.2	11.2
	Step Totals (mrem-pers):							77.5		89.5	

Scenario IV: Weld, Inspect and Repair at Cold Vacuum Drying Facility

4/11/96

W-60-SD-S-N-F-RPT-002, Rev. 0

Step	Background Doserates				Cask from KW		Cask from KE			
	Who	#	ET min	Cask mR/hr	KE mR/hr	KW mR/hr	CVD mR/hr	Total/per mrem/person	Total/crew mrem-person	
7 Install and secure all cask tie-downs	O	1	10.0	14.7	10.0	1.0	0.0	2.6	4.1	
	M	1	10.0	14.7	10.0	1.0	0.0	2.6	4.1	
	H	1	10.0	14.7	10.0	1.0	0.0	2.6	4.1	
	P	1	10.0	14.7	10.0	1.0	0.0	2.6	4.1	
Step Totals (mrem-pers):									10.5	
8 Survey and release conveyance.	O	1	15.0	45.8	10.0	1.0	0.0	11.7	14.0	
	H	2	30.0	45.8	10.0	1.0	0.0	23.4	55.8	
	P	1	10.0	45.8	10.0	1.0	0.0	7.8	9.3	
	Step Totals (mrem-pers):									66.3
9 Transfer to CVD for cold vacuum drying.	O	1	15.0	0.0	0.0	0.0	0.0	0.0	0.0	
	D	1	15.0	0.0	0.0	0.0	0.0	0.0	0.0	
	P	1	15.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Step Totals (mrem-pers):									0.0
10 Install seismic tie-downs	O	2	15.0	4.6	0.0	0.0	0.2	1.2	2.4	
	P	1	10.0	4.6	0.0	0.0	0.2	0.8	0.8	
	Step Totals (mrem-pers):									3.2
	3.2									
11 Close CVD doors. Remove cask lid.	O	2	40.0	57.1	0.0	0.0	0.2	38.2	76.4	
	H	1	40.0	57.1	0.0	0.0	0.2	38.2	38.2	
	P	1	15.0	57.1	0.0	0.0	0.2	14.3	14.3	
	Step Totals (mrem-pers):									128.9

Scenario IV: Weld, Inspect and Repair at Cold Vacuum Drying Facility

4/11/96

Step	Who	#	ET	Cask	Background Doserates			Cask from KW		Cask from KE	
					KE	KW	CVD	Total/per	Total/crew	Total/per	Total/crew
			min	mR/hr	mR/hr	mR/hr	mR/hr	mrem/person	mrem-person	mrem/person	mrem-person
12 Visually inspect joint for dryness and debris	O	1	15.0	45.8	0.0	0.0	0.2	11.5	11.5	11.5	11.5
	H	1	15.0	45.8	0.0	0.0	0.2	11.5	11.5	11.5	11.5
	W	1	15.0	45.8	0.0	0.0	0.2	11.5	11.5	11.5	11.5
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
Step Totals (mrem-pers):								38.3		38.3	
13 Lower welding machine onto MCO with aux. crane & unrig	O	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	Step Totals (mrem-pers):								3.7		3.7
14 Set up weld off gas system & activate. System may be part of weld machine or separate system.	O	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	H	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	W	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	Step Totals (mrem-pers):								11.2		11.2
15 Remove short tube cover flange, connect purge gas, and activate.	O	1	15.0	57.1	0.0	0.0	0.2	14.3	14.3	14.3	14.3
	H	1	15.0	57.1	0.0	0.0	0.2	14.3	14.3	14.3	14.3
Step Totals (mrem-pers):								28.7		28.7	
16 Inspect joint with CCTV; verify machine, TV, and light systems. Also verify off-gas sys, if part of	W	1	15.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1
	P	1	15.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1
Step Totals (mrem-pers):								0.1		0.1	
17 Double check weld machine settings at the control panel	W	1	5.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	P	1	5.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Step Totals (mrem-pers):								0.0		0.0	

Scenario IV: Weld, Inspect and Repair at Cold Vacuum Drying Facility

4/11/96

Step	Who	#	ET min	Background Doserates				Cask from KW		Cask from KE	
				Cask mR/hr	KE mR/hr	KW mR/hr	CVD mR/hr	Total/per mrem/person	Total/crew mrem-person	Total/per mrem/person	Total/crew mrem-person
18 Start welding root pass. Monitor weld progress by CCTV & adjust parameters as required. HP monitors for airborne contamination.	H	1	10.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	W	1	45.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2
	P	1	10.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	Step Totals (mrem-pers):							0.2		0.2	
19 Visually inspect root pass by CCTV.	H	1	10.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	W	1	5.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	E	1	30.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1
	P	1	5.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
Step Totals (mrem-pers):								0.2		0.2	
20 Remove and secure welding machine, off-gas, purge gas, and related support equipment. (may not be req'd)	O	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	H	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	W	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	P	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
Step Totals(mrem-pers):								14.9		14.9	
21 Allow weld to cool to <125F			60.0	0.0	0.0	0.0	0.2	0.2	0.0	0.2	0.0
	Step Totals (mrem-pers):							0.0		0.0	
22 Clean root pass of weld in preparation for PT. Capture drips for disposal.	O	2	30.0	45.8	0.0	0.0	0.2	23.0	46.0	23.0	46.0
	H	1	20.0	45.8	0.0	0.0	0.2	15.3	15.3	15.3	15.3
	E	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
Step Totals (mrem-pers):								69.0		69.0	

Scenario IV: Weld, Inspect and Repair at Cold Vacuum Drying Facility

4/11/96

Step	Who	#	ET min	Background Doserates				Cask from KW		Cask from KE	
				Cask mR/hr	KE mR/hr	KW mR/hr	CVD mR/hr	Total/per mrem/person	Total/crew mrem-person	Total/per mrem/person	Total/crew mrem-person
23 Apply penetrant and allow to dry per mfr's instructions. Capture drips for disposal.	O	2	20.0	45.8	0.0	0.0	0.2	15.3	30.7	15.3	30.7
	H	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	E	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
Step Totals (mrem-pers):								49.8		49.8	
24 Remove excess penetrant and clean per mfr's instructions. Capture drips for disposal.	O	2	20.0	45.8	0.0	0.0	0.2	15.3	30.7	15.3	30.7
	H	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	E	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
Step Totals (mrem-pers):								49.8		49.8	
25 Apply developer and wait for reaction per mfr's instructions. Capture drips for disposal.	O	2	30.0	45.8	0.0	0.0	0.2	23.0	46.0	23.0	46.0
	H	1	20.0	45.8	0.0	0.0	0.2	15.3	15.3	15.3	15.3
	E	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
Step Totals (mrem-pers):								72.8		72.8	
26 Interpret root pass PT results.	H	1	20.0	45.8	0.0	0.0	0.2	15.3	15.3	15.3	15.3
	E	1	30.0	45.8	0.0	0.0	0.2	23.0	23.0	23.0	23.0
	W	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
Step Totals (mrem-pers):								49.8		49.8	
27 Clean up weld and area. Capture drips for disposal.	O	2	30.0	45.8	0.0	0.0	0.2	23.0	46.0	23.0	46.0
	H	1	20.0	45.8	0.0	0.0	0.2	15.3	15.3	15.3	15.3
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
	Step Totals (mrem-pers):							65.2		65.2	

Scenario IV: Weld, Inspect and Repair at Cold Vacuum Drying Facility

4/11/96

Step	Who	#	ET	Background Doserates				Cask from KW		Cask from KE	
				Cask	KE	KW	CVD	Total/per	Total/crew	Total/per	Total/crew
			min	mR/hr	mR/hr	mR/hr	mR/hr	mrem/person	mrem-person	mrem/person	mrem-person
28 Re-set welding machine (if removed earlier) and Repeat Steps 17 thru 19 for the second thru fourth passes.	O	1	30.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1
	H	1	30.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1
	W	1	200.0	0.0	0.0	0.0	0.2	0.7	0.7	0.7	0.7
	E	1	60.0	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2
	P	1	30.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1
	Step Totals (mrem-pers):							1.2		1.2	
29 Weld final pass and visually inspect by CCTV.	W	1	30.0	0.0	0.0	0.0	0.2	0.1	0.1	0.1	0.1
	E	1	10.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	P	1	5.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	Step Totals (mrem-pers):							0.2		0.2	
30 Remove and secure welding machine, off-gas, purge gas, and related support equipment	O	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	H	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	W	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	P	1	15.0	14.7	0.0	0.0	0.2	3.7	3.7	3.7	3.7
	Step Totals (mrem-pers):							14.9		14.9	
31 Allow weld to cool to <125F			60.0	0.0	0.0	0.0	0.2	0.2	0.0	0.2	0.0
	Step Totals (mrem-pers):							0.0		0.0	
32 Clean final pass of weld in preparation for PT. Capture drips for disposal.	O	2	30.0	45.8	0.0	0.0	0.2	23.0	46.0	23.0	46.0
	H	1	20.0	45.8	0.0	0.0	0.2	15.3	15.3	15.3	15.3
	E	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
	Step Totals (mrem-pers):							69.0		69.0	

Scenario IV: Weld, Inspect and Repair at Cold Vacuum Drying Facility

4/11/96

WMO-80-SAN-RPT-002, Rev. 0

Step	Who	#	ET min	Background Dose Rates				Cask from KW		Cask from KE	
				Cask mR/hr	KE mR/hr	KW mR/hr	CVD mR/hr	Total/per mrem/person	Total/crew mrem-person	Total/per mrem/person	Total/crew mrem-person
33 Apply penetrant and allow to dry per mfg's instructions. Capture drips for disposal.	O	2	20.0	45.8	0.0	0.0	0.2	15.3	30.7	15.3	30.7
	H	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	E	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
	Step Totals (mrem-pers):								49.8	49.8	
34 Remove excess penetrant and clean per mfg's instructions. Capture drips for disposal.	O	2	20.0	45.8	0.0	0.0	0.2	15.3	30.7	15.3	30.7
	H	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	E	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
	Step Totals (mrem-pers):								49.8	49.8	
35 Apply developer and wait for reaction per mfg's instructions. Capture drips for disposal.	O	2	30.0	45.8	0.0	0.0	0.2	23.0	46.0	23.0	46.0
	H	1	20.0	45.8	0.0	0.0	0.2	15.3	15.3	15.3	15.3
	E	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
	Step Totals (mrem-pers):								72.8	72.8	
36 Interpret final pass PT results.	H	1	20.0	45.8	0.0	0.0	0.2	15.3	15.3	15.3	15.3
	E	1	30.0	45.8	0.0	0.0	0.2	23.0	23.0	23.0	23.0
	W	1	10.0	45.8	0.0	0.0	0.2	7.7	7.7	7.7	7.7
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
	Step Totals (mrem-pers):								49.8	49.8	
37 Clean up weld and area. Capture drips for disposal.	O	2	30.0	45.8	0.0	0.0	0.2	23.0	46.0	23.0	46.0
	H	1	20.0	45.8	0.0	0.0	0.2	15.3	15.3	15.3	15.3
	P	1	5.0	45.8	0.0	0.0	0.2	3.8	3.8	3.8	3.8
	Step Totals (mrem-pers):								65.2	65.2	

Scenario IV: Weld, Inspect and Repair at Cold Vacuum Drying Facility

4/11/96

Step	Who	#	ET	Background Doserates				Cask from KW		Cask from KE	
				Cask	KE	KW	CVD	Total/per	Total/crew	Total/per	Total/crew
			min	mR/hr	mR/hr	mR/hr	mR/hr	mrem/person	mrem-person	mrem/person	mrem-person

38 *** Weld repair, as required. See attached weld repair

39 Install cask lid sealing device in preparation for CVD processing.

O	2	30.0	57.1	0.0	0.0	0.2
H	1	30.0	57.1	0.0	0.0	0.2
P	1	15.0	57.1	0.0	0.0	0.2

28.7	57.3
28.7	28.7
14.3	14.3

28.7	57.3
28.7	28.7
14.3	14.3

** Start CVD operations **

Step Totals (mrem-pers):

100.3

100.3

O - Operators

D - Drivers

M - Millwrights

H - Health Physics

R - Riggers

W - Welder/Welding Engineer

E - Non-Destructive Evaluation Tech

P - Person in Charge

Total Dose, Scenario IV, KE: 1626.1 mrem-person

Total Dose, Scenario IV, KW: 1527.8 mrem-person

Total Time: 17.2 hrs.

Cask Doserates used in this Table:

Top:	Side:
57.1 mR/hr @ 2"	45.8 mR/hr @ 2"
9.9 mR/hr @ 1m	14.7 mR/hr @ 1m
3.3 mR/hr @ 2m	7.6 mR/hr @ 2m
1.7 mR/hr @ 3m	4.6 mR/hr @ 3m

Time	KW	KE
45.33	10.92	109.17
manhrs	mrem-per	
Dose from background		

Weld Repair Sequence - Manual

4/11/96

Step	Who	#	ET min	Cask mR/hr	KW			KE			CVD		
					Bkgrd mR/hr	Total/per mrem/per	Total/crew mrem-per	Bkgrd mR/hr	Total/per mrem/per	Total/crew mrem-per	Bkgrd mR/hr	Total/per mrem/per	Total/crew mrem-per
1 Remove welding and off gas equipment or PT equipment	O	2	15.0	14.7	1.0	3.9	7.9	10.0	6.2	12.4	0.2	3.7	7.5
	H	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	W	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	E	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	P	1	5.0	14.7	1.0	1.3	1.3	10.0	2.1	2.1	0.2	1.2	1.2
Step Totals (mrem-per):								20.9		32.9			19.9
2 Position fines drop cloth and set up contamination control booth.	O	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	H	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	R	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	P	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
Step Totals (mrem-per):								15.7		24.7			14.9
3 Grind out weld defect	M	1	30.0	45.8	1.0	23.4	23.4	10.0	27.9	27.9	0.2	23.0	23.0
	H	1	15.0	45.8	1.0	11.7	11.7	10.0	14.0	14.0	0.2	11.5	11.5
	P	1	30.0	45.8	1.0	23.4	23.4	10.0	27.9	27.9	0.2	23.0	23.0
Step Totals (mrem-per):								58.5		69.8			57.5
4 Dye-pen test base metal. Grind out base defects.	O	1	15.0	45.8	1.0	11.7	11.7	10.0	14.0	14.0	0.2	11.5	11.5
	M	1	15.0	45.8	1.0	11.7	11.7	10.0	14.0	14.0	0.2	11.5	11.5
	H	1	30.0	45.8	1.0	23.4	23.4	10.0	27.9	27.9	0.2	23.0	23.0
	E	2	60.0	45.8	1.0	46.8	93.6	10.0	55.8	111.6	0.2	46.0	92.0
Step Totals (mrem-per):								140.4		167.4			138.0
5 If repairing root pass, install HEPA flange, and connect & activate purge gas	O	2	30.0	57.1	1.0	29.1	58.1	10.0	33.6	67.1	0.2	28.7	57.3
	H	1	15.0	57.1	1.0	14.5	14.5	10.0	16.8	16.8	0.2	14.3	14.3
	P	1	30.0	57.1	1.0	29.1	29.1	10.0	33.6	33.6	0.2	28.7	28.7
Step Totals (mrem-per):								101.7		117.4			100.3
6 Position & activate off gas system	O	1	15.0	9.9	1.0	2.7	2.7	10.0	5.0	5.0	0.2	2.5	2.5
	H	1	15.0	9.9	1.0	2.7	2.7	10.0	5.0	5.0	0.2	2.5	2.5
Step Totals (mrem-per):								5.5		10.0			5.1

Weld Repair Sequence - Manual

4/11/96

Step	Who	#	ET min	Cask mR/hr	KW			KE			CVD		
					Bkgrd mR/hr	Total/per mrem-per	Total/crew mrem-per	Bkgrd mR/hr	Total/per mrem-per	Total/crew mrem-per	Bkgrd mR/hr	Total/per mrem-per	Total/crew mrem-per
7 Manually re-weld the affected area	M	1	30.0	45.8	1.0	23.4	23.4	10.0	27.9	27.9	0.2	23.0	23.0
	H	1	30.0	45.8	1.0	23.4	23.4	10.0	27.9	27.9	0.2	23.0	23.0
	W	1	60.0	45.8	1.0	46.8	46.8	10.0	55.8	55.8	0.2	46.0	46.0
	P	1	60.0	45.8	1.0	46.8	46.8	10.0	55.8	55.8	0.2	46.0	46.0
Step Totals (mrem-per):							140.4			167.4			138.0
8 Visually inspect the repaired weld.	H	1	20.0	45.8	1.0	15.6	15.6	10.0	18.6	18.6	0.2	15.3	15.3
	W	1	5.0	45.8	1.0	3.9	3.9	10.0	4.7	4.7	0.2	3.8	3.8
	E	1	5.0	45.8	1.0	3.9	3.9	10.0	4.7	4.7	0.2	3.8	3.8
Step Totals (mrem-per):							23.4			27.9			23.0
9 Shut off and disconnect MCO purge gas (root repair only)	O	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	H	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
Step Totals (mrem-per):							7.9			12.4			7.5
10 Remove the HEPA flange	O	1	15.0	57.1	1.0	14.5	14.5	10.0	16.8	16.8	0.2	14.3	14.3
	H	1	15.0	57.1	1.0	14.5	14.5	10.0	16.8	16.8	0.2	14.3	14.3
Step Totals (mrem-per):							29.1			33.6			28.7
11 Remove and secure welding machine, off-gas, purge gas, and related support equipment. (may not be req'd)	O	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	H	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	W	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
	P	1	15.0	14.7	1.0	3.9	3.9	10.0	6.2	6.2	0.2	3.7	3.7
Step Totals (mrem-per):							15.7			24.7			14.9
12 Allow weld to cool to <125F			60.0	0.0	1.0	0.5	0.0	10.0	10.0	0.0	0.2	0.2	0.0
Step Totals (mrem-per):							0.0			0.0			0.0

Step	Who	#	ET min	Cask mR/hr	KW			KE			CVD		
					Bkgd mR/hr	Total/per mrem-per	Total/crew mrem-per	Bkgd mR/hr	Total/per mrem-per	Total/crew mrem-per	Bkgd mR/hr	Total/per mrem-per	Total/crew mrem-per
13 Clean root/final pass of weld in preparation for PT. Capture drips for disposal.	O	2	30.0	45.8	1.0	23.4	46.8	10.0	27.9	55.8	0.2	23.0	46.0
	H	1	20.0	45.8	1.0	15.6	15.6	10.0	18.6	18.6	0.2	15.3	15.3
	E	1	5.0	45.8	1.0	3.9	3.9	10.0	4.7	4.7	0.2	3.8	3.8
	P	1	5.0	45.8	1.0	3.9	3.9	10.0	4.7	4.7	0.2	3.8	3.8
	Step Totals (mrem-per):							70.2		83.7			69.0
14 Apply penetrant and allow to dry per mfr's instructions. Capture drips for disposal.	O	2	20.0	45.8	1.0	15.6	31.2	10.0	18.6	37.2	0.2	15.3	30.7
	H	1	10.0	45.8	1.0	7.8	7.8	10.0	9.3	9.3	0.2	7.7	7.7
	E	1	10.0	45.8	1.0	7.8	7.8	10.0	9.3	9.3	0.2	7.7	7.7
	P	1	5.0	45.8	1.0	3.9	3.9	10.0	4.7	4.7	0.2	3.8	3.8
	Step Totals (mrem-per):							50.7		60.5			49.8
15 Remove excess penetrant and clean per mfr's instructions. Capture drips for disposal.	O	2	20.0	45.8	1.0	15.6	31.2	10.0	18.6	37.2	0.2	15.3	30.7
	H	1	10.0	45.8	1.0	7.8	7.8	10.0	9.3	9.3	0.2	7.7	7.7
	E	1	10.0	45.8	1.0	7.8	7.8	10.0	9.3	9.3	0.2	7.7	7.7
	P	1	5.0	45.8	1.0	3.9	3.9	10.0	4.7	4.7	0.2	3.8	3.8
	Step Totals (mrem-per):							50.7		60.5			49.8
16 Apply developer and wait for reaction per mfr's instructions. Capture drips for disposal.	O	2	30.0	45.8	1.0	23.4	46.8	10.0	27.9	55.8	0.2	23.0	46.0
	H	1	20.0	45.8	1.0	15.6	15.6	10.0	18.6	18.6	0.2	15.3	15.3
	E	1	10.0	45.8	1.0	7.8	7.8	10.0	9.3	9.3	0.2	7.7	7.7
	P	1	5.0	45.8	1.0	3.9	3.9	10.0	4.7	4.7	0.2	3.8	3.8
	Step Totals (mrem-per):							74.1		88.4			72.8
17 Interpret final pass PT results.	H	1	20.0	45.8	1.0	15.6	15.6	10.0	18.6	18.6	0.2	15.3	15.3
	E	1	30.0	45.8	1.0	23.4	23.4	10.0	27.9	27.9	0.2	23.0	23.0
	W	1	10.0	45.8	1.0	7.8	7.8	10.0	9.3	9.3	0.2	7.7	7.7
	P	1	5.0	45.8	1.0	3.9	3.9	10.0	4.7	4.7	0.2	3.8	3.8
	Step Totals (mrem-per):							50.7		60.5			49.8

Weld Repair Sequence - Manual

4/11/96

Step	Who	#	ET min	Cask mR/hr	KW			KE			CVD		
					Bkgrd mR/hr	Total/per mrem/per	Total/crew mrem-per	Bkgrd mR/hr	Total/per mrem/per	Total/crew mrem-per	Bkgrd mR/hr	Total/per mrem/per	Total/crew mrem-per
18 Clean up weld and area. Capture drips for disposal.	O	2	30.0	45.8	1.0	23.4	46.8	10.0	27.9	55.8	0.2	23.0	46.0
	H	1	20.0	45.8	1.0	15.6	15.6	10.0	18.6	18.6	0.2	15.3	15.3
	P	1	5.0	45.8	1.0	3.9	3.9	10.0	4.7	4.7	0.2	3.8	3.8
	Step Totals (mrem-per):							66.3		79.1			65.2
19 Collect and dispose of grinding and welding debris.	O	2	20.0	14.7	1.0	5.2	10.5	10.0	8.2	16.5	0.2	5.0	9.9
	H	1	20.0	14.7	1.0	5.2	5.2	10.0	8.2	8.2	0.2	5.0	5.0
	Step Totals (mrem-per):							15.7		24.7			14.9
20 Shut down and secure containment booth.	O	2	15.0	14.7	1.0	3.9	7.9	10.0	6.2	12.4	0.2	3.7	7.5
	H	1	10.0	14.7	1.0	2.6	2.6	10.0	4.1	4.1	0.2	2.5	2.5
	Step Totals (mrem-per):							10.5		16.5			9.9

** Weld Repair Complete **

O - Operators
D - Drivers
M - Millwrights
H - Health Physics
R - Riggers
W - Welder/Welding Engineer
E - Non-Destructive Evaluation Tech
P - Person in Charge

Total Dose for weld repair, CVD: 928.9 mrem-person
KW Total Dose for weld repair, Pit or Bay: 947.9 mrem-person
KE Total Dose for weld repair, Pit or Bay: 1161.7 mrem-person

Total Time: 9.1 hrs.

Time	KW	KE
23.75	23.75	237.50
manhrs		mrem-per
Dose from background		

Cask Doserates used in this Table:

Top:	Side:
57.1 mR/hr @ 2"	45.8 mR/hr @ 2"
9.9 mR/hr @ 1m	14.7 mR/hr @ 1m
3.3 mR/hr @ 2m	7.6 mR/hr @ 2m
1.7 mR/hr @ 3m	4.6 mR/hr @ 3m

APPENDIX C
RADIOLOGICAL SURVEY REPORTS

Mao/Sketch

SEE PAGE 3 OF 3

INFO INFO

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Continued on page 2

Air Sample Results (µCi/ml)					
	BZ	GA	Initial		Decay
	N/A	N/A	N/A		N/A
α 1					
B 1					
α 2					
B 2					

Legend

- - Smear Location - Air Sample Location
- Large Area Smear * - Contact Reading

Other H/A

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Nº 226487

Comments

Samples Counted with portable instruments for 0.0833 minutes.

Instr./Probe Model	RO-3B (CP)	E-140/Pancake (GM/Probe)	PAM	EXTENDER	N/A	N/A	N/A
Serial No.	6A22	1463/1953	2457	5366			
Efficiency	100%	10%	14%	100%			
Correction Factor	1	10	7	1			

ADDITIONAL REPORTS

RPR No. N/A Sample Counter Log(s) N/A
 RSR No. N/A ... Contamination - Skin N/A Procedure: WHF-878, 3.1.1 + 2.1
 ... Contamination - Clothing N/A Other(s) N/A

4PT:

Payroll No.: 57131/80320

First-Line HP Manager:

Date: Payroll No.:

Name (Print): ENVERMILYEA / ENJOFFENAE

Name (Print): _____

Signature: Walter J. Smith

Signature: _____

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Westinghouse Hanford Company - Health Physics
RADIOLOGICAL SURVEY REPORT Continuation Sheet

F.C. K

Survey No.

226487

Page 3 of 3

Map/Sketch

DP VIEW OF
WITH LEAD OUT PIT

DOSE RATES (MR/hr)
APPROX 1 FT BELOW
SCUM LINE
GRATING

SAND FILTER OUTLET PIPE

35 40 15
8 10 10
7 7 6

8

8

7

5 5 5
5 5 5
5 5 5

NORTH

TOP VIEW OF
SOUTH LEAD OUT PIT

DOSE RATES (MR/hr)
APPROX 2.5 FT
BELOW GRATING

SAND FILTER OUTLET PIPE

30 35 15
12 12 12
10 8 8

8

8

8

7 7 8
7 7 8
6 9 8

NORTH

TOP VIEW OF
SOUTH LEAD OUT PIT

DOSE RATES (MR/hr)
APPROX 5 FT
BELOW GRATING

SAND FILTER OUTLET PIPE

30 25 15
15 15 12
12 12 15

7

7

8

9 8
9 10 10
15 25 20

NORTH

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Westinghouse Hanford Company - Radiological Control RADIOLOGICAL SURVEY REPORT						Survey No. Nº 228364				
Date 4-11-96		Time 0945-1045		RWP No.(s) L-003.005		Page 1 of 5				
Area/Bldg./Room/Location (Code) 100K/105KW/center basin + Transfer Area/basin/SS						F.C. L				
Job Description Weekly survey for Transfer Area and center basin CA's for task L-W-109. N/A				Purpose of Survey (check appropriate box(es)): Contamination Incident: ☐ Skin, ☐ Clothing, ☐ Spill Alarm Response: ☐ CAM, ☐ ARM(RAM), ☐ PSD ☐ HRA/VHRA Work ☐ Job Coverage ☐ Other ☐ Exposure Incident ☐ Material Release ☐ RM Transfer/Shipment ☒ Required, Task No. L-W-109						
Map/Sketch <div style="text-align: center; font-size: 2em;">N/A</div> <p style="font-size: 1.5em;">see Attached map</p>				<div style="text-align: center; font-size: 2em;">N/A</div>						
No.	Description	Dist.	DOSE RATE			CONTAMINATION LEVELS				
			B (non-pen) mrad/h	γ (pen) mR/h	n mrem/h	Direct (dpm/probe)		Smear (/100cm ²)		
			B	γ	n	B	α	α (dpm)	α (dpm)	mrad/h
1	Grating	N/A	N/A	N/A	N/A	N/A	N/A	< 1,000	< 22	N/A
2	Railing							1,000	< 22	
3	Plastic cover on Lxm lifting device							4,000	< 22	
4	Grating							2,000	< 22	
5	Grating							< 1,000	< 22	
6	Step ladder.							5,000	< 22	
7	Railing							< 1,000	< 22	
8	Grating							< 1,000	< 22	
9	Hand Railing							< 1,000	< 22	
10	Stairs.	↓	↓	↓	↓	↓	↓	< 1,000	< 22	↓
Continued on page 2										
Air Sample Results (uCi/ml)						Legend				
	BZ	GA	Initial	Decay		(E) - Smear Location (Δ) - Air Sample Location (F) - Large Area Smear * - Contact Reading				
1	N/A			N/A		Other <u>All Dose Rates in mR/hr unless otherwise noted</u>				
2										
3										

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WHC - Radiological Control
RADIOLOGICAL SURVEY REPORT

F.C.

L

Page

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of 5

Survey No.

N^o 228364

No.	Description	Dist.	DOSE RATE				CONTAMINATION LEVELS				
			$\dot{H}$ (non-pen) mrad/h	$\dot{H}$ (pen) mR/h	$\dot{H}$ (non-pen) mrem/h	$\dot{H}$ (pen) mrem/h	Direct (dpm/probe)		Smear (/100cm ²)		
			$\dot{H}$	$\dot{H}$	$\dot{H}$	$\dot{H}$	$\dot{H}$	$\dot{H}$	$\dot{H}$ (dpm)	$\dot{H}$ (dpm)	mrad/h
11	Floor	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,500	< 22	N/A
12	Iron Pad								4,500	< 22	
13	Floor								70,000	< 22	
14	Floor								2,500	< 22	
15	Iron Pad								1,500	< 22	
16	Floor								1,000	< 22	
17	Floor								2,500	< 22	
18	Iron Pad								5,000	< 22	
19	Tools								< 1,000	< 22	
20	Iron Column Pad	✓	✓	✓	✓	✓	✓	✓	6,000	< 22	✓

Comments

weekly survey of Transfer Area and center Basin CA's for weekly task L-W-109. Dose rates around road out pit per special request of Jerry Kurtz. No anomalies other than one smear over task limits. Smear is circled in Red.

Samples Counted with portable instruments for 1 minutes.

Instr./Probe Model	RO-3B (CF)	E-140/Pancake (GM/Probe)	PAM	N/A	N/A	N/A	N/A
Serial No.	6524	1830/387	2978				
Efficiency	100%	10%	19%				
Correction Factor	1	10	7	✓	✓	✓	✓

ADDITIONAL REPORTS

RPR No. N/A Sample Counter Log(s) N/A
 RSR No. N/A ... Contamination - Skin N/A Procedure: WHC-IP-0718 App. I
 ... Contamination - Clothing N/A Other(s) N/A 2.1

HPT:
 Payroll No.:
 Name (Print): DAWN BROWNING
 Signature: Dawn L. Browning

First-Line HP Manager:
 Date: Payroll No.:
 Name (Print):
 Signature:

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Westinghouse Hanford Company - Health Physics
RADIOLOGICAL SURVEY REPORT Continuation Sheet

F.C.

Survey No.

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Map/Sketch

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NORTH

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DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Larry Ulbricht, BNFL	Date 4/12/96
Project Title/Work Order		EDT No. 614424
Spent Nuclear Fuel Project WHC-SD-SNF-RPT-002, Rev. 0		ECN No.

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
FW Bradshaw	R3-85	X			
DM Chenault	S0-04	X			
RG Cowan	R3-86	X			
RF Creed	X3-85	X			
BL Debban	R3-85	X			
C Defigh-Price	X3-79	X			
JI Diehl	X3-80	X			
WS Edwards	G2-02	X			
JR Frederickson	R3-86	X			
WA Frier	X3-74	X			
WD Gallo	R3-85	X			
LJ Garvin	R3-85	X			
LH Goldmann	R3-86	X			
DO Hess	X3-80	X			
DW Humphrys	X3-67	X			
JJ Irwin	R3-86	X			
M Kaviani	X3-60	X			
AT Kee	R3-86	X			
JK Keve	L6-36	X			
EA Koster	S2-46	X			
JE Kurtz	X3-60	X			
CB Loftis	S7-41	X			
LM McWethy	R3-48	X			
TD Merklng	R3-09	X			
WJ Millsap	X3-85	X			
CR Miska	R3-86	X			
CF Myott	X3-74	X			
WH Nelson	L6-36	X			
CT O'Neill	G3-17	X			
AL Pajunen	H5-49	X			
MB Palm	H5-70	X			
BA Patterson	X3-85	X			
JP Schmidt	X3-78	X			
EJ Shen	R3-86	X			
DL Sherrell	R3-86	X			
DA Smith	A2-25	X			
KE Smith	R3-85	X			
CA Thompson	R3-85	X			
JE Turnbaugh	H6-21	X			
DW Scott	(LATA)	X			
SNF Project Files	R3-11	X			