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**This document was reviewed following the
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7. Abstract

This study is one element of a larger engineering study effort by WHC to examine the feasibility of irradiated fuel and sludge consolidation in the KW Basin in response to TPA Milestone (target date) M-34-00-T03.

Six alternatives were examined in the study for transferring encapsulated fuel from the 105-KE Basin to the 105 KW Basin. The study addressed possible alternatives in transport method as well as options in the containers used for transport. The preferred alternatives were shipment by existing K Area casks and trailer, assuming cooling water would not be necessary. The preferred alternative would require 23 months to complete, cost an estimated \$5.3 million and would require a personnel exposure of 94 man-rem.

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ENGINEERING STUDY

105KE TO 105KW BASIN
FUEL AND SLUDGE TRANSFER

WHC-SD-SNF-ES-002
REV. 0

FINAL REPORT

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September 20, 1994

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**ENGINEERING STUDY
105KE TO 105KW BASIN
FUEL AND SLUDGE TRANSFER**

EXECUTIVE SUMMARY

This engineering study was performed to identify and recommend the most feasible and practical method of transferring canisters of irradiated fuel and basin sludge from the 105KE fuel storage basin (KE Basin) to the 105KW fuel storage basin (KW Basin). Six alternatives were identified during the performance of this study as possible methods for transferring the fuel and sludge from the KE Basin to the KW Basin. These methods were then assessed, based on current Westinghouse Hanford Company (Westinghouse Hanford) requirements with regard to operations, safety, radiation exposure, packaging, environmental concerns, waste management, cost, and schedule; and the most feasible and practical methods of transfer were identified.

The methods examined in detail in this study were based on shipment without cooling water except where noted.

- Transfer by rail using the previously used transfer system and water cooling,
- Transfer by rail using the previously used transfer system (without water cooling),
- Transfer by truck using the K Area fuel transfer cask (K Area cask),
- Transfer by truck using a DOE shipping cask,
- Transfer by truck using a commercial shipping cask, and
- Transfer by truck using a new fuel shipping cask.

A preliminary analysis of fuel transfer methods during the study indicates that the heat energy (watts) of the fuel and sludge to be transferred is approximately four percent of the heat and radioactivity of the fuel transferred from the 100N to the 100K Area in the 1980s, because the fuel in the KE Basin is now five to 21 years older. This relatively low level of heat may allow the encapsulated fuel and sludge to be transferred in drained casks (without cooling water), in commercial shipping casks or in the existing shipping casks and well cars, with some engineering modifications to the shipping casks and well cars. Shipment without cooling water cannot occur without more detailed analysis of heat loads.

Transfer of the irradiated fuel and sediment from the KE Basin to the KW Basin by truck using the K Area casks with no cooling water were evaluated as the best transfer method. The K Area casks, if used, would require both an initially high degree of decontamination and a subsequently high degree of contamination control during the transfer of fuel and sludge from KE Basin to KW Basin. Transfer of irradiated fuel and sludge by K Area casks and truck has an estimated schedule duration of 23 months. The time required to actually transfer fuel is seven months, which is one month less than transfer by well car due to the higher operational efficiency of truck transfer. The

cost of truck transfer, estimated at \$5,300,000, is based on the purchase of a new truck and three low boy trailers. The availability of an existing truck and three trailers, would reduce the cost by truck transfer by \$260,000. Drained transfer of K Area casks by truck also has a lower total exposure of 94 man-rem.

The first alternative method of transferring of the irradiated fuel and sludge from the KE Basin to the KW Basin is drained transfer (no cooling water) by well car using the K Area casks with some operational and engineering modifications to further minimize the environmental risks of the transfer. The well cars, if used, in this mode also would require an initial high degree of decontamination and a subsequent high degree of contamination control during the transfer of fuel and sludge from the KE Basin to the KW Basin. Drained transfer by well car and K Area casks has the lowest estimated cost for transferring fuel from the KE Basin to the KW Basin. The estimated cost to transfer the fuel by well car without water cooling is \$5,200,000. The estimated schedule duration using well cars is 24 months. The estimated radiation exposure associated with this transfer is 124 man-rem.

Water cooled transfer of irradiated fuel and sludge by existing K Area casks and railroad well cars was the next best viable alternative with respect to cost and schedule. If water cooling is required, costs and exposures increase because of well car modifications needed to control liquid leakage and lower operational efficiency during loading/unloading. The estimated cost of wet transfer is estimated at \$5,600,000 with a resultant exposure increase to 137 man-rem.

K Area operators would receive approximately 60 rem of exposure from each of the viable options. Since there are only 24 operators, an administrative exposure limit of 1,000 mrem per year can only be met by stretching the work over several years (not viable with respect to schedule) or hiring additional personnel. The cost of additional personnel is estimated at \$2,300,000, which was included in all cost estimates.

1.0 OBJECTIVE

1.1 PURPOSE AND NEED

This study was performed to identify and assess various methods of transferring KE Basin fuel and sludge to the KW Basin, that has been encapsulated in canisters. Recommendations are made based on these assessments for the best course of action to accomplish this transfer. The criteria used to assess the method were the required modifications to safety basis documents, procedures, processes and training, the estimated amounts of radiation exposure to site personnel and the public, the estimated amounts of radioactive, hazardous and other types of waste that would result, the potential risks to the safety and health of site personnel and the public and potential environmental impacts, and the associated costs and schedules to implement these methods.

1.2 BACKGROUND AND SCOPE

The KE Basin contains 1,150 metric tons of irradiated N Reactor fuel, stored in 3,671 open canisters. The fuel was discharged from N Reactor between five and 21 years ago. The basin also contains approximately 0.4 metric tons of irradiated single pass reactor (SPR) fuel elements. Sixty-three of the SPR fuel elements are stored in five open Mark II canisters and the remaining 75 are stored in three open topped, stainless steel baskets. There are three types of metallic uranium spent fuel presently stored in the KE Basin. The first type is the Mark IV fuel that is enriched to 0.95 percent by weight, the second type consists of natural uranium, and the third type consists of aluminum-clad SPR fuel assemblies (WHC 1993b).

An estimated six percent of the fuel has cladding damage resulting from N Reactor discharge and handling operations, assumed to require 1,000 canisters. This allows the fuel to be in direct contact with the basin water. Approximately 4,000 to 5,000 of the fuel elements in KE Basin are damaged where the uranium and zirconium surfaces are exposed to the basin water containing oxygen. The interaction of the irradiated fuel and the oxygenated water introduces radionuclides into the basin water, which increases the radiation exposure to KE Basin personnel, increases the release of radioactive material to the environment, and requires continued use of the basin water treatment systems to remove the radionuclides from the basin water. The basin also contains a large amount of sludge formed primarily of nonradioactive and radioactive materials that corroded or dissolved from the fuel canisters, exposed fuel, and other metallic surfaces in the basin. These corrosion products contribute metals and radionuclides to the basin water. The volume of sludge in the basin has been estimated to be 2,300 cu ft (ICF-Kaiser 1994). The radioactive materials identified in the KE Basin fuel and sludge are Co-60, Sr-90, Ru-106, Cs-134, Cs-137, U-234, U-235, U-238, Pu-238, Pu-239/240, Am-241, and Pu-241 (WHC 1993a).

In the last five years, there have been three periods at the KE Basin where the reported drawdown test rates were in excess of 25 gph. Drawdown rate in excess of this amount have been used during past operations as the primary indicators of leaks in the basin. The latest leak occurred in March 1993. The reported water loss from the KE Basin was estimated at 25 gph. Investigation of the leak determined that it occurred in the area of a construction joint in the discharge chute of KE Basin (WHC 1993a).

The irradiated fuel stored in KE Basin and the basin sludge are planned to be encapsulated by Westinghouse Hanford between June 1994 and July 1996 to isolate the irradiated fuel and sludge from the basin water. Over a period of two years after encapsulation, radioactivity in the basin water is expected to decrease, due to the control of radioactivity, to the same level experienced at KW Basin.

The scope of this engineering feasibility study is limited to evaluating the various methods of removing the encapsulated irradiated fuel and sludge from the KE Basin and transporting it to a modified KW Basin.

2.0 RECOMMENDATIONS AND CONCLUSIONS

2.1 RECOMMENDATIONS

If fuel consolidation is deemed appropriate, it is recommended that Westinghouse Hanford utilize K Area casks and truck. The well cars also have advantages for transferring the encapsulated fuel and sludge from KE Basin to the KW Basin and should also be considered. It is further recommended that consideration be given to transferring fuel without cooling water.

A preliminary conservative technical evaluation shows that a drained fuel canister's temperature increases less than 200°F during a two shift period (16 hours) assuming no heat transfer. It is recommended that a more realistic calculation be performed to more accurately calculate temperature rise over different time periods. If the more accurate evaluation determines that cooling water is needed, then the use of a well car with a decreased volume of cooling water and modified lid seal is recommended.

2.2 CONCLUSIONS

All six evaluated alternatives were rated with respect to the criteria identified shown in Table 2-1. Each criteria was scored from zero to five, with zero being an unacceptable rating and five being the highest rating. A brief discussion of each criteria and its associated rating system is discussed in more detail in Section 4.1. As can be seen from Table 2-1, drained transfer using the K Area cask and trailers has the highest score and is considered the most effective alternative. Drained transfer by well car is the next best alternative, followed closely by wet transfer by well car. Transfer using a new shielded casks follows next. Transfer using a commercial radwaste shipping cask is less effective, and transfer by JMTR cask is deemed unacceptable.

Analysis of the results of the engineering feasibility study shows that the transfer encapsulated fuel and sludge canisters by well car and existing K Area casks is the only viable transfer option if water cooling is required. If water cooling is not required, the most effective option is drained transfer using K Area casks and tractor trailer transfer. The well cars, using K Area casks is the second most effective option. The Alternative Selection By Criteria Ratings, Table 2.1, gives the truck transfer using K Area casks a rating of 37 out of 45 possible points; drained transfer using the well car received a score of 34 out of 45 points. The tractor trailer alternative has better efficiency during actual transfer, resulting in the shortest actual transfer time and lower radiation exposures. The K Area cask-tractor trailer method has approximately the same cost as well car transfer, but requires higher up front equipment purchase costs with longer lead times. Truck transfer also requires modification and improvement of access roads into the basins' railroad bays, has slightly greater safety analysis and permitting requirements, and requires more procedure modification than using well cars.

Drained transfer of K Area casks by well car also has merit. This alternative has the lowest equipment purchase costs, less safety analysis requirements, less procedure revision requirements, and system has used successfully in the past, and no modification requirements for roads or equipment. Transfer by well car does require extensive decontamination and repairs to the well car, has lower transfer efficiency, higher radiation exposure, and a slightly longer transfer time. Unless required, wet

transfer by well car is less effective than either truck or drained well car transfer. Wet transfer has slightly improved safety analysis requirements, but has higher cost, increased exposure, longer schedule duration, and increased environmental impact.

TABLE 2-1 ALTERNATIVE SELECTION BY CRITERIA RATINGS

	ALTERNATIVE					
	1a	1b	2	3	4	5
CRITERIA	Well Car-	Well Car- Wet	New Fuel Drained	Truck/ K Cask	JMTR	Commercial Cask
Operations Modifications	5	4	3	4	2	2
New Safety Issues	5	4	4	4	4	3
Radiation Exposure	2	3	5	4	0	5
Transfer Packaging Criteria	3	3	4	3	4	3
SARP/Permitting	4	3	3	3	4	3
Environmental	2	4	5	4	5	4
Waste Management	4	4	4	5	1	3
Cost	4	5	3	5	0	1
Schedule	3	4	1	5	0	3
TOTAL	32	34	32	37	25	27

3.0 UNCERTAINTIES

In completing this engineering study, it was recognized that there were many uncertainties with respect to operations, new safety issues, radiation exposure, transfer packaging, environmental issues, waste management issues, costs, and schedules which may have a direct affect on the ability of DOE and Westinghouse Hanford to complete the fuel/sludge transfer from the KE Basin to KW Basin prior to the year 2002 (DOE 1991). These uncertainties may result in additional costs and a longer schedule than predicted by this study.

3.1 OPERATIONS MODIFICATIONS UNCERTAINTIES

- The KE Basin and KW Basin are over 40 years old. An unidentified facility safety concern could develop with either or both basins leaving some uncertainty as to the exact period of time that the basins may be of beneficial use. However, there is no basis to assume that consolidation of fuel will increase the probability of problems in the KW Basin.
- An uncertainty that exists with respect to the transfer of fuel/sludge for the K Basins' operations is the state of the railroad shipping cars, railroad engines, and casks used in the past to transport fuel canisters. The state of readiness of this equipment and the resources to bring them to current standards is not known. A simple walkdown of the short section of track between the KE Basin and the KW Basin did not identify obvious degradation of the railroad track. cursory visual examination of the railroad well cars located at 105KE did not identify obvious problems. These conditions must be verified and some repairs are probably necessary. It is unlikely that car or cask repairs would impact the schedule for fuel consolidation, but could increase the overall cost.
- Use of a non-certified fuel shipping cask may not be allowed. If allowed, an equivalency evaluation similar to the existing well cars must be performed.
- It is unlikely that a commercial fuel shipping container can be placed into the loadout pits. Therefore, a shielded transfer basket must be designed and fabricated to place the canisters into and remove them out of the shipping container. This creates considerable uncertainty with respect to cost and schedule for this alternative.

3.2 NEW SAFETY ISSUE UNCERTAINTIES

- New safety issues and risks identified in this study have an uncertainty as to their overall impact with respect to required facility/equipment modifications and associated costs and schedules to resolve safety concerns.
- These safety issues/risks also have various levels of authority that may be necessary within DOE and Westinghouse Hanford to resolve any identified safety concern. Since, higher levels of authority normally require more time to resolve, there is schedule uncertainty with respect new safety issue.

3.3 RADIATION EXPOSURE UNCERTAINTIES

- Radiation exposure uncertainties exist with respect to the administration of the overall exposure limits set by DOE and the administrative limits set by Westinghouse Hanford. The administration of these limits for this work will have a direct impact on manpower and total exposure for this work.
- The dose rates estimates from canisters containing irradiated fuel for this study are based on estimates obtained from computer models. However, there is a high degree of certainty that all casks provide adequate radiation shielding.
- The airborne and contamination levels after fuel and sludge encapsulation for the KE Basin are not known.
- The rate of decrease in radionuclide concentration levels in both the basin water and walls adjacent to the loadout pit is not known.

3.4 ENVIRONMENTAL UNCERTAINTIES

- Environmental uncertainties exist with respect to the development of and time required to obtain a "Record of Decision" for an Environmental Assessment and satisfy any additional National Environmental Policy (NEPA) requirements.
- Regulatory and permitting delays focus on the uncertainty of how long it takes to perform environmental assessments, safety analyses, and to obtain required approvals. The uncertainties are dependent on the selected options. In general, the less expensive the option, the longer the delay. For example, use of the current well cars and K Area casks with only minor repairs is one of the lower cost options, but may have a significant schedule uncertainty associated with analyzing, demonstrating, and approving equivalency with DOT/NRC criteria for fuel shipping containers.
- Dose rate criteria are known to be satisfied by the well car and K Area cask combination. It is uncertain whether the combination will meet other safety criteria such as leakage of radioactivity especially for wet transfer.

3.5 WASTE MANAGEMENT UNCERTAINTIES

- The wastes generated by the transfer of irradiated fuel and sludge from the KE Basin to the KW Basin will contain transuranics. At this time, there is insufficient information to determine if any of these wastes will become transuranic or mixed wastes.
- Transportation of hazardous, transuranic and/or mixed wastes may require new packaging for shipping and disposal. Design, approval and purchase of new packages for waste disposition have not been considered in this study.

3.6 COST AND SCHEDULE UNCERTAINTIES

- The cost and schedule uncertainties in this engineering study are effected by the approval cycles of the DOE, various State of Washington agencies, and the EPA.

The projected schedule will be influenced by the times required for various approvals.

- DOE budgetary line items require the approval of DOE Headquarters and Congress. Therefore, a degree of uncertainty when budgetary approval from DOE and Congress will be obtained. If the capital cost of selected options is more than \$2 million, the budget may become a line item, requiring 18 to 36 months for approval.

4.0 DESCRIPTION OF ALTERNATIVES AND SOLUTIONS

4.1 CRITERIA

The transfer of encapsulated irradiated fuel and sludge was evaluated against the following nine criteria with each criteria rated on a scale of zero to five. Each criterion was selected due to its significant impact on implementing the transfer of irradiated fuel/sludge from 105KE to 105KW. The rating system for each criteria are discussed below. If an option was deemed unacceptable, it was assigned a score of zero.

4.1.1 Operations Modifications Criteria

K Basins' operations was evaluated based on the impact of transferring the KE Basin fuel and sludge to the KW Basin with respect to the modifications that would be required of the SARs, OSRs, process standards, procedures, training, equipment, and facilities.

Operations criteria for the transfer of fuel and sludge was rated on a scale of one to five as follows:

5 points	-	No operations modifications required for the transfer of the fuel and sludge for a particular alternative.
4 points	-	Minor operations modifications required for the transfer of fuel and sludge for a particular alternative.
3 points	-	Significant operations modifications required for the transfer of the fuel and sludge for a particular alternative.
2 points	-	Major operations modifications required for the transfer of the fuel and sludge for a particular alternative.
1 point	-	A complete new process or system is needed for the transfer of fuel and sludge from the KE Basin to the KW Basin.

4.1.2 New Safety Issues

The transfer of the fuel and sludge was evaluated in terms of the new safety issues in the form of unreviewed safety questions (USQs) that may arise from changes in operations, equipment, and facilities modifications which may impact the safety documentation and the operating envelope that has been approved by DOE and Westinghouse Hanford.

The alternatives for transferring the fuel and sludge were evaluated individually to identify the USQs that may be associated with a particular alternative. For this engineering study each transfer alternative was evaluated in terms of USQs on a scale of one to five as follows:

- 5 points - No USQs associated with this particular alternative.
- 4 points - One minor identified USQ with this alternative.
- 3 points - One significant identified USQ with this alternative.
- 2 points - A major identified USQ with this alternative.
- 1 point - Several identified USQs with this alternative.

4.1.3 Radiation Exposure Criteria

Each alternative used in this study was evaluated for the total radiation exposure in terms of man-rem expended during the entire transfer activity for each alternative. The lower the radiation exposure the higher the points allocated on the rating scale from zero (excessively high exposure) to five (lowest exposure).

4.1.4 Transfer Packaging Criteria

The transfer of irradiated fuel and sludge from the KE Basin to the KW Basin requires packaging that meets DOE requirements and DOT equivalency. The transfer of fuel and sludge will take place in a controlled area of 100K Area where DOT requirements should be considered, but are not required. Each of the transfer alternatives was evaluated with respect to how closely the transportation package met DOT certification criteria.

- 5 points - Package is currently certified.
- 4 points - Package is not certified, but meets all important certification requirements, including leak tightness.
- 3 points - Package meets most certification requirements.
- 2 points - Package has been evaluated or can be easily evaluated as DOE equivalent.
- 1 point - Package requires extraordinary controls to achieve DOE equivalency.
- 0 points - Package cannot be demonstrated as DOE equivalent.

4.1.5 New Safety Analysis for Packaging (SARP) Criteria

The viability of using the existing Safety Analysis Report for Packaging (SARP) for transferring the fuel and sludge was rated on a scale of one to five as follows:

- 5 points - The SARP could be used with no modifications for the transfer alternative.

- 4 points - The SARP would need only minor modifications for the transfer alternative.
- 3 points - The SARP would need a significant amount of modification for the transfer alternative.
- 2 points - The SARP would need a major modifications for the transfer alternative.
- 1 point - A new SARP would need to be developed for the transfer alternative.

4.1.6 Environmental Criteria

Each of the transfer alternatives was evaluated for potential impact to the environment, NEPA requirements and the requirements for various permits. The alternative with the lowest potential for causing environmental harm and/or requiring the least amount of time to acquire permits was given a rating of five and the alternative with the highest potential for environmental harm was given a rating of one.

4.1.7 Waste Management Criteria

Each of the transfer alternatives was evaluated for the potential for producing wastes that would require control under DOE Order 5820.2A. The alternative that has little or no potential for producing wastes was given a rating of five and the alternative that may produce a transuranic mixed waste was given a rating of one. The ratings were based on the increasing degree of difficulty and increasing cost of handling a particular type of waste on the Hanford Site when following DOE Orders and the Westinghouse Hanford administrative control system. The ratings were as follows:

- 5 points - Potential for producing the least amount of radwaste.
- 4 points - Potential for producing additional radwaste.
- 3 points - Potential for producing a hazardous waste.
- 2 points - Potential for producing a mixed waste.
- 1 point - Potential for producing a transuranic and/or transuranic mixed waste.

4.1.8 Cost Criteria

The cost of each alternative for the transfer of irradiated fuel and KE Basin sludge was evaluated with the lowest cost being given a rating of five and the highest cost being given a rating of one. Excessively high costs were rated zero.

4.1.9 Schedule Criteria

The time and/or schedule required to complete the transfer of irradiated fuel and sludge was evaluated for each alternative with the shortest schedule alternative being given a rating of five and the longest schedule alternative being given a rating of one. Schedule durations that do not support TPA milestone time frame requirements are assigned a score of zero.

4.2 ASSUMPTIONS

4.2.1 Operations Assumptions

- The encapsulation of the irradiated fuel and the sludge in the KE Basin, and reencapsulation of KW Basin fuel will have been completed prior to the transfer of these materials to KW Basin.
- Railroad lines are capable of transporting filled well cars with only minor repairs.
- Alternative mechanisms developed to transfer fuel will be within the existing safety envelope established by the DOT "equivalency" concept.
- The well car and K Area cask combination satisfies the DOT equivalency criteria.
- Use of commercial DOT certified shipping casks or other DOT casks will be allowed by DOE for certain alternatives assessed.
- The well cars are capable of transporting the fuel canisters and casks without major modification and repairs.
- The 100K Area can be isolated from general public and nonessential personnel as required for transfer of fuel and the controlled area can be enlarged to fully control the area where the transfer will be performed.

4.2.2 New Safety Issues Assumptions

- This study assumes the USQs have been identified and resolved prior to the transfer of irradiated fuel from the KE Basin to the KW Basin.
- Alternative mechanisms developed to transfer fuel and sludge are assumed within the authorization basis envelope established by the existing SAR and its referenced documentation.

4.2.3 Radiation Exposure Assumptions

- An ALARA plan meeting the requirements of DOE Orders and Westinghouse Hanford Administrative Control Manual requirements has been developed, approved and implemented specifically for this work.

- Irradiated fuel and sludge will be put into fully enclosed containers, thereby reducing the KE Basin water source term over time.
- Work crews will be scheduled for two shifts. Our analyses show that this is not the most effective use of personnel with respect to radiation exposure.
- Respiratory protection was assumed not to be necessary, and was not factored into the time estimate.
- Time estimates for loading and unloading canisters into the K Area casks and well cars are assumed to be similar to fuel transfers from N Reactor, which were done using the same casks and rail cars.
- Dose rates for loading fuel canisters into the K Area casks and well cars are assumed to be as described in the Fuel Encapsulation ALARA Report.
- Dose rates for transporting the canisters in the well cars are based on calculated fuel activities and Isoshield runs using the amount of lead shielding provided by the K Area cask. Current dose rates caused by well car contamination are assumed reduced after decontamination.

4.2.4 Environmental Assumptions

- This engineering study assumes that NEPA Environmental Assessment requirements and all permitting requirements will be completed prior to the starting transfer of encapsulated fuel and sludge from the KE Basin to the KW Basin.
- This engineering study assumes that the DOE, the State of Washington, and Westinghouse Hanford environmental requirements with respect to effluents and spills are met.

4.2.5 Waste Management Assumptions

- It is assumed that a small amount of mixed waste may be generated from well car and cask decontamination.

4.2.6 Cost and Schedule Assumptions

- It is assumed that this funding would proceed at the rate normally expected of a Congressionally approved line item.

4.3 ALTERNATIVES

Irradiated fuel/sludge shipments must be transferred by either a DOT/NRC Certificate of Compliance or an approved SARP or Safety Evaluation for Packaging (SEP) for on-site transport. The following packaging possibilities were reviewed for transferring fuel between the KE Basin and the KW Basin: three compartment well car and K Area casks, the JMTR spent fuel shipping casks, the NLI-1/2 cask, the Model No. 10-142 cask, a new fuel cask, and/or commercially available equivalent cask. The equipment is described in Sections 4.3.1 through 4.3.5. Most licensed packaging to carry

spent fuel is tailored to fit commercial fuels, which are not metallic, but oxides. These fuels are configured in fuel assemblies that are much longer and smaller in diameter than the Mark II canister that is to be used to store the KE Basin's fuel and sludge. Only packaging capable of transporting fuel/sludge in its current canister configuration were deemed viable.

Transfer of canisters from the KE Basin to the KW Basin may be possible by either truck or rail transfer. Since decay heat in the fuel has decreased to very low levels (approximately 22 watts per canister), it may be possible to transfer fuel between the basins without water cooling. If water cooling is required, then rail shipment by well car/K Area cask is the only viable alternative. Fuel transfer between basins can be considered as having four phases with each phase having several options. The phases and options associated with each phase are:

- Selecting and Obtaining Shipping/Transfer Cask (Wet or Drained),
 - K Area cask and well car with water cooling,
 - K Area cask and well car without water cooling,
 - K Area cask and tractor trailer without water cooling,
 - JMTR spent fuel shipping cask,
 - NLI-1/2 spent fuel cask, which was determined to be nonviable because it cannot hold MKII canisters,
 - Model No. 10-142 (other similar casks) radioactive waste shipping casks, or
 - New fuel shipping cask.
- Preparing the Basins for Transfer of the Fuel. The installation of tiered storage racks to accommodate the additional fuel/sludge canisters, which was evaluated independently of this report, is assumed to have been completed.
 - Preparing the basins for loading/unloading with no modifications required,
 - Minor modifications to the basins, or
 - Major modifications to the basins, which is not a viable alternative.
- Loading and Unloading Fuel/Sludge Canisters
 - One shift, or
 - Multiple shifts.
- Transporting Loaded Shipping Containers
 - Rail Transport, or
 - Truck Transport.

These options were evaluated against the criteria identified in Section 4.2, by following the process shown in Figure 4-1, where beneficial, transfer baskets, additional safety analysis, and amending or rewriting existing SARPs were considered part of an alternative. Alternatives requiring major facility modifications were evaluated as not feasible due to the additional costs and the extensive schedule durations.

Evaluation of the above options against the criteria, eliminated all but six alternatives. In addition, only the K Area casks and well car transfer alternative, was evaluated as being possible if water cooling is required during shipping. Possible alternatives considered in this report are:

- Use of the current K Area cask and well car and transfer by rail. Use of modified well car is a second option.
- Use K Area casks transported by truck. However, DOT equivalency must be demonstrable.
- Use JMTR shipping cask and transfer by truck. Rail transfer is possible but more costly and even longer duration.
- Use existing commercially available NRC Certified radwaste shipping cask. An option is to use Model 10-142, "Big Bertha;" however, it may not meet QA requirements.
- Construct a new fuel cask.

Description of each of the alternatives and options, if any, the major advantages and disadvantages, estimated cost, schedule duration, and radiation exposure is provided in Sections 4.3.1 through 4.3.5. A more in depth analysis of the two most cost effective transfer methods, K Area casks with well car or truck, including costs, schedule durations, radiation exposure estimates, production and programmatic impacts, operational considerations, safety considerations, USQs, radiological concern, waste management issues, environmental impacts and permitting requirements, are provided in Section 5.0.

4.3.1 Transfer of the 105KE Fuel/Sludge to the KW Basin by Well Railcar

The well car transfer system consists of a three barrier arrangement, sealed fuel/sludge storage canisters that hold 14 fuel elements or 1.63 cu ft of sludge, a K Area cask that contains three canisters, and a well car that contains three K Area casks. The K Area casks provide the shielding and accident protection during shipment, while the well car provides cooling water and contamination control. In the past, large numbers of fuel shipments were made between N Reactor Basin, the KE/KW Basins and Plutonium Uranium Extraction (PUREX) Facility. There were two different cask and well car designs as shown in WHC-SD-TP-ES-001 (WHC 1993c). One design, called the "short car", was used to transport the N Reactor fuel from N Reactor to PUREX. This cask and car arrangement was too tall to be accommodated at the KE and KW Basins (Figure 4-2) and a different railcar, called the three compartment well car (three-well car) was used, along with a shipping cask designed for K Area basin use, the K Area cask.

Figure 4-2 "Short" Well Car Used to Transfer NPR Casks (Not for Use in K Basins)

The K Area casks and well cars are a proposed alternative for transporting fuel from the KE to the KW Basin, if possible, shipment of fuel without cooling water is recommended to minimize the chances of water leakage and the associated environmental impacts. Costs, schedule duration, and exposure usage, however, are not significantly changed by water cooling. One option, modifying the current well car to improve the well car's leak tightness is also evaluated. This modification would be limited to ensure that no modifications to the basins or lifting equipment would be required.

The estimated cost for transferring by well car is \$5,200,000. The estimated exposure to complete fuel transfer by drained well car is 124 man-rem. If the transfer requires water cooling, and the well cars are modified for better leakage control, modification of the well cars requires an additional \$300,000 and 13 man-rem exposures. The estimated cost. The schedule duration from start of work to completion of drained transfer is estimated at 24 months. If well car modifications are done, the schedule duration would also increase. However, only loading, unloading, and transfer are included the critical path, which takes approximately 8 months for wet or drained transfer.

The main advantages for the K Area cask/well car transfer alternative are that the casks and well cars are already available, have been used extensively before, and have existing safety documentation and procedures. Casks and well cars have already been used extensively for fuel shipments. A SARP exists for well car and K Area cask transfer. Well cars are the only water cooling option. Well car modification is recommended if cooling water is used. Use of the well car is currently approved by DOE.

The main disadvantages are that the well cars and casks are highly contaminated and are in questionable state of repair. Also railroad transfer is inefficient over small distances.

4.3.1.1 Description of Shipping Casks. K Area casks are large, heavily shielded containers used to transport canisters between the reactor basins. The K Area Cask design, Figures 4-3 and 4-4, was developed in 1974 and was used to ship N Reactor irradiated fuel in the three well cask cars (Vitro 1974a, Vitro 1974b, Vitro 1974c, UNI 1977). Thirty casks were built and all but three were used. These three "clean" casks are sitting outdoors at 100K Area encased in plastic. The remaining casks are sitting in three well cars at the 105KE Basin, which are maintained full of water.

The K Area cask has three sections to accommodate the placement of three fuel canisters. The outer and inner walls of the cask are assembled from American Society for Testing and Materials (ASTM) A 36 carbon steel. The overall cask envelope measures 59 1/4 in. by 57 in. by 75 in. high. The outer sides and bottom of the cask are 1/2-in.-thick steel plate, encasing a nominal 10-in.-thick lead shielding. The inner walls are a minimum of 3/8-in.-thick plate. The 10-in.-thick lead shielding for the lid is encased in 3/4-in.-thick plate (Vitro 1974b, Vitro 1974c). Approximate weights are as follows: lid, 5,700 lb; cask (empty, without lid), 39,300 lb; total assembly (empty), 45,000 lb (Vitro 1974a). The weight of water in the cask is 661.4 lb (300 liters) (RHO 1982). The total weight of a fully loaded K Area cask is 48361.4 lb.

Figure 4-5 A Basin Cask Being Lowered into a Loading Bay

The K basin cask will hold three short fuel canisters. The sides and bottom of the cask are 10 in. thick lead clad surrounded by 3/8 in. carbon steel on both the inside and outside. Tubes penetrate the sides of the cask to allow cooling water circulation around the fuel. The lid is secured by locking cogs operated with an impact wrench. Overall dimensions are 59 in. by 57 in. by 75 in. tall. The total weight of an empty cask is approximately 45,000 lb.

The lower portion of the K Area cask's internal cavity sidewalls are perforated by twelve, 1-in. diameter pipes that extend vertically inside the shielding to exit the outer wall just above the bottom of the lid. Additionally, two vertically piped openings in the bottom of the cavity connect to a horizontal 1 1/2-in. diameter pipe that traverses the shielded area beneath the cavity and exits on opposite sides of the cask. The lid has six 1-in. diameter pipe perforations through it. These openings allow water from inside the cask to intermingle with water in the well cars.

The lid is locked in place by locking cogs operated by an impact wrench. A structural assessment of the K Area cask concluded that under an accident condition, where the cask tips over on its side, water will drain out of the cask through the lid and circulation pipes. The cost of modifications to eliminate these findings was estimated to be equivalent to the cost of building a new cask. A modification to the latching mechanism was recommended and the latch mechanism was modified by removing the existing locking bar made from 304 SST and substituting an identical locking bar made from AMS 564317-4 stainless steel, a high strength steel (Emory 1976). This was done to strengthen the cask latch mechanism to prevent possible loss or rearrangement of fuel in a tip-over accident (Schonholtz 1977, UNI 1977). Modifications to prevent loss of water in the event of the cask tipping over were not performed. Additional modifications to the K Area casks are not considered viable for consolidation of the irradiated fuel and sludge.

4.3.1.2 Description of Three Well Car. The three-compartment, three-well "long car" is a 200-ton capacity railcar, that is 50 ft long and supported by two four-wheel or six-wheel trucks (RHO 1982). When loaded the three-well car holds three K Area casks in individual wells filled with cooling water, Figures 4-5 and 4-6. Total quantities in a full three-well car is estimated at 4.9 metric tons of fuel in Mark IV canisters or 2.1 metric tons of fuel in Mark IA canisters (WHC 1993c). With all casks in place, the three-well car contains approximately 900 liters or 1,984 lbs of water (RHO 1982). The car's three rectangular compartments hold cooling water for the fuel casks and are mounted on top of an underslung railroad car (GE 1953a, GE 1953b, GE 1953c, Vitro 1974d). The water tanks have hinged doors on top, which are opened by a hand wheel-operated mechanism. The doors do not seal tightly and thus have the potential for sloshing or spilling water.

Figures 4-5 and 4-6 show the three-well car for K Area casks. The well cars were last used to transport fuel in 1989. Since then, the cars and the empty casks they contain, have been parked at a siding in the 100K Area. Water was placed in the wells to control any residual contamination. Originally, there were a total of 12 useable casks, and three-well cask cars. However, the number of serviceable cars available at this time is not known. For purposes of cost and schedule estimates three cars were assumed available with some repairs. An option to modify the hinged doors for a better seal on the well cars has also been evaluated.

4.3.1.3 Description of Fuel Canisters. There are two main types of canisters, short and tall. Both types consist of two nominally 8-in. diameter tubes, one type is flared at the top, connected together side-by-side at three points by short cylindrical bars, one at the top and two at the bottom of the canister, Figures 4-7 and 4-8. The top bar serves as the lifting trunnions and the lower bars as tipping trunnions. The bottom of the canister is perforated with 1-in. holes to allow water circulation around the fuel elements, and is covered with screen.

Figure 4-5 Three Well Cask Car

Figure 4-6 Three Well Cask Car

Figure 4-7 Fuel Storage Canister

Figure 4-8

FUEL/STORAGE CANISTER **MARK II CANISTERS**

Mark II canisters are used primarily to store irradiated N Reactor fuel. Each unit consists of two identical stainless steel drums, each capable of holding seven fuel assemblies. Both drums are connected by short cylindrical bars which serve as trunnions for handling. The top view in this figure shows that of an encapsulated Mark II canister. Currently, 857 open Mark II canisters are stored in the KE Basin.

Prior to fuel transfer all fuel will be encapsulated in Mark II fuel canisters. These canisters are made of 16-gauge, 300-series stainless steel, and are 28 in. long. The bottom of each tube is 1/4-in. thick stainless steel.

4.3.1.4 Description of Loading/Unloading of Fuel Canisters. Each K Basin has its own load out facility. The three-well cask cars are brought in one at a time and loaded/unloaded inside the transfer area of the building. Loading is a remote operation. Using the 30-ton overhead crane, the cask is lowered into the pit and the cask lid removed by a frame that engages and supports beam extensions welded to the top of the lid. The cavity portion of the cask is lowered further and offset from the lid to expose the cavity for loading.

For transfer from the pit, fuel canisters are suspended by their trunnions from a 20-ft long hook whose upper end is attached to a hoist and overhead monorail system. This monorail system brings each canister to the pit from the basin by way of a narrow water-filled channel connecting them. Three canisters are placed inside the cask cavity and the cask is moved under the lid and lowered from the pit, Figure 4-3. The cask lid is tightened down and the cask placed in the three-well cask car, Figure 4-9. The process is repeated for the other two casks, and then the three-well cask car is removed from the building while another car is loaded. The loaded car is then transported to the KW Basin for unloading. Unloading follows the reverse steps of loading.

Fuel canisters would be loaded into the K Area casks and well cars for loading encapsulated KE Fuel canisters in the following manner:

1. Canisters are picked up individually and moved in no more than groups of three to the load out area, Figure 4-1.
2. A cask is lowered into the north loadout pit of the KE Basin in preparation for loading of three canisters.
3. Three canisters are loaded into the cask.
4. The cask is removed from the basin water and the cask is flushed with demineralized water or blasted with carbon dioxide to minimize the transfer of radioactive basin water to the well car. The flush water is returned to the basin.
5. The cask is placed in the well car. Depending on the need for water cooling the well car may or may not contain demineralized water.
6. When three casks are loaded on well car it is moved to the KW Basin.
7. The K Area cask is removed from the well car and placed in the KW Basin loadout pit.
8. Each canister is unloaded from the transfer casks.
9. Unloaded canisters are moved to their location on the proposed three-tiered storage rack in KW Basin.

Figure 4-9 Loading K Basin Cask into Three Well Cask Car

10. The unloaded cask is placed back in the well car.
11. Steps 7, 8, 9 and 10 are repeated until all three casks are unloaded.

4.3.1.5 Description of Well Car Rail Transfer. Several equipment options for moving well cars were examined. However, the weight of the loaded well cars requires a diesel engine. Two small, slow speed diesels, currently in storage, were determined to be the most cost effective options. These engines could be left on-site in the 100K Area with no impact on other operations. In addition, the low horsepower of these engines makes them well suited for moving a single car load at slow speed over short distances.

Full and empty well cars would be shuttled between the basins. In order to preserve operational efficiency, a third car would allow continuation of loading if one of the basins gets slightly ahead of the other. No more than one full well car would be stored at any time, and no loaded cars will be left outside during off-shifts.

4.3.2 Transfer of the 105KE Fuel by Truck Using the K Area Fuel Transfer Cask

If fuel can be transported without water cooling, it is possible to use a truck to transport the K Area casks. This approach eliminates the need for rail transport and facilitates multiple shift operations, since K Area personnel can drive the trucks. However, several additional cost items are added. The trailers would need special fixtures installed, and additional work might be needed for demonstrating DOT equivalency for the truck transfers.

Transfer of fuel from the KE Basin to the KW Basin by truck is very similar to transfer by rail car. The fuel is moved over a short distance, approximately 0.5 mile, in an entirely fenced and controlled site. In addition, there is very little vehicular traffic on the site and all traffic can be controlled.

Transfer by truck requires a single truck and two or three 110-ton, three axle low boy trailers, which can carry two or three transfer casks at one time. The height of the doors and height and length of the bays are large enough to accommodate the truck trailer combination.

The estimated cost for transferring by truck is \$5,300,000. If trucks and tractors are already available, the cost would be reduced by \$260,000. The schedule duration from start of work to completion of transfer is estimated at 25 months. However, the critical path, the time needed to transfer the fuel and sludge, is only 6.5 months. The estimated exposure to complete all phases of truck transfer is 94 man-rem.

The main advantage for the truck/K Area cask transfer alternative is the higher transfer efficiency which results in the lowest critical path, transfer time, and lowest exposures.

The main disadvantages of the truck/K Area cask transfer alternative are that there is a long lead time to procure new trailers and contamination enclosures; cask tie down mechanisms would have to be designed and fabricated; and purchase of new trucks and trailers have moderately high costs.

The various components and aspects of truck transfer are described below in Sections 4.3.2.1 through 4.3.2.5.

4.3.2.1 Description of Shipping Casks. A detailed description of the fuel cask is contained in Section 4.3.1.1. The important features of the K Area casks are that they provide 10 in. of lead shielding, have closure locks that ensure fuel is not spilled in the event of an accident, and the maximum amount of fuel capable of being placed in a cask is less than the critical amount even under the most conservative conditions.

4.3.2.2 Description of Truck. Fuel transfer by truck would use 110-ton, low boy trailers. Tractors with a 250-ton trailer are already used on site; however, the 250-ton trailer is 16 ft wide and will not fit through the basins' roll up doors which are 14.5 ft wide. Therefore, the smaller 110-ton trailer is required. The 110-ton trailer is a standard three axle, low boy trailer and is certified for public highway use. The trailer fits inside the basins' railroad bays. Depending on the payload, two or three trailers are required. However, only one tractor would be required provided a backup tractor was available. It is certain that two casks can be transported on a trailer, but additional analysis is required to determine if three casks can be transferred at a time. Cost estimates have been based on three trailers each carrying two casks, which has higher capital costs, but similar transfer efficiency, as two trailers each carrying three casks.

Contamination enclosures would have to be installed on the trailers to hold the casks. These would catch any liquid (small amounts since transport is without water cooling) that drips from the cask and seal tightly enough to prevent contamination from becoming airborne during transport. The K Area casks provide all necessary shielding and structural integrity. The trailer enclosures are similar to the well cars. Therefore, DOT equivalency would have to be demonstrated based on the K Area casks, which is the same requirement as using rail transported drained well cars.

4.3.2.3 Description of Fuel Canisters. Fuel Canisters are described in Section 4.3.1.3.

4.3.2.4 Description of Loading/Unloading Of Fuel Canisters. Loading the fuel canisters into the K Area casks will be identical to the procedures described in Section 4.3.1.4. Loading K Area casks on trucks will be performed similarly to loading the casks into well cars. However, additional steps are required to secure the cask to the truck, close the contamination control enclosure over the casks prior to shipping, remove the contamination control enclosure, and unsecure the casks from the truck. A description of the truck loading process follows.

1. The transfer cask is removed from the basin water and the cask is decontaminated by flushing with demineralized water or blasting with carbon dioxide to minimize the transfer of radioactivity.
2. The cask is placed on the truck and secured.
3. Two (or three) casks are loaded on the truck following Steps 1 and 2.
4. The contamination control enclosure cover is secured.
5. The truck is moved to the KW Basin.

6. The contamination control enclosure is removed.
7. The cask is unsecured from the truck.
8. The transfer cask is placed in the basin's load out pit.
9. Each canister is unloaded from the transfer casks.
10. Empty casks are placed back on the truck and secured.
11. Unloaded canisters are moved to their location in the storage rack in KW Basin.
12. Steps 7 through 11 are repeat for all the casks on the truck.

4.3.2.5 Description of Truck Transfer. Truck transfer is easily accomplished between the KE Basin and the KW Basin. The route between the KE Basin and the KW Basin is relatively straight with one major turn on each end, and a large concrete pad area to allow lining up the truck trailer with the basin entrance. In addition, the route does not cross any roads routinely used by the public. The basins' bays and outside areas adjacent to the bays are already concrete and capable of supporting truck traffic. Modifications to the road at the point where there currently is a 90 degree turn, would allow a more moderate turn. It is possible that the existing road may need upgrading to handle the 110-ton low boy trailers which would make approximately 300 round trips during a six month time period.

Based on Isoshield runs, dose rates external to the K Area casks would be low and no radiation areas would be created during the transfer. Shift spot surveys for the route are recommended to ensure that contamination has not leaked from the enclosures, and more detailed periodic surveys would also be needed.

Security escort for transfers may not be necessary within the confines of the 100K Area.

4.3.3 Transfer of the 105KE Fuel by Truck Using the JMTR Fuel Shipping Cask

DOE owns two JMTR casks which are not currently being used. They are stored on the Hanford Site, but not attached to their flatracks. Although foreign made, the design and construction of these casks is equivalent to a DOE/NRC/DOE-licensed cask. Prior to DOE purchase, they were shipped off-site in the United States under a Certificate of Competent Authority.

A JMTR cask is shielded by 9-3/4 in. lead. The cask lid is 7 1/2-in. thick lead clad. The lid is held in place by forty 1 3/8-in. diameter steel bolts. The JMTR cask has an outside diameter of 59.5 in., which is larger than the least rail to rail dimension in the transfer pit. However, because of the position of the rails, the cask can be lowered through the framing in the pit. The cask weighs 38,820 lb, well within the limits of the 30-ton crane at the loading pits at the KE and KW Basins. The cask can be loaded underwater. The JMTR cask can hold only one canister of fuel at a time, and criticality is not a concern since at least 169 fuel elements under ideal conditions are needed for criticality.

The estimated cost for transferring by JMTR and truck is greater than \$20,000,000. The schedule duration from start of work to completion of transfer requires over 6 years. Critical path is 4 years, which is much longer than all other alternatives. The estimated exposure to complete all JMTR transfers is over 400 man-rem, which is also much higher than all other alternatives.

4.3.3.1 Advantages and Disadvantages of JMTR Cask. The advantages of the JMTR cask are that the JMTR casks are owned by DOE, stored on the Hanford Site, available for use, and are equivalent to DOE/NRC/DOE-licensed casks.

The disadvantages of the JMTR cask are that the internal cavity is small and the allowed weight of the fuel and fuel basket is only 971 lb. This would permit only one canister at a time resulting in the excessive cost, schedule duration, and high exposure.

4.3.3.2 Description of Flatrack Trailer. The JMTR casks are transported by mounting on a "Flatrack." The flatracks, which are in storage with the JMTR casks, can be mounted on either a railcar or truck trailer. A truck would have much better operational efficiency for the short transport of a single cask and truck mounting is the preferred choice and evaluated alternative.

4.3.3.3 Description of Fuel Canisters. The fuel canisters have been described in Section 4.3.1.3

4.3.3.4 Description of Loading/Unloading of Fuel Canisters. There are two possible methods for loading/unloading fuel into the JMTR casks. The first is to load/unload into the JMTR cask similar to the process steps used for loading the K Area cask. However, there are four differences that affect the loading process. These differences are discussed below.

- The JMTR cask holds only one canister. Thus, rigging the casks in and out of the load out pits must occur three times more frequently.
- Only two casks are available which means that there will be significant dead time associated with casks not being available for loading.
- Rigging the JMTR cask in and out of the pit will be more complex, so the time to rig in and out will be longer.
- The casks will be immersed in the basins for loading but drained for shipping. This will result in increased time durations and contamination on the external surfaces of the casks. Since the casks are not placed in a closed receptacle for transfer, they will have to be decontaminated and wrapped prior to transfer.

Although none of these differences prevent use of the JMTR cask for transferring irradiated fuel and sludge from KE Basin to KW Basin, they all increase the difficulty, time, costs, and exposure for loading casks. In addition, immersion would result in the cask's external surfaces becoming contaminated. Using a shielded transfer basket to load and unload the canisters to protect external surfaces from becoming contaminated is not practical, due to low weight restrictions, and the limited dimensional clearances.

A small shielded transfer basket of stainless steel filled with lead could provide adequate shielding while loading canisters. However, weight restrictions on the cask would require that the basket be removed prior to shipment which adds additional steps to the process and results in even higher costs, exposures, and schedule duration.

4.3.3.5 Description of JMTR Cask Transfer. Transfer of the loaded/unloaded JMTR cask will be done by truck, following the same route as truck transfer of K Area casks. Since the load on the trailer is less than 50,000 lb, a smaller trailer may be used, which makes the cost and time per trip less. It must be emphasized that this method only transports one canister at a time, instead of the six to nine canisters transported by the well car or K Area cask truck trailer.

4.3.4 Transfer of 105 KE Fuel by Truck Using a Commercially Available Radwaste Shipping Cask or the M10-142 Cask

If fuel can be transported without water cooling, it may be possible to use a commercially available, or M10-142 cask ("Big Bertha"), by truck and trailer to transport the fuel canisters from the KE Basin to the KW Basin. K Area personnel would be able to drive the trucks which would eliminate the need for rail transport and facilitate multiple shift operations. A cask can carry many canisters depending on criticality and weight constraints. For purposes of this study, nine canisters comprised the assumed payload. This provides an efficiency that is equal or better than K Area casks and either well car or truck shipment. The casks are DOT certified for radioactive material shipment, but are not certified for fuel shipment. Therefore, demonstration of DOT equivalency for fuel transfer is required and may be difficult.

Transfer of fuel from the KE Basin to the KW Basin is the same as using a truck and K Area casks. The fuel is moved over a short distance, approximately 0.5 mile, in an entirely fenced and controlled site. In addition, there is very little vehicular traffic on the site and all traffic can be controlled.

Commercial shipping casks are mounted on approved trailers. The height of the doors and height and length of the bays are large enough to accommodate the truck trailer combination.

The estimated cost for transferring by commercial casks is \$7,600,000. These higher costs result from the need to buy two casks and transfer baskets. Big Bertha, a preexisting cask, is on the site, and has been refurbished. Using this cask, the transfer costs could possibly be reduced by approximately \$500,000. The estimated exposure is 83 man-rem, and the schedule duration is 25 months with a six month critical path for the loading, unloading, transfer phase.

The main advantages for the commercial cask/truck transfer alternative are commercial shipping casks are DOT certified for radioactive material shipments. Obtaining casks is relatively simple, and the casks would continue to have use even after fuel transfer was completed.

The main disadvantages of the commercial cask/truck transfer alternative are purchase of new casks, trailers and transfer baskets have high capital costs, approximately \$2 million, and use of the commercial radwaste casks would require additional safety analysis to further affirm DOT/NRC equivalency for fuel transfer.

The various components and aspects of using a commercially available shipping cask are described below in Sections 4.3.4.1 through 4.3.4.5.

4.3.4.1 Description of Shipping Casks. The shipping cask has a large internal dimension. Nine or more canisters can be placed in the shipping cask. Cost estimates and exposure estimates are based on nine canisters per cask.

4.3.4.2 Description of Transfer Baskets. Commercial shipping casks are too large to fit in the basin's loadout pit. Therefore, transfer baskets are needed to transfer the canisters between the loadout pits and the shipping casks which remain mounted on their trailers inside the shipping bay. These baskets must enclose the fuel canisters and provide sufficient shielding to prevent measurable increase to working dose rates when the fuel canisters are suspended in the air. Transfer baskets must also be capable of being drained prior to loading in the commercial cask.

Basic analysis of previous Isoshield runs shows that a 2-in. lead shielded transfer basket has a sufficient shielding factor to reduce dose rates from the fuel to ALARA levels. A method to first load the basket and then shield all sides including top and bottom would have to be designed and fabricated. The transfer basket loaded with canisters must weigh less than the authorized payload of the cask which is currently 15,000 lb. The transfer basket would remain in the cask as fuel is transported.

4.3.4.3 Description of Truck and Trailer. Fuel transfer by commercial cask uses low boy trailers that are already equipped and approved for use with the casks. The trailer fits inside the basins' railroad bays. A minimum of two shipping casks and trailers are required for operational efficiency. A third cask, transfer basket, and trailer would provide additional efficiency, but is not considered cost effective. Only one tractor is required, providing a backup tractor is available.

4.3.4.4 Description of Fuel Canisters. Fuel canisters have been described in Section 4.3.1.3.

4.3.4.5 Description of Loading/Unloading of Fuel Canisters. Commercial casks would be loaded and unloaded using a shielded transfer basket. This process would be similar loading and unloading casks and well cars load and unload. A description of this entire process follows.

1. Canisters are picked up individually and moved to the loadout area.
2. A transfer basket is lowered into the load out pit of the KE Basin in preparation for loading canisters.
3. Canisters are loaded into the transfer basket until it is full.
4. The transfer basket is removed from the basin water and decontaminated by flushing with demineralized water or blasting with carbon dioxide to minimize the transfer of radioactivity. The transfer basket is placed in the shipping cask.
5. The top of the shipping casks is secured.

- 6 The truck is moved to the KW Basin.
7. The shipping cask's top is removed.
8. The transfer basket is placed in the basin's loadout pit.
9. Each canisters is unloaded from the transfer basket.
10. The transfer basket is removed from the basin water and decontaminated by flushing with demineralized water or blasting with carbon dioxide to minimize the transfer of radioactivity. The transfer basket is placed in the shipping cask. The empty basket is placed back in the shipping cask.
11. The lid of the shipping casks is secured.
12. The empty cask and transfer basket is returned to the KE Basin.
13. Unloaded canisters are moved to their location on the proposed three tiered storage rack in KW Basin.

4.3.4.6 Description of Truck Transfer. Truck transfer for commercial shipping casks is identical to truck transfer of K Area casks. Dose rates external to the shipping casks would be low and no radiation areas would be created during the transfer based on Isoshield runs.

4.3.5 Transfer of the 105-KE Fuel by Truck Using a New Transfer Cask

This option is very similar to truck transfer of K area casks except a new fuel shipping cask would be utilized. The new cask would be designed to meet 10CFR71 criteria, but still work with the current basin configuration and equipment. Although the new design meets 10CFR71 criteria, schedule constraints would prevent certifying the new casks to DOT criteria. Using a new cask provides a leak tight fit which eliminates the main disadvantage of the K Area casks. The new casks would also be free of contamination and would not require decontamination, maintenance or modification prior to use. The primary disadvantage to the using new casks would be the increased cost and schedule duration.

The estimated cost for transferring new casks by truck is \$6,300,000. The schedule duration from start of work to completion of transfer is estimated to be at least 36 months, 30 months to design, fabricate and test, and six months to complete the transfer. Since the casks must be designed and fabricated, almost the entire 36 months is critical path and major work cannot start until the work is authorized and the funds budgeted. The estimated exposure to complete all phases of truck transfer using new casks is estimated at 83 man-rem which is the lowest exposure option.

The main advantages for the truck/new cask transfer alternative is the higher transfer efficiency of truck transfer, a cask designed to 10CFR20 criteria, leak tightness, and the lowest exposure.

The main disadvantage of the truck/new cask transfer alternative is the extended time frames to design and fabricate the casks. In addition there is higher probability for schedule slippage. The cost of new casks is approximately \$800,000 dollars more than K Area cask transfer, and new casks also have potential for significant cost increases.

The various components and aspects of truck transfer are described below in Sections 4.3.3.1 through 4.3.3.5

4.3.5.1 Description of Shipping Casks. The important features of the new casks is that they would be designed to current 10CFR71 criteria, provide sufficient shielding to minimize dose rates during transfer, have closure mechanisms that ensure fuel is not spilled in the event of an accident, and have a leak tight seal. New casks would be submerged in the loadout pit and loaded using existing equipment. The amount of fuel placed in the cask would be equal to or greater than currently transported in K Area casks depending on dimensions, weight and criticality restriction. For purpose of this report the number of canisters is assumed the same as the K Area casks.

4.3.5.2 Description of Truck. Fuel transfer by truck would use the same 110-ton, low boy trailers as transfer of the K Area casks. Contamination enclosures would have to be installed on the trailers to hold the casks. These would catch liquid dripping from the cask outside surface; since the seal is leak tight no liquid or contamination will come from inside the cask.

4.3.5.3 Description of Fuel Canisters. Fuel Canisters are described in Section 4.3.1.3.

4.3.5.4 Description of Loading/Unloading of Fuel Canisters. Loading the fuel canisters into the new casks would be similar to the procedures described in Section 4.3.1.4. Some modification of how the cask lids are removed and sealed would be required.

4.3.5.5 Description of Truck Transfer. Truck transfer with the new casks would be identical to truck transfer of K Area casks.

5.0 COMPARABLE DISCUSSION OF ALTERNATIVES AND SOLUTIONS

All six of the alternatives discussed in Section 4.3 are capable of transporting N Reactor fuel and encapsulated basin sludge without water cooling, but only the well car and K Area cask can transport fuel with water cooling. Based on the criteria discussed in Section 4.1, the K Area cask with truck transfer has the highest overall rating. This alternative scored 37 out of 45 possible points. Three other alternatives also scored higher than 30 points. Well car transfer without water cooling scored 34 points. Well car with water cooling, and using a new design fuel shipping cask each scored 32 points. These scores show that even the best alternative has several shortcomings, and each method has its own advantages and disadvantages. The K Area cask alternatives scored highest with respect to cost and schedule. Using a new fuel cask design scored high in several categories but had higher costs and a long duration schedule with significant potential for not being able to support schedule requirements. Using a commercial cask has lower radiation exposure than K Area casks but had higher cost and longer schedules. The JMTR cask was determined not to be a viable alternative based on its extremely low transfer efficiency resulting in unacceptably high costs, schedule duration and radiation exposure. A tabulation of the ratings of the alternatives with respect to the criteria appears in Table 2-1. Each of the evaluation criteria and advantages and disadvantages is discussed in Sections 5.1 through 5.10.

5.1 OPERATIONS

Use of the K Area casks and well cars is the least disruptive to the operation of the 105KE and 105KW facilities. Since these casks and well cars have not been used since 1989, they are contaminated and rusty. Three well cars would need to be repaired and decontaminated. Existing casks would need to be decontaminated and renovated. The K Basins are not prepared to handle the high levels of contamination from the well cars; therefore, the well cars and casks will need to be relocated to a different location or a special decontamination area built. Modifications to the well cars may be necessary if water cooling is required. Use of truck transfer requires that minor modifications be made from the railroad bays to existing roads. This effort will need to be coordinated with existing activities. This effort is discussed in Section 4.3.2.5. Using a new fuel cask requires developing a totally new method and writing new procedures. Commercial cask transfer is further complicated by needing to use transfer baskets. The excessive length of transfer by JMTR cask will place considerable burden on long term operation of the basin. The assigned rating for operation's consideration are provided below.

ALTERNATIVE	ASSIGNED RATING
Well Car, Drained	4
Well Car, Water Cooling	5
K Area Cask and Truck	4
New Fuel Shipping Cask	3
Commercial Cask	2
JMTR Cask	2

5.2 NEW SAFETY ISSUES

Loading of encapsulated canisters from basin racks, first into casks, and then into well cars will require both Safety Analysis and Readiness Review. The extent of these Readiness Reviews depends upon the alternative selected. Transfer using well cars and K Area casks has been done extensively in the past and should require a less complex Readiness Review than the other alternatives. There should be no unreviewed safety considerations for transfer of fuel in well cars using water cooling. If drained transfer is selected, heat loading and radiation dose rates are potential USQs which would need to be resolved.

Additional calculations for heat loading and cooling, gas generation, and shielding analysis will need to be done for the current condition of the fuel. Since the radioactivity decay has significantly reduced the noble gas and radioiodine content, radiation levels, and heat generation rates, these calculations should show improved safety margins in all areas. However, detailed calculations will need to be completed before a decision can be made to transfer fuel with reduced or eliminated water cooling. A conservative technical evaluation shows that a drained fuel canister with no heat transfer could experience a temperature increase to approximately 200°F in 16 hours, and temperatures could exceed 1500°F in 10 days if no heat transferred out of the canister. While this rate of temperature rise indicates little problem with fuel integrity, it may be a potential safety issue with respect to the logistics of fuel movement. For example, fuel canisters that were 150°F could not simply be placed in the KW loadout pit water with water temperatures of approximately 50°F. Therefore, more detailed calculations using defensible heat transfer coefficients are needed for all alternatives except wet transfer by well car. In addition, some analysis may be required for pyrophoric issues. Since all of the alternatives except wet well car transfer require drained fuel shipment, wet well car transfer was assigned a value of five, all the other alternatives, except commercial cask, were assigned a value of four. Commercial casks were assigned a value of three, since they were not specifically designed for fuel shipment, and criticality issues will need to be addressed.

ALTERNATIVE	ASSIGNED RATING
Well Car, Drained	4
Well Car, Water Cooling	5
K Area Cask and Truck	4
New Fuel Shipping Cask	4
Commercial Cask	3
JMTR Cask	4

5.3 RADIATION EXPOSURE

All of the options require significant amount of radiation exposure. In general, except for the JMTR transfer, exposure to operators is similar, and the major differences between options are due to the exposure needed to decontaminate, repair and modify well cars and the K Area casks. Exposure estimates were based on the estimated hours of radiation zone work, and current dose rates adjusted to the ALARA actions identified for fuel encapsulation work. In general, KW Basin dose rates were assumed

to remain the same as current levels, and KE Basin dose rates were reduced by 40 percent in the center of the basin and 20 percent in the loadout area. Evaluation of the impact of administrative exposure limits was also evaluated. This evaluation showed that a 1,000 mrem per year administrative limit has significant impact on operators, but little impact on other work groups. Further, it was determined that a 300 mrem per week limit could be maintained if personnel worked in KE and KW Basin every week. Staffing levels needed to support the 1,000 mrem a year limit were determined, and the incremental cost added to the option. The estimated exposure for each option and the assigned rating are provided below.

ALTERNATIVE	ESTIMATED EXPOSURE REM	ASSIGNED RATING
Well Car, Drained	124	2
Well Car, Water Cooling	137	3
K Area Cask and Truck	94	4
New Fuel Shipping Cask	83	5
Commercial Cask	83	5
JMTR Cask	442	0

The majority of exposure to radiation and contamination for consolidating KE Basin fuel and encapsulated sludge occurs while loading canisters at the KE Basin and unloading at the KW Basin. Preparing both of the basins for fuel transfer also uses radiation exposure. Depending on the alternative, significant exposure also occurs while decontaminating and repairing well cars and K Area casks. Additional details on radiation exposure are provided below.

5.3.1 Radiation Exposure Estimates

Using new fuel shipping casks or commercial radioactive waste casks requires an estimated 83 man-rem of exposure. This is the lowest total exposure and is due to not having to decontaminate and rework of well cars and K Area casks. Truck transfer using K Area casks requires an estimated 94 man-rem which is the next lowest total exposure to transfer fuel and sediments. Transfer by well cars and K Area casks requires more time to load and unload as well as extensive work on the well cars, this results in 118 man-rem to transfer by well car without water cooling. If water cooling is required the exposure increases to 137 man-rem due to the exposure used to modify the well cars.

5.3.1.1 Impact of Administrative Exposure Limits. Although current radiation controls are sufficient, KE Basin's higher radiation fields combined with the needed manhours of work create difficulties in meeting Westinghouse Hanford's Administrative Control Levels for annual exposure. Meeting weekly administrative limits will necessitate balancing weekly work time for operators, Health Physics technicians, and maintenance personnel equally between KE and KW Basins, but should not be a major problem.

At estimated dose rates, required man hours, and available personnel, transfer work could be completed within individual dose limits of 5 rem per year. Lower

administrative levels cannot be met with available operators. Since fuel encapsulation activities will require significant operator exposure it is not deemed feasible to try to schedule fuel transfer activities over two calendar years. Therefore, temporary operations personnel will have to be utilized to meet lower administrative control levels. These personnel will have to be trained and more closely supervised, and a work crew composed of one experienced operator and two new operators will be required. It is estimated that hiring, training, and qualifying the new employees will take two to three months, and transferring the fuel will take approximately six to seven months. Therefore, the temporary personnel will be needed for nine months.

The number of new operators needed can be estimated in the following manner. The estimated operator exposure for fuel transfer by truck is 59 man rem and there are currently 24 K Area operators.

- Currently available exposure is assumed to be 500 mrem less than the administrative limit.
- The available exposure is subtracted from the required 59 rem.
- The number of needed temporary operators is the needed exposure divided by the administrative limit.
- The cost of the administrative limit is the number of needed temporary operators times the fully burdened labor rate (\$42 per hour) times the number of hours in nine months (1500 hours).

The associated costs for administrative exposure limits is provided below.

ADMINISTRATIVE LIMIT MREM/YEAR	NUMBER OF ADDITIONAL PERSONNEL	COST
500	108	\$6,700,000
1000	37	\$2,300,000
1500	17	\$1,000,000
2000	12	\$700,000

For the purpose of this report an administrative exposure limit of 1,000 mrem per year was assumed. Based on 1,000 mrem per operator, a total of 37 operators will need to be hired. The cost of employing 37 temporary operators for nine months is \$2,300,000. Although there is additional exposure associated with well car use, the same time frame of nine months is considered reasonable. This cost has been added to the cost of each option, except for the JMTR which requires additional personnel for over three years.

5.3.2 Surface Contamination

Previous fuel transfers have shown that surface contamination is a major concern. The current well cars and K Area casks are highly contaminated. Well cars are contaminated on external surfaces with both fixed and smearable contamination. Recent radiation surveys of the well cars containing K Area casks indicate that surface contamination inside the well cars, most likely on the K Area casks, is extremely high.

Well cars and K Area casks will need to be decontaminated prior to starting any work. This decontamination would be best accomplished in a facility that is already equipped for dealing with high contamination levels and dose rates as high as 100 mr/hr. Decontamination labor hours have been factored into the estimates. However, decontamination facility costs have not been factored into the estimates. In addition, any significant delay in starting decontamination activities could also impact schedule.

Contamination from canister surfaces, tools, and basin water (less significant) will resettle on the casks and transfer baskets, which will require that decontamination methods be developed to clean the casks and baskets as they are removed from the loadout pits. A system using a carbon dioxide blaster is recommended for this activity since this method does not generate liquid or solid radwaste. Additional discussion of this system is included in the liquid radwaste section.

5.3.3 Airborne Contamination

None of the transfer options should have significant airborne contamination during transfer. However, decontamination of casks and well cars does have potential for generating airborne contamination. Initial decontamination will have to be performed at a facility capable of controlling airborne radioactivity.

All transfer alternatives include methods to control airborne contamination while the canisters are being transported between KE Basin and KW Basin. During loading and unloading, standard operational control techniques and possibly respiratory protection will be required. These controls are factored into the estimates, however, additional requirements for facility modifications or extensive engineering controls could increase cost and schedule estimates.

5.4 TRANSFER PACKAGING CRITERIA

Except for the JMTR cask, none of the proposed transfer alternatives are capable of being DOT certified for fuel shipping. However, all transfer methods are deemed acceptable for demonstrating DOT equivalency. The new cask would be designed to DOT/NRC criteria and would have a leak tight seal. However, development and use of the required over-packs to meet DOT certification and the certification testing, along with demonstration of leak tightness for every transfer, is consider prohibitive with respect to cost and schedule. The assigned rating for each of the alternatives is provided below.

ALTERNATIVE	ASSIGNED RATING
Well Car, Drained	3
Well Car, Water Cooling	3
K Area Cask and Truck	3
New Fuel Shipping Cask	4
Commercial Cask	3
JMTR Cask	5

5.5 SAFETY ANALYSIS REPORT FOR PACKAGING

All of the alternatives will require some Safety Analysis Report for Packaging (SARP) work. The intent of the original design of the casks and well cars was to passively circulate water to the fuel elements for cooling by penetrating the cask walls with a pattern of openings. Due to the significant decrease in heat loading and radiation levels over the long time that this fuel has been stored, it should be easier to demonstrate DOT equivalency. If cooling water inside the well car is deemed necessary, modifications to the well car to minimize leakage potential may also be required. Since they have been used previously, the well car with water cooling and the JMTR cask should require the least effort for a SARP. The new fuel cask would be designed to certification criteria, but being a new design may require considerable efforts to prepare a SARP. Use of K Area casks for drained transfer, either by truck or well car, will require significant SARP revisions. The assigned ratings for SARP criteria are provided below.

ALTERNATIVE	ASSIGNED RATING
Well Car, Drained	3
Well Car, Water Cooling	4
K Area Cask and Truck	3
New Fuel Shipping Cask	3
Commercial Cask	3
JMTR Cask	4

5.6 ENVIRONMENTAL

The proposed transfer and consolidation of irradiated N Reactor fuel from KE Basin into the KW Basin will be required by DOE Orders to have an Environmental Assessment for the planned modification, transfer, and consolidation activities. The alternative with the greatest environmental impact is the liquid that has been known to splash from the well cars during wet transfer. The JMTR cask and new fuel shipping cask both provided positive seal and would experience no leakage. The assigned rating with respect to environmental criteria are:

ALTERNATIVE	ASSIGNED RATING
Well Car, Drained	4
Well Car, Water Cooling	2
K Area Cask and Truck	4
New Fuel Shipping Cask	5
Commercial Cask	4
JMTR Cask	5

5.7 WASTE MANAGEMENT

With the exception of the JMTR cask, waste management considerations are similar for all alternatives. Potential wastes are radioactive solid and liquid wastes,

transuranic wastes, mixed wastes, and hazardous wastes. However, radioactive waste is the only significant waste stream. The lowest estimated volumes of radwaste are for K Area cask and truck. New fuel casks generate the same volumes as K Area casks, but represent new radwaste themselves. The use of a commercial fuel cask requires using transfer baskets which generate slightly more waste. The decontamination and modification of well cars generates some additional radiative wastes, and has a potential to generate a very small volume of mixed wastes. The assigned rating for each option is provided below. Additional discussion of waste streams is provided in Sections 5.9.1 through 5.9.5.

ALTERNATIVE	ASSIGNED RATING
Well Car, Drained	3
Well Car, Water Cooling	3
K Area Cask and Truck	5
New Fuel Shipping Cask	4
Commercial Cask	4
JMTR Cask	1

5.7.1 Radioactive Solid Waste

Radioactive solid wastes will be generated by all alternatives. The bulk of this material will be composed of compactable materials, such as plastic and cloth used while loading and unloading canisters. A smaller amount of non-compactable materials such as pipe, valves, etc. will also be generated. Radioactive solid wastes will also be generated in the decontamination and maintenance of well cars and K Area casks. It is anticipated that all of this material would be low specific activity (LSA).

The estimated volume of radioactive waste is 700 cu ft for well cars alternatives, and 600 cu ft for truck transfer. The JMTR cask, because of its extended time frame, would generate much more solid radioactive wastes. Radwaste costs were factored into cost estimates at \$50 per cu ft.

5.7.2 Hazardous Wastes

None of the transfer alternatives generate additional hazardous wastes.

5.7.3 Mixed Wastes

The well car alternatives require decontamination of well car surfaces that may remove layers of paint, and generate a small amount of mixed waste (< one 55 gallon drum). Disposal of one mixed waste drum generated by use of well cars is not significant in relation to the large volume of existing mixed waste. This cost is not factored in well car cost estimates. Since the K Area casks already exist they are not new mixed waste. Costs of cask disposal have not been factored into the cost estimate but have been considered in radwaste criteria ratings.

5.7.4 Transuranic Wastes

None of the transfer alternatives should generate additional transuranic wastes.

5.7.5 Liquid Wastes

The only significant contaminant in K Basin liquid is radioactivity. All of the alternatives can be accomplished without generating additional liquid wastes. However, this requires purchase of new equipment to decontaminate/wash down casks (or transfer baskets) without generating additional water. A carbon dioxide blaster and equipment/methods to obtain treated basin water to decontaminate casks is needed. This approach greatly reduces the water volume, and allows water to be recycled back into the basin with no increase in water inventory. If these actions are not taken, there is potential for generating liquid wastes beyond basin usage capacity. This would necessitate the transport, treatment, and release of additional liquid wastes at another location. The cost estimates for all options include equipment for preventing additional liquid wastes.

5.8 COSTS

Drained transfer by K Area casks, using either the well car or truck, has the lowest estimated costs, and the estimated total costs are approximately the same. Although total costs are similar, truck transfer has lower labor costs and higher capital costs. Truck transfer costs include purchasing and modifying the truck and tractors and improving the road. If an existing truck and three trailers were available, truck transfer costs would be reduced by \$260,000. If water cooling is required, the well car transfer cost would increase by approximately \$300,000 due to modifications needed to control liquid leakage. Using a new fuel transfer cask, the JMTR casks, or commercially available radioactive material shipping cask increases the cost considerably. The labor costs for using a new fuel cask or a commercial cask are similar to using K Area casks and truck transfer. The majority of the cost increase for the commercial casks and new fuel cask is due to the cost of procuring the new casks. The JMTR casks requires 4.8 years to complete transfer which results in an estimated cost over \$20 million with the majority of expenditure being labor costs. The costs for each alternative and its assigned score are as follows:

ALTERNATIVE	COST	ASSIGNED RATING
Well Car, Drained	\$5,200,000	5
Well Car, Water Cooling	\$5,500,000	4
K Area Cask and Truck	\$5,300,000	5
New Fuel Shipping Cask	\$6,300,000	3
Commercial Cask	\$7,600,000	2
JMTR Cask	\$20,000,000	0

5.9 SCHEDULE

Schedule activities for the various options can be categorized into purchase, preparation, administration, and transfer activities. There is considerable overlap of the first three activities, which with proper planning can be completed in the same time frame as fuel encapsulation and installation of the tiered storage racks in the KW Basin. Therefore, the transfer phase is the principal critical path phase. Since new casks must be designed and procured prior to transfer this is a major critical path task for new fuel

casks. The design and procurement of new fuel casks takes a minimum of 30 months after availability of funds and there a high probability of schedule slippage for the new fuel cask alternative.

The alternative with earliest completion is truck transport of K Area casks. The schedule duration from start to completion of actual truck transfer is six months, which is a month faster than transfer by well car. Using the existing K Area casks and truck has the shortest completion time. Well cars, drained, has the shortest total duration of 23 months. Drained transfer by truck using either K Area casks or commercial shipping casks requires purchase of equipment with an 18 month lead time. Since the truck and trailers are standard commercial items, there is a high probability of meeting this schedule. Purchase of a commercial shipping cask has some probability of slippage. The use of the JMTR cask is extremely inefficient for transferring canisters and requires over 4.8 years to complete the transfer. The JMTR schedule duration was deemed unacceptable. The estimated total schedule durations, actual transfer times and assigned rating are provided below.

ALTERNATIVE	SCHEDULE DURATION MONTHS	TRANSFER DURATION MONTHS	ASSIGNED RATING
Well Car, Drained	24	7	4
Well Car, Water Cooling	26	8	3
K Area Cask and Truck	23	6	5
New Fuel Shipping Cask	36	6	1
Commercial Cask	23	6	3
JMTR Cask	58	40	0

5.10 ADVANTAGES AND DISADVANTAGES

Each of the alternatives have advantages and disadvantages. In general, with the exception of the K Area cask/truck transfer alternative, the higher the cost is, the lower is the transfer time, and the lower are radiation exposures. A discussion of the advantages and disadvantages of each of the six alternatives is presented below.

5.10.1 K Area Transfer Casks and Well Cars

This packaging system has a number of economic advantages. The lack of DOT/NRC certification is the main disadvantage to well cars/K Area cask use.

The advantages of the K Area transfer casks and well cars are:

- The railcars and casks are already on-site and owned by DOE.
- Loading procedures have been written and have been kept up to date until recently.
- Three Mark II canisters exactly fit into the cask.
- The well car was made to fit three casks.

- The loading facility and overhead crane were designed to use this packaging, so no modifications to the buildings would be required.
- The SARP for this package dates from 1982 but was re-reviewed in 1991 and is still active and considered useable; this is especially true for fuel transfer within the load site boundary.

The disadvantages of well car transfer are:

- This package does not meet DOT/NRC/DOE transportation requirements.
- A new SARP may need to be re-written to take advantage of lower thermal generation and radiation levels.
- If drained transfer is utilized, a new SARP will need to be written for the new radiation and thermal generation levels.
- The well cars may require a modification of the lid closure, in which case the SARP would have to be modified.
- If wet shipment is required, modification to the closure mechanism and recirculation features of the casks may be required to limit leakage. If this modification is necessary, the use of K Area casks and well cars becomes non-viable due to significantly increased costs and schedule duration.
- Based on external survey data, either the internal surfaces of the well car or the exterior surfaces of the casks stored inside them (or both) are grossly contaminated and require major decontamination.

5.10.2 K Area Casks and Truck Transfer

The advantages and disadvantages of truck transfer are very similar to well car shipments. The principal advantage of truck transfer over rail transfer is the increased efficiency of truck transport. This means that fuel could be transferred quicker and more cost effectively, especially if multiple shifts are going to be used. All other advantages are same as well car transfer.

There are two disadvantages of truck transport that are not well car transport disadvantages.

- Truck transport requires early purchase of trailers and trucks. This is a moderately high cost and long lead time item.
- The other disadvantage of truck transfer is the additional uncertainty of this type of transport being an acceptable DOT equivalent method. This also requires additional work and expense developing a SARP.

5.10.3 New Fuel Shipping Cask

If drained shipment of fuel is possible, developing a new fuel shipping cask would provide several advantages. The cask could be designed to current NRC/DOT criteria and be leak tight, which eliminates one of the main disadvantages of the K Area casks. Since the radiation levels in the fuel have significantly decreased due to decay of the shorter lived radionuclides, it would be possible to design a cask that utilizes current basin equipment and still provides equal transfer efficiency as the current system. It should be noted, however, that the new fuel shipping cask would not be certifiable without over-packs, certification testing, and demonstration of leak tightness during transfer. These activities are prohibitive with respect to cost and schedule, and prevent the new fuel casks from being certified during fuel consolidation.

The primary disadvantages of developing a new fuel shipping cask are schedule and increased costs. Based on current cask design, the cost of a new cask is not prohibitive. However, schedule is considered a major disadvantage due to the longer duration, the need to obtain funding authorization prior to starting work, and the much greater possibility that schedule slippage would impact completion of transfer.

5.10.4 JMTR Cask and Truck Transfer

The JMTR cask has extremely low efficiency of operations, which results in over 4.8 years being needed to transfer fuel, which is an unsatisfactory duration, and overwhelms all other advantages and disadvantages.

5.10.5 Commercial Radioactive Material Shipping Cask

The main advantages for the commercial cask/truck transfer alternative are:

- Commercial shipping casks are DOT certified for radioactive material shipments. Cask designs are already approved and obtaining casks is relatively simple. In addition, casks will come mounted on the trailer as part of the approved package.
- The casks would continue to have use even after fuel transfer was completed.
- Operational efficiency of a well designed transfer basket and commercially available cask is high. The number of canisters that can be moved at one time will depend on weight and criticality constraints, but could possibly be better than other options.

The main disadvantages of the commercial cask/truck transfer alternative are:

- There is a 12 to 18 month lead time to procure casks and trailers.
- Purchase of new casks, trailers, and transfer baskets have high capital costs, approximately \$2 million.
- Use of the commercial radwaste casks would require additional safety analysis to further affirm DOT/NRC equivalency for fuel transfer.

6.0 NO ACTION ALTERNATIVE

The no action alternative in this case is to leave the encapsulated irradiated fuel and encapsulated sludge in KE Basin until there exists some form of interim storage for the irradiated fuel and the sludge which contains fissionable plutonium, uranium, and some activation and fission products from the irradiation process. The no action alternative assumes the completion of the encapsulation work as planned by Westinghouse Hanford on the unencapsulated irradiated fuel in KE Basin and assumes the basin sludge is collected and encapsulated. This also assumes the upgrades identified for the KE Basin are completed.

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APPENDIX A

APPENDIX A PROVIDES THE ASSUMPTIONS AND
CALCULATIONS USED IN DETERMINING COSTS,
SCHEDULES, AND RADIATION EXPOSURES FOR FUEL
CONSOLIDATION ALTERNATIVES

FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES ASSUMPTIONS AND RATES

Major MOD of Casks Option (Not considered viable due to cost and schedule)

Estimated by B. H Johnson in Oct. 1993 at \$2,500,000 - \$3,500,000

New K Area Casks (9) estimated at \$5M-\$9M

Estimated by B. H Johnson in Oct. 1993

New Fuel Shipping Cask

Estimate provided by Jennifer Mercado 6/6/94

New fuel shipping casks will be designed to 10CFR71 but not certified (Cost and schedule)

New fuel shipping casks will use overpack (Cost and lower transfer efficiency)

New fuel shipping casks will require demonstration of DOT equivalency.

New fuel shipping casks will seal leak tight.

New fuel shipping cask will fit in loadout pit.

New fuel shipping casks will utilize current equipment.

New fuel shipping casks will hold three canisters.

Costs and schedule based on similar work on other fuel cask.

Other fuel cask design is less challenging than N Canisters

Costs are doubled

Schedule assumed to be at mid point of range

Costs to Obtain 6 New Design Fuel Shipping Casks (30 months) are as follows:

Develop design criteria	\$50,000
Design new casks	\$100,000
Purchasing	\$8,000
Project engineering and coordination.	\$137,500
Fabrication setup costs	\$150,000
Six Casks	\$360,000

Schedule estimated at 2-3 years. A duration of 30 months was assumed.

Radwaste Costs

\$50/cu ft including packaging, transportation and burial. Dave Ottley 4/27/94

Consumables, primarily clothing cost

Daily cost of set of coveralls is \$12. Dave Ottley 4/27/94

Three sets of coveralls a shift is assumed.

Labor Rates

per Clyde Gilson 6/7/94

	Fully Burdened Hourly Rate
Operators	\$42.00
Craft	\$42.00
KE Supv.	\$50.00
Eng.	\$55.00
Non Eng or HP Exempt	\$50.00
HPT	\$48.00
HP Exempt	\$57.00
Railroad	\$35.00
If exempt work combination of groups	\$52.00

Estimate Transfer Rates

1. It is assumed that two shifts will be utilized.
2. If train is used, a total of four (4) well car transfers per days are possible.
Assumes that 10% will provide sufficient time to complete the fourth transfer
Well Car holds three area casks = 9 canisters per trip.
3. If truck is used a total of seven (7) truck transfers per day occur.
Truck carries two casks per trip. = 6 canisters per trip.
Assumes that 10% will provide sufficient time to complete the seventh transfer
4. There are a total of 5168 canisters needing to be moved from KE.
1500 sludge canisters
3668 fuel canisters
5. 29 weeks needed to transfer by well car and train.
25 weeks needed for truck transfer of K Area casks.
6. Transfer rate by commercial cask and new fuel casks assumed same
as truck transfer of K Area Cask.
7. JMTR cask only transfer one (1) canister at a time.
Six (6) JMTR transfers are made per day.
8. This yields the following number of weeks for each transfer method

Well Car	Weeks
	30
Truck with K Area Cask, new fuel cask or commercial cask.	25
JMTR and Truck	175

FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES WELL CAR AND K AREA TRANSFER CASK IN CURRENT CONFIGURATION

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
Total No Well Car Modification	105 weeks	42068		\$5,171,964		123.918

(Dry transfer)

Total With Well Car Modification	112 weeks			\$306,160		137
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(Wet transfer)

The above totals have been derived from the following:

OBTAIN EQUIPMENT	21 weeks					
Prepare Decon Capability	12 weeks					
Craft		720	40	\$28,800	6	4.32
HPT		240	48	\$11,520	5	1.2
Exempt (Supv. and Eng.)		360	50	\$18,000	0.5	0.18
Management		90	60	\$5,400		
Decon Equip/Materials (1 CO2 Blaster)				\$600,000		
Purchasing		90	50	\$4,500		
Decon Well Car ext. (3 cars)	3 weeks					
Decon Worker		240	40	\$9,600	5	1.2
HPT		24	48	\$1,152	4	0.096
Supv		24	50	\$1,200	3	0.072
Radwaste (ft3)		50	50	\$2,500		
Decon Well Car Internals	3 weeks					
Decon Worker		240	40	\$9,600	25	6
HPT		24	48	\$1,152	15	0.36
Supv		24	50	\$1,200	10	0.24
Radwaste (ft3)		50	50	\$2,500		
Decon K Casks Int and External	3 weeks					
Decon Worker		240	42	\$10,080	30	7.2
HPT		24	48	\$1,152	20	0.48
Radwaste (ft3)		50		\$0		
Supv		24	50	\$1,200	10	0.24
PREPARE AREA/ EQUIPMENT	15 weeks					
Modify KE and KW Washdown System	12 weeks					
Operator		640	42	\$26,880	5	3.2
Craft		800	42	\$33,600	5	4
HPT		720	48	\$34,560	4	2.88
Exempt		360	52	\$18,720	0.4	0.144
Piping and Materials				\$100,000		
Radwaste (ft3)		100	50	\$5,000		
Well Car Repairs	6 weeks					
Craft		240	40	\$9,600	6	1.44
Supv.		24	50	\$1,200	5	0.12
HPT		24	48	\$1,152	4	0.096
Radwaste (ft3)		100	50	\$5,000		
K Area Cask Repairs	9 weeks					
Craft		360	40	\$14,400	8	2.88
Supv.		40	50	\$2,000	5	0.2
HPT		40	48	\$1,920	4	0.16
Radwaste (ft3)		50	50	\$2,500		

FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES WELL CAR AND K AREA TRANSFER CASK IN CURRENT CONFIGURATION

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
PREPARE AREA/ EQUIPMENT (cont'd)						
Prepare loadout area at KE	4 weeks					
Craft		160	42	\$6,720	7	1.12
Operator		160	42	\$6,720	7	1.12
HPT		80	48	\$3,840	6	0.48
Supv		42	50	\$2,100	6	0.252
Radwaste (ft3)		100	50	\$5,000		
Prepare loadout area at KW	4 weeks					
Operator		160	42	\$6,720	1	0.16
Craft		160	42	\$6,720	1	0.16
HPT		80	48	\$3,840	1	0.08
Supv		42	50	\$2,100	1	0.042
Radwaste (ft3)		100	50	\$5,000		
Certify cranes (KE&KW)	2 weeks					
Inspector		40	50	\$2,000	4.5	0.18
HPT		32	48	\$1,536	4.5	0.144
Operator		32	42	\$1,344	4.5	0.144
Railroad track preparation	4 weeks			\$14,000	NA	NA
ADMINISTRATIVE PREPARATION (39 weeks)						
Perform safety analysis work	26 weeks					
Exempt		2000	52	\$104,000	NA	NA
Prepare OSRs and procedures	26 weeks					
Exempt		2000	52	\$104,000	NA	NA
Obtain permits and approvals	26 weeks					
		1000	52	\$52,000	NA	NA
Consolidate Fuel (Two Shifts)	29 weeks	(Assumes Operators and railroad work 10 % overtime)				
Load at East						
Operator (3 people)		7656	44	\$336,864	6	45.936
HPT		2640	48	\$126,720	5	13.2
Supv. (50% at KE)		1200	50	\$60,000	4	4.8
Transport						
Railroad crew (3 people)		8376	37	\$309,912	1	8.376
Train operational expenses				\$70,000		
Unload at West						
Operators (3 people)		7656	44	\$336,864	1	7.656
HPT		2640	48	\$126,720	1	2.64
Supv. (50% at KW)		1200	50	\$60,000	0.6	0.72
Laundry and consumables				\$141,156		
Radwaste		200	50	\$10,000		
Cost of 1000 mrem						
Administrative Dose Limit				\$2,300,000		NA
Modify Well Car (Wet Transfer)	26 weeks	(Assumes crafts work 10% overtime)				
Modify well cars						
Craft		1760	42	\$73,920	6	10.56
Supv.		160	50	\$8,000	3	0.48
HPT		220	48	\$10,560	4	0.88
Management		100	60	\$6,000		
Purchasing		80	50	\$4,000		
Engineering		1000	55	\$55,000	1	1
Modify Well Car Materials				\$100,000		
Radwaste		100	50	\$5,000		
Laundry and Consumables				\$43,680		

FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES**K AREA CASK AND TRUCK TRANSFER**

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
Total K Area Cask/Truck Transfer	105 weeks	35448		\$5,268,344		93.658

The above totals have been derived from the following:

OBTAIN EQUIPMENT 18 months

Purchase Truck Tractor and Trailers

Obtain tractor and trailers (New purchase takes up to 18 months. Used may be faster.)

Obtain truck tractor (New cost)				\$80,000		NA
Obtain two trailers (110 Ton Low Boys. New Cost)				\$120,000		NA
Purchasing		80	50	\$4,000		
Project managemnt and coordination		200	55	\$11,000		
Prepare Decon Capability	12 weeks					
Craft		720	40	\$28,800	6	4.32
HPT		240	48	\$11,520	5	1.2
Exempt (Supv. and Eng.)		360	50	\$18,000	0.5	0.18
Management		90	60	\$5,400		
Decon Equip/Materials(1 CO2 Blaster)				\$600,000		
Purchasing		90	50	\$4,500		
Decon K Casks Int and External	3 weeks					
Decon Worker		240	42	\$10,080	30	7.2
HPT		24	48	\$1,152	20	0.48
Radwaste (ft3)		50		\$0		
Supv		24	50	\$1,200	10	0.24

PREPARE AREA/ EQUIPMENT 26 weeks

Modify KE and KW Washdown System 12 WEEKS

Operator		640	42	\$26,880	5	3.2
Craft		800	42	\$33,600	5	4
HPT		720	48	\$34,560	4	2.88
Exempt		360	52	\$18,720	0.4	0.144
Piping and Materials				\$100,000		
Radwaste (ft3)		100	50	\$5,000		
K Area Cask Repairs	9 weeks					
Craft		360	40	\$14,400	8	2.88
Supv.		40	50	\$2,000	5	0.2
HPT		40	48	\$1,920	4	0.16
Radwaste (ft3)		50	50	\$2,500		
Prepare Loadout Area KE	4 weeks					
Craft		160	42	\$6,720	7	1.12
Operator		160	42	\$6,720	7	1.12
HPT		80	48	\$3,840	6	0.48
Supv		42	50	\$2,100	6	0.252
Radwaste (ft3)		100	50	\$5,000		
Prepare Loadout Area KW	4 weeks					
Operator		160	42	\$6,720	1	0.16
Craft		160	42	\$6,720	1	0.16
HPT		80	48	\$3,840	1	0.08
Supv.		42	50	\$2,100	1	0.042
Radwaste (ft3)		100	50	\$5,000		
Certify Cranes (KE&KW)	2 weeks					
Inspector		40	50	\$2,000	4.5	0.18
HPT		32	48	\$1,536	4.5	0.144
Operator		32	42	\$1,344	4.5	0.144

**FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES
K AREA CASK AND TRUCK TRANSFER**

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
PREPARE AREA/ EQUIPMENT (Cont'd)						
Install Trailer Contamination Control	26 weeks				0	NA
Engineering		960	55	\$52,800		
Purchasing		120	50	\$6,000		
Materials				\$100,000		
Craft		1440	42	\$60,480		
Supervision		120	50	\$6,000		
Improve/Build Road	26 weeks			\$300,000		NA
ADMINISTRATIVE PREPARATION (39 weeks)						
Perform Safety Analysis Work	26 weeks					
Exempt		2000	52	\$104,000	NA	NA
Prepare OSRs and Procedures	26 weeks					
Exempt		2000	52	\$104,000	NA	NA
Obtain Permits and Approvals	26 weeks					
		1500	52	\$78,000	NA	NA
Consolidate Fuel (Two Shifts)	25 weeks	(Assumes Operators and drivers work 10% overtime)				
Load at East						
Operator (3 people)		6600	44	\$290,400	6	39.6
HPT		2400	48	\$115,200	5	12
Supv. (50% at KE)		1200	50	\$60,000	4	4.8
Transport						
Truck Driver (1 person)		2272	44	\$99,968	1	2.272
Truck Operational Expense				\$40,000		
Unload at West						
Operator (3 people)		6600	44	\$290,400	1	6.6
HPT		2400	48	\$115,200	1	2.4
Supv. (50% at KW)		1200	50	\$60,000	0.6	0.72
Laundry and Consumables				\$102,024		
Radwaste		200	50	\$10,000		
Cost of 1000 mrem						
Administrative Dose Limit				\$2,300,000		NA

FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES COMMERCIAL RAD MATERIAL SHIPPING CASK AND TRUCK TRANSFER

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
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Totals Commercial Rad Material

Cask/ Truck Transfer	103 weeks	34620	NA	\$7,164,092	NA	82.498
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The above totals have been derived from the following:

OBTAIN EQUIPMENT

Obtain 2 commercial casks (18 months)

Design engineering and purchasing	80	50	\$4,000		
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Purchase new casks			\$1,500,000		NA
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Purchase transfer baskets			\$200,000		NA
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Project management and coordination.	200	55	\$11,000		
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Purchase tractor and trailers (New purchase takes up to 18 months. Used may be faster.)

Obtain truck tractor (New cost)			\$80,000		NA
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Obtain two trailers (110 Ton Low Boys. New Cost)			\$120,000		NA
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Purchasing and engineering	80	50	\$4,000		
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Project management	200	50	\$10,000		
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Prepare Decon capability 12 weeks

Craft	720	40	\$28,800	6	4.32
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HPT	240	48	\$11,520	5	1.2
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Exempt (Supv. and Eng.)	360	50	\$18,000	0.5	0.18
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Management	90	60	\$5,400		
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Decon Equip/materials (2 CO2 blaster)			\$600,000		
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Purchasing	90	50	\$4,500		
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PREPARE AREA/ EQUIPMENT 26 weeks

Modify KE and KW washdown system 12 weeks

Operator	640	42	\$26,880	5	3.2
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Craft	800	42	\$33,600	5	4
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HPT	720	48	\$34,560	4	2.88
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Exempt	360	52	\$18,720	0.4	0.144
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Piping and Materials			\$100,000		
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Radwaste (ft3)	100	50	\$5,000		
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Prepare loadout Area KE 4 weeks

Craft	160	42	\$6,720	7	1.12
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Operator	160	42	\$6,720	7	1.12
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HPT	80	48	\$3,840	6	0.48
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Supv	42	50	\$2,100	6	0.252
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Radwaste (ft3)	100	50	\$5,000		
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Prepare loadout area KW 4 weeks

Operator	160	42	\$6,720	1	0.16
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Craft	160	42	\$6,720	1	0.16
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HPT	80	48	\$3,840	1	0.08
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Supv	42	50	\$2,100	1	0.042
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Radwaste (ft3)	100	50	\$5,000		
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Certify cranes (KE&KW) 2 weeks

Inspector	40	50	\$2,000	4.5	0.18
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HPT	32	48	\$1,536	4.5	0.144
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Operator	32	42	\$1,344	4.5	0.144
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**FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES
COMMERCIAL RAD MATERIAL SHIPPING CASK AND TRUCK TRANSFER**

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
PREPARE AREA/ EQUIPMENT (Cont'd)						
Install trailer contamination control	26 weeks				0	NA
Engineering		960	55	\$52,800		
Purchasing		120	50	\$6,000		
Materials				\$100,000		
Craft		1440	42	\$60,480		
Supervision		120	50	\$6,000		
Improve/Build Road	26 weeks			\$300,000		NA
ADMINISTRATIVE PREPARATION (39 weeks)						
Perform safety analysis work	26 weeks					
Exempt		2000	52	\$104,000	NA	NA
Prepare OSRs and procedures	26 weeks					
Exempt		2000	52	\$104,000	NA	NA
Obtain permits and approvals	26 weeks					
		1500	52	\$78,000	NA	NA
Consolidate Fuel (Two Shifts)	25 weeks	(Assumes Operators and drivers work 10% overtime)				
Load at East						
Operator (3 people)		6600	44	\$290,400	6	39.6
HPT		2400	48	\$115,200	5	12
Supv. (50% at KE)		1200	50	\$60,000	4	4.8
Transport						
Truck driver (1 person)		2272	44	\$99,968	1	2.272
Truck operational expense				\$40,000		
Unload at West						
Operator (3 people)		6600	44	\$290,400	1	6.6
HPT		2400	48	\$115,200	1	2.4
Supv. (50% at KW)		1200	50	\$60,000	0.6	0.72
Laundry and consumables				\$102,024		
Radwaste		200	50	\$10,000		
Cost of 1000 mrem						
Administrative Dose Limit (includes training costs)				\$2,300,000		NA

FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES

NEW FUEL SHIPPING CASK AND TRUCK TRANSFER

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
Totals New Fuel Cask and Truck Transfer	154 weeks	34820		\$6,254,592		82.498
The above totals have been derived from the following:						
OBTAIN EQUIPMENT	30 months					
Obtain 6 New Design Fuel Shipping Casks (30 months)						
Develop design criteria				\$50,000		
Design new casks				\$100,000		NA
Purchasing		160	50	\$8,000		NA
Project engineering and coordination		2500	55	\$137,500		NA
Fabrication setup costs				\$150,000		NA
Cask costs		6	60000	\$360,000		NA
Purchase Tractor and Trailers (New purchase takes up to 18 months. Used may be faster.)						
Obtain Truck Tractor (New cost)				\$80,000		NA
Purchasing			50			
Obtain two trailers (110 Ton Low Boys. New Cost)				\$120,000		NA
Purch and eng		80	50	\$4,000		
Purchase and Eng.		200	50	\$10,000		
Prepare Decon Capability	12 weeks					
Craft		720	40	\$28,800	6	4.32
HPT		240	48	\$11,520	5	1.2
Exempt (Supv. and Eng.)		360	50	\$18,000	0.5	0.18
Management		90	60	\$5,400		
Decon Equip/Materials(2 CO2 Blaster)				\$600,000		
Purchasing		90	50	\$4,500		
PREPARE AREA EQUIPMENT	26 weeks					
Modify KE and KW Washdown System	12 weeks					
Operator		640	42	\$26,880	5	3.2
Craft		800	42	\$33,600	5	4
HPT		720	48	\$34,560	4	2.88
Exempt		360	52	\$18,720	0.4	0.144
Piping and Materials				\$100,000		
Radwaste (ft3)		100	50	\$5,000		
Prepare Loadout Area KE	4 weeks					
Craft		160	42	\$6,720	7	1.12
Operator		160	42	\$6,720	7	1.12
HPT		80	48	\$3,840	6	0.48
Supv		42	50	\$2,100	6	0.252
Radwaste (ft3)		100	50	\$5,000		
Prepare Loadout Area KW	4 weeks					
Operator		160	42	\$6,720	1	0.16
Craft		160	42	\$6,720	1	0.16
HPT		80	48	\$3,840	1	0.08
Supv		42	50	\$2,100	1	0.042
Radwaste (ft3)		100	50	\$5,000		
Certify Cranes (KE&KW)	2 weeks					
Inspector		40	50	\$2,000	4.5	0.18
HPT		32	48	\$1,536	4.5	0.144
Operator		32	42	\$1,344	4.5	0.144

**FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES
NEW FUEL SHIPPING CASK AND TRUCK TRANSFER**

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
PREPARE AREA/ EQUIPMENT (Cont'd)						
Install Trailer Contamination Control	26 weeks				0	NA
Engineering		960	55	\$52,800		
Purchasing		120	50	\$6,000		
Materials				\$100,000		
Craft		1440	42	\$60,480		
Supervision		120	50	\$6,000		
Improve/Build Road	26 weeks			\$300,000		NA
ADMINISTRATIVE PREPARATION (39 weeks)						
Perform Safety Analysis Work	26 weeks					
Exempt		2000	52	\$104,000	NA	NA
Prepare OSRs and Procedures	26 weeks					
Exempt		2000	52	\$104,000	NA	NA
Obtain Permits and Approvals	26 weeks					
		1500	52	\$78,000	NA	NA
Consolidate Fuel (Two Shifts)	25 weeks	(Assumes Operators and drivers work 10% overtime)				
Load at East						
Operator(3 people)		6600	44	\$290,400	6	39.6
HPT		2400	48	\$115,200	5	12
Supv. (50% at KE)		1200	50	\$60,000	4	4.8
Transport						
Truck Driver (1 person)		2272	44	\$99,968	1	2.272
Truck Operational Expense				\$40,000		
Unload at West						
Operator (3 people)		6600	44	\$290,400	1	6.6
HPT		2400	48	\$115,200	1	2.4
Supv. (50% at KW)		1200	50	\$60,000	0.6	0.72
Laundry and Consumables				\$102,024		
Radwaste		200	50	\$10,000		
Cost of 1000 mrem						
Administrative Dose Limit				\$2,300,000		NA

FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES**JMTR CASK AND TRUCK TRANSFER**

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
Totals JMTR Cask and Truck						
Transfer	58 months	142837	NA	\$24,542,099	NA	442.3
The above totals have been derived from the following:						
OBTAIN EQUIPMENT	18 months					
Prepare Decon Area (at KE only)	12 weeks					
Craft		720	42	\$30,240	9	6.5
HPT		240	48	\$11,520	6	1.4
Exempt (Supv. and Eng.)		360	52	\$18,720	0.5	0.2
Decon Equip/Materials (1 CO2 Blaster)				\$300,000		
Modify KE and KW Washdown System	12 weeks					
Craft		1440	42	\$60,480	5	7.2
HPT		720	48	\$34,560	4	2.9
Exempt		360	52	\$18,720	0.4	0.1
Piping and Materials				\$100,000		
Radwaste (ft3)						
Purchase Tractor and Trailers (New purchase takes up to 18 months. Used may be faster.)						
Obtain Truck Tractor (New cost)				\$80,000		NA
Obtain two trailers (110 Ton Low Boys. New Cost)				\$120,000		NA
Purchasing		80	50	\$4,000		
Purchase and Eng.		120	55	\$6,600		
PREPARE AREA/ EQUIPMENT	15 weeks					
Cask Repair	9 weeks					
Maintenance Worker		80	42	\$3,360	8	0.6
Supv.		20	50	\$1,000	3	0.1
HPT		10	48	\$480	4	0.0
Radwaste (ft3)						
Prepare Loadout Area KE	4 weeks					
Bargaining Unit		320	42	\$13,440	9	2.9
HPT		80	48	\$3,840	9	0.7
Supv		42	50	\$2,100	9	0.4
Radwaste (ft3)						
Prepare Loadout Area KW	4 weeks					
Bargaining Unit		320	42	\$13,440	1	0.3
HPT		80	48	\$3,840	1	0.1
Supv		42	50	\$2,100	1	0.0
Radwaste (ft3)						
Certify Cranes (KE&KW)	2 weeks					
Inspector		40	50	\$2,000	4.5	0.2
HPT		32	48	\$1,536	4.5	0.1
Operator		32	42	\$1,344	4.5	0.1
Prepare Road Between KE and KW	26 weeks			\$300,000		
ADMINISTRATIVE PREPARATION (39 weeks)						
Perform Safety Analysis Work	26 weeks					
Exempt		1500	50	\$75,000	Na	NA
Prepare OSRs and Procedures	26 weeks					
Exempt		1500	50	\$75,000	Na	NA
Obtain Permits and Approvals	26 weeks					
		750	50	\$37,500	Na	NA

FUEL CONSOLIDATION COST, SCHEDULE, AND EXPOSURE ESTIMATES**JMTR CASK AND TRUCK TRANSFER**

	Duration (Weeks)	Man (Hours)	Rate (per Hour)	Cost (Dollars)	Dose Rate (mrem/hr)	Man Rem (Rem)
Consolidate Fuel (Two Shifts)	40 months					
Load at East (6 trips per day)						
Operator (3 people)		44000	44	\$1,936,000	6	264.0
HPT		13222	48	\$634,667	5	66.1
Supv. 50% at KE)		4400	50	\$220,000	4	17.6
Transport						
Truck Drivers		14544	44	\$639,945	2	29.1
Truck Operational Expense			50000	\$1		
Unload at West						
Operator (3 people)		44000	44	\$1,936,000	1	44.0
HPT		13222	48	\$634,667	1	13.2
Supv. (50% at KW)		4400	50	\$220,000	0.6	2.6
Cost of 1000 mrem						
Administrative Dose Limit (need additional 70 operators/year)				\$17,000,000		NA