Alternative C2 – Savannah River Vault – Double Stack (3 Sheets)

Evaluation Criteria Category	Evaluation Criteria Description	Performance of Alternative	Weight	Score	Subtotal
Constructability	Qualitative measure of ease of construction assessing complexity, ability to use standard construction methods and materials.	Constructability is similar in both options – C2 has smallest footprint and quantity of vaults and the load-in/ load-out cell interface is least complicated as it will be above grade. Overall C2 is marginally less complex than C1.	5	2	10
Capital cost	Comparison of the capital cost for each option. Capital cost is a relative cost factor only, based on cost elements that are major discriminators only.	Footprint of vault is 17,040 ft^2 and volume of vault is 630,480 ft^3. This is best of both options, when the operating area volume is factored in. This option will incur less capital costs to ventilate than the double stacking option – having overall 55% less volume to ventilate than Alternative C1. From an equipment standpoint this option is the least expensive – with a $22M vault equipment costs and least bulk concrete required. HVAC will also be proportionate due to least overall volume.	20	2	40
Operating cost	Comparison of the O&M costs for each option. Costs will be a relative cost factor only.	Operating costs will be similar scoring to capital costs – HVAC running costs will be smallest of all options.	15	2	30
Total score					*200*

ALARA = as low as reasonably achievable.
HVAC = heating, ventilation, and air conditioning.
O&M = Operations and Maintenance.
SCT = shielded canister transporter.

Alternative D1 – Dry Cask Storage – Single Canister Overpacks (4 Sheets)

Evaluation Criteria Category	Evaluation Criteria Description	Performance of Alternative	Weight	Score	Subtotal
Operability	Qualitative measure of inherent complexity determined by the following factors: • Physical complexity • Operator interfaces • System responsiveness.	Physical complexity of loading single canisters horizontally in the load-in/load-out cell is increased over vertical loading as the canisters are designed for vertical handling and additional equipment would be required in the load-in/load-out cell to turn the canisters to the horizontal and push them into the overpack. In addition, due to size of storage pad required handling times will be more than handling a multi-canister overpack, as five overpacks need to be retrieved to fill one MGR cask. Scores worst of both options.	10	1	10
Availability	Qualitative measure of the following: • Maintainability • Reliability • Inspectability.	There are more unit operations involved in handling the canister horizontally and vertically, as opposed to just vertically. This necessitates additional handling equipment; therefore, probability of failure increases. Scores worst of both options.	10	1	10
Technology Maturity	Measure of the relative maturity of the concept applied on a production scale in the nuclear industry.	Horizontal handling of SNF into dry casks is a proven concept. However, the IHLW canister is thin-walled and not designed to be handled or stored horizontally and the existing design would have to be analyzed accordingly. Therefore, for this particular application the application is not proven.	5	1	5

Alternative D1 – Dry Cask Storage – Single Canister Overpacks (4 Sheets)

Evaluation Criteria Category	Evaluation Criteria Description	Performance of Alternative	Weight	Score	Subtotal
Expandability	Qualitative measure of the ease with which each concept can be expanded to add an additional storage module.	Expandability is a simple matter of expanding the storage pad size to accommodate additional overpacks. However, due to the overall footprint required for this storage pad it is the most constrained of any of the alternatives analyzed in this report and significantly larger than Alternative D2. Scores worst of both options.	5	1	5
Environmental	Measurement of the following factors: • Airborne effluent generation and associated cleanup equipment • Secondary solid and liquid waste generation and disposal • Permitting requirements.	From a permitting standpoint there is little difference between the options. Both overpack types would go through the same permitting process. There is significantly more handling equipment required in this option than in D2 and therefore solid waste from maintenance activities would be the largest of both options. Scores worst of both options.	10	1	10
Safety	Assessment of the following factors: • Radiological protection and criticality safety • Industrial safety • ALARA.	Both overpack types and storage configurations will be designed to be critically safe. There are five times as many overpacks in this option as well as discrete handling operations, and therefore more challenge on operational safety. Scores worst of all options.	15	1	15

Alternative D1 – Dry Cask Storage – Single Canister Overpacks (4 Sheets)

Evaluation Criteria Category	Evaluation Criteria Description	Performance of Alternative	Weight	Score	Subtotal
Decontamination/ decommissioning	Qualitative measure of features incorporated into design to facilitate future decontamination for decommissioning.	Quantity of handling equipment in the load-in/load-out cell is greater than in D2 and therefore more to D&D. 1,960,000 ft^3 of concrete is required to construct a storage pad for 2,000 single canister overpacks and represents 267% more concrete to dispose of than for the 5-canister overpack configuration. The single-canister overpack also require 2.5 times as much total concrete to construct as the 5-canister overpacks. Scores worst of all options.	5	1	5
Constructability	Qualitative measure of ease of construction assessing complexity, ability to use standard construction methods and materials.	The single canister overpacks can be constructed offsite for shipment to the HSF. The multi-canister overpacks should be constructed onsite. The storage pad is significantly larger than in D2 (more than double) but has the same constructability issues as D2. Overall marginally better than D2.	5	2	10
Capital cost	Comparison of the capital cost for each option. Capital cost is a relative cost factor only, based on cost elements which are major discriminators only.	The load-in/load-out cell will be larger and have more mechanical handling equipment for this option. From an equipment standpoint this option is the most expensive.	20	1	20

Alternative D1 – Dry Cask Storage – Single Canister Overpacks (4 Sheets)

Evaluation Criteria Category	Evaluation Criteria Description	Performance of Alternative	Weight	Score	Subtotal
Operating cost	Comparison of the O&M costs for each option. Costs will be a relative cost factor only.	Operating costs will be similar scoring to capital costs. Because canisters are handling singularly then there are five operations required for transfer to and from the storage pad and therefore operational time and cost is *significantly larger*. Scores worst of both options.	15	1	15
Total score					105

ALARA = as low as reasonably achievable.
D&D = decontamination and decommissioning.
HSF = Hanford Shipping Facility.
IHLW = immobilized high-level waste.
O&M = Operations and Maintenance.
MGR = monitored geologic repository.
SNF = spent nuclear fuel.

Alternative D2 – Dry Cask Storage – Five Canister Overpacks (3 Sheets)

Evaluation Criteria Category	Evaluation Criteria Description	Performance of Alternative	Weight	Score	Subtotal
Operability	Qualitative measure of inherent complexity determined by the following factors: • Physical complexity • Operator interfaces • System responsiveness.	Physical complexity of loading multiple canisters vertically in the load-in/load-out cell is decreased over horizontal loading as the canisters are designed for vertical handling and no additional handling equipment would be required in the load-in/load-out cell. In addition, size of storage pad required handling times will be significantly less than handling a single-canister overpack, as five overpacks. Scores best of both options.	10	2	20
Availability	Qualitative measure of the following: • Maintainability • Reliability • Inspectability.	There are five times less unit operations involved in handling the canister vertically, as opposed to vertically and horizontally. This reduces handling equipment and therefore probability of failure decreases. Scores best of both options.	10	2	20
Technology maturity	Measure of the relative maturity of the concept applied on a production scale in the nuclear industry	Vertical handling of SNF into dry casks is a proven concept and can be applied directly to IHLW canisters. Therefore scores best as D1 is not proven for IHLW canister handling.	5	2	10
Expandability	Qualitative measure of the ease with which each concept can be expanded to add an additional storage module.	Expandability is a simple matter of expanding the storage pad size to accommodate additional overpacks. The overall footprint required for this storage pad is the least constrained of the two alternatives, and significantly smaller than Alternative D1. Scores worst of both options.	5	2	10

Alternative D2 – Dry Cask Storage – Five Canister Overpacks (3 Sheets)

Evaluation Criteria Category	Evaluation Criteria Description	Performance of Alternative	Weight	Score	Subtotal
Environmental	Measurement of the following factors: • Airborne effluent generation and associated cleanup equipment • Secondary solid and liquid waste generation and disposal • Permitting requirements.	From a permitting standpoint there is little difference between the options. Both overpack types would go through the same permitting process. There is significantly less handling equipment required in this option than in D1 and therefore solid waste from maintenance activities would be the smallest of both options. Scores best of both options.	10	2	20
Safety	Assessment of the following factors: • Radiological protection and criticality safety • Industrial safety • ALARA.	Both overpack types and storage configurations will be designed to be critically safe. There are five times less overpacks in this option, as well as discrete handling operations, and therefore less challenge on operational safety. Scores best of all options.	15	2	30
Decontamination/ decommissioning	Qualitative measure of features incorporated into design to facilitate future decontamination for decommissioning.	Quantity of handling equipment in the load-in/load-out cell is less than in D1 and therefore more to D&D. 735,00 ft^3 of concrete is required to construct the 400 five-canister overpacks and represents significantly less concrete to dispose of than in the single canister overpack configuration. Scores best of all options.	5	2	10
Constructability	Qualitative measure of ease of construction assessing complexity, ability to use standard construction methods and materials.	The five-canister overpacks should be constructed onsite because of their size and weight for shipment to the HSF. The storage pad is significantly smaller than in D1 but has the same constructability issues as D1. Overall marginally worse than D1.	5	1	5

Alternative D2 – Dry Cask Storage – Five Canister Overpacks (3 Sheets)

Evaluation Criteria Category	Evaluation Criteria Description	Performance of Alternative	Weight	Score	Subtotal
Capital cost	Comparison of the capital cost for each option. Capital cost is a relative cost factor only, based on cost elements that are major discriminators only.	The load-in/load-out cell will be impacted less in this option than in D1 and have less mechanical handling equipment for this option.	20	2	40
Operating cost	Comparison of the O&M costs for each option. Costs will be a relative cost factor only.	Operating costs will be similar scoring to capital costs. Because canisters are handling in fives then there are less operations required for transfer to and from the storage pad and therefore operational time and cost is significantly smaller. Scores best of both options.	15	2	30
Total score					**195**

ALARA = as low as reasonably achievable.
D&D = decontamination and decommissioning.
HSF = Hanford Shipping Facility.
IHLW = immobilized high-level waste.
O&M = Operations and Maintenance.
SNF = spent nuclear fuel.

ATTACHMENT B2
EVALUATION MATRICES FOR PREFERRED VAULT CONCEPT

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Evaluation Criteria Matrix – Open Rack Vault Alternative A2 (3 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Operability	10	The use of a laser guided overhead crane for placing canisters into an open rack module is an overall simpler concept than using a charge machine (in Alternatives B2 and C2), which requires multiple operations to load the canister into the tube/rack. The crane is a less complex machine than the gantry crane/charge machine/SCT as evidenced by the difference in capital cost. System *responsiveness is better with an in-cell crane*, speed is greater, and overall operational time is less than the gantry crane/charge machine/SCT alternative. Dry cask storage is worst of all options due to multiple tasks required to transfer to and from storage pad. A2 receives best score.	4	40
Availability	10	The simple handling equipment for this alternative provides the greatest availability.	4	40
Technology Maturity	5	The in-cell crane is proven in the U.S. and U.K., as are the other concepts. All receive best score. Receives the best score.	4	20
Expandability	5	Expansion is relatively easy, using a bogie transfer tunnel to transfer between adjacent vault modules. As the vault is open, bay the bay cannot be extended simply to utilize the same crane for future expansions, as in B2 and in C2. The dry cask storage pad can easily be expanded to add more overpacks. This option, although requiring an additional in-cell crane in the expansion module has the smallest footprint of all options and is therefore the least constrained from a siting perspective. Receives best score.	4	20

Evaluation Criteria Matrix – Open Rack Vault Alternative A2 (3 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Environmental	10	This concept requires an active ventilation system to cool the vault. Vault volume is minimized (684,759 ft^3) which is 64% of B2 and there is no large operating area that requires ventilation over the vault as in C2 also. Overall emissions have potential to be greater due to the need to active ventilate the vault than in B2. Overall passive system in B2 is better than in A2. Receives second worst score.	2	20
Safety	15	Canister storage loading operations are totally remote, therefore minimizing dose to operators. Maintenance of handling equipment is in a dedicated area with requisite shielding. The main difference is that the charge machine in B2 and C2 requires temporary tenting/HVAC provisions and there is a greater potential for safety incidents than A2. In D2 the canisters are constantly being transferred into and out of cell for the external storage and therefore more chance for a safety incident. Receives best score.	4	60
Decontamination/ decommissioning	5	In the open rack storage concepts A2 and C2, there is a slightly greater potential for contamination build up in the vault area over time that will require decontamination during decommissioning via cross-contamination of canisters. However, the intention is that canisters will be checked for contamination before storage. Decontaminable surfaces will be provided and the overall volume for decontamination is 56% of B2 and slightly more than C2. Overall slightly worse than B2 and C2 but not as great as D2.	2	10

Evaluation Criteria Matrix – Open Rack Vault Alternative A2 (3 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Constructability	5	Construction is a simple regular box shape with the roof acting as a diaphragm. There are no complicated penetrations and 12,245 yd^3 of bulk concrete are required. This is 48% of that required in B2 and less than C2, which also has 173 Tons of steel for the large operating area over the vault. Receives second best score.	3	15
Capital cost	20	The active volume of the vault is 684,759 ft^3, which is 64% of B2 but slightly more than C2. Vault volume is less than B2 due to smaller canister pitching in the rack that can be achieved using closed tubes. Receives best score Capital cost of this alternative is significantly smaller than all other alternatives. The discriminating cost elements of $7.9M for mechanical handling equipment (16% of B2) and $11M for bulk concrete construction is significantly smaller than B2 and C2. Receives best score.	4	80
Operating cost	15	Vault requires active ventilation for the 684,759 ft^3 vault area. Ventilation will be via single-stage HEPA filtration and fan system to a single stack. This volume is 1/3 of the operating area volume requiring ventilation in B2 and, although no detailed estimates have been prepared, running costs for the once-through active system will be lower than in B2 or C2. Receives best score.	4	60
Total score				365

HEPA = high-efficiency particulate air.
HVAC = heating, ventilation, and air conditioning.
SCT = shielded canister transporter.

Evaluation Criteria Matrix – Closed Tube Alternative B2 (3 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Operability	10	The use of a gantry-mounted charge machine for canister placement is a proven concept; however, it is a more complex machine, requiring a number of manual and automated movements for canister storage loading. System responsiveness is worse than the open rack concept due to quantity of operations, slower speed of gantry, etc. The gantry is better than the SCT as positioning of the gantry is automated, and also better than the dry cask storage system, which has multiple operations for transfer to storage. Receives next to best score.	3	30
Availability	10	The gantry crane/charge machine is located out-cell in a readily accessible area for maintenance. However, the complexity of the machine is greater than the in-cell crane in Alternative A2, and although gantry maintenance will be easier than the in-cell crane, maintenance of the charge machine is complicated and lengthy, requiring tenting and temporary HVAC provisions. This is the same for the SCT in C2. Availability should be greater than equipment provided in C2 and D2. Receives second best score	3	30
Technology maturity	5	The gantry crane/charge machine is proven both in the U.S. and U.K. and there is no difference than the other concepts. Receives best score.	4	20
Expandability	5	This vault concept has the option to either expand the vaults at the end of the existing array or extend the gantry crane/charge machine travel to cover the new vaults or a bogie tunnel transfer can be provided, as in A2. Overall there is more expansion capability, but the footprint (30,163 ft^2) is 240% more than A2, 177% more than C2, and 22% of D2. Receives second worst score.	2	10

Evaluation Criteria Matrix – Closed Tube Alternative B2 (3 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Environmental	10	Canister storage is passively ventilated and canisters do not come into contact with cooling air. However, there is a large operating area over the vault that requires ventilation. Overall this system places less of a challenge on emissions than open rack concepts A2 and C2. Receives second best score.	3	30
Safety	15	Canister storage loading takes place with operators local to the storage tube, shielded by the charge machine and the charge floor concrete bulk shielding. Due to more complex canister storage loading operations and maintenance operations this option has a slightly greater potential for safety incidents than A2. Receives second to best score, as potential for incident is less in this concept than using the SCT in C2.	3	45
Decontamination/decommissioning	5	The closed tube concept segregates the canisters from each other and the cooling air does not come into contact with the canisters. Although there is a larger volume to decontaminate there is an overall advantage over A2 with the closed tube concept. Scores best.	4	20
Constructability	5	Construction of the basic vault uses regular box shapes; however, the charge floor is very complicated, catering for the penetration for the storage tubes. Much larger volume of bulk concrete required in this option and in addition there is 496 tons of primary steel required for the operating area structure. Overall more complex than A2 and C2. Receives worst score.	1	5

Evaluation Criteria Matrix – Closed Tube Alternative B2 (3 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Capital cost	20	The active volume of the vault is 1,069,744 ft^3, which is 56% more than A2. In addition, there is an additional 1,950,000 ft^3 of Operating Area space above the vault for the gantry crane operation. Vault volume is less than A2 due to larger canister spacing in the tubes (4ft, 6 in.) that can be achieved using open rack (3 ft, 0 in.). Capital cost discriminating elements are significantly larger than A2 with $49M in mechanical handling equipment and $19M in bulk concrete costs. Costs are more than C2. but less than D2. Receives second lowest score.	2	40
Operating cost	15	Vault volume of 1,247,664 ft^3 is passively ventilated and running costs are for monitoring systems only. However, the operating area above the vault is 1,951,560 ft^3 and this requires ventilation and filtration. This ventilation system includes a recirculation system and a bleed via HEPA filtration to a single stack. Detailed estimates have not been prepared but it is thought that running costs to ventilate an area 3 times the vault area in A2 will be greater. Running costs will be more than C2 based on active and operating volumes but less than D2.	2	30
Total score				260

HEPA = high-efficiency particulate air.
HVAC = heating, ventilation, and air conditioning.
SCT = shielded canister transporter.

Evaluation Criteria Matrix – Savannah River Vault Alternative C2 (2 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Operability	10	The SCT is more complicated to position than the gantry mounted charge machine in B2 and more complicated than the in-cell crane in A2. However, it is better than D2, where multiple operations are required for transfer to storage. Receives second to worst score.	2	20
Availability	10	The SCT is located out-cell in a readily accessible area for maintenance. However, the complexity of the machine is greater than the in-cell crane in A2 and SCT maintenance is complicated and lengthy, requiring tenting and temporary HVAC provisions. This alternative is however better than D2. Receives second to worst score.	2	20
Technology maturity	5	The SCT is proven at SRS, as are the other concepts. Receives best score.	4	20
Expandability	5	This concept would expand adjacent to the existing vault and use the same SCT. Overall the footprint (17,040 ft^2) is less constrained than B2 and D2. Receives second best score.	3	15
Environmental	10	The storage area is actively ventilated and canisters come into contact with cooling air. In addition there is a large operating area over the vault that requires ventilation. Overall this system places more of a challenge on emissions. Receives worst score.	1	10
Safety	15	Storage loading takes place with operators local to the storage tube, shielded by the charge machine and the charge floor concrete bulk shielding. Because of more complex canister storage loading operations and maintenance operations this option has a slightly greater potential for safety incidents than A2 and B2. Receives second to worst score.	2	30
Decontamination/decommissioning	5	This alternative uses an open rack concept and therefore from a D&D perspective is not as good as B2, but better than D2 and A2. Scores second best.	3	15

Evaluation Criteria Matrix – Savannah River Vault Alternative C2 (2 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Constructability	5	Construction of the basic vault uses regular box shapes; however, the charge floor is very complicated, because of the penetrations for the shield plugs. Much larger volume of bulk concrete required in this option and in addition there is 176 tons of primary steel required for the operating area structure. Overall more complex than A2, less than B2. Receives second worst score.	2	10
Capital cost	20	Capital costs are better than B2 and D2, but not as good as A2, with $22M of vault equipment, $20M in concrete construction costs. Receives second best score.	3	60
Operating cost	15	Vault volume of 630,480 ft^3 is actively ventilated. The operating area above the vault is 681,600 ft^3 and this requires ventilation and filtration. This ventilation system includes a recirculation system and a bleed via HEPA filtration to a single stack. Detailed estimates have not been prepared, but it is thought that running costs to ventilate an area two times (total) the vault area in A2 will be greater; therefore receives second to best score.	3	45
Total score				**245**

D&D = decontamination and decommissioning.
HEPA = high-efficiency particulate air.
HVAC = heating, ventilation, and air conditioning.
SCT = shielded canister transporter.
SRS = Savannah River Site.

Evaluation Criteria Matrix – Dry Cask Storage Alternative D2 (2 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Operability	10	The operations involved with load out and transfer to and from the storage pad make this option the most time consuming and costly from an operations standpoint. Receives worst score.	1	10
Availability	10	The overall quantity of handling equipment in this concept is greater than in all the other concepts and, therefore, due to complex and lengthy handling availability will be the most challenged. Receives worst score.	1	10
Technology maturity	5	The concept of vertical dry cask loading is proven in the U.S. Receives best score.	4	20
Expandability	5	The storage pad has a footprint of 138,000 ft^2 and therefore is the most constrained for siting of all the options. Expansion is simple but the storage size constrains siting. Receives worst score.	1	5
Environmental	10	From an environmental perspective casks are sealed and there is no active ventilation system. Receives best score.	4	40
Safety	15	Transfer to storage requires the canister to go in and out of cell and therefore most potential for safety incidents. Receives worst score.	1	15
Decontamination/decommissioning	5	This concept involves more handling equipment than other concepts and requires D&D of 400 casks and a large storage pad. Scores worst of all concepts.	1	5
Constructability	5	Construction of a concrete pad is simpler than the other options and receives best score.	4	20
Capital cost	20	This option has largest capital costs with $110M in overpack costs and $12M in handling equipment costs. Scores the worst of all options.	1	20

Evaluation Criteria Matrix – Dry Cask Storage Alternative D2 (2 Sheets)

Evaluation Criteria	Criteria Weight	Performance	Score	Weighted Score
Operating cost	15	An additional loading bay is required in this option, and although the storage pad has no ventilation operating costs, the complex handling operations to take overpacks to and from the storage pad will be more costly than the other alternates. Receives worst score.	1	15
Total score				160

D&D = decontamination and decommissioning.

APPENDIX C
HANFORD SHIPPING FACILITY MATERIAL HANDLING EVALUATION

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CONTENTS

ATTACHMENTS

TABLE

LIST OF TERMS

CSB	Canister Storage Building
DOE	U.S. Department of Energy
HLW	high-level waste
HSF	Hanford Shipping Facility
IHLW	immobilized high-level waste
LSTS	locally shielded transfer system
MCO	multi-canister overpack
MGR	monitored geologic repository
MHM	MCO handling machine
SNF	spent nuclear fuel
WTP	Waste Treatment Plant

C1.0 PROBLEM STATEMENT

Provide a technically feasible and cost-effective material handling concept within the Hanford Shipping Facility (HSF) required for shipping and receiving of canisters containing immobilized high-level waste (IHLW) and spent nuclear fuel (SNF). The material handling concepts include those necessary for the following activities:

- Shipping and receiving bays for the onsite road transportation casks and the monitored geologic repository (MGR) rail transportation cask
- Cask handling
- Canister handling
- Canister inspection
- Transfer of IHLW canisters to and from storage as applicable
- Onsite transportation casks unloading
- MGR transportation cask loading
- Lag storage of canisters within HSF
- Decontamination and overpacking of canisters.

C2.0 DECISION ANALYSIS SUMMARY

Several material handling alternatives are evaluated in this appendix:

- Receiving and shipping
  - One bay for shipping and receiving
  - Two bays; one for shipping and one for receiving
  - Receipt of canisters via a transfer passage
- Canister handling
  - In-cell canister handling
  - Locally shielded canister handling
- Cask handling
  - One crane for operations of both MGR and onsite transportation casks
  - Two cranes; one for MGR cask operations and one for onsite cask operations

- Canister decontamination and overpacking
  - Obtain a waiver from MGR
  - Use decontamination and overpacking capabilities at other Hanford facilities
  - Store noncompliant canisters at the Canister Storage Building (CSB) for end-of-mission disposition
  - Provide decontamination and overpacking capabilities in the HSF.

The preferred alternatives for receiving and shipping and for cask handling were driven by the HSF siting and the throughput requirements of two IHLW canisters per day. Based on the time and motion study (Attachment C1), the preferred facility configuration is as follows:

- One bay for receipt of canisters in onsite truck casks
- Two bays for export of canisters in MGR rail casks (two rail casks in process with one MGR cask loading station)
- One crane for onsite cask operations
- One crane dedicated to MGR cask operations
- Depending on HSF siting, incorporation of a transfer passage will increase capital costs (onsite cask bay and crane still required) with no improvement in throughput, but will decrease operating costs and increase operability, availability, and safety.

In-cell canister handling was the preferred alternative in every category of the criteria evaluation and is the preferred canister handling alternative.

The canister decontamination and overpacking evaluation shows that providing these capabilities within the HSF is not required because there is an anticipated low incident rate of noncompliant canisters and because of the available alternatives to disposition noncompliant canisters.

C3.0 CONSTRAINTS, ASSUMPTIONS, AND RISKS

This section identifies the constraints and assumptions used in the evaluation and any associated uncertainty or risk. The following are constraints and assumptions used in this evaluation:

- The HSF will receive one design of MGR rail cask with baskets/internals as required to accept the various canisters produced at Hanford (IHLW, multi-canister overpack [MCO], and U.S. Department of Energy [DOE] standard canister). There are multiple designs of rail casks produced by multiple commercial companies for transport of radioactive materials to the MGR. This study assumes that operations of the MGR casks are similar.

- The MGR rail casks will be provided by the MGR according to a schedule that supports HSF throughput and planned canister export rates. This study assumes that the MGR casks are provided at 100% availability and also assesses potential impacts to the HSF if cask availability is 50%. The availability of MGR casks is important in establishing the HSF parameters including the required availability and operational times of the handling equipment. If MGR casks are not received at 100% availability, the ability of the HSF to receive canisters can be impacted when staging capacity is exceeded or can impact the efficiency of operations because of the additional handling operations required for placement into and retrieval from storage. At reduced MGR cask availability, peak material handling throughput rates would have to increase to maintain the average throughput requirement and additional material handling lines (e.g., cask bays, cranes) may be required.

- The MGR cask without impact limiters will maintain containment after a drop from 6 feet onto the floor of all MGR cask handling areas. This assumption is important to establishing confinement areas during handling of the loaded cask.

- The material handling alternatives shall comply with all relevant requirements in *Hanford Shipping Facility System Specification* (RPP-20270).

- The HSF throughput shall be based on a just-in-time philosophy that will receive IHLW canisters at the Waste Treatment Plant (WTP) production rate for immediate shipment to the MGR. WTP has a canister storage area for 45 IHLW canisters and the WTP nominal production rate is 480 canisters per year.

- The HSF shall be designed to receive two IHLW canisters per day to prevent impact to WTP operations.

- The staging area shall be designed based on the 2 IHLW canisters per day receipt rate, the projected HSF availability, the assumed MGR cask availability, and the WTP production rate.

- Canisters will be processed through the HSF in campaigns according to canister type. Change out of canister grapples and onsite cask interface equipment will be required because of the different lift features of each canister type (IHLW, MCO, DOE standard canister) and the different onsite transportation casks for each canister type. Processing the canisters in campaigns limits the negative impact to the HSF total operating efficiency.

- The MGR basket/internals are assumed to be keyed or fixed relative to the cask body, providing a known and repeatable interface location for loading canisters into the MGR cask.

- The staging area shall include staging for IHLW, MCO, and DOE standard canisters.

- 9,400 IHLW canisters, 418 MCOs, and 71 DOE standard canisters are to be processed through the HSF.

- The allowable shipment rates of canisters from the Hanford Site to the MGR are 655 IHLW canisters per year concurrent with either 78 MCOs or 36 DOE standard canisters. Based on this and the driving receipt rate from the Hanford facilities, MGR shipment constraints are not impacted because the MGR can accept at a greater average rate than the HSF can process (i.e., 480 IHLW canisters per year maximum will be available for HSF processing).

- Receipt rate of SNF canisters is 78 MCOs per year or 36 DOE standard canisters per year. Based on the small percentage of these canisters, the assumption is that they will be 'worked in' to the overall shipping operations or will be accommodated by additional operating shifts. The flexibility to campaign these canister types has clear benefits, especially as the requirement is that the facility is 'just-in-time' and only staging (no storage) provisions are required for SNF canisters.

- Material handling concepts, when integrated into the facility design, must be feasible with respect to the preferred storage and siting options. Concepts cannot be developed in isolation to the other facility functions and facility siting constraints. The preferred option for storage is the open rack vault with in-cell canister handling operations; canister handling within the HSF must be compatible with the planned canister handling methods in the storage facility.

- The design shall allow for expansion for long-term storage of a total of 4,000 IHLW canisters without negatively affecting the ability of the HSF to receive, store, and ship canisters.

- The HSF is designed for a 40-year operational life.

C4.0 ALTERNATIVES CONSIDERED

This section describes the alternatives for the material handling functions. The four primary material handling functions are receiving and shipping, canister handling, cask handling, and canister decontamination and overpacking. The alternatives and the corresponding material handling considerations are defined in the following sections.

C4.1 RECEIVING AND SHIPPING

The facility configuration alternatives considered for shipping and receiving at the HSF are as follows:

- A single bay that is used for import of canisters in the onsite transportation casks and for export of canisters in the MGR cask.

- Two bays with one dedicated for receipt of canisters in onsite transportation casks and one dedicated for the export of canisters in the MGR cask.

- Receipt of IHLW canisters via a transfer passage from the WTP high-level waste (HLW) vitrification building and a bay for export of canisters in the MGR cask. MCOs and DOE standard canisters would be imported in either a bay dedicated for receipt of onsite transportation casks or in the MGR cask bay.

- Receipt of MCOs and DOE standard canisters via a transfer passage from the CSB and a bay for export of canisters in the MGR cask. IHLW canisters would be imported in either a bay dedicated for receipt of the IHLW onsite transportation cask or in the MGR cask bay.

Receiving and shipping alternatives must be evaluated with consideration of facility throughput requirements and the proposed HSF sites.

C4.2 CANISTER HANDLING

The two basic alternatives for handling the canisters within the HSF are (1) bare canister handling within a shielded cell using an overhead crane (in-cell handling as is used at the WTP for all canister handling operations) or (2) within transfer equipment that provides local shielding (locally shielded handling as is used in the CSB via the MCO handling machine [MHM] and at Savannah River Plant through the shielded canister transporter).

Canister handling alternatives must be evaluated with consideration of facility throughput requirements and the other functions that must be performed within the HSF including the following:

- Inspection of canisters
- Transfer of IHLW canisters to and from storage
- Unloading of onsite transportation casks
- Loading of the MGR cask
- Staging of canisters.

C4.3 CASK HANDLING

The casks are designed to be loaded and unloaded vertically and are designed to be handled by overhead crane. The alternatives considered for cask handling are limited to the number of overhead cranes as follows:

- One common crane for MGR and onsite casks
- Two cranes, one for MGR cask handling and one for handling of onsite casks.

Cask handling alternatives must be evaluated with consideration of facility throughput requirements and the other functions that must be performed within the HSF including the following:

- Receiving and shipping
- Unloading of onsite transportation casks
- Loading of the MGR cask
- Canister handling.

C4.4 CANISTER DECONTAMINATION AND OVERPACKING

Canisters that exceed the MGR acceptance criteria for surface contamination may require decontamination or overpacking. Canisters that do not meet MGR dimensional or containment acceptance requirements may require overpacking. The following alternatives are evaluated with consideration of the probability of having a canister that does not meet MGR acceptance criteria:

- Obtain a waiver from MGR for out-of-specification canisters
- Use decontamination and overpacking capabilities at other Hanford Site facilities
- Store out-of-specification canisters at CSB for disposition at the end of the shipping campaign
- Provide decontamination and overpacking capabilities at the HSF.

C5.0 EVALUATION CRITERIA

As identified in Section C4.0, the alternatives must be evaluated in conjunction with facility throughput requirements, other HSF functions, and proposed facility siting, as applicable. Viable alternatives are then evaluated against the criteria in Table C.1, as appropriate.

Table C.1. Summary of Handling Equipment Evaluation Criteria

Evaluation Criteria	Description
Operability	Qualitative measure of inherent complexity determined by the following factors: • Physical complexity • Operator interfaces • Placement repeatability
Availability	Qualitative measure of the following: • Maintainability • Reliability • Inspectability
Safety	Assessment of the following factors: • Radiological protection • Industrial safety • ALARA
Capital cost	Qualitative comparison of the capital cost for each option
Operating cost	Qualitative comparison of the O&M costs for each option

ALARA = as low as reasonably achievable.
O&M = operations and maintenance.

The following criteria were determined to be non-differentiating for handling equipment:

- Decontamination and decommissioning
- Technical maturity
- Expandability
- Environmental considerations
- Constructability.

C6.0 ANALYSIS OF ALTERNATIVES

This section provides an evaluation of the alternatives, including the rationale for selection of the preferred alternative. Facility throughput is a driving factor in the evaluation of the alternatives. Time and motion studies conducted through the use of an operations research model that support the material handling evaluations are presented in Attachment C1.

C6.1 RECEIVING AND SHIPPING

The applicability of alternatives are first evaluated considering required facility throughput, the proposed sites for the HSF, and compatibility with other HSF functions and then as applicable are evaluated against the evaluation criteria identified in Section C5.0.

C6.1.1 Hanford Shipping Facility Throughput Considerations

The time and motion study provided in Attachment C1 indicates that the facility throughput is limited by the MGR cask operational times. The assumed operational time to operate the MGR cask is 24 hours and includes the following operations:

- Receipt of radiological and physical inspection
- Removal and installation of personnel barrier (thermal shield)
- Removal and installation of impact limiters
- Removal and installation of tiedowns
- Uprighting and removal of cask from rail car
- Placement of cask on rail car and rotating to horizontal position
- Removal and installation of cask lid bolts and lid
- Performance of assembly verification leak test
- Radiological and physical inspection of cask and rail car.

The time and motion study projects a facility throughput of 1.1 canisters per day with 1 dedicated MGR cask bay, 1 dedicated import bay, and operating 8 hours per day and 5 days per week. Sensitivity analyses on the time and motion study show that the facility throughput would increase to 1.9 canisters per day with 2 MGR casks in process. The implications of the MGR cask operations being the limiting factor regarding facility throughput are the following:

- A single bay for receiving and shipping will not provide adequate facility throughput
- Although receiving canisters through a transfer passage would require less operational hours, facility throughput is not affected by incorporation of a transfer tunnel instead of onsite truck cask transportation
- A dedicated MGR cask bay with two MGR casks in process is required
- A dedicated bay for receipt of canisters through onsite truck casks is required.

C6.1.2 Hanford Shipping Facility Siting Considerations

The two alternatives considered for receipt of canisters at the HSF are through a transfer passage or with onsite truck transportation casks. The applicability of receiving canisters through a transfer passage is dependent upon the selected site of the HSF. All canisters will be shipped from the HSF in the MGR rail cask.

If the HSF is sited in close proximity to the WTP HLW vitrification facility, IHLW canisters from WTP could be received through a transfer passage, but MCOs, DOE standard canisters, and IHLW canisters from CSB would be received in onsite transportation casks. The WTP HLW vitrification facility has a truck bay for IHLW canister export, but because of weight limitations, canister dose rates, and safeguards and security issues, this bay is not adequate for import of the SNF canisters and their associated onsite transportation casks. A dedicated truck bay in the HSF would be required to receive the MCOs and DOE standard canisters.

If the HSF is sited in close proximity to the CSB, IHLW canisters from WTP would be received via onsite transportation casks but MCOs, DOE standard canisters, and IHLW canisters from CSB could be received through a transfer passage. The canister import bay and the MHM will be retrofitted for receipt of IHLW canisters, and therefore could be used for receipt of all IHLW canisters. However, because of the complexity of operations, availability of the MHM, and differences in planned operational timeframes for the HSF and CSB, a dedicated IHLW canister import bay at the HSF is the recommended configuration.

C6.1.3 Alternative Evaluation

The following are the viable alternatives for receiving and shipping of canisters. These non-competing alternatives are dependent upon the siting of the HSF and are not evaluated against each other, but a discussion of the addition of a transfer tunnel with regards to the evaluation criteria in Section C5.0 is provided.

- Alternative 1
  - A dedicated truck bay for receipt of canisters via onsite transportation cask
  - Two dedicated rail bays for shipping of canisters via MGR transportation cask

- Alternative 2a
  - A dedicated truck bay for receipt of IHLW canisters from WTP via onsite transportation cask
  - Two dedicated rail bays for shipping of canisters via MGR transportation cask
  - A canister transfer passage from the CSB to the HSF
- Alternative 2b
  - A dedicated truck bay for receipt of MCOs, DOE standard canisters, and IHLW canisters from CSB via onsite transportation cask
  - Two dedicated rail bays for shipping of canisters via MGR transportation cask
  - A canister transfer passage from the WTP HLW vitrification facility to the HSF.

C6.1.3.1 Operability

Receipt of canisters via a transfer passage requires significantly fewer operations than receipt in onsite transportation packaging. The transfer passage is of low physical complexity, provides a defined position for the canister at each end of the transfer passage, and requires few operator interfaces. Incorporation of a transfer passage would provide increased operability and flexibility of canister receipt operations.

C6.1.3.2 Availability

The transfer passage requires fewer mechanical handling components than is required for receipt by onsite cask. With the operating environment and access for inspection and maintenance essentially equivalent, availability of canister receipt by the transfer passage is greater than that by onsite transportation cask.

C6.1.3.3 Safety

Use of a transfer passage eliminates the potential safety issues associated with vehicle traffic, onsite cask transportation accidents, and cask handling operations.

C6.1.3.4 Capital Cost

The addition of a canister transfer passage will increase the capital cost of the HSF. If the HSF is sited at CSB, capital costs may be partially offset by the cost savings in eliminating the need for an onsite transportation system for DOE standard canisters.

C6.1.3.5 Operating Cost

Canister receipt via the transfer passage will have significantly less operating costs than by onsite transportation cask because of reduced maintenance costs (fewer mechanical handling systems) and reduction in required operating staff. A transfer passage at the WTP HLW vitrification building will require no additional personnel, because all IHLW canister handling will be by remote cell crane. At the CSB, the number of personnel required to move canisters from CSB storage to the HSF will be limited to those required to operate the MHM.

C6.2 CANISTER HANDLING

The alternatives for canister handling are evaluated in the following sections against criteria provided in Section C5.0.

C6.2.1 Operability

The canister handling system will have to accommodate each of the three types of canisters. Each of the canister types requires a different grapple and different onsite transportation cask. Also, the canister handling system must be capable of loading the canisters into the MGR cask in multiple canister position arrays depending on the type of canister.

The in-cell canister handling alternative provides better operability and is therefore the preferred operability alternative. The operations and equipment required for each alternative are described in the following subsections.

C6.2.1.1 In-Cell Canister Handling Alternative

The in-cell canister handling alternative remotely handles bare canisters within a shielded cell. The mechanical handling operations for receipt of a canister are briefly described below (operations for MCOs would be slightly different because of onsite cask lid design and integral MCO shield plug):

- *Onsite cask is removed from trailer and placed onto a bogie in a shielded transfer tunnel* by overhead crane and cask lift fixture
- Cask lid bolts are removed using jib crane and long-handled tools
- Hatch cover is closed
- Cask is translated to lid removal station with bogie
- Cask lid is remotely engaged, removed, and retained with remote tool
- Cask is translated into load-in/load-out cell with bogie
- In-cell shielded hatch cover is opened
- Canister is removed from onsite cask for transfer to MGR cask, staging, or storage with remotely operated in-cell crane with canister grapple
- Operations are reversed for export of empty cask.

The mechanical handling operations for export of canisters in the MGR cask are briefly described below:

- MGR cask is removed from railcar and placed onto a bogie in a shielded transfer tunnel with overhead crane and cask lift fixture
- MGR cask lid bolts are removed using jib crane and long handled tools

- Hatch cover is closed
- MGR cask is translated to lid removal station with bogie
- MGR cask lid is remotely engaged, removed, and retained with remote tool
- MGR cask is translated into load-in/load-out cell with bogie
- In-cell shielded hatch cover is opened
- Canister is placed into one of the MGR cask basket array positions with remotely operated in-cell crane with canister grapple
- Operations are reversed for export of loaded MGR cask.

Visual inspection with camera and staging of the canisters is provided for in the shielded cell. The cell is equipped with shield windows and manual slave manipulators that can be used for canister inspections and canister grapple change out. Grapple change-out could also be performed in the in-cell crane maintenance area. If required, a canister swab station could be installed in the shielded cell.

The cask bogie must accommodate the three types of onsite casks. Simple adapters may be needed to provide consistent location of the cask centerline.

This alternative requires relatively simple mechanical handling equipment, canister handling operations, and canister staging operations. This alternative requires fewer operations and less time per canister for canister handling operations.

C6.2.1.2 Locally Shielded Canister Handling Alternative

This alternative provides handling of the canister within a locally shielded transfer enclosure. The MHM and shielded canister transporter are examples of locally shielded canister handling systems for single-canister handling. A shielded enclosure is also required for removal and installation of the MGR cask lid and shielded interface that provides access ports to each canister position within the MGR cask. Canister staging would consist of storage tubes below a shielded operating floor with individual floor shield plugs.

The mechanical handling operations for receipt of IHLW or DOE standard canisters are briefly described below (operations for MCOs would be slightly different due to onsite cask lid design and integral MCO shield plug):

- Onsite cask is removed from trailer and placed in a pit via overhead crane and cask lift fixture
- Cask lid bolts are removed using jib crane and long-handled tools
- Locally shielded transfer system (LSTS) is positioned over the onsite cask within the pit using crane (overhead, gantry, or mobile)

- Cask lid is remotely engaged, removed, and retained within the LSTS lid/plug shield using LSTS lid/plug hoist and grapple
- LSTS is indexed to align canister shield with canister in onsite cask while maintaining shielding from the canister
- LSTS bottom shielded hatch is opened
- Canister is removed from onsite cask into canister shield using LSTS hoist with canister grapple
- LSTS bottom shielded hatch is closed
- LSTS is indexed to align cask lid with onsite cask while maintaining shielding from the canister
- Cask lid is placed on to cask using LSTS lid/plug hoist and grapple
- LSTS with canister is moved to interface with either MGR cask, staging, or storage

The mechanical handling operations for export of canisters in the MGR cask are briefly described below:

- MGR cask is removed from railcar and placed in a pit using overhead crane and cask lift fixture
- MGR cask lid bolts are removed using jib crane and long-handled tools
- Lid/basket interface shielded enclosure is placed over MGR cask using overhead crane and lift fixture
- MGR cask lid is engaged, removed, and retained in lid/basket interface shielded enclosure using integral hoist and grapple
- Lid/basket interface shielded enclosure is indexed to align the multi-port shielded interface with the MGR cask while maintaining shielding from the canisters in the MGR cask
- Multi-port shielded interface is positioned on MGR cask using integral hoist and grapple
- Lid/basket interface shielded enclosure is removed using overhead crane and lift fixture
- LSTS is placed onto multi-port shielded interface over the desired canister position using crane
- Access port plug is remotely engaged, removed, and retained within the LSTS lid/plug shield using LSTS lid/plug hoist and grapple

- LSTS is indexed to align canister shield with canister position in MGR cask while maintaining shielding from the canisters in the MGR cask
- LSTS bottom hatch is opened
- Canister is placed into MGR cask using LSTS hoist with canister grapple
- LSTS bottom hatch is closed
- LSTS is indexed to align access port plug with canister position while maintaining shielding from the canisters in the MGR cask
- Access port plug is placed using LSTS lid/plug hoist and grapple
- Operations are reversed for export of loaded MGR cask.

The mechanical handling operations for staging of canisters are briefly described below (operations for transfer to storage would be similar):

- LSTS is placed on a staging cell via crane (overhead, gantry, or mobile)
- Floor plug is remotely engaged, removed, and retained within the LSTS lid/plug shield using LSTS lid/plug hoist and grapple
- LSTS is indexed to align canister shield with staging cell while maintaining shielding from the canister
- LSTS bottom hatch is opened
- Canister is placed into canister staging cell using LSTS hoist with canister grapple
- LSTS bottom hatch is closed
- LSTS is indexed to align cask lid with onsite cask while maintaining shielding from the canister
- Floor plug is placed in position via LSTS lid/plug hoist and grapple
- Operations are reversed for removing a canister from staging.

This alternative requires multiple and complex mechanical handling systems and operations with many operator interfaces. Several multi-port shielded interface assemblies would be required to accommodate the different canister loading configurations in the MGR cask. Adapters would be required for positioning the different onsite casks in the pit.

Grapple change-out could be performed in a grapple maintenance pit. Canister visual inspections would be accomplished in the LSTS using cameras, but direct visual observation of the canister is not supported by this alternative. Also, addition of canister swabbing capability would require the addition of a hot cell with shield windows and manual slave manipulators.

C6.2.2 Availability

The in-cell canister handling system has fewer and less complex mechanical handling equipment and component interfaces. This alternative provides higher maintainability and reliability because of its simpler canister handling system and is therefore the preferred alternative considering availability.

C6.2.3 Safety

The locally shielded canister handling system requires multiple lifting and moving of large and heavy equipment during canister handling. Operators will be required in close proximity of the equipment to ensure correct positioning and placement of the equipment, leading to increased industrial safety hazards from lifted equipment and radiological exposure.

The remote operations of the in-cell canister handling system minimize operator exposure to both industrial and radiological hazards. The in-cell canister handling system is the preferred alternative considering safety.

C6.2.4 Capital Cost

Capital costs are less for the in-cell canister handling alternative. The locally shielded alternative requires a larger number of more complex mechanical handling equipment. Also, the complexity and time associated with the locally shielded alternative would negatively impact facility throughput; a larger facility to accommodate additional MGR cask loading pits and additional cranes and canister handling equipment would be required to meet throughput requirements. In-cell canister handling is the preferred alternative considering capital cost.

C6.2.5 Operating Cost

Operating costs are less for the in-cell canister handling alternative because of fewer required operators and lower maintenance. In-cell canister handling is the preferred alternative considering operating cost.

C6.3 CASK HANDLING

MGR cask operations are crane-intensive operations. The time and motion study provided in Attachment C1 indicates that MGR cask operational times are a limiting factor in facility throughput and that a crane dedicated to MGR cask operations is required. Thus no further evaluation is required and the appropriate alternative is to provide two cranes: one for MGR cask handling and one for handling onsite casks.

C6.4 CANISTER DECONTAMINATION AND OVERPACKING

Attachment C2 provides the estimated frequency of having an out-of-specification canister and provides an evaluation of the alternatives for dispositioning out-of-specification canisters, the results of which are summarized in this section. Based on the evaluation presented in Attachment C2, there is no need for canister decontamination or overpacking capability in the HSF. Specifically, the following conclusions are reached:

- IHLW canisters are decontaminated at WTP to an extent that the probability of receiving a contaminated IHLW canister above the MGR acceptance criteria is very low.
- Operating experience with MCOs at the CSB indicate that although approximately 10% of the MCOs are contaminated, the levels are below the MGR acceptance criteria, and the contamination is typically local and readily accessible such that it can be removed using spray and wipe decontamination methods.
- The planned fuel preparation facility will provide the capability for packaging SNF in DOE standard canisters and for gas sampling of the MCOs. The capability to decontaminate the DOE standard canisters and the MCOs will also be provided within the fuel preparation facility. The fuel preparation facility could provide the capability to decontaminate and overpack limited quantities of IHLW canisters with minor impacts to the fuel preparation facility design.
- The CSB is equipped with sealed storage tubes that could provide long-term monitored storage of contaminated or damaged canisters pending disposition at the end of the canister shipping operations.
- It is unlikely that canisters will be damaged during canister handling operations within the HSF such that overpacking is required. The probability that a canister will be dropped is estimated to be one in 5,000 (see Section 2.3.2.1 of Attachment C-2), or approximately 2 canisters over the lifetime of the facility based on 9,400 IHLW canisters, 418 MCOs, and 71 DOE standard canisters. All canisters are designed to prevent loss of containment when dropped from a height of 7 meters onto the bottom of the canister. The HSF design concept minimizes the potential drop height or provides other mitigating features to prevent loss of canister containment during all canister handling operations.
- The MGR will have the capability to package SNF into canisters and to overpack canisters. For limited quantities, the most cost-effective approach may be to pursue a waiver from the MGR to allow shipment of out of specification canisters to the MGR for remediation.

C7.0 FINDINGS AND RECOMMENDATIONS

The HSF configuration should incorporate the following recommended material handling alternatives.

- Separate receiving and shipping bays are required:
  - One truck bay for receipt of canisters by onsite truck casks
  - One dedicated shipping bay for two MGR rail casks. Two MGR casks need to be in process, but a single in-cell MGR cask loading station is adequate.
- If appropriate based on HSF siting, a transfer passage for receipt of canisters should be incorporated in the HSF; the number and configuration of receiving and shipping bays is

not affected by the addition of a transfer passage. If the facility is sited near the CSB, the 418 MCOs, 71 DOE standard canisters, and up to 880 IHLW canisters could be received at the HSF through the transfer passage instead of by onsite transportation cask. Similarly, if the facility is sited adjacent to the WTP HLW vitrification plant, the 8,520 IHLW canisters (and up to 9,400 IHLW canisters) would be directly transferred to the shipping facility. Although, facility throughput is not affected, incorporation of a transfer passage would increase operability, availability and safety while reducing life-cycle costs.

- The preferred canister handling method is to remotely handle bare canisters in a shielded structure (in-cell canister handling).

- Separate receiving and shipping cranes are required
  - One crane for operation of onsite transportation casks in the receiving bay
  - One dedicated crane for operation of the two MGR casks in the shipping bay.

- *Canister decontamination and overpacking capabilities do not need to be provided in the* HSF.

This study is based on currently available and preliminary information. The time and motion study shows that the MGR cask operations govern the facility throughput. The cask operation times are a function of cask design and operating procedures and do not include loading of the cask or other cask handling operations within the HSF. The assumed time to operate the MGR cask is 24 hours and includes the following operations:

- Receipt radiological and physical inspection
- Removal and installation of personnel barrier
- Removal and installation of impact limiters
- Removal and installation of tiedowns
- Uprighting and removal of cask from rail car
- Placement of cask on rail car and rotating to horizontal position
- Removal and installation of cask lid bolts and lid
- Performance of assembly verification leak test
- Radiological and physical inspection of cask and rail car.

The MGR cask operational requirements should be further studied and confirmed to reduce uncertainty in the estimated HSF throughput.

The material handling alternatives are based on 100% availability of the MGR cask. A 50% MGR cask availability was evaluated in the time and motion study with results indicating that the HSF throughput is significantly reduced. The anticipated impact to the HSF required to achieve the required throughput at 50% cask availability is significant in that an additional MGR cask crane, railcar bay and in-cell MGR cask loading station may be required to reduce turnaround times on the MGR cask. Refinement of the throughput requirements, MGR cask delivery and shipment schedule, and the number of MGR casks in a train is needed, and further study of the impact to the HSF due to MGR cask availability should be performed.

C8.0 REFERENCE

RPP-20270, 2004, *Hanford Shipping Facility System Specification*, DRAFT, April 15, CH2M HILL Hanford Group, Inc., Richland, Washington.

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ATTACHMENT C1
TIME AND MOTION STUDY

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1. Introduction

The Integrated Mission Accelerated Plan (Ref. 1) requires the HSF to package approximately 9,400 canisters of IHLW, 418 multi-canister overpacks (MCO's), and 71 U.S. Department of Energy (DOE) standard canisters into MGR casks for transport to the MGR for permanent disposition. As such, there is a requirement for a dedicated shipping facility to ship IHLW and SNF offsite to MGR. The shipping facility is required to receive and accept the canisters and casks, repackage the canisters as necessary, store and package the canisters and ultimately load the cask for shipment to the MGR.

An OR assessment has been performed in order to evaluate the options available for the Hanford Shipping Facility (HSF) design including concept, operational features and transportation requirements to ensure throughput performance levels can be achieved. The study utilizes a stochastic simulation model which provides a visual and dynamic representation of the various processes including canister import/export, canister staging and MGR cask import/export. The model integrates the process flow logic (i.e. process and mechanical handling equipment, size and operational requirements), control and instrumentation requirements, operator interfaces, equipment reliability and maintenance.

2. Methodology

The model was developed using the WITNESS 2003 (Lanner) simulation software. The models inputs (e.g. canister inter-arrival times, equipment sizing, process times, transfer times etc) and output parameters (e.g. throughput, timescales and total operating efficiency) are controlled using the software interact box. The model inputs have been obtained from design through *formal and informal meetings and recorded in this report. In summary the model was developed* to integrate the process flow diagrams (i.e. process and mechanical handling equipment size, capacity and operational requirements), process times, shift patterns, operator interfaces and mean time to failure analysis. Once the model is developed, it was successfully verified and validated in accordance with BNFL Inc QA procedures.

The verification and validation process ensures that the content of the model (i.e. input data and source code) is consistent with the system design concept and results are realistic compared to similar operating systems. Once the model is developed, a number of what if case scenarios are performed which involves running the model for a specific period of time under different operating conditions. The results from each run are recorded, compared and actions fed back to the design team for implementation.

3. Design Bases and Assumptions

The HSF model bases and assumptions have been used to establish flows necessary to achieve likely throughput targets. This section includes the bases for equipment sizes, times to conduct individual process steps in unit operations; times for mechanical handling and equipment reliability estimates.

3.1. HSF Throughput Requirements

The HSF is required to receive and repackage the following canisters into MGR casks

- 9,400 IHLW canister from WTP
- 418 multi-canister overpacks from an ISF
- 71 U.S. DOE Standard canisters from an ISF

The HSF is designed to receive a maximum of two canisters per day which accommodates the WTP average canister production rate of 480 canisters per year.

3.2. HSF Operation

For the purpose of this assessment, the main operating characteristics associated with the HSF are summarized as follows:

- HSF will operate for 52 weeks days per year using a 5 day-8 hour shift system
- No manpower constraints
- Empty MGR casks are received into the HSF every three days
- No re-work or recycles for out-of-specification canisters
- No upstream (e.g. WTP) or downstream (e.g. MGR) constraints
- Multi-canister overpacks and DOE standard containers from an ISF will be repackaged using extra shifts.

An overview of the HSF OR model is shown in Figure 1.

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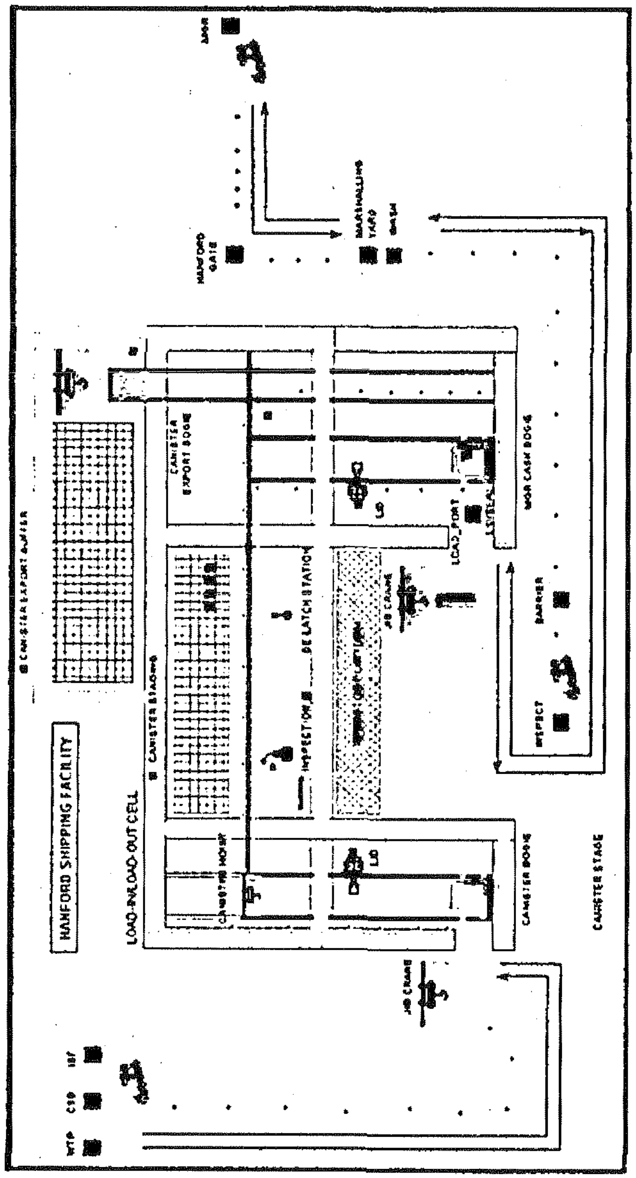
Figure 1. Hanford Shipping Facility Model Overview



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3.3. Canister Import

The HSF receives HLW canisters from the WTP (WTP) or Interim Storage Facility, MCO's of SNF from the Canister Storage Building (CSB) and DOE standard containers from an Interim Storage Facility (ISF). The canisters are transported to the HSF by road on tractor-trailer vehicles and arrive in vertically oriented transport casks. Upon receipt, the cask will be transferred to a loading area or placed into lag storage. The cask is removed from the trailer using a crane and placed into a cask bogie and then transferred to a lid/delid station. After the lid has been removed, the canister is transferred through a hatch to an inspection station. An in-cell crane lifts the canister from the cask and transfers it to the inspection station where it is visually inspected. After successful monitoring the canister is transferred by crane to an MGR cask or lag storage.

3.4. MGR Cask Import

Empty MGR casks are transported from the MGR by rail on a railcar. The empty MGR's are received into a Marshalling Area at the Hanford Site and transferred onto a rail-car. When required by the HSF, an empty MGR with rail-car is washed and dried before it is transported to the HSF load-out station. Upon receipt, the personnel barriers are removed using an overhead crane and then a physical inspection and radiological survey are performed on the cask externals. The front and rear impact limiters and tie downs are then removed from the cask using an auxiliary hoist. The MGR cask is then placed onto an MGR cask bogie using the overhead crane. The MGR cask lid is unbolted and placed by crane onto an inspection stand where the seals are inspected and the lid is placed back on to the MGR cask. The MGR cask mounted bogie is then traversed to the lid/delid station where the lid is removed. After the lid has been removed, the MGR cask bogie is traversed to the load-out port.

3.5. MGR Cask Export

After the MGR cask has been filled, the MGR cask bogie is traversed to the lid/delid station where the lid is refitted. The MGR cask bogie is then transferred to the MGR cask loading platform position where the lid is bolted on and secured. A smear test and a containment verification test are then performed on the MGR cask and then placed onto a railcar using the overhead crane. After being placed onto a railcar, a radiological and contamination survey is performed on the cask externals. Upon successful monitoring, the impact limiters and personnel barrier are installed using the overhead crane. The cask shipping documentation is prepared and a final inspection performed before it is transferred by rail car to the marshalling area. Upon agreement between HSF and MGR, the MGR cask is transported to the MGR. The mechanical handling times associated with the HSF are shown in Appendix A.

3.6. Equipment Reliability Data

Before an assessment of HSF performance can be made, it is necessary to examine how each item of equipment is contributing to the effectiveness of the operation. In this case, an assessment of equipment reliability has been made using benchmark data from similar operational facilities (Ref. 2). The equipment reliability estimates including mean time between failure and equipment downtimes for the HSF are shown in Table 1.

Table 1. HSF Equipment Reliability Data

No.	Equipment Item	MTBF (hrs)	MTTR (hrs)
1	Cask Import Crane	4380	72
1	MGR Cask Export Crane	4380	72
1	Cask Bogie	8760	96
1	MGR Cask Bogie	8760	96
1	Canister Hoist (in-cell)	4380	96
1	Cask Lidding Station	8760	8
1	MGR Cask Lidding Station	8760	8

4. Model Results

This section provides an evaluation of the HSF throughput and canister staging utilizing the model and taking into account the base case canister inter-arrival times, mechanical handling steps, transfer times, transportation requirements and equipment reliability. Where target throughput rates cannot be achieved the key bottlenecks will be identified. The model will be used to eliminate these bottlenecks in order to optimize the HSF design and daily throughput. A roadmap of how the model was used in order to get to the optimized HSF design is given in Appendix B.

4.1. Baseline Model Results (Version 1.0)

By linking the Canister Import, Canister Staging and MGR Cask Import and Export areas of the HSF base case throughput has been calculated. Since HSF is designed to receive a maximum of two canisters per day which accommodates the WTP average canister production rate of 480 canisters per year, the results are based on repackaging the IHLW canisters from WTP only.

According to the Baseline Model (Version 1.0) and assuming a 5 day-8 hour shift system, approximately 1.1 IHLW canisters per day can be repackaged into an MGR cask. The results suggest that it would take (on average) 4.5 days to fill and export an MGR cask with 5 IHLW canisters. Assuming the HSF is designed to receive a maximum of 2 canisters per day, the results indicate a Total Operating Efficiency (TOE) of 55%. The results indicate that the HSF is off-shift approximately 75% of the time, thus indicating that the 5 day 8 hour shift system dictates the rate at which canisters are repackaged into MGR casks.

4.1.1. Equipment Utilization

In order to verify whether items of equipment within the HSF have been adequately utilized with respect to normal operations and confirm the factors affecting throughput, an assessment of equipment utilization has been performed. The utilization of equipment is a measure of how often it is used and often points to a bottleneck in the system. Percentage utilization figures indicate how often an item of equipment was busy as opposed to being idle, broken down (i.e. failed) or off-shift. The utilization statistics for the individual items of equipment within the HSF are based on on-shift time and are shown in Table 2. The results indicate that the MGR export crane (51.86%) and the in-cell canister hoist (23.67%) are demanded a large percentage of the time. Since the MGR export crane has the highest utilization, this item of equipment is a bottleneck in the HSF. The results also indicate that both bogies and both lidding stations are utilized the least.

Table 2. HSF Equipment Utilization Based on On-Shift Time

Equipment Item	Busy (%)	Idle (%)	Blocked (%)	Down (%)
Cask Import Crane	20.68	78.52	-	0.8
Cask Bogie	22.55	77.25	-	0.2
Cask Lidding	1.72	97.5	-	0.1
Canister Hoist	23.67	77.02	-	0.7
MGR Cask Bogie	1.35	98.55	-	0.1
MGR Cask Lidding	0.28	99.62	-	0.1
MGR Export Crane	51.86	47.24	-	0.9

4.1.2. Canister Staging

Assuming the base case scenario, a maximum of 100 canisters could be held in the canister staging area. This is due to the percentage of time spent off-shift and the high demand on the MGR export crane. However, it is important to note that over a period of 12 months, the mean number of canisters occupying the staging area is 50.

4.1.3. Sensitivity Analysis

A single factor sensitivity analysis on the process parameters affecting throughput has been undertaken. Using the Baseline Model Version 1.0, the HSF throughput has been recalculated by adjusting each variable one at a time to measure the change to the base case results.

4.1.3.1. Shift Patterns

A sensitivity analysis has been carried out to determine how sensitive HSF throughput rates and total operating efficiency are to a change in shift patterns. For example, Table 3 shows that if a 5 Day 1 x 8 hour shift system is introduced, a mean throughput of 1.1 cans per day can be achieved with an MGR cask export time of 4.5 days and a total operating efficiency of 55% (Base Case). If the HSF adopts a 5 Day 2 x 8 hour shift system, the daily throughput is increased to 1.9 canisters per day with an MGR cask export time of 2.6 days and a total operating efficiency of 95%. Similarly if a 7 Day 1 x 8 hour shift system was introduced, the daily throughput is increased to 1.6 canisters per day with an MGR cask export time of 3.2 days and a total operating efficiency of 79%. Finally, the results in Table 3 illustrate that there is no benefit in adopting a third shift system. This is due to the fact that the HSF is no longer constrained by the shift system but is constrained by the total time it takes to import/export MGR casks to/from the HSF load-in/load-out cell. It currently takes 11 hours to transfer and prepare a washed empty MGR cask from the marshalling yard to the HSF load-in/load-out cell and after the MGR cask is filled it takes 10 hours to prepare and transfer the MGR cask to the marshalling yard. Since there is only one MGR cask position in the export bay, these times have an impact on throughput rates.

Table 3. Sensitivity to HSF Shift Patterns

Shift Pattern	Mean Throughput (IHLW canisters)	Time to Ship MGR Cask (days)	Canister Staging	TOE (%)
5 Day 2 x 8 Hour	1.9	2.63	25	95%
5 Day 3 x 8 Hour	1.9	2.63	25	95%
7 Day 2 x 8 Hour	1.9	2.63	24	95%
7 Day 3 x 8 Hour	1.9	2.63	24	95%
7 Day 1 x 8 Hour	1.57	3.18	100	79%
5 Day 1 x 8 Hour	1.1	4.55	100	55%

4.1.3.2. MGR Import/Export

A similar sensitivity analysis has been carried out to determine how sensitive throughput is to a change in MGR import/export times. The base case assumes that it takes 11 hours to open/close a washed empty cask from the marshalling area to the HSF load in/out cell – this includes time for removal/installation of personnel barrier, impact limiters, tie downs, cask lid, removal/placement of cask on/from railcar etc. Table 4 shows that if the MGR cask import times were reduced by 50% to 6.5 hours, the mean throughput would increase to 1.8 canisters per day with an MGR cask export time of 2.8 days and a total operating efficiency of 92%. Conversely if the MGR cask import times were effectively doubled the mean throughput would fall to 0.6 canister per day and it would take 8.2 days to ship an MGR cask.

Table 4. Sensitivity to MGR Import Times

Time to Import MGR Cask (hrs)	Mean Throughput (IHLW canisters)	Time to Ship MGR Cask (days)	Canister Staging	TOE (%)
3.2	1.84	2.72	38	92%
6.5	1.8	2.78	47	90%
9.8	1.36	3.68	75	68%
11 (Base Case)	1.1	4.55	100	55%
26.2	0.61	8.20	145	31%

Further sensitivity was carried out to determine the impact on throughput to a change in the number of empty MGR cask positions in the HSF export bay area. For example, if two empty MGR casks on rail cars were transported to the HSF from the marshalling yard and provisions were made to prepare and stage one empty MGR cask while the other is being filled with canisters in the load in/out cell, the daily throughput would increase to 1.87 canisters per day and the MGR cask export time would be reduced to 2.7 days. By having an additional empty MGR cask available, the occupancy of the canister staging area would decrease to 24.

4.2. Optimization Results

Using Baseline Model Version 1.0 and optimizing the HSF shift pattern and MGR Import/Export operations this section provides an evaluation of throughput and canister staging requirements. The incorporation of these improvements changes the base case assumptions and therefore a change to the baseline model. As a result, the revised model will now be referred to as Baseline Model Version 2.0

4.2.1. Baseline Model Results Version 2.0

Using the Baseline Model Version 2.0 and assuming the HSF operates with a 5 day 2 x 8 hour shift system and an additional cask space in the MGR export area is made available the results show that the required target throughput of 2 canisters per day can be achieved. The results also illustrate a reduction in the number of canisters occupying the store from 50 to 14.

4.2.2. Sensitivity Analysis

A single factor sensitivity analysis on the process parameters affecting throughput has been undertaken. Using the Baseline Model Version 2.0, the HSF throughput has been recalculated by adjusting each variable one at a time to measure the change to the base case results.

4.2.2.1. One Bay 'v' Two Bays

A sensitivity analysis has been carried out to determine how sensitive throughput is to the number of import/export bays in the HSF. The Baseline Model Version 2.0 assumes that there are two bays, one for canister receipt and one for cask shipping and each bay is equipped with a crane. The canister import crane is used to transfer canisters into and out of the HSF. The MGR cask export crane is used to transfer MGR casks into and out of the HSF. This analysis assesses the impact on throughput and equipment utilization when both the canister and MGR cask movements are performed by one crane.

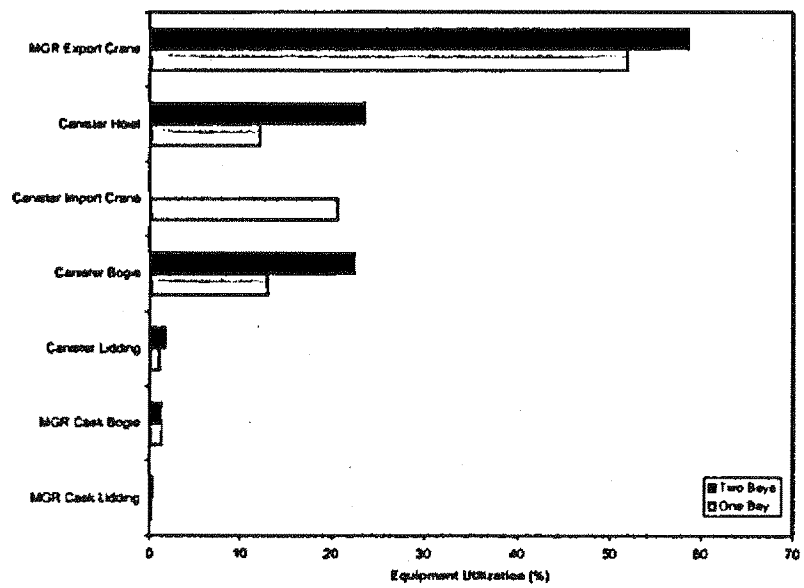
According to the base case scenario where there are two bays for canister receipt and cask shipping and each bay is equipped with a crane, approximately 2 IHLW canisters per day can be repackaged into an MGR cask. Figure 2 shows the percentage utilization for each individual item of equipment. Assuming the base case (i.e. 2 bays), the canister import crane is utilized for 20.68% of shift time and the MGR export crane is utilized for 50.97% of shift time. The results suggest that both the canister import and MGR cask export cranes are not fully utilized in the HSF, therefore we need to assess the impact of removing one crane and have the second crane perform both canister and MGR cask movements in the HSF. For the purposes on this assessment, the MGR cask export crane will perform both import and export operations.

Assuming one bay at the HSF and both the canister and MGR cask movements are performed by the MGR export crane, the daily throughput is reduced to 1.19 IHLW canisters. Figure 2 shows the percentage utilization for each individual item of equipment for both scenario's. For example, assuming one bay at the HSF, the MGR cask export crane is utilized for 58.7% of shift time and as a result, the daily throughput is reduced by more than 40% to 1.19 canisters.

A reduction in throughput is experienced due to the amount of time it takes to prepare a filled cask for export (11 hours) and the time it takes to prepare an empty cask (10 hours). Both operations have to be carried out sequentially since there is only one crane.

Although this only occurs once every 4 days (i.e. after an MGR cask has been filled with 5 canisters), the crane is utilized to when preparing the MGR cask for export (i.e. replacing tie downs, installing barrier and trunnions etc) and therefore, has a significant impact on the ability to import canisters into the HSF. Therefore, in order to maintain the required target throughput of 2 IHLW canisters per day, the HSF will require an import and export bay each equipped with a crane to perform canister and MGR cask movements.

Figure 2. Equipment Utilization (One Bay 'v' Two Bays)



4.2.2.2. MGR Cask Availability

An analysis has been carried out to determine how sensitive canister storage is to a change in MGR cask availability. The Baseline Model Version 2.0 assumes that MGR casks are available on demand (i.e. at 100% availability) and a single MGR cask is transferred by railcar from Yucca to the marshalling yard on average every 2.5 days which accommodates the HSF production rate of 2 canisters per day. Table 5 illustrate how sensitive HSF throughput and canister staging requirements are to a change in the number of MGR casks delivered to the marshalling yard and MGR cask availability.

For example, if 1 MGR cask is delivered from Yucca Mountain to the marshalling yard and the MGR availability is reduced to 50% and the MGR turnaround time increases from 2.5 to 5 days, and as a consequence the HSF daily throughput is reduced to 1.1 and the mean number of containers occupying the store is increased from 3 to 97.

However, if 2 MGR casks are delivered from Yucca Mountain to the marshalling yard and the MGR cask availability is also reduced to 50% and the turnaround time increases from 5 days to 10 days, as a consequence the HSF daily throughput is reduced to 1.1 and the mean number of containers occupying the staging area is increased from 3 to 72.

The results show that when an additional MGR cask is delivered to the marshalling yard, this has no impact on daily throughput. The HSF cannot achieve higher throughput rates since it is constrained by the rate at which WTP delivers IHLW canisters (i.e. 2 IHLW canisters per day).

However, the results in Table 5 show that canister staging requirements are reduced by more than 25%. Therefore, in order to minimize the impact of MGR cask availability on HSF canister staging requirements, 2 MGR casks should be delivered to the marshalling yard. The results illustrate that when 3 MGR casks delivered to the marshalling yard every 7.5 days, the daily throughput is reduced to 1.1 and the canister staging requirements are increased by 16%.

Table 5. HSF Throughput based on Yucca Mountain Delivery Schedule

Yucca Mountain			HSF		
No. MGR Casks Delivered to HSF	Turnaround Time (days)	Availability (%)	Daily Throughput (IHLW canisters)	Canister Staging	
				Mean	Max
1	2.5	100	2	3	14
1	5	50	1.1	97	173
2	5	100	2	3	14
2	10	50	1.1	72	173
3	7.5	100	2	3	14
3	14	50	1.1	105	200

4.2.2.3. Direct Transfer from WTP to HSF

Using the Baseline Model Version 2.0 and assuming all IHLW canisters will be transferred by bogie from the WTP lag storage area through a tunnel to the HSF canister import area, a sensitivity analysis has been carried out to determine the impact on throughput and canister staging. This option eliminates the requirement of the canister import crane since IHLW canisters will not be delivered to the HSF in casks on transporters as previously assumed. Instead the canisters will be transferred by bogie direct to the HSF import area. Therefore, the canister import handling times are significantly reduced. Table 7 shows how the direct transfer option affects HSF daily throughput and canister staging requirements.

Table 6. Direct Transfer 'v' Base Case

	Baseline Model Version 2.0	Direct Transfer Model
Daily Throughput (IHLW canisters)	2	2
Canister Staging (No. Positions)	14	17

The results in Table 6 demonstrate that a reduction in the time it takes to import a IHLW canister using the direct transfer bogie from WTP to the HSF, the canister staging requirements are minimally impacted. Previously, when IHLW canisters were transferred from WTP, they were occasionally staged in the HSF import bay. These canisters were staged for one of two reasons - either because a IHLW canister was in the process of being unloaded or because the HSF was off-shift an unable to accept canisters. As a result of the direct transfer option, the import staging area is no longer used and therefore has a knock-on effect to the canister staging area within the HSF. Therefore, an additional three positions will be required in the canister storage area for the Direct Transfer option.

4.2.2.4. Number of MGR Cask Positions in the HSF Export Area

The Baseline Model Version 2.0 assumes that 2 x washed empty MGR's are transferred on rail cars from the marshalling yard to the HSF export bay. By doing so this means that an MGR cask can be opened and prepared in parallel to an MGR cask being filled in the HSF load-in/load-out cell. Using the Baseline Model Version 2.0, a sensitivity analysis has been undertaken to assess the impact of adding a third MGR cask position in the HSF export area. Table 8 shows that there is no increase in throughput but the canister staging store occupancy is reduced by more than 50%. For example, assuming 2 MGR positions in the HSF export area, a maximum of 16 positions will be required in the canister staging store area. However, when an additional MGR position is made, a maximum of 7 positions will be required in the canister staging store.

Table 7. Sensitivity to No MGR Positions in HSF Export Area

No. MGR Positions in HSF Export Bay	Daily Throughput (IHLW Canisters)	Canister Staging	
		Mean	Max
2	2	3	14
3	2	1	7

4.2.2.5. MGR Cask Open and Close Time

Using Baseline Model Version 2.0, a sensitivity analysis has been carried out to assess the impact of changing the time it takes to open and close an MGR cask. The base case assumes that it takes 11 hours to transfer a washed empty MGR from the marshalling yard area, prepare and open it at the HSF before it is filled with IHLW canisters and it takes 10 hours to prepare a filled MGR cask, close it and transfer from the HSF to the marshalling yard (see Appendix A). When these operations are combined, it takes a total of 21 hours to open and close an MGR cask in the HSF Export Bay. Table 8 shows that when the time to open and close an MGR cask is increased to 24 hours, the daily throughput is reduced to 1.96 and the maximum number of canisters occupying the store is increased to 18. Therefore, the results show that both throughput and canister staging are not very sensitive to an increase in the time it takes to open/close an MGR cask. The results show that only 4 additional positions will be required in the canister staging area.

Table 8. Time to Open and Close an MGR Cask

Time to Open & Close MGR Cask (hrs)	Daily Throughput (IHLW Canisters)	Canister Staging	
		Mean	Max
21	2	3	14
24	1.96	6	18

5. Conclusions and Recommended Actions

The model has been used to optimize the HSF design throughput and canister staging requirements. If the HSF design is optimized in accordance with this study, the HSF is capable of achieving the required throughput and performance rates

Initial results from the Baseline Model Version 1.0 showed that a daily throughput of only 1.1 canisters per day could be achieved and the HSF would require a maximum of 100 canister positions in the staging area. The results showed that throughput was been constrained by the 5 day 1 x 8 hour shift system and the MGR cask import/export operation. A sensitivity analysis in Section 4.1.3 showed how each of these bottlenecks could be eliminated in order to achieve higher throughput rates.

Therefore, using the underlying assumptions for the Baseline Model Version 2.0 and assuming a 5 day 2 x 8 hour shift system and having 2 MGR cask positions in the export bay, the required daily throughput of 2 IHLW canisters could be achieved and the size of the canister staging could be reduced to 14 positions.

Further analysis showed that the HSF design could be optimized further if additional changes were made to the MGR import/export bay area. For example, assuming 3 MGR cask positions in the export bay, the study shows that the size of the canister staging area could be reduced to 7.

However, assuming these improvements are made there is still a risk that HSF throughput and performance could be impacted by other (external) factors. For example, assuming 50% MGR cask availability, the results show that the daily throughput could be reduced to 1.1 IHLW canisters per day.

It is recommended that the model scope be increased to include casks from other facilities such as CSB and other interim storage facilities (as applicable) to identify whether these operations can be performed on-shift or off-shift. The model should also include off-normal operations including re-work for out-of-specification canisters, total operating efficiency of upstream (e.g. WTP, ISF) and downstream (e.g. MGR) plants. It is also recommended that the labor

labor requirements for normal and off-normal operations (e.g. maintenance) are also included to determine the size of each shift.

6. References

1. Integrated Mission Plan - RPP-136782
2. Howarth, J 2001, RPP-WTP Basis of Operational Research Report, RPT-W375-TE00014

Appendix A –

HSF Process Times

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Appendix A – HSF Process Times (Normal Operations)

Major Function	Minor Function	Detailed Task	Time to Complete (mins)	Notes
Receive HLW & Containerized SNF	Receive Cask at Guard Check Point, Check Documentation		15	
	Receive Cask/Transporter into HSF Load-in Station	From Check Point to Loading Bay	5	
		Open Loading Bay door and drive transporter into position under crane, stabilize transport trailer, survey and remove tractor	30	
		Carry Out Smear Test on Cask externals	30	Includes preparation of receipt documentation
	Remove Cask From Transporter	Position Crane with lifting attachment over cask	10	Includes checking lifting devices
		Attach crane to cask	5	
		Remove Tie-downs and associated apparatus	30	
		Raise cask off transporter to transfer height	5	
		Move cask to roller shutter door	5	
		Open Roller shutter door	2	
		Move cask into Operating area and over Cask Loading Platform	3	
	Place Cask in Unload Station	Open Cask Loading Platform sliding gate	3	
		Lower Cask into Bogie	10	
		Disconnect Crane from Cask	2	
		Operate Jib Crane with impact wrench to unbolting position	3	
		Break tamper seals and unbolt lid with impact wrench	20	12 bolts in lid
	Prepare Cask For Canister Unloading	Close Cask Loading Platform	3	
		Move cask on Cask Bogie to Lid Removal Station	3	Required only for HLW and DOE Std canister - MCO will have manual lid removal

Appendix A – HSF Process Times (Normal Operations)

Major Function	Minor Function	Detailed Task	Time to Complete (mins)	Notes
				and installation of a spacer
		Remove and retain lid	3	
		Move cask on Cask Bogie to Load-in position	3	
	Remove Canister From Cask and place into Inspection Station	Open Hatch	3	
		Remove canister from cask using in-cell crane	10	
		Close Hatch	3	
		Move canister to Inspection station	3	
	Inspect Canister	Lower canister into inspection station, rotating to perform visual inspection	10	
		As canister is lowered take swipe test of selected canister locations	0	Not normal operation
		Transfer swabs to loadout port	0	"
		Loadout swabs	0	"
		Monitor swabs	0	"
	Prepare/Survey Cask for Release From HSF	Move empty cask on bogie back to lidding station	3	
		Place lid back on cask	3	
		Move empty cask on bogie back to Cask Loading Platform	3	
		Open Cask Loading Platform sliding gate	3	
		Lower crane & Attach to lid	10	
		Lift lid off cask to height sufficient to visually inspect seal	10	
		Lower lid back onto cask after inspection	10	
		Operate Jib Crane with impact wrench to bolting position	3	
		Torque lid bolts with impact wrench	20	
		Perform smear test on lid area	10	
		Connect crane lifting attachment to Cask	3	

BNFL Inc.

Appendix A – HSF Process Times (Normal Operations)

Major Function	Minor Function	Detailed Task	Time to Complete (mins)	Notes
		Raise empty cask from bogie with crane	10	Includes checking lifting devices
		Close Cask Loading Platform	3	
		Open Roller Shutter Door	2	
		Move cask into Loading Bay and onto Trailer	3	
		Replace tie-downs	30	
		Disconnect Crane from cask and move crane to Park Position	10	
	Prepare/Survey Transporter For Release From HSF	Perform smear test on cask and transporter	30	Includes preparation of documentation
		Open Loading bay door	3	
		Drive empty cask on transporter out of loading bay	5	
		Close Loading bay door	3	
	Return Cask/Transporter to Originating Facility	Drive empty cask on transporter to guard checkpoint, check documentation	5	
Decontaminate & Overpack Out-of-specification canisters				Not modeled at this stage - dependant on whether HSF will provide this function
Stage Canisters	Move Canister from Inspection Station to Staging Area	Raise canister with crane from inspection station	5	
		Move canister to Staging Rack	5	
	Place canister in selected staging position	Lower canister into Staging Rack	3	Raise and lower functions include grappling the canister
	Stage Canister	Stage Canisters		Dependant on lag required between inspection and MGR cask loading
Store Canister	Move Canister from Inspection Station to Store	Raise canister with crane from inspection station	5	
		Move canister to Store load-in/out position	5	15ft/min loaded travel

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Appendix A – HSF Process Times (Normal Operations)

Major Function	Minor Function	Detailed Task	Time to Complete (mins)	Notes
		Open Hatch	3	
		Lower canister into Store Transfer Bogie	5	
		Degrapple canister from crane and raise hoist	5	
		Close Hatch	3	
		Move canister on bogie to Store Load position	5	
		Open Hatch	3	
		Using Store Crane raise canister to transfer height in store	5	
		Close Hatch	3	
	Place canister in selected storage position	Move canister to selected storage location	5(15)	5 mins minimum - 15 mins to other end of store based on Option 2A
		Lower canister into rack	5	Includes degrappling
		Raise Store crane hoist and return crane to Park position	5(5)	50ft/min unloaded
	Store/monitor canister	Store/monitor canister		Dependant on lag required between storage and MGR cask loading
Receive Empty MGR Shipping Casks	Receive Shipping Casks at Guard Check Point		0	
	Move Shipping casks to Marshalling Yard with HSF locomotive		60	Dependant on site and length of rail - based on Site 4 Includes handover to HSF locomotive
	Marshal shipping casks		60	
	On request from HSF move selected cask on railcar to washdown area		15	
	Washdown Railcar and Cask		120	Allowing for airdrying
	Move Selected Cask on Railcar into HSF Load-out Station	Move railcar to Loading Bay	20	
		Open Loading Bay Door	3	
		Move railcar to unload position	10	

Appendix A – HSF Process Times (Normal Operations)

Major Function	Minor Function	Detailed Task	Time to Complete (mins)	Notes
		Disconnect loco and move loco out of Import Bay	15	
	Remove Personnel Barrier and Stage	Move OH Crane from park to cask position	10	
		Manually unbolt personnel barrier	20	
		Using Aux hoist and slings raise personnel barrier away from cask	15	
		Move personnel barrier to storage location and lower, disconnect slings	10	
	Physical Inspection and Rad survey Cask Externals		60	
	Remove Front and Rear Impact Limiters and Stage	Includes unbolting impact limiters and using Aux hoist and slings removing limiters and placing in staging location	180	
	Remove Tiedown assembly and stage	Unbolt tiedown and using Aux hoist remove and place in staging area	20	
	Lift cask to vertical and off railcar	Using main crane and lifting beam attach to trunnions and rotate to vertical on railcar	60	
	Move cask to Load-out Port Transfer	Move cask with main crane to Roller shutter door	10	
		Open Roller Shutter door	3	
		Move cask to position over MGR Cask Loading Platform	5	
		Open Cask Loading Platform rolling gate	3	
		Lower Cask onto MGR Cask Bogie	10	
		Disconnect lifting beam from cask, raise hoist to transfer height and park	10	
	Unbolt cask lid and move cask to load-out port	Operate Jib Crane with impact wrench to unbolting position	5	
		Break tamper seals and unbolt lid with impact wrench	45	
		Using Aux Hoist attach	10	

Appendix A – HSF Process Times (Normal Operations)

Major Function	Minor Function	Detailed Task	Time to Complete (mins)	Notes
		lid lifting attachment		
		Lift lid off cask and place on lid inspection stand	15	
		Inspect seals	10	
		Lift lid and replace on cask	10	
		Disconnect lifting attachment and raise hoist to transfer height	10	
		Close Roller Shutter Door	3	
		Close Cask Loading Platform	3	
Load Canisters Into Shipping Casks	*Remove Lid From* Shipping Cask and Stage	Move Cask on bogie to Lid Removal Station	5	
		Remove and Retain Lid	5	
		Move Cask on bogie to Load-out port	5	
	Remove Selected Canister From Inspection Station	Move in-cell crane to inspection station and grapple canister	5	
		Raise canister to transfer height	5	
	OR			
	Remove Selected Canister From Staging Rack	Move in-cell crane to staging rack and grapple canister	5	
		Raise canister to transfer height	5	
	OR			
	Remove Selected Canister From Store	Move store crane to selected storage position and grapple canister	5(5)	
		Raise canister to transfer height	5	
		Move canister to Store load-in/out position	20(10)	Allows for removal and local storage of impact absorbers on canister number 2 and 4
		Open hatch	3	
		Lower canister into Store Transfer Bogie	5	
		Degrapple canister from crane and raise hoist	5	
		Close Hatch	3	
		Move canister on bogie to Load in/out cell	5	
		Move in-cell crane to	5	

Appendix A – HSF Process Times (Normal Operations)

Major Function	Minor Function	Detailed Task	Time to Complete (mins)	Notes
		hatch		
		Open hatch	3	
		Lower hoist and grapple canister	5	
		Raise canister to transfer height	5	
	Move Canister to Inspection Station	Move Canister to Inspection Station	5	
		Lower canister into inspection station, rotating to perform visual inspection	10	
		As canister is lowered take swipe test of selected canister locations	0	Not normal operation
		Transfer swabs to loadout port	0	"
		Loadout swabs	0	"
		Monitor swabs	0	"
	Move Canister to Load-out Port and Load into Shipping Cask	Move Canister to Load-out port	5	
		Open hatch	3	
		Lower canister into cask	5	
		Degrapple canister from crane and raise hoist	5	
		Close Hatch	3	
	Repeat for another 4 canisters	Repeat steps for canisters coming from inspection	124	4 x 31
		OR		
		Repeat steps for canisters coming from staging	124	4 x 31
		OR		
		Repeat steps for canisters coming from store	360	4 x 90
	Move Cask from Load-out Port to Transfer Port	Move Cask on MGR Cask Bogie to Lid Removal Station	5	
		Remove and Retain Lid	5	
		Move Cask on MGR Cask Bogie to Load-out Port	5	
	Move Lid From Staging Area and Replace on Cask	Move Cask on MGR Cask Bogie to Lid Removal Station	5	
		Replace Lid on cask	5	
		Move Cask on bogie to MGR Cask Loading Platform position	5	

Appendix A – HSF Process Times (Normal Operations)

Major Function	Minor Function	Detailed Task	Time to Complete (mins)	Notes
		Open MGR Cask Loading Platform	3	
		Open Cask Loading Platform sliding gate	3	
	Tighten Lid Bolts	Operate Jib Crane with impact wrench to bolting position	3	
		Torque lid bolts with impact wrench	45	
		Perform smear test on lid area	30	
	Perform Containment Assembly Verification Test	Perform Containment Assembly Verification Test	120	
		Connect crane lifting attachment to Cask	3	
		Raise MGR cask from bogie with crane	10	
		Close Cask Loading Platform	3	
		Open Roller Shutter Door	2	
	Move Full cask to Rail Car	Using main crane and lifting beam attach to trunnions on cask	10	
		Raise MGR cask from bogie with crane	10	
		Move Cask into Loading Bay to Railcar location	10	
		Close Roller Shutter Door	2	
	Lower Cask to Horizontal on Railcar and Secure	Lower cask onto bottom trunnion supports on railcar and turn to horizontal.	60	
		Using Aux hoist and slings retrieve tie-downs from staging area and replace	30	
	Perform Radiation and Contamination Survey on Cask Externals		60	
	Move Impact Limiters From Staging Area and Install		180	
	Move Personnel Barrier From Staging Area and Install		55	

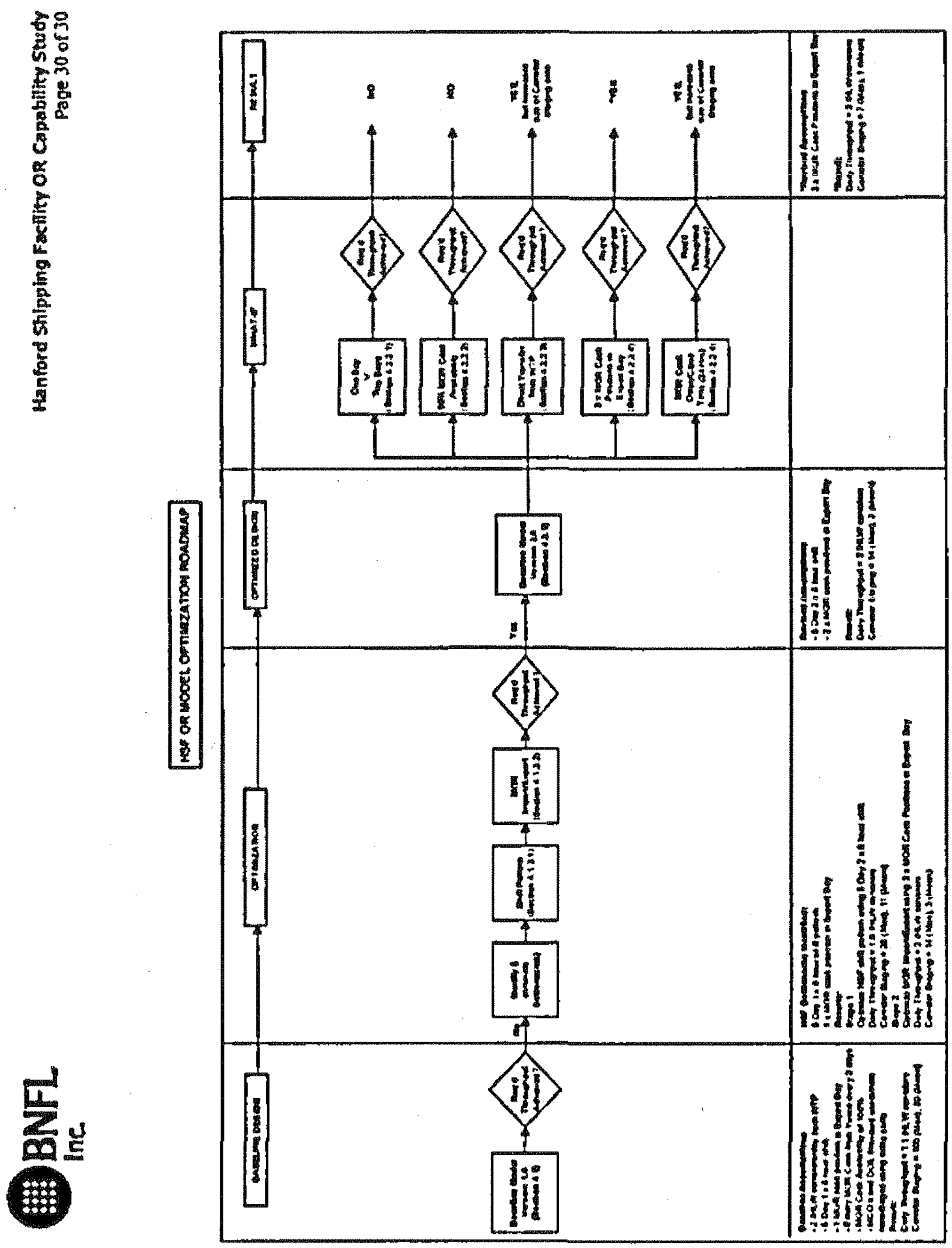
Appendix A – HSF Process Times (Normal Operations)

Major Function	Minor Function	Detailed Task	Time to Complete (mins)	Notes
	Perform Final Inspection and Prepare Shipping Documents		30	
	Move Full Cask out of HSF to Marshalling Yard	Open Loading bay door	5	
		Move loco into position and couple to railcar	30	
		Move loaded MGR cask on railcar out of loading bay	20	
		Close Loading Bay Door	5	
Dispatch Loaded MGR Shipping Casks	Stage Loaded Railcars in Marshalling Yard		60	
	On agreement between HSF and MGR move railcar to facility boundary		20	
	Check Documentation at Guard Check point for dispatch		30	
	Handover Railcar to offsite locomotive		30	

Appendix B –

HSF OR Model Optimization Roadmap

BNFL Inc.



Hanford Shipping Facility OR Capability Study
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BNFL Inc.
HSF OR MODEL OPTIMIZATION ROADMAP
BASELINE DESIGN
OPTIMIZATION
OPTIMIZED DESIGN
WHAT-IF
RESULT

ATTACHMENT C2
DECONTAMINATION AND OVERPACKING

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CONTENTS

TABLES

LIST OF TERMS

CSB	Canister Storage Building
DOE	U.S. Department of Energy
FPF	fuel preparation facility
HSF	Hanford Shipping Facility
IHLW	immobilized high-level waste
MCO	multi-canister overpack
MGR	monitored geologic repository
SNF	spent nuclear fuel
WTP	Waste Treatment Plant

1.0 INTRODUCTION

The Hanford Shipping Facility (HSF) will package canisters of immobilized high-level waste (IHLW) and spent nuclear fuel (SNF) in transport packages for rail shipment to the monitored geologic repository (MGR) at Yucca Mountain, Nevada. The MGR acceptance criteria is as specified in *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms* (DOE/EM-0093) and *Waste Acceptance System Requirements Document* (DOE/RW-0351). This appendix provides an evaluation of the requirements and methods for providing the following capabilities within the HSF:

- Decontamination of canisters
- Overpacking of canisters
- Decontamination of transportation casks.

2.0 CANISTER DECONTAMINATION AND OVERPACKING

This section evaluates the need for providing the capability for decontaminating or overpacking the IHLW, multi-canister overpack (MCO), and U.S. Department of Energy (DOE) standard canisters in the HSF. This evaluation considers the production methods, handling operations, or other processes used to prevent canister damage and contamination spread in assessing the probability of having damaged or contaminated canisters. Depending on the probability, the following options are considered in lieu of providing decontamination and overpacking capability within the HSF:

- Provision for canister decontamination and overpacking at other Hanford Site facilities
- Storing canisters at the Canister Storage Building (CSB) for decontamination or overpacking at the end of canister shipping operations
- Obtaining a waiver from the MGR for out of specification canisters.

2.1 EVALUATION RESULTS SUMMARY

Based on this evaluation, there is not a need for canister decontamination or overpacking capability in the HSF. Specifically, the following conclusions are reached:

- IHLW canisters are decontaminated at the Waste Treatment Plant (WTP) to an extent that the probability of receiving a contaminated IHLW canister above the MGR acceptance criteria is very low.
- Operating experience with MCOs at the CSB indicate that although approximately 10% of the MCOs are contaminated, the levels are below the MGR acceptance criteria and the contamination is typically local and readily accessible such that it can be removed using spray and wipe decontamination methods.

- The planned fuel preparation facility (FPF) will provide the capability for packaging SNF in DOE standard canisters and for gas sampling of the MCOs. The capability to decontaminate the DOE standard canisters and the MCOs will also be provided within the FPF. The FPF could provide the capability to decontaminate and overpack limited quantities of IHLW canisters with minor impacts to the FPF design.

- The CSB is equipped with sealed storage tubes that could provide long term monitored storage of contaminated or damaged canisters pending disposition at the end of the canister shipping operations.

- It is unlikely that canisters will be damaged during canister handling operations within the HSF such that overpacking is required. The probability that a canister will be dropped is estimated to be one in 5,000; or approximately 2 canisters over the lifetime of the facility based on 9,400 IHLW canisters, 418 MCOs, and 71 DOE standard canisters. All canisters are designed to prevent loss of containment when dropped from a height of 7 meters onto the bottom of the canister. The HSF design concept minimizes the potential drop height or provides other mitigating features to prevent loss of canister containment during all canister handling operations.

- The MGR will have the capability to package SNF into canisters and to overpack canisters. For limited quantities, the most cost effective approach may be to pursue a waiver from MGR to allow shipment of out of specification canisters to the MGR for remediation.

2.2 ASSUMPTIONS

The underlying assumption is that all canisters are verified to be compliant with the MGR acceptance criteria at the sending facility (high-level waste vitrification building, CSB, FPF). Only visual inspection of the canisters is required in the HSF to determine if the canisters have been damaged during onsite transportation or handling within the HSF.

2.3 EVALUATION METHODOLOGY

To establish the need for canister decontamination or overpacking, operations and processes associated with canister handling are evaluated to estimate the number canisters that will require decontamination or overpacking. Also considered is the ability to decontaminate or overpack canisters at other facilities to preclude unnecessarily providing duplicate decontamination and overpacking capability within the HSF.

2.3.1 Canister Decontamination Need within Hanford Shipping Facility

Each type of canister is evaluated separately in the following subsections.

2.3.1.1 Immobilized High-Level Waste Canisters

IHLW canisters produced by the WTP are planned to be decontaminated to the MGR acceptance criteria before transport to the HSF. The planned decontamination system for IHLW canisters is a chemical milling method that is considered state-of-the-art. Every canister is placed in a decontamination bath containing nitric acid and cerium(IV) nitrate in solution. The cerium(IV) nitrate etches the surface of the stainless steel canister, removing both the steel and contamination on the surface. The canister is rinsed with a nitric acid solution. The canister is then placed in a second cerium(IV) nitrate bath, and then rinsed with de-mineralized water. Following this two stage chemical milling process, the canister is surveyed. This process is expected to reduce the surface contamination to below 17,000 dpm/100 cm^2 for beta/gamma and 1,700 dpm/100 cm^2 for alpha radiation. Past experience with this decontamination method indicates a first cycle failure rate of 1%. If the removable surface contamination exceeds the MGR acceptance criteria, the canister is cycled back through the decontamination process until it meets the surface contamination limits.

Based on this aggressive decontamination approach for IHLW canisters, it is very unlikely that a received canister would have contamination above the MGR acceptance criteria.

2.3.1.2 Multi-Canister Overpack Canisters

The MCOs are received at the Cold Vacuum Drying Facility after being wet loaded in the Hanford K-West basin where approximately the top four inches of the canister wall and the shield plug are exposed to the basin water. Before transporting the MCOs from the Cold Vacuum Drying Facility, the accessible surfaces of the MCOs are swiped and checked for contamination. Only the top four inches of the MCO is swiped, as this is the most probable location of contamination and this is the only accessible area of the MCO. If contamination is found, the surface is decontaminated using a spray and wipe method. The accessible surfaces of the MCO are surveyed again upon receipt at the CSB and decontaminated if necessary before placement in the CSB storage tube. The onsite MCO transportation cask is routinely surveyed for contamination with low levels of contamination occasionally found in the bottom of the cask.

Approximately 10% of the MCOs transported to the CSB are found to have removable surface contamination. Under normal circumstances, the highest level of surface contamination found on the MCOs has been approximately 4,000 to 5,000 dpm/100 cm^2 beta/gamma. No alpha contamination has been found. These contamination levels are below the MGR acceptance limits of 22,000 dpm/100 cm^2 beta/gamma and 2,200 dpm/100 cm^2 alpha. Facility personnel indicate that the source of the contamination is most likely from migration from crevices in the MCO lid where contamination is not accessible by the spray and wipe decontamination method. Two MCOs were transported from the Cold Vacuum Drying Facility to the CSB with higher levels of contamination that resulted from process upsets during loading. In both of these instances, the higher levels of contamination were known and managed appropriately during receipt and placement in storage. No MCOs have been placed in storage at the CSB with contamination levels greater than the MGR acceptance criteria.

Before transporting offsite, the internal gas in the MCOs (or a subset of the total MCO population) will be sampled to verify compliance with MGR disposal requirements. It is planned that the sampling will occur at the future FPF. The FPF is currently planned to provide this capability, and the facility is in the earliest planning stages.

Given the contamination incidence (10%) and the low levels of contamination (0% exceeding the MGR acceptance criteria) that have been shown to be removable using spray and wipe decontamination, additional decontamination features or permanent provisions for decontamination of MCOs is not warranted.

2.3.1.3 U.S. Department of Energy Standard Canisters

DOE standard canisters will be loaded with SNF from sources other than the Hanford K Basins at the planned FPF. The facility is now in the earliest planning stages, and facility concepts and approaches have not yet been established. The FPF is envisioned to provide fuel handling and packaging into DOE standard canisters, decontamination of the canisters, and loading into on-site transportation casks for movement to the HSF. The canisters will be decontaminated to MGR acceptance criteria.

2.3.2 Canister Overpacking Need within Hanford Shipping Facility

Overpacking of the canisters may be required when the canister does not meet the MGR acceptance criteria for surface contamination, containment, or dimensional specifications. The IHLW canisters and the DOE standard canisters will be inspected for conformance to the MGR acceptance criteria at their production facilities (WTP or FPF, respectively). The MCOs will be processed through the FPF for gas sampling, inspection, and decontamination as necessary prior to transfer to the HSF. Because the canisters will be verified to be compliant with the MGR acceptance criteria before shipment to the HSF, overpacking of canisters would only be required due to contamination or damage during onsite shipment or during handling within the HSF.

2.3.2.1 Overpacking Need Due to Canister Drop

The only envisioned manner in which a canister would be damaged is a drop from the lifting equipment during canister handling operations within the HSF. The IHLW canisters are designed to survive a 7 meter drop without loss of containment. The design objective of the HSF concept development is to eliminate canister handling operations above 7 meters. Therefore, if a canister is dropped, the canister could be physically deformed, but loss of containment and contamination spread caused by canister failure is not expected.

Past experience at the West Valley Demonstration Project with a similar grapple has shown that a canister drop has not occurred, but the number of canisters is small in comparison with the number of canisters that will be processed through the HSF. Savannah River Site has handled approximately 1,500 canisters with no drop incidents using a grapple similar to the IHLW canister grapple. Based on BNFL fuel and vitrified waste canister handling experience in England, the probability of dropping a canister is conservatively projected to be one in 5,000 (probability of 2×10^{-4}). *Project W-464 Interim High-Level Waste Canister Drop Mitigation in Canister Storage Building Analysis* (RPP-16360) projected a drop probability of 1.1×10^{-7} while handling IHLW canisters with the MCO handling machine. Using the higher probability of dropping a canister of one in 5,000, approximately two canisters would be dropped over the life of the shipping campaign. The dropped canister is not expected to have a breach of containment, but the canister may be deformed such that it does not meet the MGR dimensional acceptance criteria. If the damage to the dropped canisters does not violate the integrity of the canisters and does not violate the size and shape requirements, then the need to overpack would be negated.

2.3.2.2 Overpacking Need Due to Contamination

The producing facilities will certify that the canisters meet the MGR acceptance criteria for contamination prior to transportation to the HSF. Except for cross-contamination from the transportation cask, the canisters within the HSF should remain within the surface contamination limits during canister handling and storage operations at the HSF because canister containment is not expected to be breached even in a dropped canister scenario. To limit the probability that a contaminated canister would be received at the HSF, the interior surfaces of the transportation casks will be routinely inspected for removable contamination after receipt of each canister. If the surface contamination on the interior surfaces of the cask is higher than expected, the received canister will be treated as suspect for excessive surface contamination levels.

2.4 DECONTAMINATION OR OVERPACKING OPTIONS

The following options are considered for dispositioning canisters at the HSF that require decontamination or overpacking. Evaluation of the options considers the low probability of having canisters in HSF that do not meet the MGR acceptance criteria.

- Use decontamination and overpacking capabilities at other Hanford Site facilities
- Store canisters requiring decontamination or overpacking at the CSB for disposition at the end of HSF mission
- Obtain a waiver of the MGR acceptance requirements for each non-compliant canister and ship the non-compliant canisters to the MGR for disposition
- Provide decontamination and overpacking capabilities within the HSF.

2.4.1 Decontamination or Overpacking at Other Facilities

A facility is needed for packaging of SNF (other than that stored at K-Basins) into DOE standard canisters. The planned FPF will be designed to package SNFs into DOE standard canisters and to sample the gas in the MCOs. To accomplish these functions, the FPF will require the capability to handle the MCOs and DOE standard canisters, open test port welds, perform closure welds and decontaminate the external surfaces of the canisters. The length, diameter, and weight of the IHLW canisters are enveloped by those of the MCO and DOE standard canisters and thus the FPF would be able to accommodate IHLW canisters with limited or no impact on FPF design requirements. The planned FPF will have the capability to decontaminate MCOs and DOE standard canisters, and could be designed to accommodate decontamination of IHLW canisters. The planned FPF will have the capability to repackage DOE standard canisters and could be designed to accommodate overpacking of MCOs, IHLW, and DOE standard canisters.

The WTP high-level waste vitrification building has designed capability for decontamination of IHLW canisters. The WTP has no plans to receive a returned canister once it is transferred to either the HSF or storage facility. However, IHLW canisters could be returned to WTP and decontaminated if conditions warranted such a return and it did not interfere with the WTP operating schedule. For instance, if warranted, contaminated IHLW canisters could be returned to WTP for decontamination during high-level waste melter outages when new IHLW canisters are not being produced if returning a contaminated canister did not affect the production schedule. Also, contaminated IHLW canisters could be returned to WTP for decontamination during planned vitrification outages or at end of mission.

2.4.2 Store Non-Compliant Canisters at Canister Storage Building until end of Mission

CSB has six sealed, monitorable oversized storage tubes per vault that could be used to store contaminated canisters or deformed canisters. These oversized storage tubes will hold up to 12 SNF canisters (MCOs or DOE standard canisters) and 24 IHLW canisters. These special storage tubes within the CSB will provide adequate capacity for the projected number of canisters that will need decontamination or overpacking. Canisters needing either decontamination or overpacking can be transported via the onsite transportation cask to the CSB for storage until decontamination or overpacking facilities are available.

2.4.3 Obtain Monitored Geologic Repository Waiver

The MGR receipt facility will have the capability to receive bare commercial SNF assemblies and package them into canisters. The MGR also will have the capability to package multiple canisters into an MGR overpack for placement within the MGR. A waiver from the MGR acceptance criteria could be pursued on an individual noncompliant canister basis that would allow shipment of the noncompliant canisters to MGR for decontamination or overpacking at the MGR receipt facilities.

Considering the relatively few number of canisters from Hanford that are expected to be non-compliant, request for a waiver on the MGR acceptance criteria is an option that should be considered if onsite decontamination or overpacking cannot be effected.

2.4.4 Decontamination or Overpacking within the Hanford Shipping Facility

The HSF could be designed to incorporate decontamination and overpacking capabilities. These functions would have to be done in a cell with capability of handling the canisters and overpacks and have remote welding and decontamination capability; the same capability as required by the FPF. However, providing these redundant capabilities in the HSF is not warranted given the low number of canisters that can be expected to require either decontamination or overpacking, the capability to store noncompliant canisters, the existing capability for decontamination of the IHLW canisters in the WTP high-level waste vitrification facility, and the capability to decontaminate and overpack canisters in the planned FPF.

3.0 CASK DECONTAMINATION METHOD EVALUATION

Although it is unlikely that onsite transportation casks and MGR casks would be received at the HSF with unacceptable contamination levels or would be contaminated during unloading and loading activities at the HSF, capabilities for decontamination of casks must be provided at the HSF. This section provides an evaluation of common cask decontamination methods and identifies the recommended method for incorporation into the HSF design.

3.1 EVALUATION RESULTS SUMMARY

The evaluated decontamination methods for casks include manual swiping, liquid decontamination using decontamination solutions, and dry ice blasting.

Based on the evaluation of decontamination methods for casks, the recommended cask decontamination method is manual swiping for decontamination of both internal and external surfaces of the cask. A manual spray and wipe method should be used for the external surfaces of the cask and a swab on a pole or other similar technique should be used for internal cask surfaces.

3.2 CONSTRAINTS, ASSUMPTIONS, AND RISKS

The assumptions for decontamination of casks used to develop this evaluation are presented in this section. For each assumption, the basis or rationale for the assumption is provided.

- The level of contamination of the cask internal surfaces will not preclude manual decontamination methods. Because the canisters transported in the casks are sealed and decontaminated to the MGR acceptance criteria before being loaded into the cask, any cross contamination that may occur should be at a level that allows manual decontamination.

- The dose rates from loaded casks will not preclude manual decontamination methods of the external cask surfaces. MGR casks must comply with the external radiation level requirements as stipulated in "Shippers – General Requirements for Shipments and Packagings" (49 CFR 173) for transport in public, and onsite transportation casks are required to provide an equivalent degree of protection or be designed to maintain radiation exposures as low as reasonably achievable.

3.3 ALTERNATIVES CONSIDERED

The alternatives considered in the evaluation of cask decontamination are provided below. Each of the alternatives is described in sufficient detail to allow evaluation and selection of the preferred approach.

Alternative 1 – Manual Swipe Decontamination. This alternative consists of decontamination using manual techniques that do not use large liquid volumes and that can be accomplished locally in the receiving bay. If the internal surface is found to be contaminated, operating personnel will use a swab attached to a long reach pole to reach the contaminated surfaces. The swab will be lightly moistened with a decontamination solution to assist in removal of the contamination. A special facility area will not be required.

Alternative 2 – Dry Ice Blasting. Dry ice blasting relies on the ablating properties of solidified carbon dioxide projected onto a surface to remove contamination. Dry ice pellets are sprayed onto the contaminated surface through a nozzle. Upon contact, the solidified carbon dioxide sublimates to gas, removing surface contamination as an airborne particulate. The resulting particulate is collected by the facility ventilation system or a specially designed collection hood. Contaminated casks would be moved to a nearby area or room equipped with appropriate ventilation and decontamination equipment for the generated airborne radioactivity where the casks would be decontaminated. In addition, dry ice pellet receiving and storing or manufacturing capabilities would have to be provided.

Alternative 3 – Solution Decontamination. Under this alternative, contaminated casks would be decontaminated using various decontamination solutions. Solutions commonly used in the nuclear industry include acids and bases, oxidizers and reducers, and surfactants alone or in combination. Solutions can be sprayed on or the contaminated equipment can be immersed in the solution. For this application, immersion in a solution bath is considered impractical and cost prohibitive. For sprayed applications, solutions are sprayed onto the contaminated surface, sometimes at high pressure, and drainage is collected. For this alternative, a separate decontamination room would be required. The room would be equipped with coated walls, drains, and a ventilation system. Additionally, waste solution handling equipment and solution makeup equipment (tanks, pumps, piping, spray wands) would be required. Casks would be moved into the decontamination room, sprayed with solutions and rinsed, and swiped for verification of decontamination.

3.4 EVALUATION CRITERIA

Table 1 provides a summary of the cask decontamination evaluation criteria.

Table 1. Summary of Cask Decontamination Evaluation Criteria

Evaluation Criteria	Description
Operability	Qualitative measure of inherent complexity determined by the following factors: • Physical complexity • Operator interfaces
Availability	Qualitative measure of the following: • Maintainability • Reliability • Inspectability
Environmental Considerations	Measurement of the following factors: • Airborne effluent generation and associated cleanup equipment • Secondary liquid waste generation and disposal • Permitting requirements
Safety	Assessment of the following factors: • Radiological protection • Industrial safety • ALARA
Decontamination/Decommissioning	Qualitative measure of features incorporated into design to facilitate future decontamination for decommissioning
Capital Cost	Qualitative comparison of the capital cost for each option
Operating Cost	Qualitative comparison of the O&M costs for each option

ALARA = as low as reasonably achievable.
O&M = operations and maintenance.

The following criteria were determined to be non-differentiating for decontamination capabilities:

- Technical maturity
- Constructability
- Expandability.

3.5 ANALYSIS OF ALTERNATIVES

The three alternatives were evaluated against the evaluation criteria using qualitative as opposed to quantitative ranking. Table 2 presents the evaluation of alternatives against the evaluation criteria.

3.6 FINDINGS AND RECOMMENDATIONS

Based on the above evaluation, Alternative 1 – Manual Swipe Decontamination, is preferred. The potential infrequency and ease of decontaminating a cask does not justify installation of complex or aggressive decontamination systems. Based on the cask geometry, size, and expected contamination, decontamination using manual swiping techniques should be satisfactory.

4.0 REFERENCES

49 CFR 173, "Shippers – General Requirements for Shipments and Packagings," *Code of Federal Regulations*, as amended

DOE/EM-0093, 1996, *Waste Acceptance Product Specifications for Vitrified High-Level Waste Forms*, Rev. 2, U.S. Department of Energy, Office of Environmental Management, Washington, D.C.

DOE/RW-0351, 1995, *Waste Acceptance System Requirements Document*, Rev. 1, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, D.C.

RPP-16360, 2003, *Project W-464 Interim High-Level Waste Canister Drop Mitigation in Canister Storage Building Analysis*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Table 2. Cask Decontamination Alternative Evaluation

Evaluation Criteria	Alternative 1 – Manual Decontamination	Alternative 2 – Dry Ice Blasting	Alternative 3 – Solution Decontamination
Operability	High. Fewest movements of cask. Can be accomplished without changing the handling process. Simple tools and operations.	Moderate. Additional cask movements and operating processes are required. Additional complexity of operations for CO_2 pellet production and blasting equipment. Additional operational restrictions due to ventilation system for airborne contamination and CO_2 gas.	Moderate. Additional cask movements and operating processes required. Additional complexity for solution pumping, distribution, and collection systems. Additional operational restrictions due to ventilation system for airborne contamination and aerosols.
Availability	High. Minimal impact to operations and maintenance.	Moderate. Decontamination equipment must be maintained for infrequent use.	Moderate. Decontamination equipment must be maintained for infrequent use.
Environmental Considerations	Generates small volumes of solid LLW.	Generates airborne contamination and small volumes of solid LLW.	Generates airborne contamination and aerosols. Generates liquid LLW and small volumes of solid LLW.
Safety	No safety issues.	Potential safety risk to operators from spray nozzle and low temperature system.	Potential safety risk from hazardous chemicals.
Decontamination and Decommissioning	No added facility footprint to D&D.	Added footprint to D&D. System can be used during operations for housekeeping.	Added footprint to D&D. System can be used during operations for housekeeping.
Capital Cost	Lowest	Moderate relative increase to capital cost.	Moderate relative increase to capital cost.
Operating Cost	Lowest	Moderate relative increase for system operation and maintenance.	Moderate relative increase for system operation and maintenance.

D&D = decontamination and decommissioning.
LLW = low-level waste.

APPENDIX D
ROUGH-ORDER-OF-MAGNITUDE COST ESTIMATE

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CONTENTS

ATTACHMENTS

TABLE

LIST OF TERMS

HSF	Hanford Shipping Facility
ROM	rough-order-of-magnitude

APPENDIX D
ROUGH-ORDER-OF-MAGNITUDE COST ESTIMATE

D1.0 SCOPE

The rough-order-of-magnitude (ROM) cost estimate includes the capital cost for the design, construction, installation, and commissioning of the preferred Hanford Shipping Facility (HSF) alternatives as described in Section 2.0 of this document. A security requirements analysis must be completed to determine facility protection measures. Upon completion of the security requirements analysis, the cost of security protection measures will be established. ROM cost estimates are provided for the following:

- HSF without canister storage (Attachment D1)
- HSF with storage for 2,000 immobilized high-level waste canisters (Attachment D2)
- Future addition of additional storage module for 2,000 immobilized high-level waste canisters (Attachment D3) – Costs are not included in the base facility cost
- Incorporation of canister decontamination and overpacking capability into the HSF (Attachment D4) – Costs are not included in the base facility cost
- Supporting infrastructure for alternative sites 3, 5A, and 5B. (Appendix A) – Costs are included in the base facility cost.

D2.0 COST ESTIMATE BASIS

The following are the assumptions that form the basis for the ROM cost estimates. Additional basis for the addition of a future 2,000 immobilized high-level waste canister storage module is provided in Section D2.1, and for incorporation of canister decontamination and overpacking capability is provided in Section D2.2.

a) Civil quantities were based on a manual takeoff of cubic yards of concrete from the layouts and cost obtained using unit rates for construction from Bechtel National Incorporated's Waste Treatment Plant project estimate in 2002/2003 escalated to 2004 dollars.

b) Excavation costs assume chosen site is clean and free from contamination.

c) Steel quantities were obtained using parametric estimating of volume and unit rates for construction from Bechtel National Incorporated's Waste Treatment Plant project estimate in 2002/2003 escalated to 2004 dollars.

d) Heating, ventilation, and air conditioning quantities were developed by takeoffs of volumes from the layout and using heating, ventilation, and air conditioning equipment quotes and installation costs provided by Superior Air Handling Corporation for the

Foster Wheeler/BNFL conceptual design estimate for the salt waste processing facility at the Savannah River Site (2003) escalated to 2004 dollars and increased by a location factor of 1.23 to account for the higher cost of construction in Richland, Washington, versus Savannah, Georgia.

e) Mechanical equipment costs were obtained via budget quotation (Cranes – American Crane Company) and parametric estimating, using Bechtel National Incorporated's Waste Treatment Plant project estimate in 2002/2003, which has similar mechanical handling equipment and is based on vendor quotes; escalated to 2004 dollars.

f) Control, electrical, and instrumentation equipment estimates were based on the Foster Wheeler/BNFL estimate for the salt waste processing facility and scaled accordingly for the reduced complexity in the HSF and include dollar escalation and location factor adjustments.

g) All other cost elements were parametrically estimated from the Foster Wheeler/BNFL estimate for the salt waste processing facility and include dollar escalation and location factor adjustments.

h) Cost estimates include the following:

   a. Project Management: 10%
   b. Project Support: 10%
   c. Contingency: 30%.

D2.1 FUTURE STORAGE MODULE ADDITION

The following are the additional assumptions that form the basis for the ROM cost estimate for the future addition of a 2,000 immobilized high-level waste canister storage module.

a) It was assumed that the future storage structure is physically attached to the existing storage structure as shown on Drawing CEES-04-044-C-004, sheet 1, provided in Appendix E, with a bogie transfer tunnel between the existing storage structure.

b) The future storage is self-sufficient from a heating, ventilation, and air conditioning, electrical and instrumentation, and control and other services perspective.

D2.2 CANISTER DECONTAMINATION AND OVERPACKING CAPABILITY

The following are the additional assumptions that form the basis for the ROM cost estimate for incorporation of canister decontamination and overpacking capability in the HSF:

a) Receipt and staging of empty overpack containers and limited space for out-of-specification canisters

b) In-cell decontamination booth, complete with carbon dioxide blasting remote lance, to be operated using master-slave manipulators and viewed through a shielding window (carbon dioxide pelletizer is located out-cell)

c) Weld station to enable remote welding of the overpack lid, once the out-of-specification canister is ready for overpacking. The weld station includes a remotely operated orbital welding head, wire feed, inspection cameras and a re-work milling head that can be used to re-work a bad weld. A cell transfer port is provided to facilitate transfer of consumables. Weld inspection will be visual only and weld parameters will be qualified, such that nondestructive examination can be limited to visual and demonstrating weld parameters are within range

d) Empty overpacks will enter the cell using the existing canister import bogie, complete with overpack lid. A spider is provided for centralizing the overpack in the bogie

e) A remotely operated confinement door is provided between the main load in/out area of the cell and the decontamination and overpacking area

f) The load in/out crane is utilized for canister movements between the two areas

g) It is assumed that decontamination/overpacking would occur off-shift to the normal load in/out cell operations, such that the 2 canister/day throughput in the load in/out area is not affected.

D3.0 SPECIFIC EXCLUSIONS FROM THE ESTIMATE

The following items were specifically excluded from the estimate for the facility:

a) Decommissioning and demolition costs

b) Provisions for decontamination and overpacking of canisters within the HSF. The additional cost for this capability is provided in Attachment D4

c) Subcontractor's fee

d) Permitting

e) Taxes.

D4.0 COST SUMMARY

Table D.1 provides a cost summary of the capital cost for design, construction, installation, and commissioning.

Table D.1. Unescalated Rough-Order-of-Magnitude Cost Estimate Summary (2004 $)

	HSF Only at Site 3 ($)	HSF with 2000 IHLW Canister Storage at Site 3 ($)	Future Addition of 2000 IHLW Canister Storage ($)	Addition of Canister Decontamination and Overpacking Capability ($)
Conceptual Design Report	3,150,000	4,830,000	1,810,000	480,000
Design (Title I & II)	7,850,000	11,820,000	4,700,000	1,170,000
Engineering/Inspection (Title III)	2,730,000	3,960,000	1,900,000	390,000
Building Construction	48,570,000	83,710,000	49,120,000	8,820,000
Commissioning	4,510,000	7,510,000	3,230,000	470,000
Subtotal	66,810,000	111,830,000	60,750,000	11,330,000
Supporting Infrastructure	1,510,000	1,510,000	0	0
Subtotal	**68,320,000**	**113,340,000**	**60,750,000**	**11,330,000**
Project Management (10%)	6,830,000	11,330,000	6,080,000	1,130,000
Project Support (10%)	6,830,000	11,330,000	6,080,000	1,130,000
Contingency (30%)	20,500,000	34,000,000	18,230,000	3,400,000
TOTAL	**102,480,000**	**170,000,000**	**91,140,000**	**16,990,000**

HSF = Hanford Shipping Facility.
IHLW = immobilized high-level waste.

ATTACHMENT D1
HANFORD SHIPPING FACILITY WITHOUT STORAGE
ROUGH-ORDER-OF-MAGNITUDE
COST ESTIMATE DATA SHEETS

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Design and Engineering Costs – HSF Only

Conceptual Design		
		Assumptions
Hours	38,560	Hours include all engineering, design, project management manhours for the 6 month conceptual design with an FTE across all disciplines of 44 at $80/hr average loaded rate - 2 mth rampup to full strength
$ Hours	$3,084,800	
ODCs	$61,696	Allowance of 2% of hours
Subtotal	$3,146,496	Excludes fee and escalation

Title I and II Design		
		Assumptions
Hours	93,440	Hours include all engineering, design, project management manhours for the 12 month design with an FTE across all disciplines at $80/hr average loaded rate - 1 mth rampup to full strength (44,60)
$ Hours	$7,475,200	
Subcontracts	$150,000	Subcontracts for SSI Analysis, Fire Suppression system at $100K and $50K respectively
Equipment/Materials	$74,752	Allowance of 1% of hours for office and supplies
ODCs	$149,504	Allowance of 2% of hours
Subtotal	$7,849,456	Excludes fee and escalation

Title III Engineering Support to Construction		
		Assumptions
Hours	33,120	Hours include all engineering, design, project management manhours for the 18 months with an FTE across all disciplines of 12 at $80/hr average loaded rate
$ Hours	$2,649,600	
Equipment/Materials	$26,496	Allowance of 1% of hours for office and supplies
ODCs	$52,992	Allowance of 2% of hours
Subtotal	$2,729,088	Excludes fee and escalation

FTE = full-time employee.
HSF = Hanford Shipping Facility.
ODC = other direct cost.
SSI = soil-structure interaction.

Summary Sheet Construction Costs - HSF Only			
WBS No	Construction Costs	$	Notes
3.4.1	Construction Staff & Coordination	2,819,790	Includes Construction Management and Supervision labor
3.4.2	General Requirements	5,749,711	Includes general office expenses, paper, computers, welding supplies, scaffolding, utilities, temporary roads and parking, waste disposal, small tools and capital tool rental and purchase, general craft labor, 3rd party rental for construction cranes and builder's insurance, and allowance for permits
3.4.3	Civil	8,749,335	Includes earthwork and concrete
3.4.4	Structural Steel	2,551,699	Includes all steel framing, platforms, ladders, grating, roof structures, handrails, stair treads
3.4.5	HVAC	5,846,072	Includes Admin building and main building C2 & C3 supply and exhaust systems and stack
3.4.6	Equipment	10,826,390	Includes all mechanical equipment e.g., cranes, bogies, racks, windows, hatches, support stands, special doors
3.4.7	Piping	366,108	Includes allowance for process air, instrument air, potable water, drains - excludes fire suppression pipework
3.4.8	*Architectural*	3,938,416	*Includes all finishes, exterior siding,* Interior gypsum and block walls, doors, windows, false floors, acoustic tiles, partitions, roofing, gutters, admin building sanitary hardware and furniture, carpeting, elevator, plumbing and dry fire suppression distribution system
3.4.9	Electrical & Instrumentation	5,595,853	Includes power, lighting, CCTV, instruments and radiometric instruments, all cable, tray, conduit, terminations, Integrated Control System and local panels, MCCs, emergency diesel generator, UPS power supply
3.4.11	Insulation	82,410	Includes pipe insulation and fire proofing blockouts
3.4.12	Painting	62,928	Includes pipework painting, structural steel painting and equipment touch up
		1,977,271	Unit rates were based on 2002/2003 figures - escalate at 2.1% per year for 2005 figures
Subtotal		48,565,988	Unescalated costs (2005) includes G&A and OH - no fee

CCTV = closed-circuit television.
G&A = general and administrative.
HSF = Hanford Shipping Facility.
HVAC = heating, ventilation, and air conditioning.
MCC = motor control center.
OH = overhead.
UPS = uninterruptible power supply.

Commissioning Costs – HSF Only		
Commissioning Costs		
		Assumptions
Hours	52,800	Hours include all engineering, design, project management manhours for 8 (Cold) and 3 months (Hot) with an FTE across all disciplines of 30 at $80/hr average loaded rate
$ Hours	$4,224,000	
Equipment/Materials	$200,000	Commissioning materials include dummy cans, dummy cask - allow $200,000
ODCs	$84,480	Allowance of 2% of hours
Subtotal	$4,508,480	Excludes fee and escalation

FTE = full-time employee.
HSF = Hanford Shipping Facility.
ODC = other direct cost.

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ATTACHMENT D2
HANFORD SHIPPING FACILITY WITH STORAGE
ROUGH-ORDER-OF-MAGNITUDE
COST ESTIMATE DATA SHEETS

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Design and Engineering Costs – HSF with 2,000 IHLW Canister Storage		
Conceptual Design		
		Assumptions
Hours	59,200	Hours include all engineering, design, project management manhours for the 8 month conceptual design with an FTE across all disciplines at $80/hr average loaded rate - 2 mth rampup to full strength
$ Hours	$4,736,000	
ODCs	$94,720	Allowance of 2% of hours
Subtotal	$4,830,720	Excludes fee and escalation

Title I and II Design		
		Assumptions
Hours	141,600	Hours include all engineering, design, project management manhours for the 12 month design with an FTE across all disciplines at $80/hr average loaded rate - 1 mth rampup to full strength (60,75)
$ Hours	$11,328,000	
Subcontracts	$150,000	Subcontracts for SSI Analysis, Fire Suppression system at $100K and $50K respectively
Equipment/Materials	$113,280	Allowance of 1% of hours for office and supplies
ODCs	$226,560	Allowance of 2% of hours
Subtotal	$11,817,840	Excludes fee and escalation

Title III Engineering Support to Construction		
		Assumptions
Hours	48,000	Hours include all engineering, design, project management manhours for 20 months with an FTE across all disciplines at $80/hr average loaded rate
$ Hours	$3,840,000	
Equipment/Materials	$38,400	Allowance of 1% of hours for office and supplies
ODCs	$76,800	Allowance of 2% of hours
Subtotal	$3,955,200	Excludes fee and escalation

FTE = full-time employee.
HSF = Hanford Shipping Facility.
IHLW = immobilized high-level waste.
ODC = other direct cost.
SSI = soil-structure interaction.

Summary Sheet Construction Costs – HSF with 2,000 IHLW Canister Storage

WBS No	Construction Costs	$	Notes
3.4.1	Construction Staff & Coordination	4,208,642	Includes Construction Management and Supervision labor
3.4.2	General Requirements	8,147,802	Includes general office expenses, paper, computers, welding supplies, scaffolding, utilities, temporary roads and parking, waste disposal, small tools and capital tool rental and purchase, general craft labor, 3rd party rental for construction cranes and builder's insurance, and allowance for permits
3.4.3	Civil	19,650,023	Includes earthwork and concrete
3.4.4	Structural Steel	4,370,934	Includes all steel framing, platforms, ladders, grating, roof structures, handrails, stair treads
3.4.5	HVAC	8,408,619	Includes Admin building and main building C2 & C3 supply and exhaust systems and stack
3.4.6	Equipment	20,535,500	Includes all mechanical equipment e.g., cranes, bogies, racks, windows, hatches, support stands, special doors
3.4.7	Piping	610,181	Includes allowance for process air, instrument air, potable water, drains - excludes fire suppression pipework
3.4.8	Architectural	5,730,668	Includes all finishes, exterior siding, interior gypsum and block walls, doors, windows, false floors, acoustic tiles, partitions, roofing, gutters, admin building sanitary hardware and furniture, carpeting, elevator, plumbing and dry fire suppression distribution system
3.4.9	Electrical & Instrumentation	8,426,791	Includes power, lighting, CCTV, instruments and radiometric instruments, all cable, tray, conduit, terminations, Integrated Control System and local panels, MCCs, emergency diesel generator, UPS power supply
3.4.11	Insulation	123,000	Includes pipe insulation and fire proofing blockouts
3.4.12	Painting	93,922	Includes pipework painting, structural steel painting and equipment touch up
		3,408,270	Unit rates were based on 2002/2003 figures - escalate at 2.1% to 2004/5
Subtotal		83,714,357	Unescalated costs (2005) includes G&A and OH - no fee

CCTV = closed-circuit television.
G&A = general and administrative.
HSF = Hanford Shipping Facility.
HVAC = heating, ventilation, and air conditioning.
IHLW = immobilized high-level waste.
MCC = motor control center.
OH = overhead.
UPS = uninterruptible power supply.

Commissioning Costs – HSF with 2,000 IHLW Canister Storage		
Commissioning Costs		
		Assumptions
Hours	89,600	Hours include all engineering, design, project management manhours for 10 months (Cold) and 4 months (Hot) with an FTE across all disciplines at $80/hr average loaded rate
$ Hours	$7,168,000	
Equipment/Materials	$200,000	Commissioning materials include dummy cans, dummy cask - allow $200,000
ODCs	$143,360	Allowance of 2% of hours
Subtotal	$7,511,360	Excludes fee and escalation

FTE = full-time employee.
HSF = Hanford Shipping Facility.
IHLW = immobilized high-level waste.
ODC = other direct cost.

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ATTACHMENT D3
FUTURE ADDITION OF 2,000 IMMOBILIZED HIGH-LEVEL WASTE CANISTER STORAGE ROUGH-ORDER-OF-MAGNITUDE COST ESTIMATE DATA SHEETS

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Design and Engineering Costs – Future Addition of 2,000 IHLW Canister Storage

Conceptual Design		
		Assumptions
Hours	22,240	Hours include all engineering, design, project management manhours for the is 6 month conceptual design with an FTE across all disciplines at $80/hr average loaded rate - 2 mth rampup to full strength
$ Hours	$1,779,200	
ODCs	$35,584	Allowance of 2% of hours
Subtotal	$1,814,784	Excludes fee and escalation

Title I and II Design		
		Assumptions
Hours	55,200	Hours include all engineering, design, project management manhours for the 10 month design with an FTE across all disciplines at $80/hr average loaded rate - 1 month rampup
$ Hours	$4,416,000	
Subcontracts	$150,000	Subcontracts for SSI Analysis, Fire Suppression system at $50K and $25K respectively
Equipment/Materials	$44,160	Allowance of 1% of hours for office and supplies
ODCs	$88,320	Allowance of 1% of hours
Subtotal	$4,698,480	Excludes fee and escalation

Title III Engineering Support to Construction		
		Assumptions
Hours	23,040	Hours include all engineering, design, project management manhours for 18 months with an FTE across all disciplines at $80/hr average loaded rate
$ Hours	$1,843,200	
Equipment/Materials	$18,432	Allowance of 1% of hours for office and supplies
ODCs	$36,864	Allowance of 2% of hours
Subtotal	$1,898,496	Excludes fee and escalation

FTE = full-time employee.
IHLW = immobilized high-level waste.
ODC = other direct cost.
SSI = soil-structure interaction.

Summary Sheet Construction Costs – Future Addition of 2,000 IHLW Canister Storage			
WBS No	Construction Costs	$	Notes
3.4.1	Construction Staff & Coordination	2,777,704	Includes Construction Management and Supervision labor
3.4.2	General Requirements	5,464,668	Includes general office expenses, paper, computers, welding supplies, scaffolding, utilities, temporary roads and parking, waste disposal, small tools and capital tool rental and purchase, general craft labor, 3rd party rental for construction cranes and builder's insurance, and allowance for permits
3.4.3	Civil	13,190,151	Includes earthwork and concrete
3.4.4	Structural Steel	2,489,734	Includes all steel framing, platforms, ladders, grating, roof structures, handrails, stair treads
3.4.5	HVAC	6,205,439	Includes Admin building and main building C2 & C3 supply and exhaust systems and stack
3.4.6	Equipment	9,470,170	Includes all mechanical equipment e.g., cranes, bogies, racks, windows, hatches, support stands, special doors
3.4.7	Piping	366,108	Includes allowance for process air, instrument air, potable water, drains - excludes fire suppression pipework
3.4.8	Architectural	3,023,032	Includes all finishes, exterior siding, interior gypsum and block walls, doors, windows, false floors, acoustic tiles, partitions, roofing, gutters, admin building sanitary hardware and furniture, carpeting, elevator, plumbing and dry fire suppression distribution system
3.4.9	Electrical & Instrumentation	4,046,265	Includes power, lighting, CCTV, instruments and radiometric instruments, all cable, tray, conduit, terminations, Integrated Control System and local panels, MCCs, emergency diesel generator, UPS power supply
3.4.11	Insulation	61,500	Includes pipe insulation and fire proofing blockouts
3.4.12	Painting	23,831	Includes pipework painting, structural steel painting and equipment touch up
		1,999,760	Unit rates were based on 2002/2003 figures - escalate at 2.1% to 2004/5
Subtotal		49,118,364	Unescalated costs (2005) includes G&A and OH - no fee

CCTV = closed-circuit television.
G&A = general and administrative.
HVAC = heating, ventilation, and air conditioning.
IHLW = immobilized high-level waste.
MCC = motor control center.
OH = overhead.
UPS = uninterruptible power supply.

Commissioning Costs – Future Addition of 2,000 IHLW Canister Storage		
Commissioning Costs		
		Assumptions
Hours	38,400	Hours include all engineering, design, project management manhours for 8 months (Cold) and 4 months (Hot) with an FTE across all disciplines at $80/hr average loaded rate
$ Hours	$3,072,000	
Equipment/Materials	$100,000	Allowance of $100,000
ODCs	$61,440	Allowance of 2% of hours
Subtotal	$3,233,440	Excludes Fee and escalation

FTE = full-time employee.
IHLW = immobilized high-level waste.
ODC = other direct cost.

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ATTACHMENT D4
INCORPORATION OF CANISTER DECONTAMINATION AND OVERPACKING ROUGH-ORDER-OF-MAGNITUDE COST ESTIMATE DATA SHEETS

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Design and Engineering Costs – Incorporation of Canister Decontamination & Overpacking (2 Sheets)				
Conceptual Design	**HSF Combo**	**Assumptions**	**Decon & Overpack $**	**Assumptions**
Hours	59,200	Hours include all engineering, design, project management manhours for the 8 month conceptual design with an FTE across all disciplines at $80/hr average loaded rate - 2 mth rampup to full strength	5,920	Assume 10% of hours for additional equipment
$ Hours	$4,736,000		$473,600	
ODCs	$94,720	Allowance of 2% of hours	$9,742	Allowance of 2% of hours
Subtotal	$4,830,720	Excludes fee and escalation	$483,072	Excludes fee and escalation

Title I and II Design				
	HSF Combo	**Assumptions**	**Decon & Overpack $**	
Hours	141,600	Hours include all engineering, design, project management manhours for the 12 month design with an FTE across all disciplines at $80/hr average loaded rate - 1 mth rampup to full strength (60,75)	14,160	Assume 10% of hours for additional equipment
$ Hours	$11,328,000		$1,132,800	
Subcontracts	$150,000	Subcontracts for SSI Analysis, Fire Suppression system at $100K and $50K, respectively	0	No addition
Equipment and Materials	$113,280	Allowance of 1% of hours for office accommodations, supplies etc	$11,328	Allowance of 1% of hours for office/supplies
ODCs	$226,560	Allowance of 2% of hours	$22,656	Allowance of 2% of hours
Subtotal	$11,817,840	Excludes fee and escalation	$1,166,784	Excludes fee and escalation

Title III Engineering Support to Construction				
	HSF Combo	**Assumptions**	**Decon & Overpack $**	
Hours	48,000	Hours include all engineering, design, project management manhours for 20 months with an FTE across all disciplines at $80/hr average loaded rate	4,800	Assume 10% of hours for additional equipment
$ Hours	$3,840,000		$384,000	
ODCs	$76,800	Allowance of 2% of hours	$7,680	
Subtotal	$3,916,800	Excludes fee and escalation	$391,680	

FTE = full-time employee.
ODC = other direct cost.
SSI = soil-structure interaction.

Summary Sheet Construction Costs – Incorporation of Canister Decontamination & Overpacking

WBS No	Construction Costs	$	Notes
3.4.1	Construction Staff & Coordination	210,432	Includes Construction Management and Supervision labor
3.4.2	General Requirements	407,390	Includes general office expenses, paper, computers, welding supplies, scaffolding, utilities, temporary roads and parking, waste disposal, small tools and capital tool rental and purchase, general craft labor, 3rd party rental for construction cranes and builder's insurance, and allowance for permits
3.4.3	Civil	1,022,780	Includes earthwork and concrete
3.4.4	Structural Steel	103,896	Includes all steel framing, platforms, ladders, grating, roof structures, handrails, stair treads
3.4.5	HVAC	83,640	Includes Admin building and main building C2 & C3 supply and exhaust systems and stack
3.4.6	Equipment	4,653,890	Includes all mechanical equipment e.g., cranes, bogies, racks, windows, hatches, support stands, special doors
3.4.7	Piping	24,600	Includes allowance for process air, instrument air, potable water, drains - excludes fire suppression pipework
3.4.8	Architectural	123,000	Includes all finishes, exterior siding, interior gypsum and block walls, doors, windows, false floors, acoustic tiles, partitions, roofing, gutters, admin building sanitary hardware and furniture, carpeting, elevator, plumbing and dry fire suppression distribution system
3.4.9	Electrical & Instrumentation	1,781,148	Includes power, lighting, CCTV, instruments and radiometric instruments, all cable, tray, conduit, terminations, Integrated Control System and local panels, MCCs, emergency diesel generator, UPS power supply
3.4.11	Insulation	24,600	Includes pipe insulation and fire proofing blockouts
3.4.12	Painting	24,600	Includes pipework painting, structural steel painting and equipment touch up
		359,049	Unit rates were based on 2002/2003 figures - escalate at 2.1% to 2004/5
Subtotal		8,819,026	Unescalated costs (2005) Includes G&A and OH - no fee

CCTV = closed-circuit television.
G&A = general and administrative.
HVAC = heating, ventilation, and air conditioning.
MCC = motor control center.
OH = overhead.
UPS = uninterruptible power supply.

Commissioning Costs - Incorporation of *Canister Decontamination & Overpacking*		
Commissioning Costs		
		Assumptions
Hours	4,480	Assume 5% of HSF Combo hours
$ Hours	$358,400	
Equipment/Materials	$100,000	Allowance of 100,000 for test pieces
ODCs	$7,168	Allowance of 2% of hours
Subtotal	$465,568	Excludes fee and escalation

HSF = Hanford Shipping Facility.
ODC = other direct cost.

APPENDIX E
FACILITY LAYOUT

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APPENDIX E
FACILITY LAYOUT

This appendix contains the preferred Hanford Shipping Facility layout and site plan drawings for the Hanford Shipping Facility with and without storage alternatives. These drawings were developed incorporating the findings and recommendations of the engineering evaluations contained in Appendices A, B and C of this document.

The following drawings are included in this appendix.

CEES-04-044-C-004, Sht. 1	Hanford Shipping Facility With Storage Alternative 3
CEES-04-044-C-004, Sht. 2	Hanford Shipping Facility Without Storage Alternative 3
CEES-04-044-C-004, Sht. 3	Hanford Shipping Facility With Storage Alternative 3

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APPENDIX F
SKETCHES

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APPENDIX F
SKETCHES

The sketches included in this appendix are provided to provide the reader with an understanding of the truck and railcar cask and canister handling sets used to unload truck transported casks and to load and remove monitored geologic repository casks from the Hanford Shipping Facility. There is one section view of the Hanford Shipping Facility provided, BNFL-HSF-04, Sht. 6, to give the reader a better understanding of the overall Hanford Shipping Facility vertical layout and drawing CEES-04-044-C-007, Shts. 1-3, that provides a graphical depiction of the material handling steps identified in Table F.1.

Table F.1, below, provides a listing of the major and minor functions associated with the cask and canister handling and provides references to the included sketches showing these activities.

Table F.1. Cask and Canister Processing Functions and Actions (5 Sheets)

Major Function	Minor Function	Action	Assumptions
Receive canisters	Import (export) on-site transporter (see Sketch 1A)	Open bay door	Assume transporter and cask radiological survey performed prior to introduction into import bay
		Back in transporter	
		Decouple and remove tractor	
		Close bay door	
	Import (export) on-site cask (see Sketch 1B)	Attach crane with lift fixture to cask	
		Remove cask tiedowns	
		Lift cask from transporter	
		Open isolation door	
		Move cask to cask import tunnel	
		Close isolation door	
		Open tunnel hatch	
		Lower cask onto import cask bogie	
		Disconnect cask from lift fixture	
	Open (close) on-site cask (see Sketch 1C)	Position impact wrench on jib crane	
		Unbolt cask lid bolts	
		Install cask lid lift feature	
		Close tunnel hatch	

Table F.1. Cask and Canister Processing Functions and Actions (5 Sheets)

Major Function	Minor Function	Action	Assumptions
Receive canisters (Cont'd)	Transfer cask to/from loadout station (see Sketch 1D)	Move cask/bogie to lid removal station	
		Remove and retain lid	
		Move cask/bogie to canister removal station	
	Remove canister from on-site cask (see Sketch 1E)	Position in-cell crane over canister	
		Open hatch	
		Grapple and lift canister	
		Close hatch	
Export on-site cask	Close on-site cask (refer to Sketch 1A)	Transfer cask to/from loadout station	
		Open hatch	
		Lift lid with jib and place on lid inspection station	
		Inspect lid/seals	
		Lift lid with jib and place on cask	
		Open (close) on-site cask	
		Torque cask lid bolts	
	Export on-site cask	Import (export) on-site cask	
	Export on-site transporter	Import (export) on-site transporter	
		Perform radiological survey of tractor	
Inspect and load canister	Canister inspection (see Sketch 3A)	Move canister to inspection station	
		Rotate and inspect canister via CCTV	Assumes rotating grapple
	Load MGR cask (see Sketch 3B)	Move canister to MGR cask loading station	Assumes loading directly from inspection station
		Open hatch	
		Lower canister into MGR cask	
		Degrapple canister	
		Close hatch	

Table F.1. Cask and Canister Processing Functions and Actions (5 Sheets)

Major Function	Minor Function	Action	Assumptions
Canister staging (no sketches provided)	Stage canister	Move canister to staging position	No sketches provided for this function
		Lower canister into staging position	
		Degrapple canister	
Store canister	Transfer canister to/from store	Move canister to store transfer station	
		Open hatch	
		Lower canister into store bogie	
		Degrapple canister	
		Close hatch	
	Store/retrieve canister	Move bogie to store import station	
		Open hatch	
		Grapple and lift canister with store crane	
		Close hatch	
		Move canister to storage position	
		Lower canister into storage position	
		Degrapple canister	
MGR cask loading (no sketches provided)	Load MGR cask from staging	Grapple canister in staged position	No sketches provided for this function
		Load MGR cask	
	Load MGR from store	Store/retrieve canister	
		Transfer canister to/from store	
		Load MGR cask	
Receive MGR cask	Import (export) MGR railcar (refer to Sketch 7D)	Open export bay door	Assumes cask and railcar have been radiologically examined and cleaned of grime
		Position MGR railcar	
		Remove locomotive	
		Close export bay door	

Table F.1. Cask and Canister Processing Functions and Actions (5 Sheets)

Major Function	Minor Function	Action	Assumptions
Receive MGR cask (Cont'd)	Import (export) MGR cask (refer to Sketch 7C)	Attach lifting device to personnel barrier	
		Lift personnel barrier and place in laydown area	
		Attach lifting device to impact limiter (top and bottom)	
		Remove impact limiter attachments	
		Move impact limiters to laydown area	
		Remove tiedowns	
		Engage cask lift fixture	
		Rotate cask to vertical	
		Lift cask from railcar	
		Move cask to MGR cask station	
		Open hatch	
		Lower cask onto MGR cask bogie	
		Disconnect cask from lift fixture	
	Open (close) MGR cask (refer to Sketch 7B)	Position jib crane with impact wrench	
		Remove lid bolts	
		Attach lid lift feature	
		Engage cask lid lift fixture	
		Lift lid and move to lid inspection station	
		Inspect lid/seals	
		Perform inspections of cask internals	
		Place lid on cask	
		Close hatch	
	Transfer MGR cask to/from loading station (refer to Sketch 7A)	Move cask on bogie to lid removal station	
		Remove and retain lid	
		Move cask on bogie to loading station	

Table F.1. Cask and Canister Processing Functions and Actions (5 Sheets)

Major Function	Minor Function	Action	Assumptions
Export MGR cask	Close MGR cask (see Sketch 7A)	Open (close) MGR cask	
		Transfer MGR cask to/from loading station	
		Open hatch	
		Position jib crane with impact wrench	
		Install cask lid bolts	
		Torque cask lid bolts	
		Perform assembly verification leak test	
		Perform radiological contamination survey	
		Remove lid lift feature	
	Export MGR cask (see Sketch 7B)	Import (export) MGR cask	
	Export MGR railcar (see Sketch 7C)	Import (export) MGR railcar	

CCTV = closed-circuit television.
MGR = monitored geologic repository.

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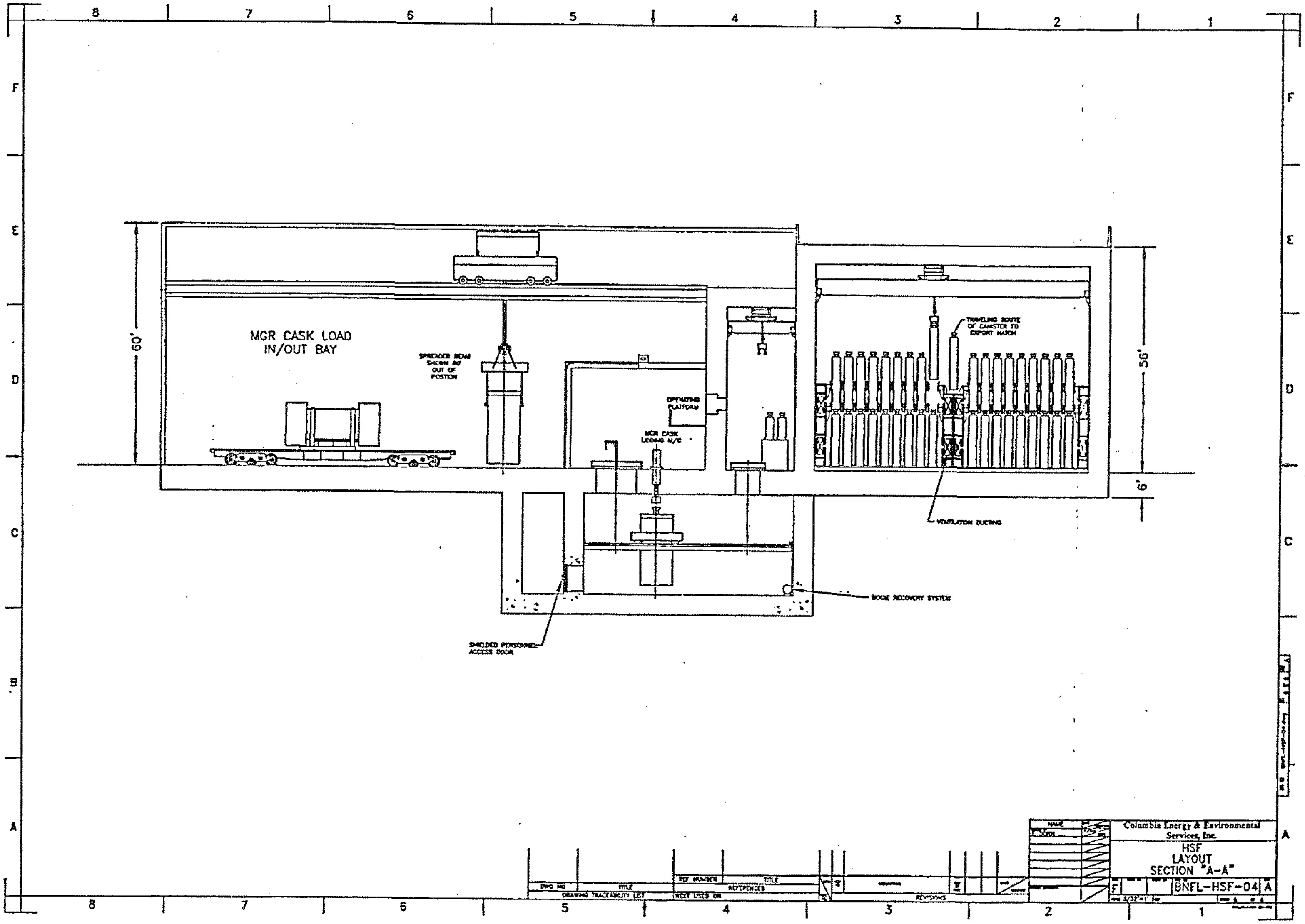
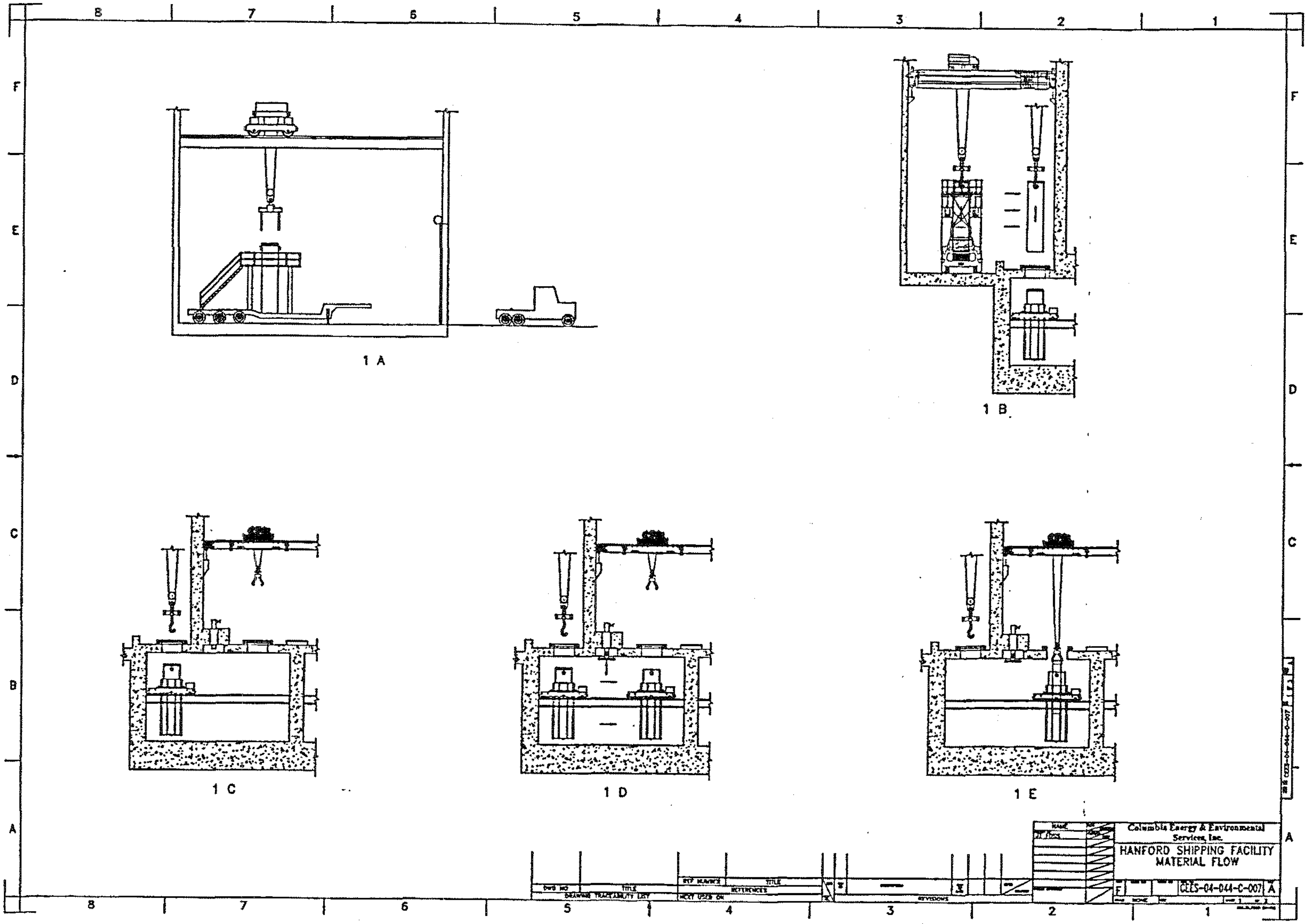

MGR CASK LOAD
IN/OUT BAY
60'
56'
6'
SPREADER BEAM SHOWN 90° OUT OF POSITION
OPERATING PLATFORM
MGR CASK LOADING M/C
TRAVELING ROUTE OF CANISTER TO EXPORT HATCH
VENTILATION DUCTING
BOGIE RECOVERY SYSTEM
SHIELDED PERSONNEL ACCESS DOOR
Columbia Energy & Environmental Services, Inc.
HSF
LAYOUT
SECTION "A-A"
BNFL-HSF-04
A


1 A
1 B
1 C
1 D
1 E
Columbia Energy & Environmental Services, Inc.
HANFORD SHIPPING FACILITY
MATERIAL FLOW
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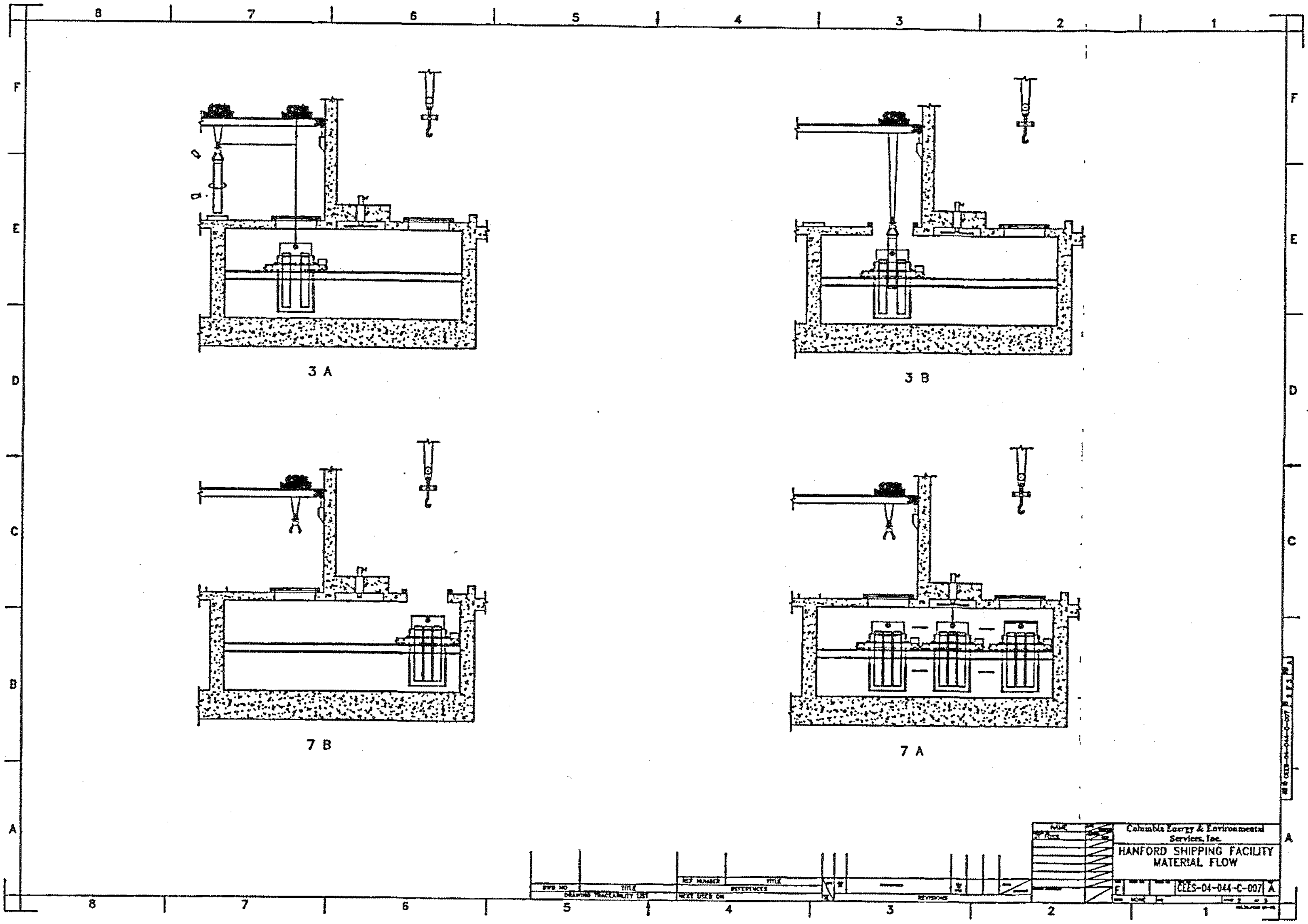
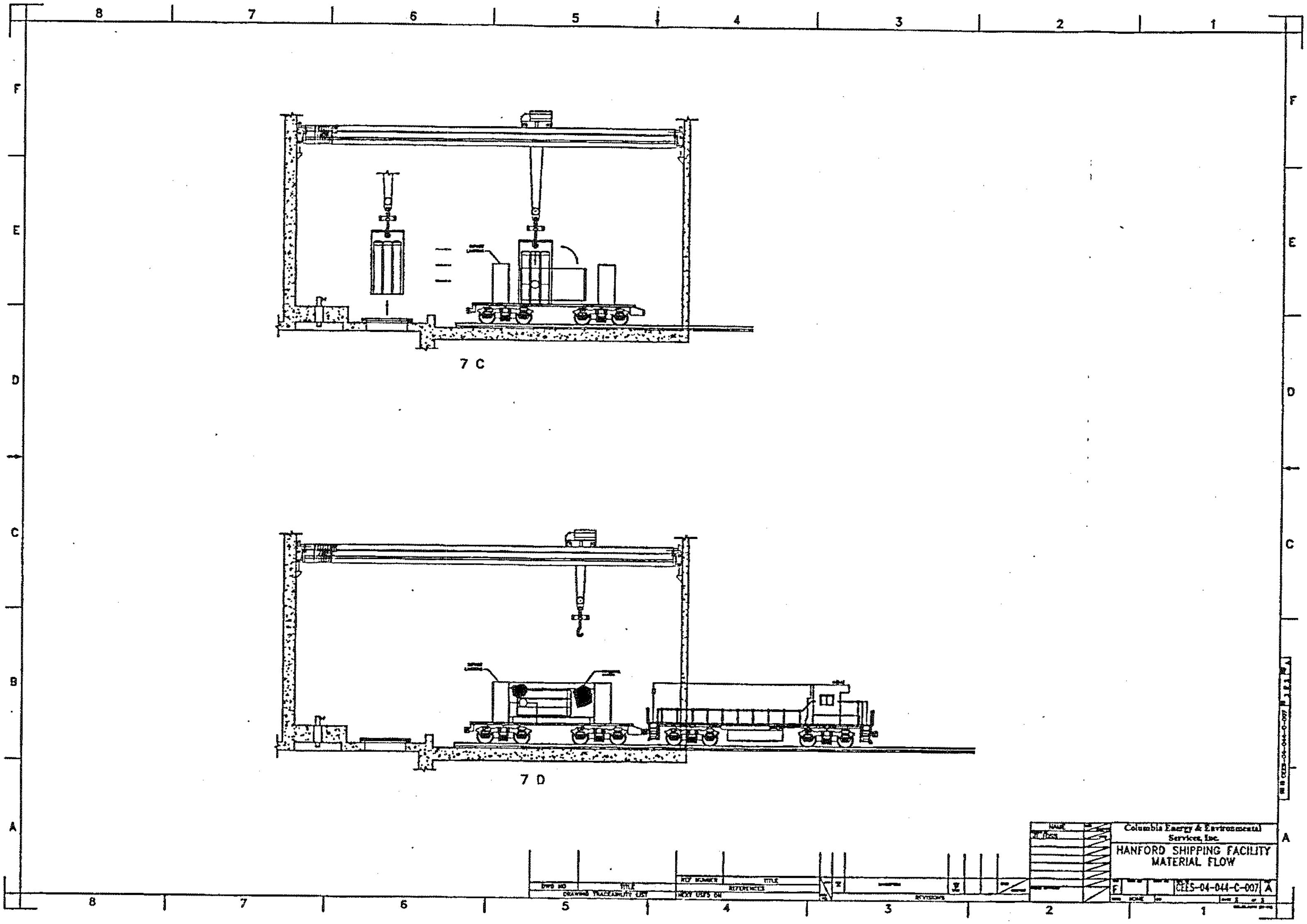

3 A
3 B
7 B
7 A
Columbia Energy & Environmental Services, Inc.
HANFORD SHIPPING FACILITY MATERIAL FLOW
CEES-04-044-C-007
DRAWING TRACEABILITY LIST
REFERENCES
NEXT USED ON
REVISIONS


7 C
7 D
Columbia Energy & Environmental Services, Inc.
HANFORD SHIPPING FACILITY
MATERIAL FLOW
CEES-04-044-C-007
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