APPENDIX A2

STUDY 1 - ALTERNATIVE STORAGE SYSTEMS FOR DUAL PURPOSE CANISTERS

Alternative 2 – Pad Storage Using a Standardized Overpack (C-STD)

Alternative 2 – Pad Storage Using a Standardized Overpack (C-STD)

A2-1.0 Description of Storage Alternative

Alternative 2 evaluates the use of a standardized overpack to store currently deployed and licensed above grade vertical and horizontal storage "canister-based" systems associated with dry storage canister design. Therefore, this Alternative is designated C-STD for commercial system stored in a standardized overpack on a concrete pad.

This approach could reduce the design and operation variables and permit a more simplified process at the ISF. Currently in use there are 23 various sizes of dual purpose canisters (DPCs) which can be stored in 7 different overpacks as shown in **Table A2-1** (References A2-1 through A2-13) :

Table A2-1
Commercial Overpacks and Associated Canisters

<table>
<tr><th>Overpack</th><th>Canister</th><th>Overpack</th><th>Canister</th></tr>
<tr><td colspan="2">AREVA TN</td><td colspan="2">Holtec International</td></tr>
<tr><td rowspan="11">NUHOMS HSM-H (Horizontal Storage Module)</td><td>24PT*</td><td rowspan="5">HI-STORM 100 (Vertical Storage Overpack)</td><td>MPC-24</td></tr>
<tr><td>24PT1*</td><td>MPC-24E/EF*</td></tr>
<tr><td>24PT4*</td><td>MPC-32</td></tr>
<tr><td>24PTH</td><td>MPC-68</td></tr>
<tr><td>32PT*</td><td>MPC-HB*</td></tr>
<tr><td>32PTH</td><td rowspan="2">HI-STORM FW (Vertical Storage Overpack)</td><td>MPC-37</td></tr>
<tr><td>32PTH1*</td><td>MPC-89</td></tr>
<tr><td>32PTH2*</td><td></td><td></td></tr>
<tr><td>37PTH</td><td colspan="2">NAC International</td></tr>
<tr><td>61BT</td><td rowspan="3">NAC-MPC (Vertical Storage Overpack)</td><td>CY-MPC</td></tr>
<tr><td>61BTH</td><td>Yankee-MPC</td></tr>
<tr><td></td><td></td><td>LACBWR*</td></tr>
<tr><td colspan="2">Energy Solutions</td><td>NAC-UMS (Vertical Storage Overpack)</td><td>UMS-24*</td></tr>
<tr><td rowspan="2">Fuel Solutions W150 (Vertical Storage Overpack)</td><td rowspan="2">W74*</td><td rowspan="2">MAGNASTOR (Vertical Storage Overpack)</td><td>TSC-37*</td></tr>
<tr><td>TSC-87</td></tr>
</table>

* Systems already being used at shutdown reactor sites

Like all canister-based systems, the DPC is licensed under 10CFR72 (Reference A2-14) for storage and 10CFR71 (Reference A2-15) for transportation. The SNF is placed into a welded sealed metal container, the DPC, which provides the primary confinement boundary for the SNF.

The DPC is placed in different overpacks or casks, which provide radiation shielding and physical protection, during canister transportation, transfer, or storage. A typical PWR canister will hold 24 to 37 PWR SNF assemblies and a typical BWR canister will hold 61 to 89 BWR SNF assemblies.

During SNF loading and DPC transfer between the fuel pool and dry storage or shipping, a metal transfer cask provides physical protection and radiation shielding. During transportation, a metal shipping cask protects the DPC from any credible accident that might occur. The casks are metal and provide the confinement boundary for the SNF assemblies. The metal cask is fitted with impact limiting devices for additional protection during transit. The shipping cask must comply with the requirements of 10CFR71.

There are three variations that are evaluated for this Alternative as follows:

- C-STDa, using Single Vertical Standard Storage Overpack
- C-STDb, using Single Horizontal Standard Storage Overpack
- C-STDc, using both Vertical & Horizontal Standard Storage Overpacks

For simplicity, it will be assumed that all SNF arrives in the site in a DPC, licensed for both transportation and storage. Each of these variations are discussed in the following paragraphs.

C-STDa, Single Vertical Standard Storage Overpack

This variation would place all DPCs into a single vertical type overpack. Having a single overpack design would greatly simplify overpack fabrication enabling the ISF to focus on a production mode throughout the fabrication process. A single vertical overpack would simplify the pad design since the pad analysis would only need to consider one universal overpack. All design and analysis would only need to consider support and tipover of one overpack.

However, there are issues to consider. The first issue is with DPC dimensions. A single overpack would be sized for the largest DPC meaning that all smaller DPCs need to be shimmed in order to meet seismic and stability conditions. See **Figure A2-2** through **Figure A2-5**. The figures show a single one-size-fits-all vertical overpack and all the DPCs that would be placed in it. The DPCs are color coded with similar colors representing the same diameter. The inside diameter of the overpack are set at 81.0” to accommodate the 79” diameter NAC MPC canisters. The inside length of the overpack are set at 212.0” to accommodate the longer fuel assemblies yet to be stored. The longest DPCs currently in storage are the 196.30” long 24PTH, 61PT and 61PTH canisters supplied by AREVA TN.

Secondly, thermal transmission is derived through stack effect which necessitates certain clearances between the outside wall of the DPC and inside wall of the overpack to efficiently create air flow. A larger clearance may need to be evaluated for heat removal capability. Another solution is to install a steel cylinder shell around the DPC to reduce the clearances. The shell could also be used as a shim to satisfy seismic and stability concerns. Horizontal DPCs would also need to be analyzed for long tern storage in a vertical position.

Thirdly, the horizontal storage type DPCs lack lifting capabilities which requires the use of a lifting cage as shown in **Figure A2-1**.

Figure A2-1
Holtec Conceptual Design of a Lifting Cage for Storing NUHOMS Canisters

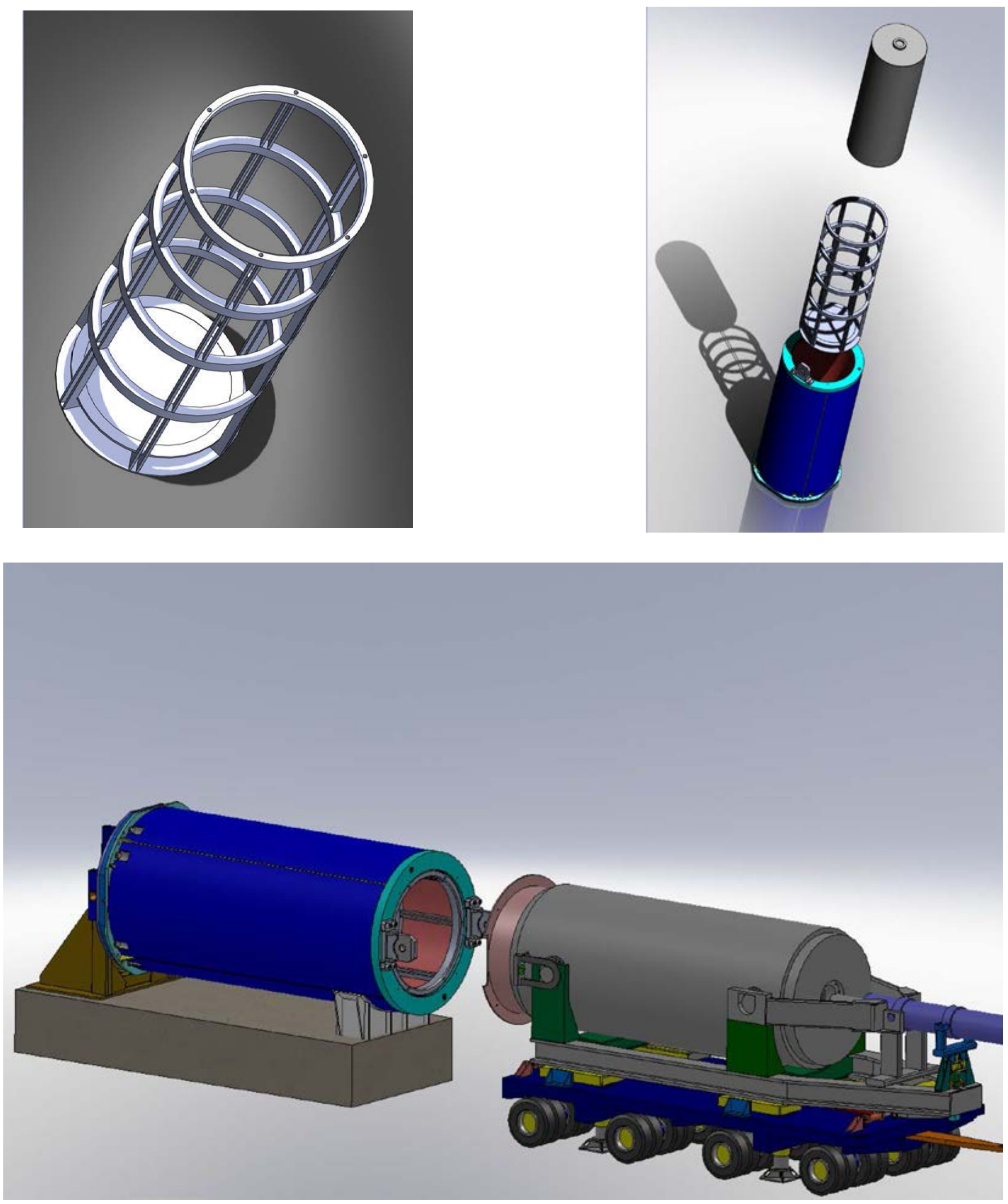


Figure A2-2
Energy Solutions Fuel Solutions Canisters in a Vertical Overpack (elev & plan view)

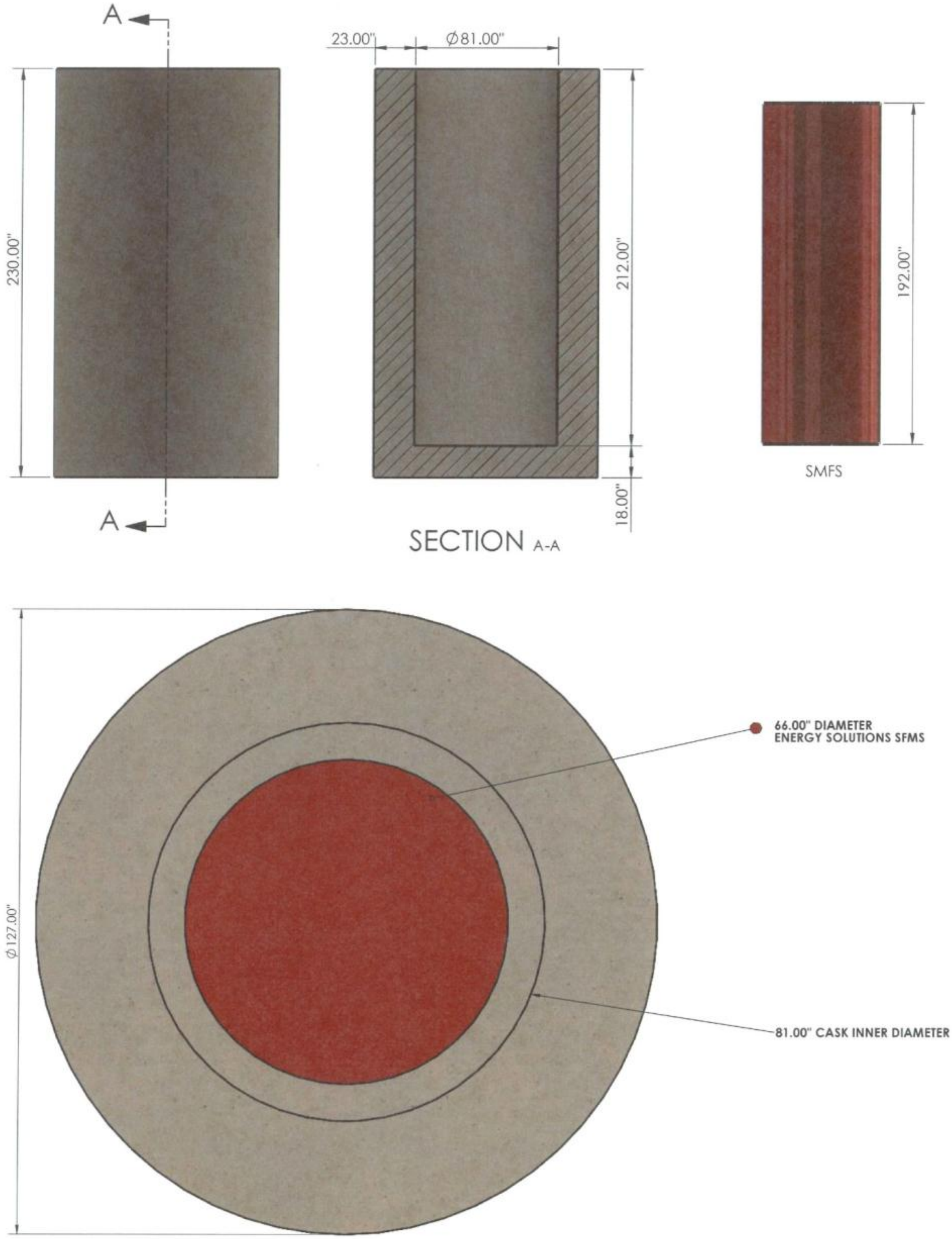
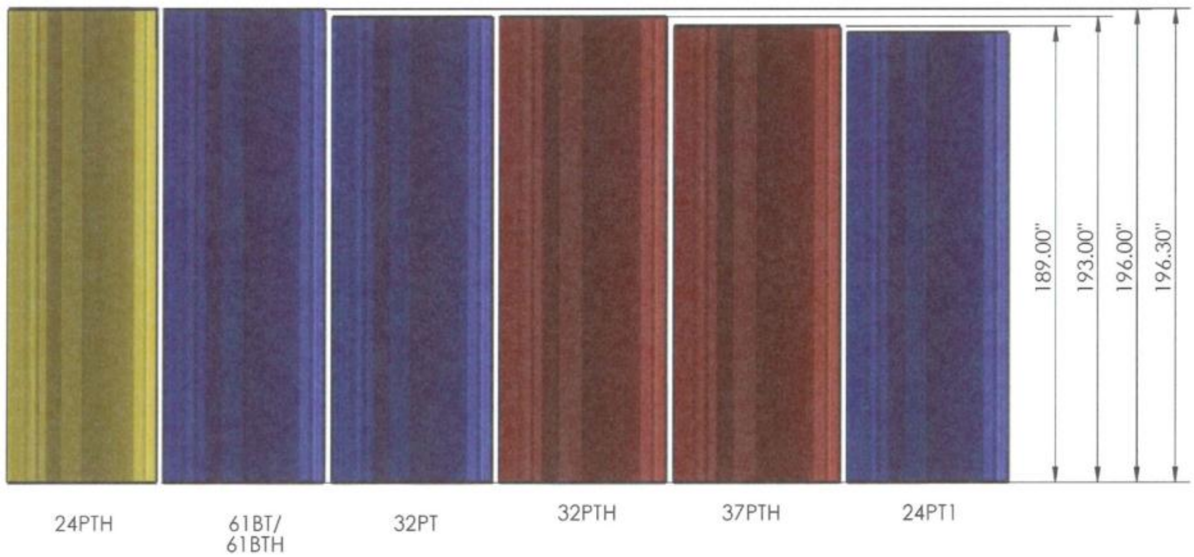


Figure A2-3
AREVA TN NUHOMS Canisters in a Vertical Overpack (elev & plan view)



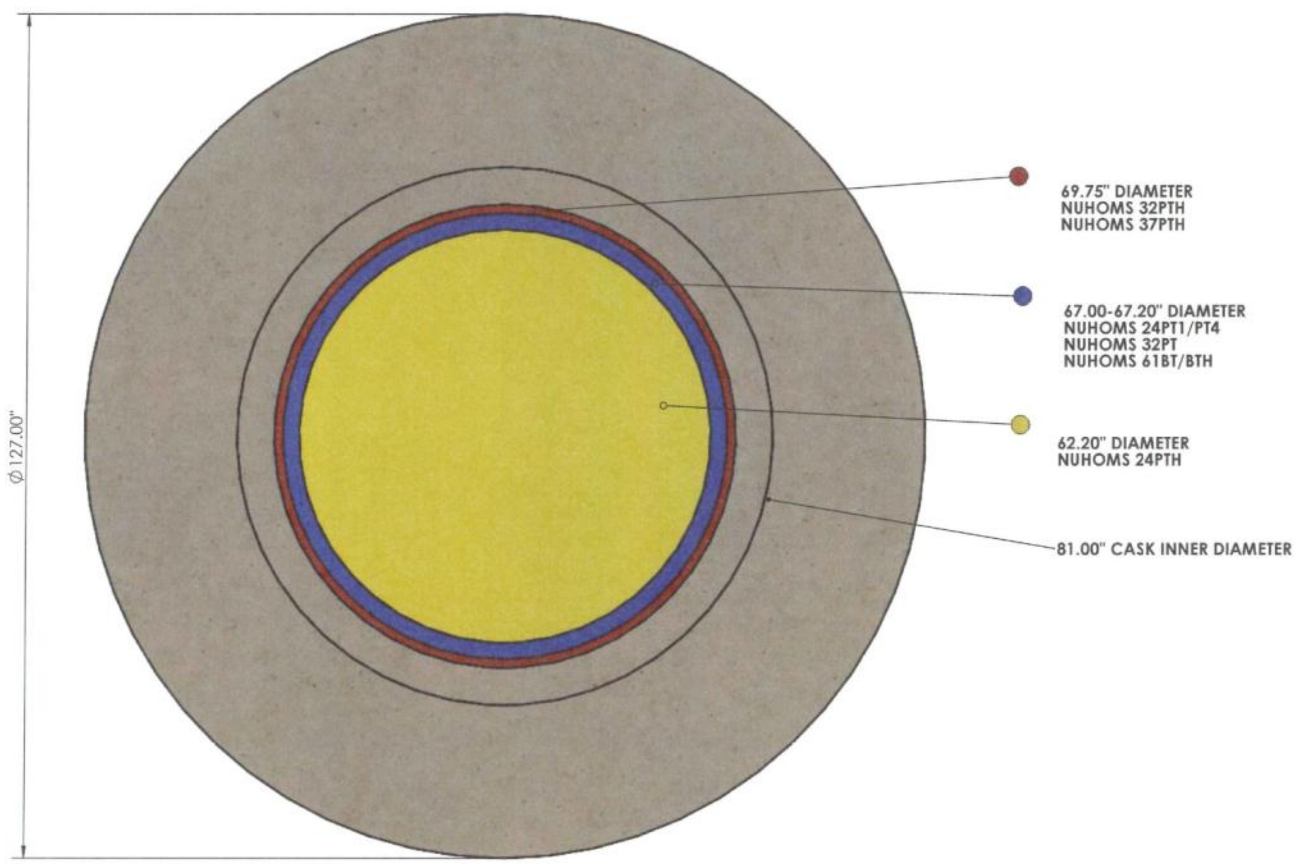
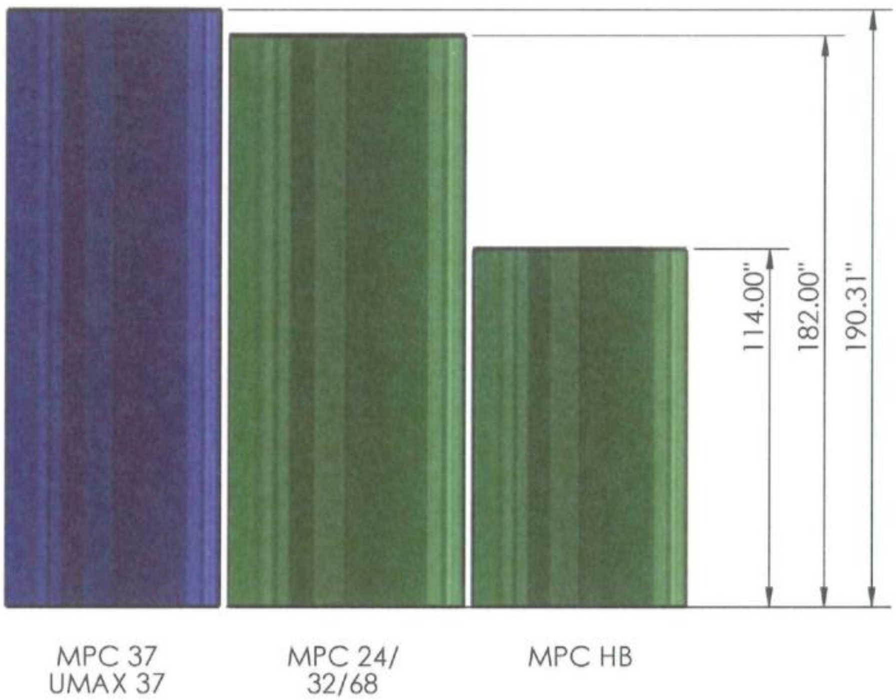


Figure A2-4
Holtec HI-STORM MPC Canisters in a Vertical Overpack (elev & plan view)



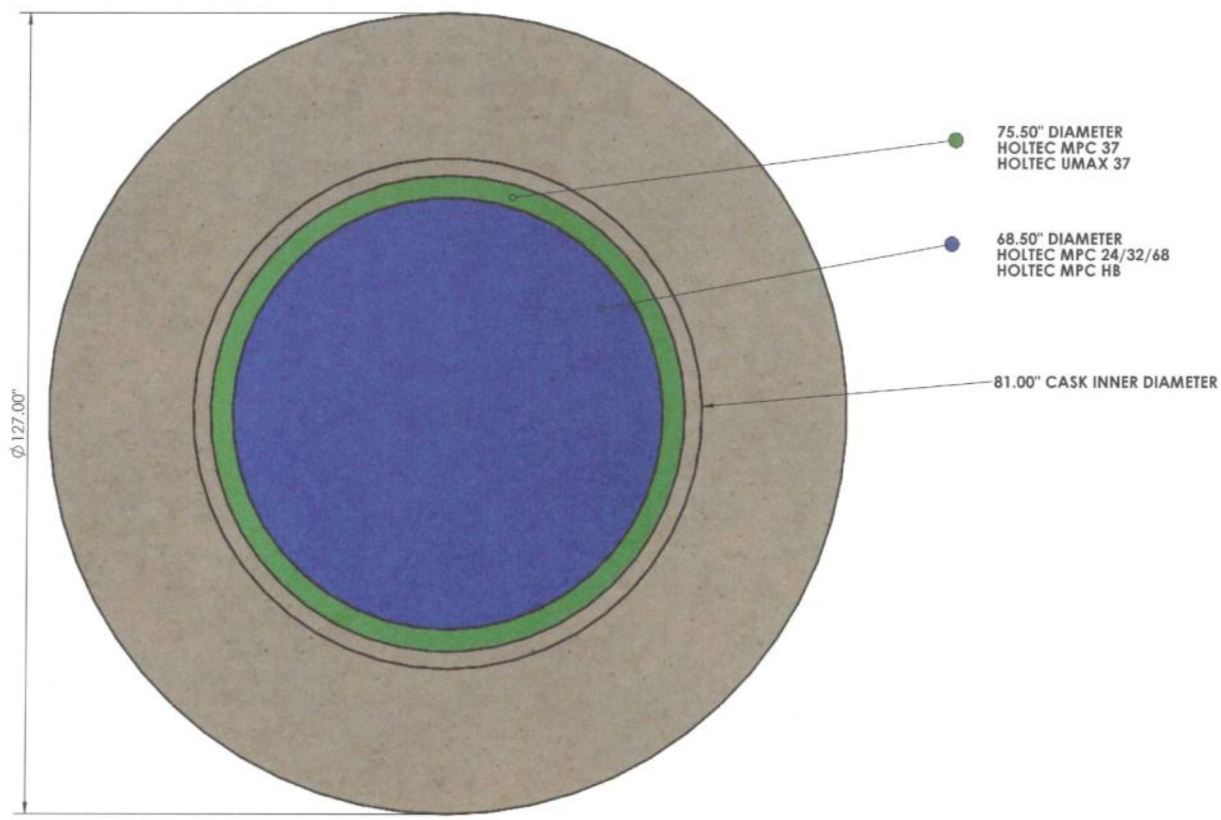
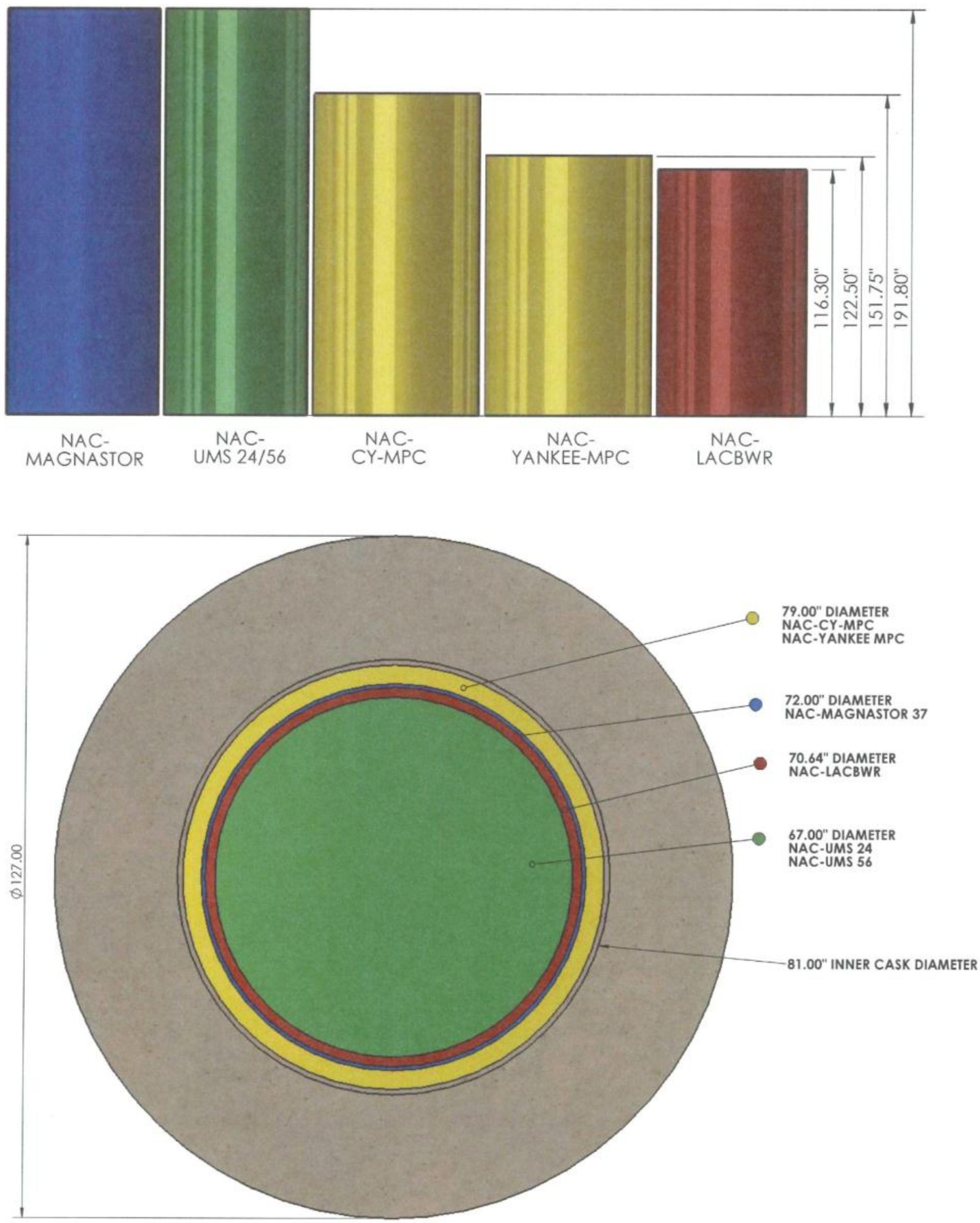


Figure A2-5
NAC MPC, UMS and MAGNASTOR Canisters in a Vertical Overpack (elev & plan view)



C-STDb, Single Horizontal Standard Storage Overpack

This variation would place all DPCs into a single horizontal type overpack. Having a single overpack design would greatly simplify overpack fabrication enabling the ISF to focus on a production mode throughout the fabrication process. A single horizontal overpack would simplify the pad design since the pad analysis would only need to consider one universal overpack. All design and analysis would only need to consider support of one overpack.

However, there are issues to consider. The first issue is with DPC dimensions. A single overpack would be sized for the largest DPC meaning that the horizontal storage module would need to be designed to accommodate all smaller DPCs. See **Figure A2-6** through **Figure A2-9**. The figures show a single one-size-fits-all horizontal module and all the DPCs that would be placed in it. The DPCs are color coded with similar colors representing the same diameter. This is not a major issue for the horizontal module because it uses adjustable rails to accommodate the DPC size – only the door opening must be sized for the largest DPC. The diameter of the door opening is set at 81.0” to accommodate the 79” diameter NAC MPC canisters. The inside length of the module is set at 212.0” to accommodate the longer fuel assemblies yet to be stored. Some consideration may need to secure the very short DPCs.

Secondly, thermal transmission is derived through stack effect. For the horizontal storage module this is less of an issue since the module design, not the canister to overpack clearance sets the air flow parameters. However, the vertical DPC licenses would need to amended to address long term storage in the horizontal position.

Thirdly, the horizontal storage type DPCs are designed with radiation shield plugs on both ends since they are transferred horizontally. The vertical DPCs are only designed with a shield plug on one end. Some shielding measures would need to be added to the transfer cask for ALARA purposes

Figure A2-6
Energy Solutions Fuel Solutions Canisters in a Horizontal Overpack (elev & plan view)

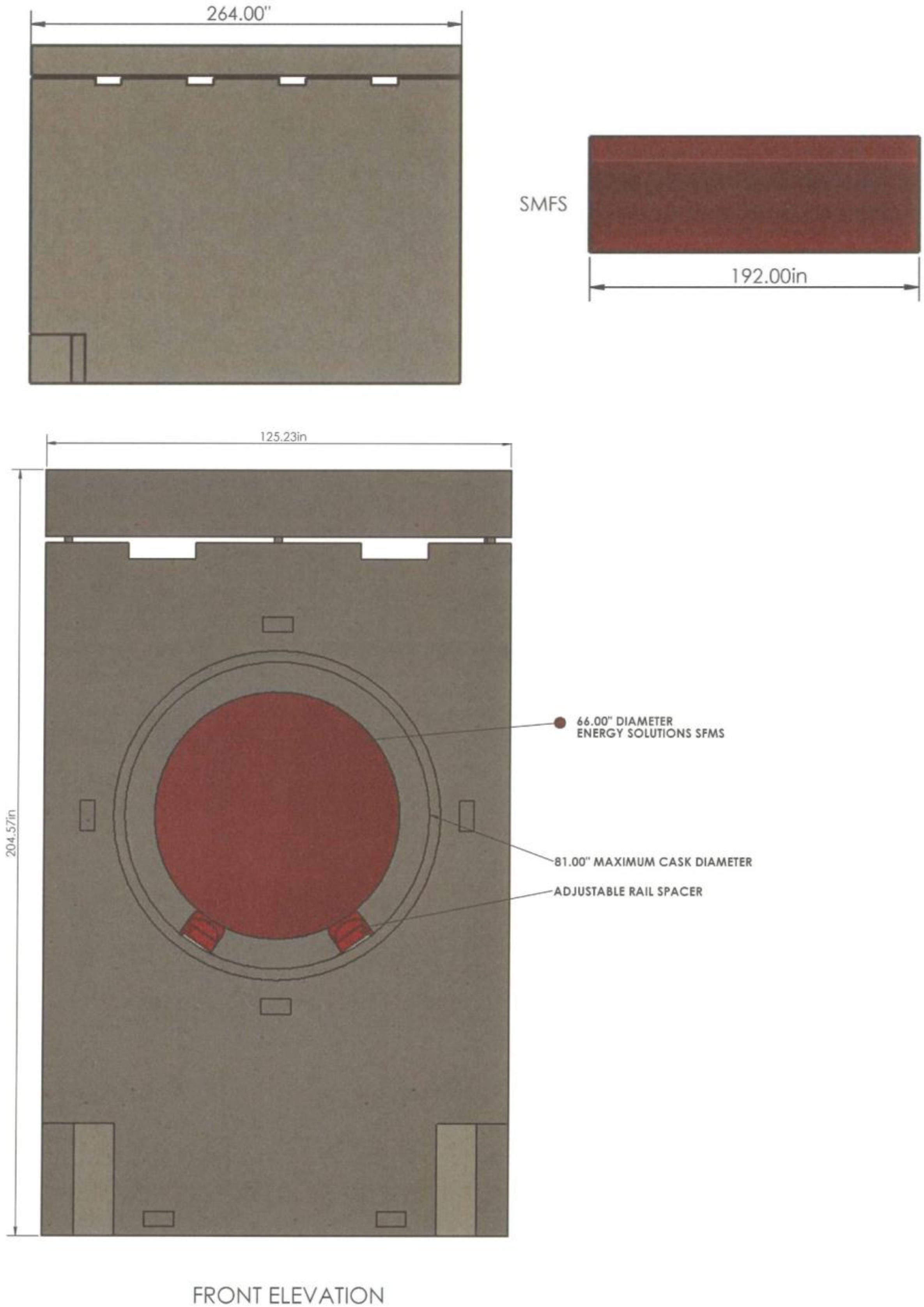


Figure A2-7
AREVA TN NUHOMS Canisters in a Horizontal Overpack (elev & plan view)

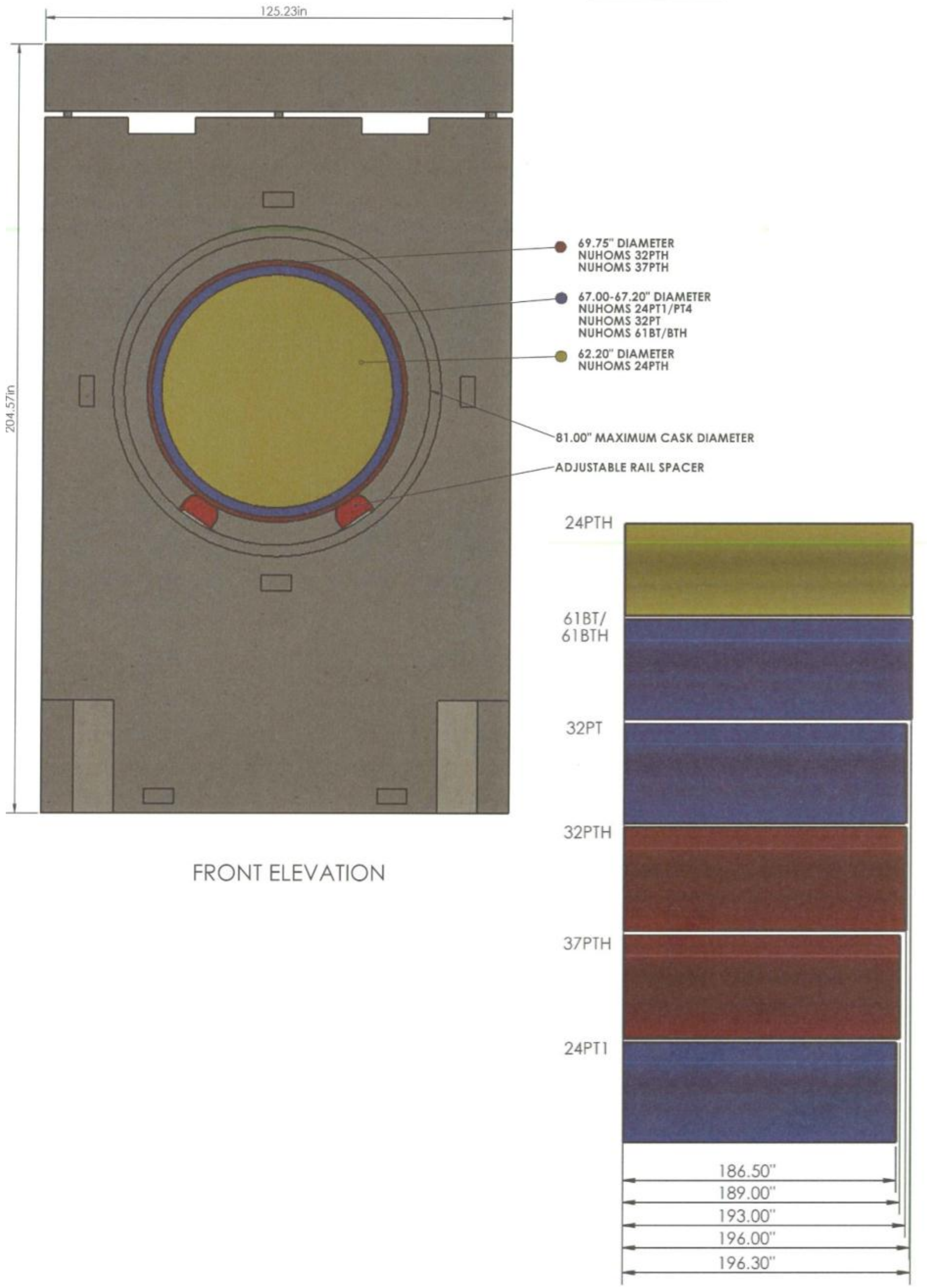


Figure A2-8
Holtec HI-STORM MPC Canisters in a Horizontal Overpack (elev & plan view)

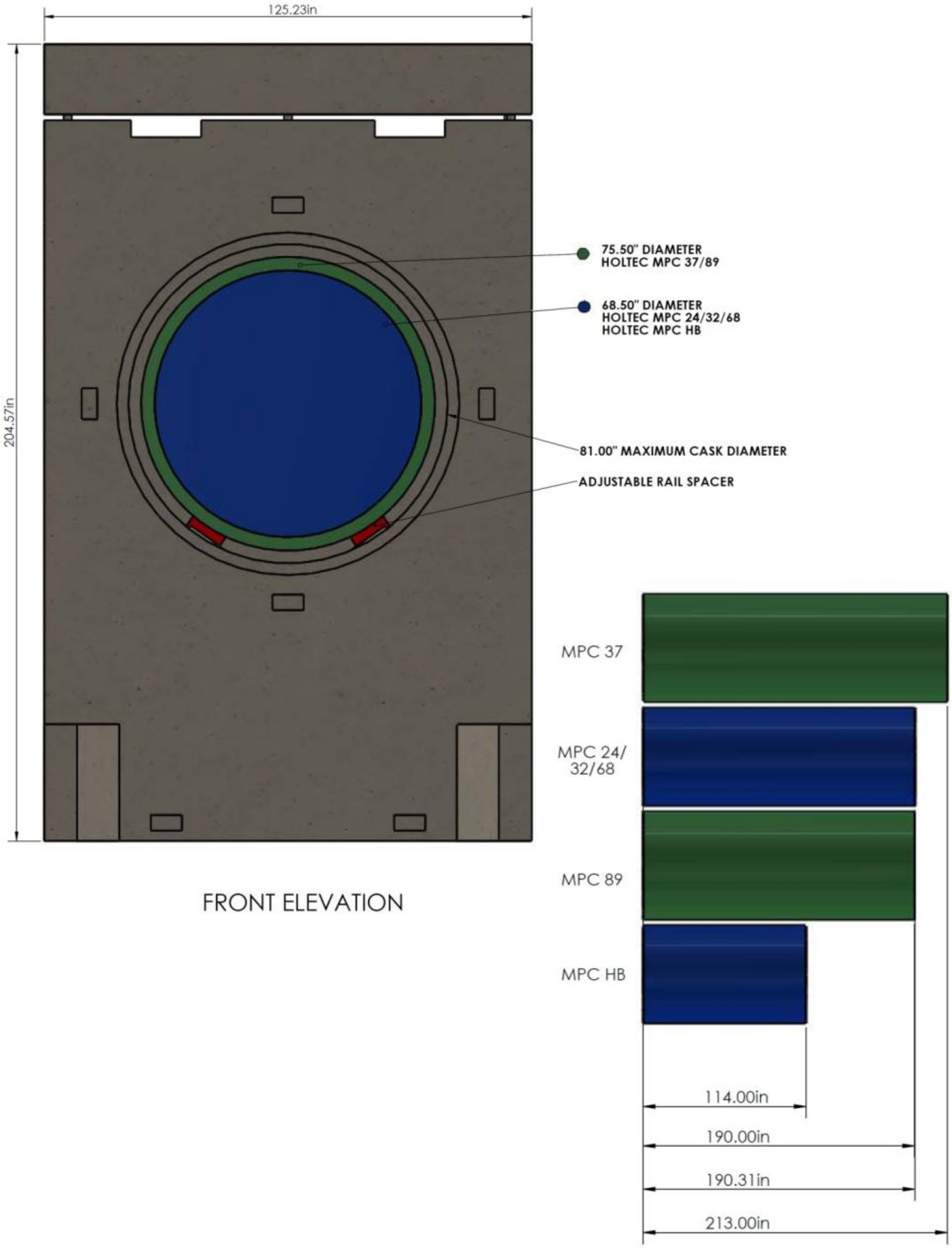
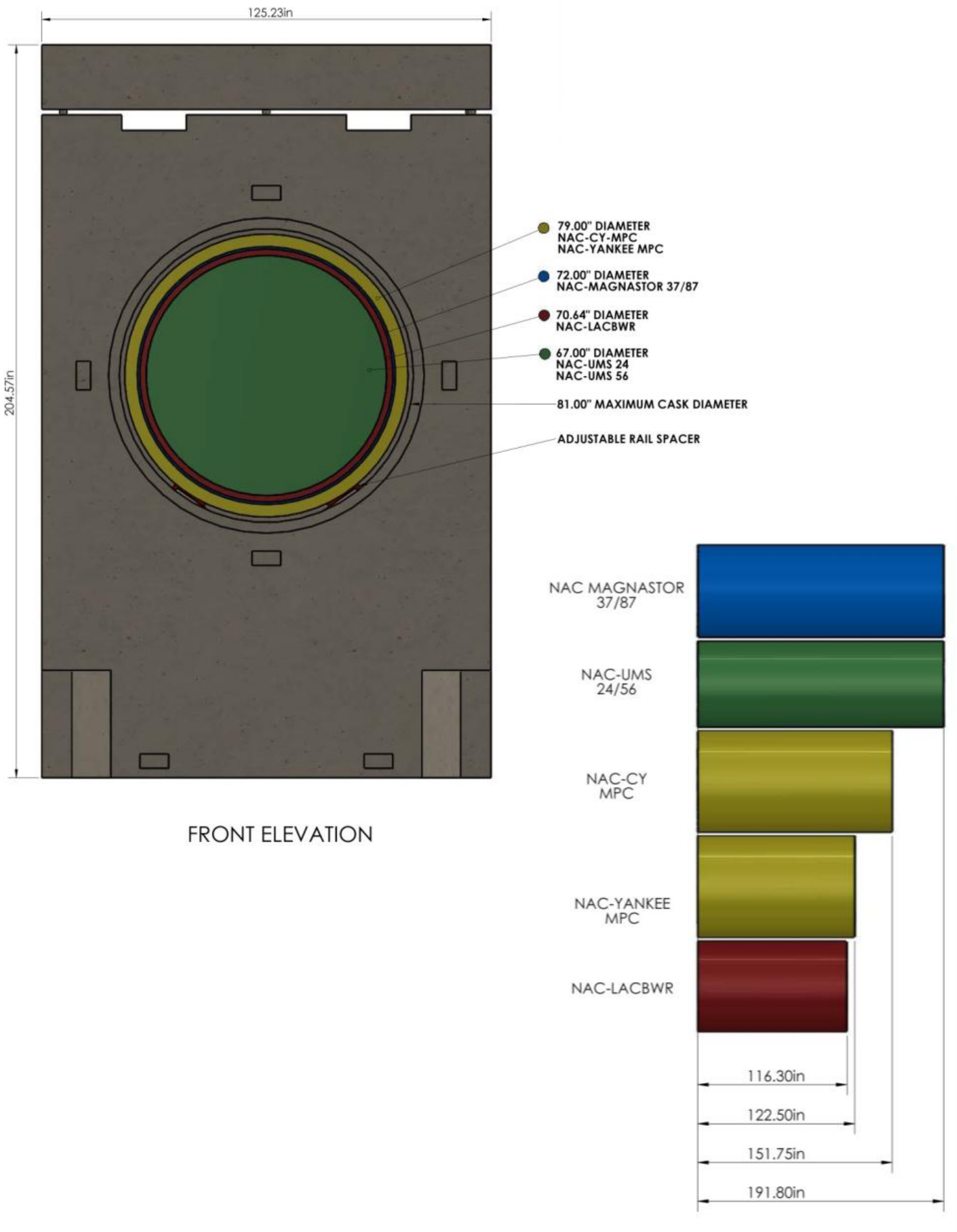


Figure A2-9
NAC MPC, UMS and MAGNASTOR Canisters in a Horizontal Overpack (elev & plan view)



C-STDc, Single Vertical and Horizontal Standard Storage Overpack

This variation would place all the horizontal type DPCs into a single horizontal storage overpack and all the vertical type DPCs into a single vertical storage overpack. This would effectively mean 98 horizontal storage modules and 267 vertical storage overpacks from the 12 shutdown nuclear plants would be required for the Pilot ISF. Having a single overpack design for each type of storage system would still simplify overpack fabrication process even though there would be two types. Two pad designs would be required; one for the horizontal storage module and one for the vertical storage overpack. Having a storage orientation that matches the storage type and license would reduce the potential issues associated with heat removal and canister handling.

Even with this approach there are issues to consider. There is the issue with DPC dimensions. The vertical overpack would be sized for the largest DPC so that all smaller DPCs would be shimmed in order to meet seismic and stability conditions as in C-STDa above. This is not an issue with the horizontal system since all the horizontal type DPCs are designed and manufactured by AREVA-TN and licensed by the NRC for use in a single horizontal storage module.

The thermal stack effect which necessitates certain clearances between the outside wall of the DPC and inside wall of the vertical overpack would also need to be evaluated. Again this is not an issue with the horizontal system which has already evaluated heat removal from all horizontal DPCs in the horizontal storage module.

Perhaps a fourth variation would be to have each of the four vendors be responsible to design, license and fabricate a standard overpack for their DPCs. This approach would avoid the transfer of proprietary information to another vendor in this highly competitive industry. Clearly four different standard overpacks are not as efficient as one or two standard overpacks but it is better than the current 7 available overpacks. Since the purpose of a standard overpack is to simplify the ISF storage and overpack fabrication operations, this hybrid approach would need to be fully investigated to determine if it negated the standardize benefits.

A2-2.0 Concept of Operations

A2-2.1 Facility Layout

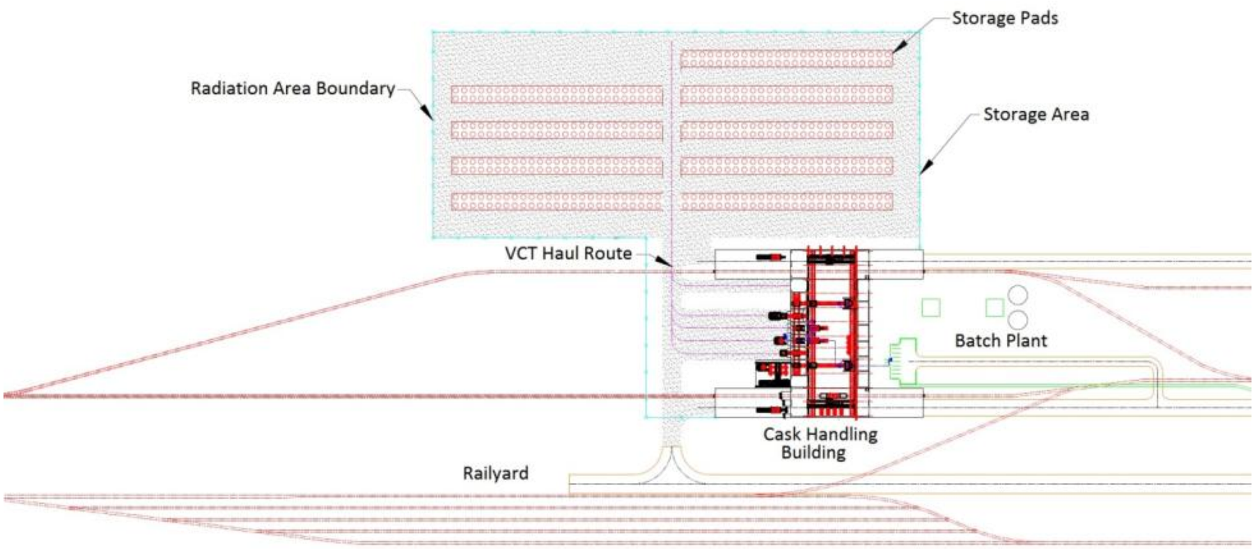
C-STD is a straightforward application of existing SNF storage technologies brought together at a common site. However, in order to simplify the logistics and the operations this alternative employs standard overpacks to house the DPCs. There are three variants to this alternative. The first variant of this concept houses all canisters in vertical standardized overpacks. The second variant of this concept stores all canisters in horizontal standardized overpacks. The third variant maintains the original orientation of the storage configuration. In other words, a vertical storage canister is housed in the vertical standardized overpack while a horizontal canister is stored in a horizontal standardized overpack. The first two variants are included for completeness but they add new concepts to the handling of SNF storage canisters that could result in additional licensing effort and unanticipated operational issues.

Whichever variant of the concept is selected, they all utilize a canister transfer facility or Cask Handling Building (CHB) to simplify dry storage canister transfer operations. For horizontal systems, the transport cask will be unloaded from the railcar and the DPC transfer from the transport cask to the horizontal storage module will be performed at the pad. This is typical for these storage systems where they are originally packaged into the DPC at the SNF generator's site. The storage method will continue to be employed here at this version of the Interim Storage Facility (ISF) for the first variant. This alternative will also study variants in which all DPCs are stored in either vertical or horizontal overpacks.

The transport casks are delivered via rail to the site. They are brought on site by the dedicated ISF tug. This small locomotive brings the railcars from the mainline siding to the inspection station located at the entrance of the ISF. There, site security officers will review the shipping paperwork and perform a thorough check of the rolling stock and the packaging to ensure that there is no contraband on the shipment. The railroad tracks have a powered derailer that is positioned at the gate to prevent unauthorized access to the site via rail. After the security inspection, the transport cask railcars are separated from the security railcar and are move onto the site's rail yard where they are staged until the Cask Handling Crew is ready for them in the CHB.

The CHB is where the transition from the rolling stock to the storage pad is begun. As a result, it is located at the intersection of the rail yard and the concrete storage pads. The storage pads are laid out to provide easy access for the cask transport machines and the survey and security teams. A conceptual layout is shown in **Figure A2-10**.

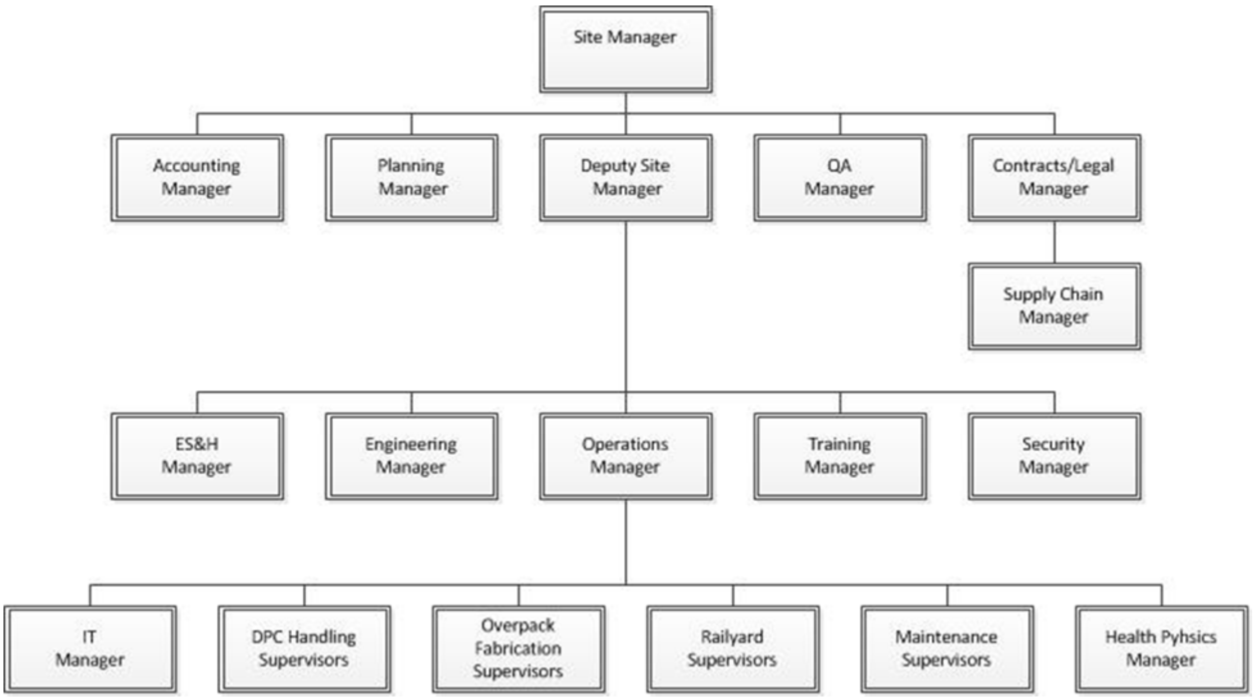
Figure A2-10
Conceptual Plan of the C-STD Alternative using Vertical Storage Overpacks



A2-2.2 ISF Operations

The Interim Storage Facility (ISF) operates 24-hour, 7-days a week basis, but cask handling operations are limited to a single 8-hour shift, 40-hour work week. This has been done because the logistics issues associated with delivering a large number of transport casks to the site do not warrant around-the-clock cask handling operations. It also provides the ability to accommodate surges of work that might be necessary by the simple expedient of adding additional cask handling crew shifts. It is assumed that the ISF is operated by an independent contractor so that many of the administrative and Human Resource functions of an organization are not required within the site organization. The costs for these services are covered in the overhead calculation for labor. **Figure A2-11** is the chart of the site organization.

Figure A2-11
Typical ISF Organization Chart



There are two phases to ISF operations: Cask Handling Operations and Storage Facility Surveillance and Maintenance Operations. The Cask Handling Operations are the activities necessary to accept SNF packaged in DPCs from nuclear generators and to place the SNF into interim storage on site. This is a temporary activity lasting only as long as necessary to accept the design basis amount of SNF considered in this study; either 5,000 MTU for the Pilot ISF or 10,000 MTU for the Expanded ISF. This activity lasts only a few years and involves the most labor intensive activities experienced at the ISF. Additional Cask Handling Operations will be necessary at the end of ISF life when the stored SNF is repackaged and shipped to its final destination, whether that is a repository or a recycling facility. However, that effort is not within the scope of this study.

The Storage Facility Surveillance and Maintenance Operation is the ongoing activity that spans the entire operational lifetime of the ISF. It consists of all the activities necessary to plan, to monitor the performance and aging of the storage systems used to house and cool the SNF, and to provide for the safeguards and security necessary to protect the facility from unwanted intrusions and/or damage. The Surveillance and Maintenance Operations begin immediately upon the commissioning of the ISF and continue until the last DPC has been removed.

During the Cask Handling Operations, many supporting activities need to be performed by the ISF staff. The most directly related to the Cask Handling Activities is the vertical storage overpack or horizontal storage module fabrication function. This is a full-time activity to complete the fabrication of the standardized overpacks necessary to support DPC placement activities. The steel components of the storage systems are fabricated by contractors working to a specification developed by the ISF design team. They are shipped to the site via rail and delivered to the overpack fabrication location near the concrete batch plant. After receipt inspection to ensure that the components meet specifications, concrete is added to the steel components in accordance with the ISF specification to complete the overpack design. A minimum of 30 days would be required to allow the concrete to cure. The vertical overpacks are large enough to accommodate the largest commercially available DPC applicable to that variant. The horizontal overpacks are compatible with all sizes of DPCs that could be installed. The Overpack Fabrication Crew would place concrete on the standardized overpack to provide the necessary shielding mass.

The original vendor or contractors under the original vendor's control will develop and supply the inserts/adaptors necessary for the original DPCs to meet the design requirements. These inserts/adaptors are proprietary and are necessary to ensure that the DPC inside the standard overpack is securely positioned and thermally connected to the heat removal surfaces of the standardized overpack to ensure adequate cooling. Since the inserts are produced by the original vendor, there is no need to share proprietary information across competing companies. This activity needs to be carefully managed to ensure that the insert/adaptor placed into the overpack or transfer cask is matched to the DPC scheduled to be stored in the overpack. This requirement eliminates some of the benefit expected from this concept in that the logistic planning and execution is just as important as if the DPCs were being stored in new overpacks from the original vendors.

Once again, these components are shipped to the site via rail and delivered to the Overpack Fabrication yard. They are unpacked, receipt inspected and prepared for insertion in the standardized overpacks (or in transfer casks for certain variants). These prefabricated inserts require additional personnel in the Overpack Fabrication Crew at the ISF to coordinate and to complete the placement of these inserts/adaptors.

The procurement activities necessary to support the overpack production must be well ahead of the delivery of the SNF because the lead time for the overpack components, delivery and final fabrication is on the order of 6 to 12 months. Orders must be placed with overpack vendors well ahead of the need in order to ensure that there is no interruption in DPC placement. In addition, Supply Chain Management must identify the correct vendor for the DPCs expected to be delivered, and place orders for the correct insert/adaptors for the model of DPC to be received and the schedule for delivery of the DPCs. Ideally, the system should be support just-in-time delivery of all of the necessary overpack components so that they can be used directly by the Cask Handling Crews. However, as a practical matter, the system should allow for buffer storage of these components in order to assure that SNF shipments are not held up by the lack of availability of overpacks or the necessary inserts/adaptors. This aspect of this alternative controls the ability of the ISF staff to accept SNF. No shipment of SNF should be undertaken unless there is an appropriate overpack system available on site.

Another major activity at the ISF necessary to support SNF placement is maintenance of the equipment necessary to perform the heavy lifts and heavy load movements necessary to fulfill the SNF handling function. While Cask Handling Operations are underway, the major equipment necessary to move the heavy loads around the ISF must be available and in working order. Cranes, carts and wheeled vehicles that handle DPCs need to be single failure proof and inspected and maintained rigorously to ensure operability and safety. Some of the commercially available machines may need to be modified to make them more capable of sustaining the sustained work load during the early stages of the ISF life cycle.

In addition to physical labor, the ISF requires planning and engineering to support operations. As already described, engineering, procurement and overpack fabrication activities need to be well ahead of actual SNF acceptance activities. The timescale of the work necessary to prepare the overpacks for the storage of SNF requires that the planning and engineering activities be performed nearly a year ahead of the SNF acceptance activities. Engineering activities are required for safety analyses and modifications to processes and materials to support SNF storage. Also, record keeping is required to identify where each DPC originates from, what it contains, the SNF characteristics and where it has been stored. In addition, all material certifications for SNF storage containers and other materials used for SNF handling need to be meticulously maintained for easy retrieval in the future.

Finally, the largest functional activity at the ISF is physical security. The security group needs to actively maintain the security of the site in addition to inspecting all materials coming onto the site. This security function is the largest single group of the organization and is a 24-7 operation. In addition, IAEA oversight systems need to be developed and maintained in order to meet the potential oversight functions associated with safeguards and security systems.

Table A2-2 is a listing of the site organization staff. The organizational staff would be adequate to support the activities at the ISF necessary to support the cask handling activities. This staff totals 154 but does not include the cask handling crew.

Table A2-2
Site Organization

Position	Staff	Position	Staff
Site Manager	1	Mechanical Engineers	4
Deputy Site Manager	1	I&C Engineers	1
Accounting Manager	1	Electrical Engineers	2
Planning Manager	1	Civil/Structural Engineers	4
QA – Manager	1	Quality Engineers	3
Contracts/Legal Manager	1	Buyers	2
Supply Chain Manager	1	Planners	3
Operations Manager	1	Security	54
ES&H Manager	1	Trainers	2
Engineering Manager	1	Railyard Operators	2
Training Manager	1	Supervisors	4
Security Manager	1	Mechanics	6
IT Manager	1	Electricians	4
DPC Handling Supervisors	1	CHB Facility Operators	10
Overpack Fabrication Supervisors	1	IT Technicians	2
Railyard Supervisors	2	Administration Assistants	2
Maintenance Supervisors	2	EMT	1
Health Physics Manager	1	RR Tug Engineers/Brakemen	4
Nuclear Safety Engineers	2	Overpack Fabrication Team	20
Health Physicists	2		
		Total	154

A2-2.3 Cask Handling Crew Size

The Cask Handling Operations staff is dedicated to the movement of DPCs around the site. These operations are carried out by dedicated crews who focus on certain areas of the operation. This way, when multiple DPCs are processed each week, a crew learns specialized skills that will improve efficiency. The crews are: 1. the Railbay Crew, 2. the Cask Transfer Crew and 3. the Transporter Crew.

The Railbay crew consists of the skilled crafts necessary to prepare the transport cask to be unloaded and later to be reassembled to be shipped back to the generator. These activities include receipt inspection of the as-received package, removal and storage of the impact limiters, removal and storage of the transport cask cover, and removal and storage of the tie-down straps. Then, the Railbay crew rigs the transport cask for lift by the overhead traveling bridge crane and, depending on the ultimate storage concept, either places it on the horizontal cask transporter or on the transfer cart in the CHB.

As soon as the transport cask is removed from the railcar, the Railbay Crew's supervisor informs the Railyard Supervisor to remove the empty railcar and to bring in the next railcar for service. This is done as needed to maintain throughput and to assure that the Railbay Crew is fully engaged throughout the work week. Again, before the transport cask is returned to the railbay, the Railbay Crew will arrange with the Railyard supervisor to have its original railcar returned to the Railbay.[1] Once the transport cask is returned to the railbay, the Railbay Crew inspects and surveys the cask, rigs it and repositions it back on the railcar, and then reassembles the transportation packaging for reshipment to the generator. This crew specializes in unloading the transport cask and repackaging empty transport casks for reshipment back to generators. There are two sets of Railbay Crews that can be used in either bay since the activities are identical. Also, the Railbay Crews are unaffected by which variant of this alternative is chosen. All activities in the Railbay are consistent throughout. The only difference among the three variants of this alternative for the Railbay crew is where the transport cask is placed after it has been removed from the railcar.

The Cask Transfer crews have very different skillsets depending on the variant of this concept chosen. For the first variant, in which the spent nuclear fuel canisters are stored in the same orientation as they had been stored originally, there are two different sets of skills. The Vertical Transfer Crews work in the CHB and transfer the fuel canister from the transport cask into the storage overpack before it is transported to the pad. The Horizontal Transfer crews work on the pad preparing the storage module to receive the spent nuclear fuel canister and working with the transporter crew to affect the transfer.

For the first alternative variation, in which the spent nuclear fuel canisters are all stored in vertical overpacks, the Cask Transfer Crews work in the CHB and transfer the fuel canister from the transport casks into the standardized storage overpacks in the vertical transfer cells. Canisters that were originally stored horizontally are transferred into the storage overpack in the horizontal transfer rig. Horizontal DPCs are not intended to be lifted vertically by their upper end cover plate. Therefore, they cannot be lifted in the same manner as the DPCs designed for vertical storage. The universal overpack will be rotated into the horizontal position in a transfer rig. The overpack will have been preloaded with the appropriate lifting frame with adaptors to center and secure the DPC in the oversized standard overpack.[2] The horizontal DPC will be first loaded into a transfer cask, rotated 180° and then pushed into the lifting frame. This is necessary to avoid storing the SNF assemblies upside down. The horizontal DPC is pushed into the overpack by means of a hydraulic ram engaged on a full diameter pressure disk in the transfer cask. This assures that the DPC is pushed straight into the lifting frame without concern about the rigidity of the ram. This transfer cart will share many design features from HCTs but will have fewer degrees of motion permitting rapid alignment with the overpack. The universal

[1] It is assumed that the railcar and the transport cask need to remain paired.

[2] The lifting frame is necessary to remove the DPC from the Overpack in the future. Without the lifting frame, there could be no means of removing the DPC because the Ram Grapple Ring necessary to remove horizontal DPCs would be inaccessible at the bottom of the vertical overpack

overpack will then be righted into the vertical orientation and the lid will be installed in the normal manner. The reoriented horizontal DPC in the universal overpack is then ready to be picked off of the transfer rig by the vertical cask transporter (VCT).

For the second alternative variation, in which the spent nuclear fuel canisters are all stored in horizontal overpacks, the Cask Transfer Crews work in the CHB and on the pad near the universal horizontal overpacks. This is because the vertical dual purpose canisters do not have a ram grapple ring on the bottom of the canister and therefore cannot be pushed into the horizontal overpack. To address this deficiency, the vertical storage canisters are first loaded into an adaptor frame that has been preloaded into a transfer cask and positioned in the vertical transfer receiving cell. This adaptor frame provides a tight fit to the DPC and incorporates a ram grapple ring on the bottom. The transfer cask replaces the transport cask for the final waste placement enabling the transport cask to be returned to the Railbay Crew for repackaging before the SNF canister is placed into storage. Traditional horizontal SNF storage concepts do not need vertical transfer cells, (and indeed is one of the concept's greatest advantages) this variant requires both the vertical transfer cells and the work crew on the pad preparing the horizontal overpack to receive the vertical DPCs. This process requires double handling of the vertical DPCs in order to affix this necessary component onto the canister. The transport cask containing a vertical DPC is placed on the transfer cart and the lifting lug is bolted onto the upper cover. The transport cask is moved into the transfer cell and the shield door is closed. In the receiving cell, the adaptor frame has been positioned inside of a reusable transfer cask that has all of the functionality of a transport cask. The DPC is grappled and lifted into a shielded transfer cask above the transfer cells. The upper transfer cask is repositioned over the receiving cell and the DPC is lowered into the shielded transfer cask. The receiving transfer cask is then moved out of the cell on its transfer cart allowing access for the Cask Transfer Crew to remove the lifting lug from the DPC and to attach the upper cover of the adaptor frame that secures it to the DPC. Then the transfer cask upper lid is installed on the transfer cask. The transfer cask is picked by the overhead traveling bridge (OTB) crane and placed onto a HCT for movement to the pad.

A horizontal DPC is handled in the normal manner in that the transport cask is placed directly onto the HCT from the railcar. It is transported to the universal storage overpack. The Cask Transfer Crew prepares the universal horizontal storage module to receive the DPC and removes the cover from the transport or the transfer cask. The cover to the horizontal storage module is removed and the transport/transfer cask is mated to the module. The DPC is pushed into the universal overpack. The HCT is backed off, and the seismic restraint is installed. The overpack cover is reinstalled and the lid to the transport/transfer cask is reinstalled.

The Transporter Crews operate the vertical canister transporter (VCT) and/or the horizontal canister transporter (HCT) for each DPC. In the case of the HCT, the Transporter Crew position the transporter in the CHB and the Railbay Crew places the transport cask directly on the HCT.

In the case of the VCT, the transporter crew positions an empty storage overpack in the receiving transfer cell and after it is loaded, pick the storage overpack and transports it to the pad. They also seismically secure the storage overpack to the pad if required.

The third alternative variation, in which the spent nuclear fuel canisters are stored in their normal position, horizontal or vertical, the process would follow the current horizontal or vertical transfer operation discussed in the previous alternative variations.

Tables A2-3 through Table A2-5 shows the staffing for each major activity necessary to move SNF canisters from the transport cask to the pad for each of the three storage variations. These values are based on current experience with moving DPCs around operating nuclear sites to store the SNF at generator ISFSIs. Each DPC has a dedicated supervisor who is responsible for all activities associated with that package from receipt until placement in storage. In addition, a supervisor is assigned to each transport cask as it is serviced and packaged for reshipment. The mechanics are responsible for removing the mechanical fasteners that hold the various cask lids on and the lifting lugs. The Riggers are responsible for attaching the lifting devices to casks and other lifted components (loads) and for visually monitoring the lifts.

The Electricians are instrumentation specialists who visually inspect the tamper proof seals on the transport casks and reinstalling them for the reshipment. They also have a role in installing the instrumentation packages to the storage overpacks in the fabrication crew and attaching the instrumentation to the monitoring systems once the SNF is placed on the pad.

Health Physics teams are associated with all DPC handling activities as are QA/QC inspectors. The Crane Operators are needed for three different types of cranes. The railbay cranes are overhead traveling 200 ton bridge cranes. The vertical transport cask crane is a jib crane and a collection of other lifting devices and hoists associated with specialized transfer devices. The Heavy Equipment operators are the operators of the VCTs or the HCTs.

Table A2-3, Basis of Staffing - C-STDa Pad Storage in Vertical Standardized Overpacks

Vertical - DPCs stored vertically in standardized overpack		Supervisor	Mechanics	Electricians	Riggers	Ops *	HP	QA/QC	Crane	RR Ops *	Heavy Eq. Operator	Security *	Total Staff	Duration (Hrs)
0)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
1)	Receive transport cask at BGV/AGV	1	2	2	0	1	2	1	0	2	0	2	13	1
2)	Remove impact limiters and place in temporary storage	1	2	0	2	0	2	0	1	0	0	0	8	3
3)	Upend and lift transport cask off of railcar and place on transfer cart	1	0	0	2	0	0	0	1	0	0	0	4	2
3a)	Remove railcar from Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
4)	Remove transport cask cover using jib crane and set down	1	2	0	2	0	2	0	1	0	0	1	9	1
4a)	Secure the Transport cask and the transfer cart seismically	1	2	0	2	0	0	1	1	0	0	0	7	0.5
4b)	Plan of the Day and Safety Meeting	1	2	0	2	0	2	1	1	0	1	0	10	0.5
5)	Attach lifting lug to top of DPC	1	2	0	2	0	2	1	1	0	1	0	10	1
6)	Position transport cask transfer cart in unloading cell and close shield doors	1	0	0	2	0	2	0	0	0	1	0	6	1
7)	Stage empty storage cask in receiving cell using a transfer cart	1	0	0	2	0	0	1	0	0	1	0	5	1
8)	Unbolt empty storage cask lid and hoist on VCT	1	2	0	2	0	0	0	0	0	1	0	6	1
9)	Retract VCT from receiving cell and close shield doors	1	0	0	2	0	0	0	0	0	1	0	4	0.5
10)	Position shielded transfer sleeve cart over unloading cell	1	0	0	2	0	0	1	0	0	1	0	5	0.5
11)	Lower shield sleeve hoist and grapple DPC lifting lug	1	0	0	2	0	2	0	0	0	1	0	6	0.5
12)	Raise DPC into shield sleeve	1	0	0	2	0	2	1	0	0	1	0	7	1
13)	Position shielded transfer sleeve cart over storage cask in receiving cell	1	0	0	2	0	2	0	0	0	1	0	6	0.5
14)	Lower DPC into empty storage cask, release grapple, and retract hoist	1	0	0	2	0	2	0	0	0	1	0	6	1
15)	Open receiving cell shield doors and position VCT at storage cask	1	0	0	2	0	2	0	0	0	1	0	6	0.5
16)	Remove lifting lug from DPC	1	2	0	2	0	2	0	0	0	1	0	8	0.5
17)	Install storage cask lid	1	2	0	2	0	2	1	0	0	1	0	9	1
17a)	Secure Seismic restraints	1	2	0	2	0	0	1	1	0	0	0	7	0.5
17b)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
18)	Pick up storage cask and transfer to pad using VCT	1	0	0	0	0	0	0	0	0	1	0	2	2
18a)	Turnover to Operations	0	0	2	0	2	2	1	0	0	0	0	7	24
19)	Return VCT to CHB	0	0	2	0	0	0	0	0	0	1	0	3	2
20)	Open unloading cell shield doors and position transfer cart under jib crane	1	2	0	0	0	2	0	1	0	0	0	6	1
21)	Install transport cask lid	1	3	0	0	0	2	1	1	0	0	0	8	1
22)	Lift transport cask and transfer to maintenance	1	0	0	2	0	2	0	1	0	0	0	6	1
22a)	Survey and wipedown Transport Cask	1	0	0	0	0	2	0	0	0	0	0	3	1
22b)	Reposition Empty Railcar to Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
23)	Lift transport cask and place on railcar	1	2	2	2	0	0	0	1	0	0	0	8	1
24)	Install impact limiters on transport cask	1	2	0	2	0	0	1	1	0	0	0	7	2
25)	Release railcar for shipment	1	0	0	0	1	2	1	0	2	0	2	9	1

* These categories are loaned to the Cask Handling Crew

Table A2-3, Basis of Staffing - C-STDa Pad Storage in Vertical Standardized Overpacks (cont.)

Horizontal - DPCs stored vertically in standardized overpacks		Supervisor	Mechanics	Electricians	Riggers	Ops *	HP	QA/QC	Crane	RR Ops *	Heavy Eq. Operator	Security *	Total Staff	Duration (Hrs)
0)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
1)	Receive transport cask on railcar at Cask Handling Building	1	2	2	0	1	2	1	0	2	0	2	13	1
2)	Remove impact limiters and place in temporary storage	1	2	0	2	0	2	0	1	0	0	0	8	3
3)	Upend and lift transport cask off of railcar and place on transfer fixture	1	0	0	2	0	2	0	1	0	0	0	6	2
4)	Stage universal overpack on upright transfer fixture using VCT	1	0	0	1	0	0	0	0	0	1	0	3	1
5)	Unbolt and hoist overpack lid and retain on VCT	1	2	0	2	0	0	0	0	0	1	0	6	1
6)	Downend universal overpack on transfer fixture	1	0	0	2	0	0	1	1	0	1	0	6	1
7)	Remove transport cask lid	1	3	0	1	0	2	1	1	0	0	1	10	1
7a)	Secure Transport cask and transfer cart seismically	1	2	0	2	0	0	1	1	0	0	0	7	0.5
7b)	Plan of the Day and Safety Meeting	1	2	0	2	0	2	1	1	0	0	0	9	0.5
8)	Dock transfer sleeve on horizontal transfer cart with transport cask	1	0	0	2	1	2	0	0	0	0	0	6	1
9)	Push DPC from transport cask into transfer sleeve using ram mounted to fixed rack	1	0	0	2	1	0	0	0	0	0	0	4	1
10)	Decouple horizontal transfer cart from transport cask and close shield door	1	0	0	2	1	2	0	0	0	0	0	6	0.5
11)	Roll horizontal transfer cart onto turntable and rotate 180°	1	0	0	2	1	0	0	0	0	0	0	4	0.5
12)	Roll horizontal transfer cart to upending cell and dock storage/transfer cask on upender	1	0	0	2	1	0	0	0	0	0	0	4	0.5
13)	Push DPC from transfer sleeve into lift frame in storage/transfer cask	1	0	0	2	1	0	0	0	0	0	0	4	1
14)	Unbolt docking collar from storage/transfer cask and undock horizontal transfer cart	1	0	0	2	1	0	0	0	0	0	0	4	1
15)	Upend storage/transfer cask w/ DPC	1	0	0	2	1	0	0	0	0	0	0	4	0.5
16)	Install storage/transfer cask lid using jib crane in upender transfer cell	1	2	0	2	0	2	1	1	0	0	0	9	1
16a)	Secure Seismic restraints	1	2	0	2	0	0	1	1	0	0	0	7	0.5
16b)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
17)	Pick up universal overpack and transfer to pad using VCT	1	0	0	0	0	0	0	0	0	1	0	2	2
17a)	Turnover to Operations	1	0	2	0	2	2	1	0	0	0	0	8	24
18)	Return VCT to CHB	1	0	0	0	0	0	0	0	0	1	0	2	2
19)	Install transport cask lid	1	2	0	1	0	0	1	1	0	0	1	7	1
20)	Lift transport cask and transfer to maintenance	1	0	0	2	0	0	0	1	0	0	0	4	1
20a)	Survey and wipedown Transport Cask	0	0	0	0	0	2	0	0	0	0	0	2	1
20b)	Reposition Empty Railcar to Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
21)	Lift transport cask and place on railcar	1	2	2	2	0	0	0	1	0	0	0	8	1
22)	Install impact limiters on transport cask	1	3	0	1	0	0	1	1	0	0	0	7	2
23)	Release railcar for shipment	1	0	0	0	1	2	1	0	2	0	2	9	1

* These categories are loaned to the Cask Handling Crew

Table A2-4, Basis of Staffing - C-STDb Pad Storage in Horizontal Standardized Overpacks

Vertical DPCs - DPCs into universal horizontal overpacks on pad		Supervisor	Mechanics	Electricians	Riggers	Ops *	HP	QA/QC	Crane	RR Ops *	Heavy Eq. Operator	Security *	Total Staff	Duration (hrs)
0)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
1)	Receive transport cask on railcar at Cask Handling Building	1	2	2	0	1	2	1	0	2	0	2	13	1
2)	Remove impact limiters and place in temporary storage	1	2	0	2	0	2	0	1	0	0	0	8	3
3)	Upend and lift transport cask off of railcar and place on unloading cell transfer cart	1	0	0	2	0	2	0	1	0	0	0	6	2
3a)	Remove railcar from Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
4)	Unbolt and remove transport cask lid using jib crane	1	2	0	2	0	2	0	1	0	0	1	9	1
5)	Receive adaptor frame from Overpack Fabrication yard	1	2	0	2	0	0	0	0	0	1	0	6	1
6)	Unpack and inspect adaptor frame	1	2	0	2	0	0	1	0	0	0	0	6	1
7)	Pick Transfer Cask off HCT and place on receiving transfer cart with OTB crane	1	2	0	2	0	0	0	1	0	1	0	7	1
8)	Remove Transfer Cask lid with OTB crane	1	2	0	2	0	0	0	1	0	0	0	6	1
9)	Install adaptor frame into Transfer Cask with OTB crane	1	2	0	2	0	0	1	1	0	0	0	7	1
10)	Position transfer cask transfer cart in receiving cell and close shield doors	1	0	0	2	0	2	0	0	0	1	0	6	0.5
10a)	Secure Transport cask and transfer cart seismically	1	2	0	2	0	0	1	1	0	0	0	7	0.5
10b)	Plan of the Day and Safety Meeting	1	2	0	2	0	2	1	1	0	0	0	9	0.5
11)	Attach lifting lug to top of DPC using jib crane	1	2	0	2	0	2	1	1	0	0	0	9	1
12)	Position transport cask transfer cart in unloading cell and close shield doors	1	0	0	2	0	2	0	1	0	0	0	6	1
13)	Position shielded transfer sleeve cart over unloading cell	1	0	0	2	0	0	1	1	0	0	0	5	0.5
14)	Lower shield sleeve hoist and grapple DPC lifting lug	1	0	0	1	0	2	0	1	0	0	0	5	0.5
15)	Raise DPC into shielded transfer sleeve	1	0	0	1	0	2	1	1	0	0	0	6	1
16)	Position shielded transfer sleeve cart over transfer cask in receiving cell	1	0	0	1	0	2	0	1	0	0	0	5	0.5
17)	Lower DPC into adaptor frame in transfer cask, release grapple, and retract hoist	1	0	0	1	0	2	1	1	0	0	0	6	1
18)	Open receiving cell shield doors and position transfer cask under jib crane	1	0	0	1	0	2	0	1	0	0	0	5	0.5
19)	Remove lifting lug from DPC	1	2	0	1	0	2	0	1	0	0	0	7	0.5
20)	Install adaptor frame lid	1	2	0	2	0	2	0	1	0	0	0	8	1
20a)	Secure Seismic restraints	1	2	0	2	0	0	1	1	0	0	0	7	0.5
20b)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
21)	Install Transfer Cask lid	1	2	0	2	0	2	0	1	0	0	0	8	1
22)	Pick Transfer Cask with OTB crane and place on HCT	1	2	0	2	0	0	0	1	0	1	0	7	1
23)	Open unloading cell shield doors and position transport cart under jib crane	1	2	0	0	0	2	0	1	0	0	0	6	1
24)	Install transport cask lid	1	2	0	0	0	2	1	1	0	0	1	8	1
25)	Lift transport cask and transfer to maintenance	1	2	0	2	0	2	0	1	0	1	0	9	1
25a)	Survey and wipedown Transport Cask	1	0	0	0	0	2	0	0	0	0	0	3	1
25b)	Reposition Empty Railcar to Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
26)	Lift transport cask and place on railcar	1	0	0	2	0	0	0	1	0	1	0	5	1
27)	Install impact limiters on transport cask	1	2	2	2	0	0	1	1	0	1	0	10	2
28)	Release railcar for shipment	1	0	0	0	1	2	1	0	2	0	2	9	1
28a)	Plan of the Day and Safety Meeting	0	0	0	0	0	0	0	0	0	3	0	3	0.5
29)	Move transfer caskk to the pad using HCT	1	0	0	0	0	0	0	0	0	3	0	4	2
30)	Preparation of Module	1	2	0	2	0	2	0	1	0	0	0	8	2
31)	Remove transfer cask lid	1	2	0	2	0	2	0	1	0	0	1	9	1
32)	Dock HCT with HSM and push DPC into module	1	2	0	2	0	2	0	0	0	1	0	8	3
33)	Install HSM port cover (Plus Seismic Restraints)	1	2	0	2	0	2	1	1	0	0	0	9	1
33a)	Turnover to Operations	0	0	2	0	2	2	1	0	0	0	0	7	24
34)	Install transfer cask lid	1	2	0	2	0	0	1	1	0	1	1	9	1
35)	Return transfer cask to Cask Handling Building via HCT	1	0	0	2	0	0	0	0	0	1	0	4	2

* These categories are loaned to the Cask Handling Crew

Table A2-4, Basis of Staffing - C-STDb Pad Storage in Horizontal Standardized Overpacks (cont.)

	Horizontal DPCs - DPCs into universal horizontal overpacks on pad	Supervisor	Mechanics	Electricians	Riggers	Ops *	HP	QA/QC	Crane	RR Ops *	Heavy Eq. Operator	Security *	Total Staff	Duration (Hrs)
0)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
1)	Receive transport cask on railcar at Cask Handling Building	1	2	2	0	1	2	1	0	2	0	2	13	1
2)	Remove impact limiters and place in temporary storage	1	2	0	2	0	0	0	1	0	1	0	7	3
3)	Stage Horizontal Cask Transporter in truck bay	1	0	0	2	0	0	0	0	0	1	0	4	1
4)	Upend and lift transport cask off of railcar and downend on HCT	1	0	0	2	0	2	0	1	0	0	0	6	2
4a)	Remove railcar from Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
4b)	Secure Transport Cask and HCT seismically	1	2	0	2	0	0	1	1	0	0	0	7	0.5
4c)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	1	1	0	13	0.5
5)	Transfer transport cask to Horizontal Storage Module on pad via HCT	1	0	0	2	0	0	1	0	0	1	0	5	2
5a)	Preparation of Module	1	2	0	2	0	2	0	1	0	0	0	8	2
6)	Remove transport cask lid	1	2	0	2	0	2	0	1	0	0	1	9	1
7)	Dock HCT with HSM and push DPC into module	1	0	0	0	0	2	1	0	0	3	0	7	3
8)	Install HSM port cover (Plus Seismic Restraints)	1	2	0	2	0	2	1	1	0	0	0	9	1
8a)	Turnover to Operations	0	0	2	0	2	2	1	0	0	0	0	7	24
9)	Install transport cask lid	1	2	0	2	0	0	1	1	0	0	1	8	1
10)	Return transport cask to Cask Handling Building via HCT	1	0	0	0	0	0	0	0	0	3	0	4	1
10a)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
11)	Lift transport cask and transfer to maintenance	1	0	0	2	0	0	0	1	0	1	0	5	1
11a)	Survey and wipedown Transport Cask	1	0	0	0	0	2	0	0	0	0	0	3	1
11b)	Reposition Empty Railcar to Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
12)	Lift transport cask and place on railcar	1	2	2	2	0	0	0	1	0	1	0	9	1
13)	Install impact limiters on transport cask	1	2	0	2	0	0	1	1	0	1	0	8	2
14)	Release railcar for shipment	1	0	0	0	1	2	1	0	2	0	2	9	1

* These categories are loaned to the Cask Handling Crew

Table A2-5, Basis of Staffing - C-STDc Pad Storage in Vertical and Horizontal Standardized Overpacks

	Vertical DPCs - DPCs in universal overpacks on pad	Supervisor	Mechanics	Electicians	Riggers	Ops *	HP	QA/QC	Crane	RR Ops *	Heavy Eq. Operator	Security *	Total Staff	Duration (hrs)
0)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
1)	Receive transport cask on railcar at Cask Handling Building	1	2	2	0	1	2	1	0	2	0	2	13	1
2)	Remove impact limiters and place in temporary storage	1	2	0	2	0	2	0	1	0	0	0	8	3
3)	Upend and lift transport cask off of railcar and place on unloading cell transfer cart	1	0	0	2	0	0	0	1	0	0	0	4	2
3a)	Remove railcar from Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
4)	Unbolt and remove transport cask lid using jib crane	1	2	0	2	0	2	0	1	0	0	1	9	1
4a)	Secure Transport cask and transfer cart seismically	1	2	0	2	0	0	1	1	0	0	0	7	0.5
4b)	Plan of the Day and Safety Meeting	1	2	0	2	0	2	1	1	0	1	0	10	0.5
5)	Attach lifting lug to top of DPC	1	2	0	2	0	2	1	1	0	1	0	10	1
6)	Position transport cask transfer cart in unloading cell and close shield doors	1	0	0	2	0	2	0	0	0	1	0	6	1
7)	Stage empty storage cask in receiving cell using VCT	1	0	0	2	0	0	1	0	0	1	0	5	1
8)	Unbolt empty storage cask lid and hoist on VCT	1	2	0	2	0	0	0	0	0	1	0	6	1
9)	Retract VCT from receiving cell and close shield doors	1	0	0	2	0	0	0	0	0	1	0	4	0.5
10)	Position shielded transfer sleeve cart over unloading cell	1	0	0	2	0	0	1	0	0	1	0	5	0.5
11)	Lower shield sleeve hoist and grapple DPC lifting lug	1	0	0	2	0	2	0	0	0	1	0	6	0.5
12)	Raise DPC into shield sleeve	1	0	0	2	0	2	1	0	0	1	0	7	1
13)	Position shielded transfer sleeve cart over storage cask in receiving cell	1	0	0	2	0	2	0	0	0	1	0	6	0.5
14)	Lower DPC into empty storage cask, release grapple, and retract hoist	1	0	0	2	0	2	0	0	0	1	0	6	1
15)	Open receiving cell shield doors and position VCT at storage cask	1	0	0	2	0	2	0	0	0	1	0	6	0.5
16)	Remove lifting lug from DPC	1	2	0	2	0	2	0	0	0	1	0	8	0.5
17)	Install storage cask lid	1	2	0	2	0	2	1	0	0	1	0	9	1
17a)	Secure Seismic restraints	1	2	0	2	0	0	1	1	0	0	0	7	0.5
17b)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
18)	Pick up storage cask and transfer to pad using VCT	1	0	0	0	0	0	0	0	0	1	0	2	2
18a)	Turnover to Operations	0	0	2	0	2	2	1	0	0	0	0	7	24
19)	Return VCT to CHB	0	0	2	0	0	0	0	0	0	1	0	3	2
20)	Open unloading cell shield doors and position transfer cart under jib crane	1	2	0	0	0	2	0	1	0	0	0	6	1
21)	Install transport cask lid	1	3	0	0	0	2	1	1	0	0	0	8	1
22)	Lift transport cask and transfer to maintenance	1	0	0	2	0	2	0	1	0	0	0	6	1
22a)	Survey and wipedown Transport Cask	1	0	0	0	0	2	0	0	0	0	0	3	1
22b)	Reposition Empty Railcar to Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
23)	Lift transport cask and place on railcar	1	2	2	2	0	0	0	1	0	0	0	8	1
24)	Install impact limiters on transport cask	1	2	0	2	0	0	1	1	0	0	0	7	2
25)	Release railcar for shipment	1	0	0	0	1	2	1	0	2	0	2	9	1

* These categories are loaned to the Cask Handling Crew

Table A2-5, Basis of Staffing - C-STDc Pad Storage in Vertical and Horizontal Standardized Overpacks (cont.)

Horizontal DPCs - DPCs in universal horizontal overpacks on pad		Supervisor	Mechanics	Electricians	Riggers	Ops *	HP	QA/QC	Crane	RR Ops *	Heavy Eq. Operator	Security *	Total Staff	Duration (Hrs)
0)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
1)	Receive transport cask on railcar at Cask Handling Building	1	2	2	0	1	2	1	0	2	0	2	13	1
2)	Remove impact limiters and place in temporary storage	1	2	0	2	0	0	0	1	0	1	0	7	3
3)	Stage Horizontal Cask Transporter in truck bay	1	0	0	2	0	0	0	0	0	1	0	4	1
4)	Upend and lift transport cask off of railcar and downend on HCT	1	0	0	2	0	2	0	1	0	0	0	6	2
4a)	Remove railcar from Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
4b)	Secure Transport Cask and HCT seismically	1	2	0	2	0	0	1	1	0	0	0	7	0.5
4c)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	1	1	0	13	0.5
5)	Transfer transport cask to Horizontal Storage Module on pad via HCT	1	0	0	2	0	0	1	0	0	1	0	5	2
5a)	Preparation of Module	1	2	0	2	0	2	0	1	0	0	0	8	2
6)	Remove transport cask lid	1	2	0	2	0	2	0	1	0	0	1	9	1
7)	Dock HCT with HSM and push DPC into module	1	0	0	0	0	2	1	0	0	3	0	7	3
8)	Install HSM port cover (Plus Seismic Restraints)	1	2	0	2	0	2	1	1	0	0	0	9	1
8a)	Turnover to Operations	0	0	2	0	2	2	1	0	0	0	0	7	24
9)	Install transport cask lid	1	2	0	2	0	0	1	1	0	0	1	8	1
10)	Return transport cask to Cask Handling Building via HCT	1	0	0	0	0	0	0	0	0	3	0	4	1
10a)	Plan of the Day and Safety Meeting	1	2	2	2	0	2	1	1	0	1	0	12	0.5
11)	Lift transport cask and transfer to maintenance	1	0	0	2	0	0	0	1	0	1	0	5	1
11a)	Survey and wipedown Transport Cask	1	0	0	0	0	2	0	0	0	0	0	3	1
11b)	Reposition Empty Railcar to Railbay	0	0	0	0	1	0	0	0	2	0	2	5	1
12)	Lift transport cask and place on railcar	1	2	2	2	0	0	0	1	0	1	0	9	1
13)	Install impact limiters on transport cask	1	2	0	2	0	0	1	1	0	1	0	8	2
14)	Release railcar for shipment	1	0	0	0	1	2	1	0	2	0	2	9	1

* These categories are loaned to the Cask Handling Crew

In order to establish how large the crew sizes are, the table above needs to be used with the time motion studies presented in **Section A2-1.4**. Several of the shifts do not require a full complement of workers for the entire shift. The idled workers will be rotated back to the matrixed workforce for other assignments as necessary. Certain workers such as the supervisor, the Health Physics techs and the QA/QC inspectors are area workers in that they either stay with the SNF canister throughout the process or cover a certain area of the ISF, such as the CHB HP techs. The crane operators use radio remote controllers for the OTB cranes, the shielded transfer sleeve hoists and for jib cranes so that one person could, in fact, operate all of the cranes with the addition of a spotter or flagman (standard practice) in a certain area. The stick cranes used in the yard are controlled by a dedicated operator inside the control cab on the crane.

The results of this effort are summarized in **Table A2-6 through Table A2-8** below. This staffing estimate is approximate since not all crafts are required for an entire shift. Also, some intermediate steps do not require a certain craft, but in reality, they do not disappear. These interruptions are ignored because they provide opportunities for breaks for the workers and do not materially impact the assessment. The ISF labor pool will be a matrix structure where necessary craft and managers will be drawn from the site organization staff as necessary to achieve the desired operations. This is an obvious requirement because of the variability in the Cask Handling Crew size by shift in **Tables A2-6 through A2-8**. Based on this study, the site organization staff will need to be modified based on the variant of C-STD chosen. This results in a total ISF staff of 201 regardless of the variant of C-STD chosen.

Table A2-6
Cask Handling Crew Makeup for C-STDa (Vertical Standardized Overpacks)

C-STDa Craft	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5	Maximum*
Supervisor	5	5	5	5	5	5
Mechanics	8	8	8	8	8	8
Electricians	4	4	4	4	4	4
Riggers	12	12	12	12	12	12
HP	8	8	8	8	8	8
QA/QC	5	5	5	5	5	5
Crane Operator	3	3	3	3	3	3
Heavy Eq. Operator	2	2	2	2	2	2
Totals	47	47	47	47	47	47

* To the nearest whole person

Table A2-7
Cask Handling Crew Makeup for C-STDb (Horizontal Standardized Overpacks)

C-STDb Craft	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5	Maximum*
Supervisor	5	5	5	5	5	5
Mechanics	8	8	8	8	8	8
Electricians	4	4	4	4	4	4
Riggers	12	12	12	12	12	12
HP	8	8	8	8	8	8
QA/QC	5	5	5	5	5	5
Crane Operator	3	3	3	3	3	3
Heavy Eq. Operator	2	2	2	2	2	2
Totals	47	47	47	47	47	47

* To the nearest whole person

Table A2-8
Cask Handling Crew Makeup for C-STDc (Vertical and Horizontal Overpacks)

C-STDc Craft	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5	Average*
Supervisor	5	5	5	5	5	5
Mechanics	8	8	8	8	8	8
Electricians	4	4	4	4	4	4
Riggers	12	12	12	12	12	12
HP	8	8	8	8	8	8
QA/QC	5	5	5	5	5	5
Crane Operator	3	3	3	3	3	3
Heavy Eq. Operator	2	2	2	2	2	2
Totals	47	47	47	47	47	47

* To the nearest whole person

A2-2.4 Material Handling Flow Diagram

Figure A2-12 is a representation of the material handling flow for the base variant of the C-STD alternative for the ISF. It describes the four large material flows of the operation. The central flow is the movement of DPCs containing SNF to the site. But equally important to the operations of the ISF are the material flows necessary to support the production of the standardized overpacks for the vertical and for the horizontal DPCs.

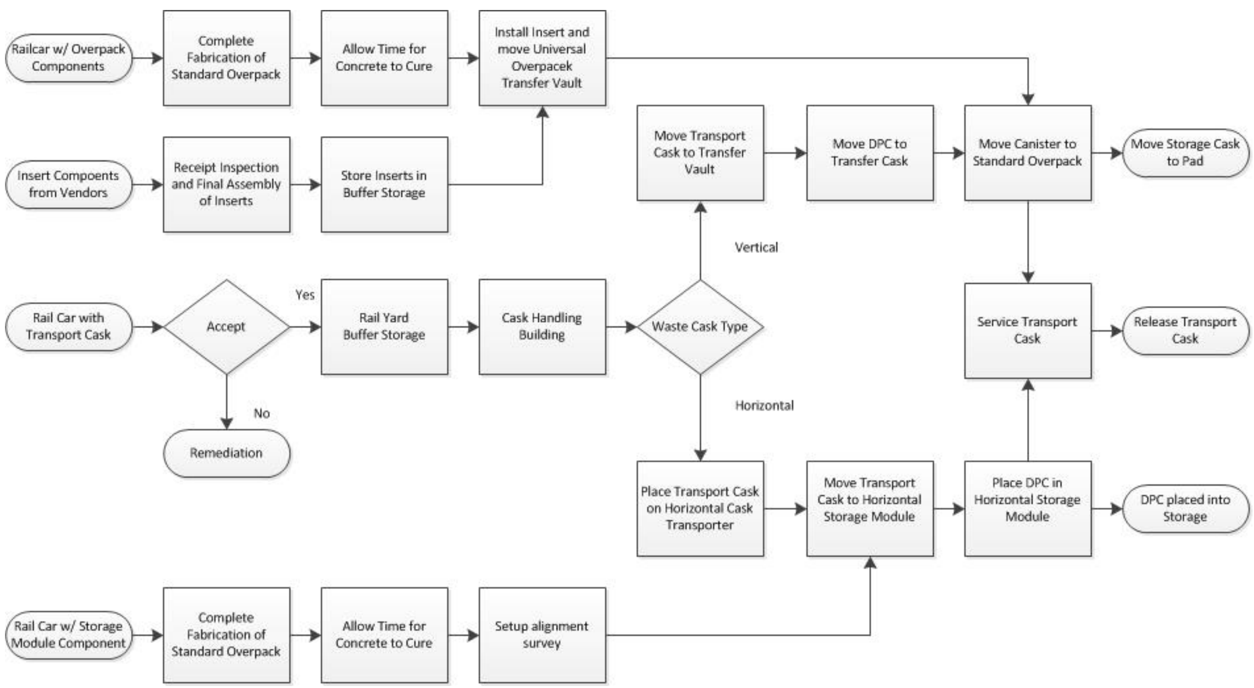
The standardized overpack components are prefabricated by vendors selected by the ISF staff and shipped to the site as steel structures packaged to protect them during transit. The site crew needs to accept these packages as undamaged and then complete the fabrication by placing concrete necessary meet the design specification.

In addition to the standardized overpacks, there is a major material flow of inserts/adaptors to accommodate the various sized DPCs into the overpacks. For vertical storage systems, the site fabrication crew needs to receipt inspect the inserts/adaptors from the original DPC vendors that are needed to ensure that the legacy DPC will be secured and thermally connected to the standardized overpack. These inserts/adaptors are custom designed by the original vendors and need to be carefully fitted into the standardized overpack in order to assure conformance with the licensing basis.

For horizontal storage systems, the site fabrication crew needs to customize the internals of the overpack to accommodate the expected version of the horizontal DPCs. These modules are larger and more complex construction packages than the vertical overpacks and take longer to construct and to align to ensure that the DPCs can be readily placed into storage. These overpacks contain multiple DPCs so the lead time issues are exacerbated. The horizontal overpack represents a fairly major construction effort. There are also the adaptor frames necessary to place vertical DPCs into a horizontal overpack.

The largest operations challenge for the C-STD alternative is controlling the supply chain to ensure that the proper storage system is available to match the DPC being received from the generator. The correct operation of the final DPC is based on the conformance of the storage system with the original licensed dry storage system. Since these DPCs will be stored in a new, standardized overpack, care must be taken to assure that tolerance stackup do not adversely impact the functional performance of the storage system. The insert/adaptors need to fit properly inside the overpack and they need to provide the proper contact with the DPC to ensure its performance.

Figure A2-12
Cask Handling Material Flow Diagram (Typical) [3]



The lead time for this combination of shipments could be six to twelve months. Therefore, up to a year ahead of the receipt of the SNF at the site, the supply chain manager needs to place an order for the necessary storage system components. This means that the ISF staff needs to know well in advance of delivery what vendor and what model (or combination thereof) of DPC system is needed. The coordination of the supply chain for the overpack fabrication and the SNF storage operations will be the largest management challenge for this design alternative.

A2-2.5 Operations

A2-2.5.1 Operational Sequence

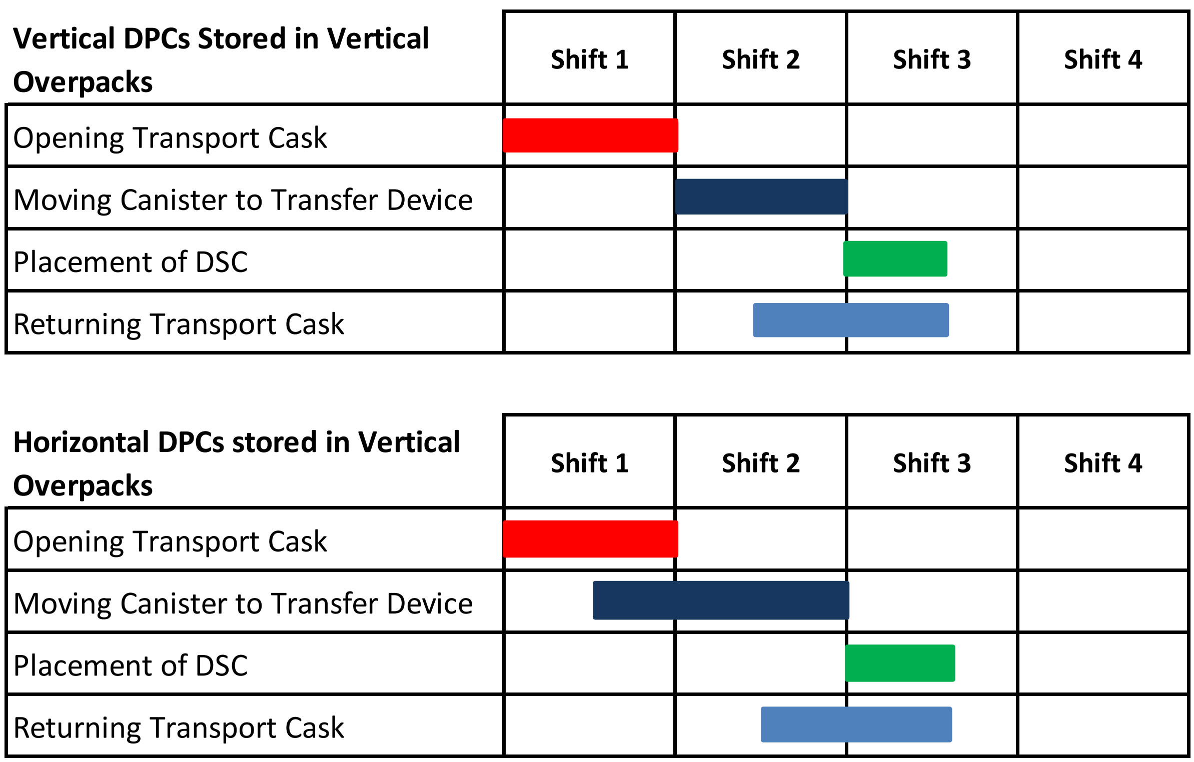
Cask handling operations are a series of heavy lifts and heavy equipment movements that move the SNF in sealed DPCs from the rail head to the storage pad. The operational sequence was benchmarked against ISFSI operations at operating U.S. nuclear plants. Although no one has actually performed all of the operations at an ISF, each operation has a precedent established in the nuclear industry. The crew sizes and the durations necessary to perform each activity therefore has basis. This benchmarking provides the underpinning supporting this operational sequence and the Time and Motion analysis the follows in **Section A2-2.6**.

[3] Remediation is not part of this study's work scope and is not addressed other than to note that the packages are not accepted on site regardless of their condition.

Figure A2-13 through Figure A2-15 show the high-level schedules for the three variants of the C-STD storage concept assuming 8-hour shifts. The operational sequence once the transport cask is accepted into the CHB can be divided into four large generic blocks:

1. Opening the transport cask
2. Moving the DPC into the Transfer device or system
3. Placement of the DPC in the storage overpack and
4. Preparing for the turnaround of the transport cask.

Figure A2-13
High-Level Operational Sequence - C-STDa (Vertical Storage Overpacks)



The C-STDa approach shown in **Figure A2-13** stores all legacy vertical and horizontal DPCs in vertical standardized overpacks. This simplifies the logistics of providing the overpacks and establishes some economies of scale, but it complicates the Operational Sequencing. Horizontal DPCs have no means of being lifted by the upper cover plate to be placed into the overpack. Moreover, if they are pushed into an overpack and upended, the fuel assemblies in the DPC are inverted and stored upside down. This study assumes a double transfer into a horizontal transfer sleeve. First, the transport cask is placed on a transfer fixture and docked with the transfer sleeve. A conventional ram similar to the ones used on the HCTs indexes with the Ram Grapple Ring on the bottom of the DPC and pushes into the Transfer Sleeve. A shield door on the

Transfer Sleeve is closed and the transfer cart is rolled via rails onto turn table that rotates the assembly 180°. It then docks with the storage overpack preloaded with a lifting frame that is loaded into an upender fixture. A different hydraulic ram pushes against a full diameter pressure plate within the transfer sleeve to push the DPC into the storage overpack. The overpack is upended and the overpack lid is installed. The overpack is then picked by the VCT and transported to the storage pad.

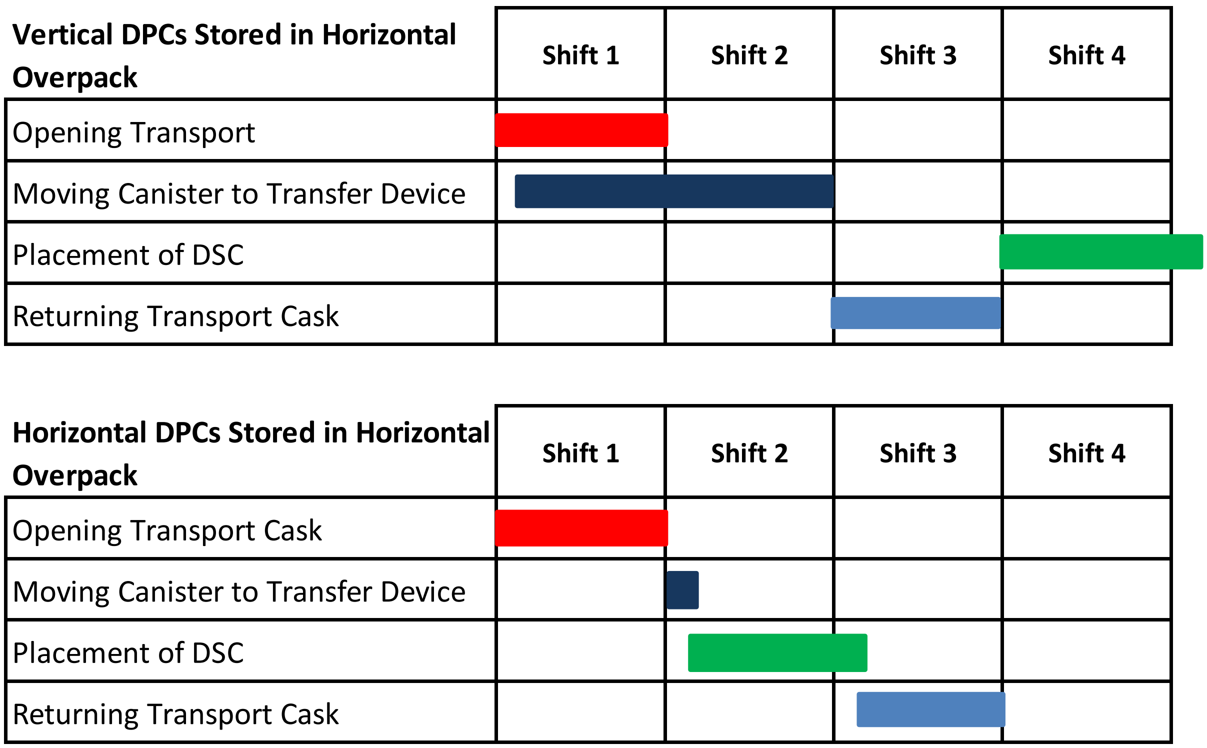
As can be seen in **Figure A2-13**, the sequence and cycle time for the two DPC types are essentially identical. Horizontal DPCs experience a slight, non-critical path penalty in the time needed to prepare the vertical overpack for horizontal insertion.

At the end of the storage period, the horizontal packages would be removed from the vertical overpacks by means of the lifting frame and the lift frame lifting device that indexes with the lifting lugs on the lift frames.

The second variation of the C-STD concept, called C-STDb, supposes that only horizontal storage overpacks are developed. This simplifies the logistics of providing the overpacks and establishes some economies of scale, but it complicates the Operational Sequencing. Vertical DPCs do not have the ram grapple ring on the bottom of the canister, so there is no means to push them into the horizontal overpack. Moreover, even if some means could be arranged to push them into the horizontal overpack, there would be no means extracting the canister from the overpack at some future date when the ultimate disposition of SNF is determined. Therefore, the vertical DPCs must be provided with a ram grapple ring on the bottom head in order to interface with the HCT ram.

This study postulates the insertion of the vertical DPC into an adaptor frame that has the ram grapple ring on the bottom. In order to accomplish this, it is necessary to preload the appropriate adaptor frame into a dedicated transfer cask. The adaptor frame must be designed to accommodate the dimensions and heat transfer requirements of the legacy vertical DPC and to be compatible with the horizontal overpack. The transfer cask with the preloaded adaptor frame is prepositioned in the receiving cell of the transfer cell system. The workers attach the lifting lug to the top of the vertical DPC and position it in the adjacent unloading cell of the transfer cell in the normal manner for vertical DPC transfers. The DPC is the grappled by the overhead shielded transfer sleeve hoist and lifted out of the transport cask. The transfer sleeve is repositioned over the receiving cell in the transfer cell and the DPC is lowered into the adaptor frame inside the transfer cask. The Cask Transfer Crew then removes the lifting lug from the DPC and secures the top to the adaptor frame. They then install the transfer cask lid and the transfer cask is lifted by the overhead crane and placed on the HCT that has been staged in the CHB. The rest of the sequence is exactly the same as a normal horizontal transfer albeit using the transfer cask rather than the transport cask.

Figure A2-14
High-Level Operational Sequence - C-STDb (Horizontal Storage Overpacks)

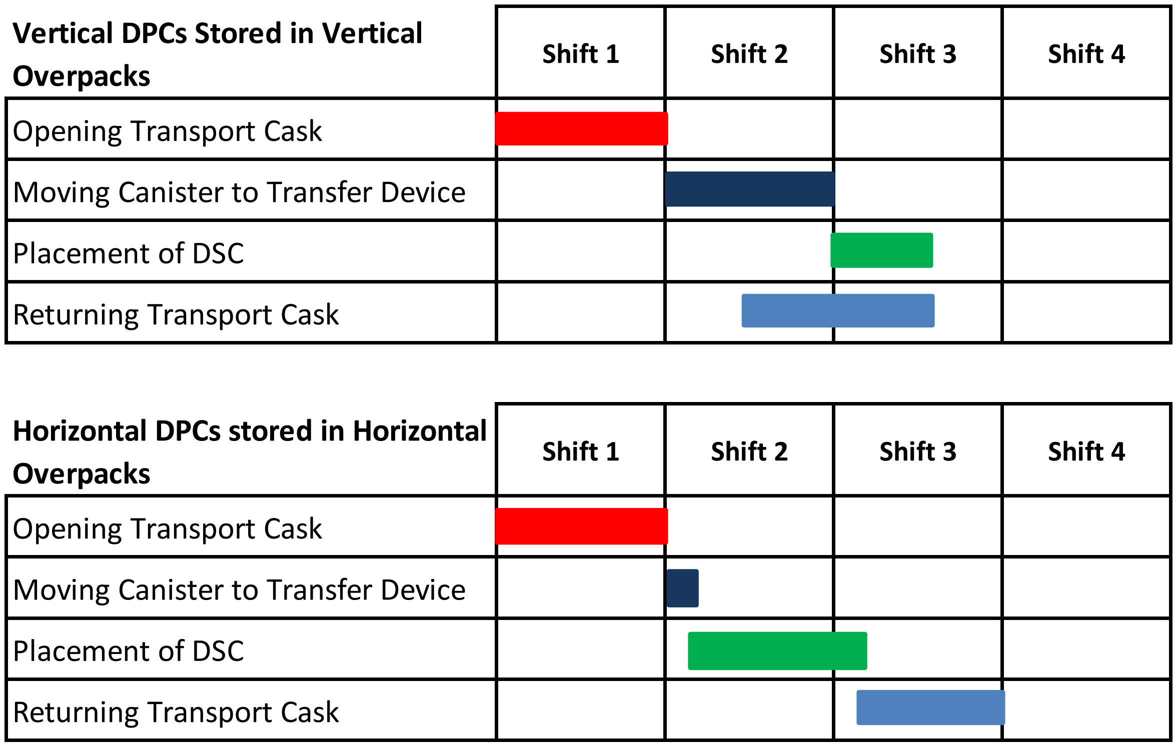


In the third variant of the C-STD concept, called C-STDc, standard overpacks would be developed for vertical and for horizontal DPCs. In this concept, the legacy DPCs would be stored in whichever overpack was consistent with the original design. This eliminates specialty lifting frames or horizontal frames since the original concepts would be retained. Adapter inserts would still be required, but only to correct for tolerances and to establish seismic restrains within the storage overpacks.

As can be seen in **Figure A2-15**, the operational impact is minimized by this approach. Once again, there are no significant differences between the operations required for each.

In addition to the major operational sequences described above, there is the necessary step of repackaging the empty transport cask onto the rolling stock for shipment back to a generator's site. The ability to maintain throughput requires that the transport casks are removed from the CHB as soon as practical in order to permit the processing of a new shipment. Moreover, the overall system cycle time is determined by how rapidly a transport cask can be returned to the generator to accept another DPC.

Figure A2-15
High-Level Operational Sequence - C-STDc (Vertical and Horizontal Storage Overpacks)



Once the transfer has been completed, the transport cask is returned to the railbay where it is surveyed and inspected for damage. Then the transport cask is mated with its original railcar and the shipping package is reassembled: tie-down straps are installed, the transport cask cover is secured and the impact limiters are reinstalled. This process takes about one shift to accomplish. The vertical storage systems have a slight timing advantage in that the transport cask is emptied earlier in the process and inside the CHB. So the transport cask is available for reassembly sooner than the horizontal transport cask. Horizontal systems move the loaded transport cask directly to the storage module on the pad and therefore the transport cask is available for reassembly on the railcar only after the DPC has been placed in the storage module.

A2-2.5.2 Limits to Operation

Railbay

C-STD Cask Handling Operations are a three shift process with the exception of vertical DPCs in variant C-STDb which is a four and a half shift process. In any case, two of the shifts take place in the railbay. Therefore, the railbay is central to ISF operation and its design limits the ISF throughput. If there were only one railbay that could accommodate only one railcar, the ISF could only process about ten DPCs every four weeks assuming shuffling of the railcars to maintain workflow. If the three shift process began on day one, the next shipment could only be brought into the CHB on day four. That would permit the placement of two DPCs the first week but the second week would only place one DPC because the first shift would be dedicated to turning around the transfer cask allowing one DPC to be placed by midweek and the introduction of a second new transport cask by the fifth shift. Also, any outage that occurs will prevent any movement of transport casks.

In the case of the processing of vertical DPC into the horizontal storage overpack in variant C-STDc, the movement of the transfer casks through the railbay takes only three shifts. So, even though the vertical DPC is not placed into the horizontal overpack until the fourth shift for this variant, the critical activity of turning around the transport cask is accomplished by the end of the third shift. Therefore, while there is more effort required to accomplish this, the ISF throughput is unchanged.

Adding a second railbay eliminates some of the congestion but only doubles the ISF throughput to an average of three DPCs per week. The reason for this is that the railbay crew in each bay would be idle while awaiting the transport cask to return to the railbay. That would result in a work pattern of one shift on, one shift off, followed by two shifts on, etc. So, a new transport cask can only be brought into the CHB after a complete cycle of the process. This forces outages in the process. The railbay crew would work the first day, but would be idle the second day.

If there is an inventory of loaded transport casks awaiting processing in the ISF railyard, this study assumes that the Railyard supervisor will work with the Railbay Crew to shuffle rolling stock so that there is always the correct railcar in the railbay for operations to be continuous and on-going. Of course, if there is only one car awaiting turnaround in the railyard, then the car will be brought into the railbay and three shifts later, it will be removed from the railbay. If, on the other hand, there are several railcars awaiting turnaround, the unloaded railcar will be removed (or repositioned) to allow the introduction of a new loaded railcar into the railbay. All of these activities are required to prevent the railbay from being a choke point for the operations of the ISF.

Overhead Traveling Bridge Cranes

The railbay requires a heavy lift crane to be available to maneuver the transport cask off of the railcar and onto the transfer cart or the HCT in the CHB. It also requires a crane to reverse this process and to replace the transport cask onto the railcar. Two overhead traveling bridge (OTB) cranes were selected for the conceptual CHB model. One OTB crane assigned per railbay ensures that the Railbay Crews can operate unimpeded by outages waiting for the crane. In order to keep the height of the building reasonable, both OTB cranes would operate on the same rails enabling either crane to service either railbay. Obviously, a failure or outage of either of the

OTB cranes would seriously impact the throughput of the ISF but this expedient permits some functionality in the event of an extended crane outage.

The availability of the OTB cranes is the most limiting component to overall ISF throughput. Because the activities necessary to disassemble and to reassemble the shipping package for the transport cask, only one transport cask can be worked on at a time. This limits the ISF throughput to five DPCs placed into storage per week. Even if the railbays could support multiple railcars under the OTB crane, the throughput is limited by the crane availability.

Canister Transfer Cells

The vertical storage system transfers require canister transfer cells to provide shielding and to simplify operations during the transfer of the DPCs from the transport cask into the vertical storage overpacks. Each canister transfer cell consist of a door to allow a transport cask on a transfer cart to enter and exit the cell and a door on the opposite side to allow a storage overpack on a transfer cart to enter and exit the cell. On the floor above the cells is a shielded transfer sleeve cell which can retrieve DPCs from and dispense DPCs to the cell below. In the ceiling above the transport cask or storage overpack positions, a transfer port allows the DPC to be passed between the lower and upper cells. Since it takes a shift to make the DPC transfer from the transport cask to the storage overpack, the CHB needs a minimum of two of these cells to achieve the minimum desired throughput of DPC transfers. This is especially true if the ISF is processing only vertical storage DPCs. The transfer carts and the shielded transfer sleeve above the transfer cells are all required to operate flawlessly during the active shift to maintain ISF throughput. The actual CHB design in this study has additional cells in case of equipment failures or as potential storage areas for DPC with failures. These cells are not required for horizontal DPCs but there are no variants of this alternative that can function without them.

Transporters

Both vertical cask transporters (VCTs) and horizontal cask transporters (HCTs) are very complex, heavy haul machines. They move slowly at approximately 1 mph and take a long time to move their loads to the storage locations. It takes one and a half shifts from being loaded in the CHB until a transporter returns ready for a second load. If there is a need to process all vertical DPCs for period of time, then there is a need for four VCTs in order not to cause a bottleneck: one VCT to service each railbay, and one VCT to preposition storage overpacks. In addition, one of two spare VCTs are likely to be required to permit routine maintenance of the complex machinery to ensure continued throughput.

HCTs are central to the operation of horizontal DPC transfer operations. HCTs are more complex than VCTs because they include positioning hydraulics to align the transport cask to the horizontal storage module and a hydraulic ram that pushes or pulls the DPC in or out of the module. Any failure of the HCTs immediately impacts the placement of horizontal DPCs and the throughput of the ISF. The HCT is used for more than one and a half shifts. If the site is processing nothing but horizontal DPCs for a period of time, there would be a need for four HCTs to maintain the ISF throughput. Once again, there may be the need for one or two spare HCTs to ensure that maintenance outages do not impact the ISF throughput.

The C-STDa variant of this alternative would require four VCTs plus spares while the C-STDb variant would require four HCTs plus spares. C-STDc would need four VCTs and four HCTs plus spares to maintain throughput when an either all horizontal or all vertical legacy site's DPCs were being processed.

A2-2.6 Time and Motion Analysis

A2-2.6.1 Methodology

No one has operated a national scale ISF for the dry storage of SNF. In addition, no one has operated an ISF with standardized overpacks for legacy DPCs to be repackaged. For this study, a high-level operational sequence was developed by the concept designers. These high-level activities were then decomposed down to their constituent activities. At this level, the activities were generally ones that had been performed by operators at existing nuclear facilities, or that could be estimated by small extrapolations of existing operational experience. Interviews were conducted with several individuals with real, hands-on operational experience with moving SNF to achieve a consensus on the completeness, the durations and the staff size necessary to achieve each of these constituent activities. These were then pieced together to develop a bottom up estimate of durations and crew sizes for each step.

Additional steps were added to recognize the standard industry practice of having a "Plan of the Day" meeting and a safety meeting at the start of each shift. Also, steps such as HP surveys of the emptied transport casks, and utilizing seismic restraints to packages containing SNF at the end of a shift were added to allow time for these necessary steps.

Once the operational sequence was developed, the sequences were considered in parallel to determine how many DPCs could be placed per week. Several basic assumptions were made. The first was that a continual (i.e. steady) supply of transport casks on railcars was staged on the site ready for processing. If the ISF railyard is empty or contains only two railcars during a week, this time and motion study does not apply. The two railcars will be processed and the Cask Handling Crews will be given other duties to fill up the week. So, the first inherent assumption is that the logistics supply chain is adequate to fully support the capacity of the ISF. Secondly, this study only considers operations that are already developed and in operation at existing operating nuclear plant experience. No unusual enhancements were considered. The only exception is that the vertical DPC transfers were made in canister transfer cells rather than in a cask transfer facility on the pad as is the case at some nuclear plants. So, the CHB eliminated the steps routinely applied to vertical stack-ups with a simplified approach that is essentially the same. However, C-STD did not consider automating the transfer or adding a great deal of remote sensors to the area to eliminate personnel exposures. (See A-OPS for these improvements)

The variants that required the storage of horizontal DPCs in vertical overpacks or vertical DPCs in horizontal overpacks required additional considerations. The transfer of horizontal DPCs into vertical overpacks required the development of a universal overapack that could be loaded in the horizontal orientation. It also required the development of a transfer rack that would upend the overpack and index it into position with a transfer collar the mated with the transport cask. A ram mechanism would be necessary to push the horizontal DPC into the vertical overpack while in the horizontal position. The transfer of vertical DPCs into a horizontal overpack is more complex in detail but essentially similar. The vertical DPC is transferred in an adaptor frame that provides the missing ram grapple ring on the bottom of the DPC/frame combined structure. This permits the vertical DPC to be pushed into and eventually retrieved from the horizontal overpack. While these represent novel approaches to DPC handling, they do not represent major technological developments or departures from common practice.

A major consideration for the Time and Motion Analysis was that no operation involving the movement of a DPC would be started during a shift if it could not be completed by the end of that shift. This is necessary because the CHB does not operate continuously, so no load would be left suspended or in some other intermediate condition during a design basis event. Abandoning the DPC in mid-operation is not consistent with industry best (acceptable) practice without qualified canister handling expertise on hand in case of abnormal operations. In addition, the DPC was assumed to be secured seismically at the end of each shift.

As stated earlier, this study considers only a single 8-hour shift per week with no overtime. Clearly, the throughput could easily be increased by adding workers and shifts, and indeed that would be a cost effective expedient if additional capacity is desired. However, a working assumption of this study is only a single, 40-hour shift is necessary per week. Based on the certain problems with the logistics of moving SNF to the site, it is considered that this is a reasonable approach.

A2-2.6.2 Conclusion

It was determined that the C-STD throughput with all of the assumptions is at best 5 full-sized DPCs placed into storage each week. Several observations came out of the Time and Motion Analysis. First, the CHB requires two railbays with the ability to shuffle railcars into and out of the railbay daily. This is necessary to get the throughput because it takes an entire shift to open a shipment and an entire shift to repackage a transport cask for reshipment. In between these two evolutions, there is an entire shift where the railbays are idle unless a new shipment is moved in for processing. This way, the shipments are processed through the facility in a staggered manner in order to assure continuous operation.

Second, with the CHB having two railbays, it is the OTB cranes that determine the maximum throughput of the CHB. Two overhead traveling bridge cranes service the railbays; one for each railbay. These cranes are both on the same rails to reduce overhead space, but they typically operate in a dedicated railbay only. If one of the cranes becomes unavailable for any reason, it is moved into a maintenance position and the remaining crane can be used to maintain operations, albeit at a reduced throughput forced by the lack of crane availability.

Third, there needs to be four horizontal and four vertical cask transporters operational on site to develop and maintain full ISF throughput since their size and mass limit their speed when loaded. Their speed is limited when carrying DPCs in order to limit the potential impact to the DPC should there be a mechanical malfunction. The transporters become critical path if any one of them is out of service. In addition, they are currently designed for a limited amount of duty. The ISF would use these machines far more than their design. This could force a great deal of maintenance to keep them available. One or two spares (included in the four transporters) are considered necessary for the long-term functionality of the ISF.

Fourth, the use of the standardized overpacks for the storage of SNF adds several additional operations to the ISF and may actually cost more than procuring more traditional overpacks from the original vendors. Indeed, the overpacks would need to be large enough to accommodate the largest of all of the commercial DPCs so they would, in general, be larger and more expensive than the legacy storage overpacks. This coupled with the need to provide inserts/adaptors to ensure the protection of the confinement barrier and heat transfer capability of the original storage system, could well increase rather than decrease the cost of the overall system.

Table A2-9 through Table A2-11 below shows the schedules for the C-STD alternatives. The X-axis columns indicate the hour duration and show what can be accomplished in an eight hour shift. The activities on the Y-axis are the steps necessary to process the DPCs from when they enter the Cask Handling Building until the empty transport cask has been reinstalled on the railcar and removed from the CHB. The time across the top of the schedule is in hours. The red bars are critical path activities; the blue are near critical path activities. It has been assumed that it will take 24-hours of observations of the DPC once stored to accept the package. This activity is show as a green dashed line on this chart but is not really part of the cask handling crew's scope. It is the hand-off to ISF Operations for long-term surveillance and safeguards. It will consist of a series of temperature, air flow and radiation measurements over the initial 24-hour period to validate that the expected performance has been achieved.

The schedules in **Table A2-9 through Table A2-11** were then placed in series and in parallel to establish the maximum throughput of the ISF. Separate time motion study scenarios were considered for each variant but the results were all very similar. **Figure A2-16** shows the typical results for most of the variants. **Figure A2-17** shows the results for the vertical DPC into a horizontal overpack in variant C-STDc. In spite of some detailed differences, all C-STD cases result in a consistent ability to process 20 DPCs every four weeks, for an average of 5 DPCs per week. Since canisters contain about 11.1 MTU each, that is equivalent approximately 2,900 MTU per year, assuming no outages.

Note that the **Table A2-9 through A2-11** below assumes the same train would be used to carry spent fuel casks in and empty overpacks out.

Table A2-9 - Time Motion Schedules (Single DPC Operation Shown) for C-STDa, Vertical and Horizontal DPCs Stored in Vertical Standardized Overpacks

Vertical DPCs - DPCs in vertical overpacks on pad		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0)	Plan of the Day and Safety Meeting																														
1)	Receive transport cask on railcar at Cask Handling Building																														
2)	Remove impact limiters and place in temporary storage																														
3)	Upend and lift transport cask off of railcar and place on unloading cell transfer cart																														
3a)	Replace empty railcar																														
4)	Unbolt and remove transport cask lid using jib crane																														
4a)	Secure Transport cask and transfer cart seismically																														
4b)	Plan of the Day and Safety Meeting																														
5)	Attach lifting lug to top of DPC																														
6)	Position transport cask transfer cart in unloading cell and close shield doors																														
7)	Stage empty universal overpack in receiving cell using VCT																														
8)	Unbolt empty universal overpack lid and hoist on VCT																														
9)	Retract VCT from receiving cell and close shield doors																														
10)	Position shielded transfer sleeve cart over unloading cell																														
11)	Lower shield sleeve hoist and grapple DPC lifting lug																														
12)	Raise DPC into shield sleeve																														
13)	Position shielded transfer sleeve cart over universal overpack in receiving cell																														
14)	Lower DPC into empty universal overpack, release grapple, and retract hoist																														
15)	Open receiving cell shield doors and position VCT at universal overpack																														
16)	Remove lifting lug from DPC																														
17)	Install universal overpack lid																														
17a)	Secure Seismic restraints																														
17b)	Plan of the Day and Safety Meeting																														
18)	Pick up universal overpack and transfer to pad using VCT																														
18a)	Turnover to Operations																														
19)	Return VCT to CHB																														
20)	Open unloading cell shield doors and position transfer cart under jib crane																														
21)	Install transport cask lid																														
22)	Lift transport cask and transfer to maintenance																														
22a)	Survey and Wipedown Transport Cask																														
22b)	Reposition Empty Railcar to Railbay																														
23)	Lift transport cask and place on railcar																														
24)	Install impact limiters on transport cask																														
25)	Release railcar for shipment																														

Table A2-9 - Time Motion Schedules (Single DPC Operation Shown) for C-STDa, Vertical and Horizontal DPCs Stored in Vertical Standardized Overpacks (cont.)

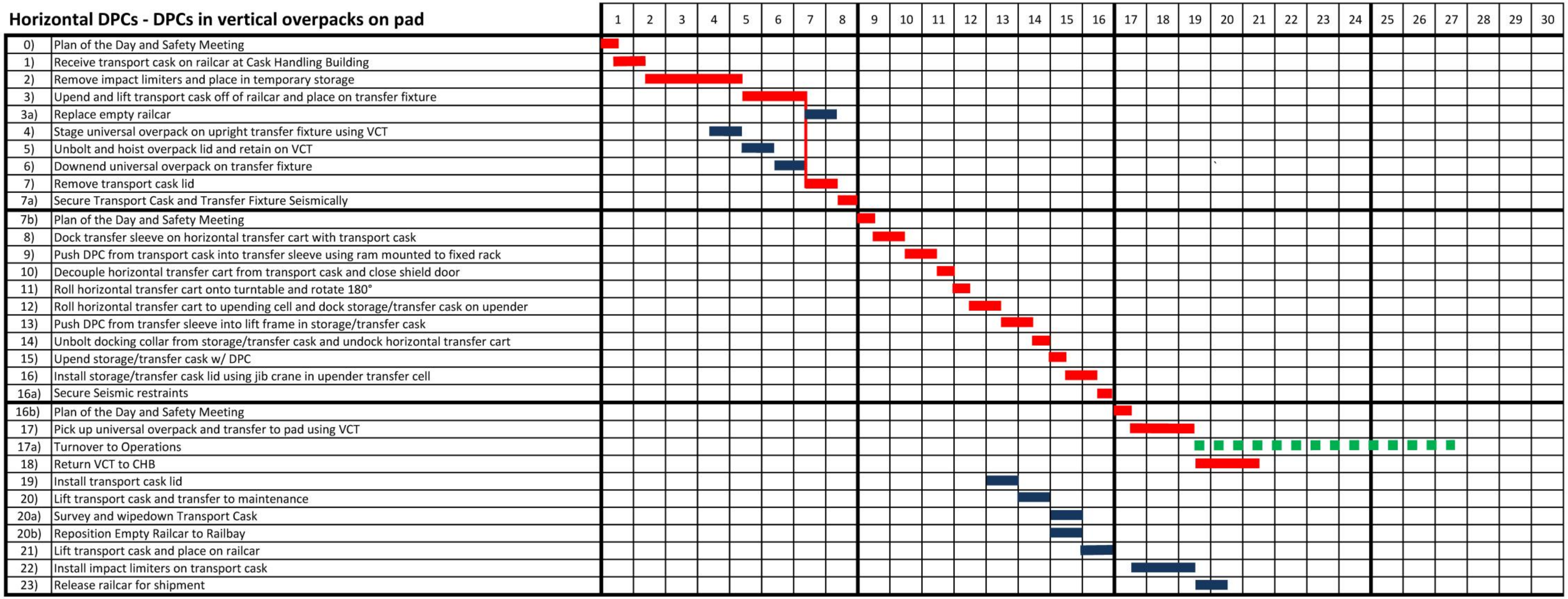


Table A2-10 - Time Motion Schedules (Single DPC Operation Shown) for C-STDb, Vertical DPCs Stored in Horizontal Standardized Overpacks and Horizontal DPCs Stored in Horizontal Standardized Overpacks

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Vertical DPCs - DPCs in horizontal overpacks on pad	
0)	Plan of the Day and Safety Meeting
1)	Receive transport cask on railcar at Cask Handling Building
2)	Remove impact limiters and place in temporary storage
3)	Upend and lift transport cask off of railcar and place on unloading cell transfer cart
3a)	Remove railcar from Railbay
4)	Unbolt and remove transport cask lid using jib crane
5)	Receive adaptor frame from Overpack Fabrication yard
6)	Unpack and inspect adaptor frame
7)	Pick Transfer Cask off HCT and place on receiving transfer cart with OTB crane
8)	Remove Transfer Cask lid with OTB crane
9)	Install adaptor frame into Transfer Cask with OTB crane
10)	Position transfer cask transfer cart in receiving cell and close shield doors
10a)	Secure Transport cask and transfer cart seismically
10b)	Plan of the Day and Safety Meeting
11)	Attach lifting lug to top of DPC using jib crane
12)	Position transport cask transfer cart in unloading cell and close shield doors
13)	Position shielded transfer sleeve cart over unloading cell
14)	Lower shield sleeve hoist and grapple DPC lifting lug
15)	Raise DPC into shielded transfer sleeve
16)	Position shielded transfer sleeve cart over transfer cask in receiving cell
17)	Lower DPC into adaptor frame in transfer cask, release grapple, and retract hoist
18)	Open receiving cell shield doors and position transfer cask under jib crane
19)	Remove lifting lug from DPC
20)	Install adaptor frame lid
20a)	Secure Seismic restraints
20b)	Plan of the Day and Safety Meeting
21)	Install Transfer Cask lid
22)	Pick Transfer Cask with OTB crane and place on HCT
23)	Open unloading cell shield doors and position transport cart under jib crane
24)	Install transport cask lid
25)	Lift transport cask and transfer to maintenance
25a)	Survey and wipedown Transport Cask
25b)	Reposition Empty Railcar to Railbay
26)	Lift transport cask and place on railcar
27)	Install impact limiters on transport cask
28)	Release railcar for shipment
28a)	Plan of the Day and Safety Meeting
29)	Move transfer cask to the pad using HCT
30)	Preparation of Module
31)	Remove transfer cask lid
32)	Dock HCT with HSM and push DPC into module
33)	Install HSM port cover (Plus Seismic Restraints)
33a)	Turnover to Operations
34)	Install transfer cask lid
35)	Return transfer cask to Cask Handling Building via HCT

Table A2-10 - Time Motion Schedules (Single DPC Operation Shown) for C-STDb, Vertical DPCs Stored in Horizontal Standardized Overpacks and Horizontal DPCs Stored in Horizontal Standardized Overpacks (cont.)

Horizontal DPCs - DPCs in Horizontal Overpacks on pad	
0)	Plan of the Day and Safety Meeting
1)	Receive transport cask on railcar at Cask Handling Building
2)	Remove impact limiters and place in temporary storage
3)	Stage Horizontal Cask Transporter in truck bay
4)	Upend and lift transport cask off of railcar and downend on HCT
4a)	Replace empty railcar
4b)	Secure Transport Cask and HCT seismically
4c)	Plan of the Day and Safety Meeting
5)	Transfer transport cask to Horizontal Storage Module on pad via HCT
5a)	Preparation of Storage Module
6)	Remove transport cask lid
7)	Dock HCT with HSM and push DPC into module
8)	Install HSM port cover (Plus Seismic Restraints)
9)	Install transport cask lid
9a)	Turnover to Operations
10)	Return transport cask to Cask Handling Building via HCT
10a)	Plan of the Day and Safety Meeting
11)	Lift transport cask and transfer to maintenance
11a)	Survey and wipedown Transport Cask
11b)	Reposition Empty Railcar to Railbay
12)	Lift transport cask and place on railcar
13)	Install impact limiters on transport cask
14)	Release railcar for shipment

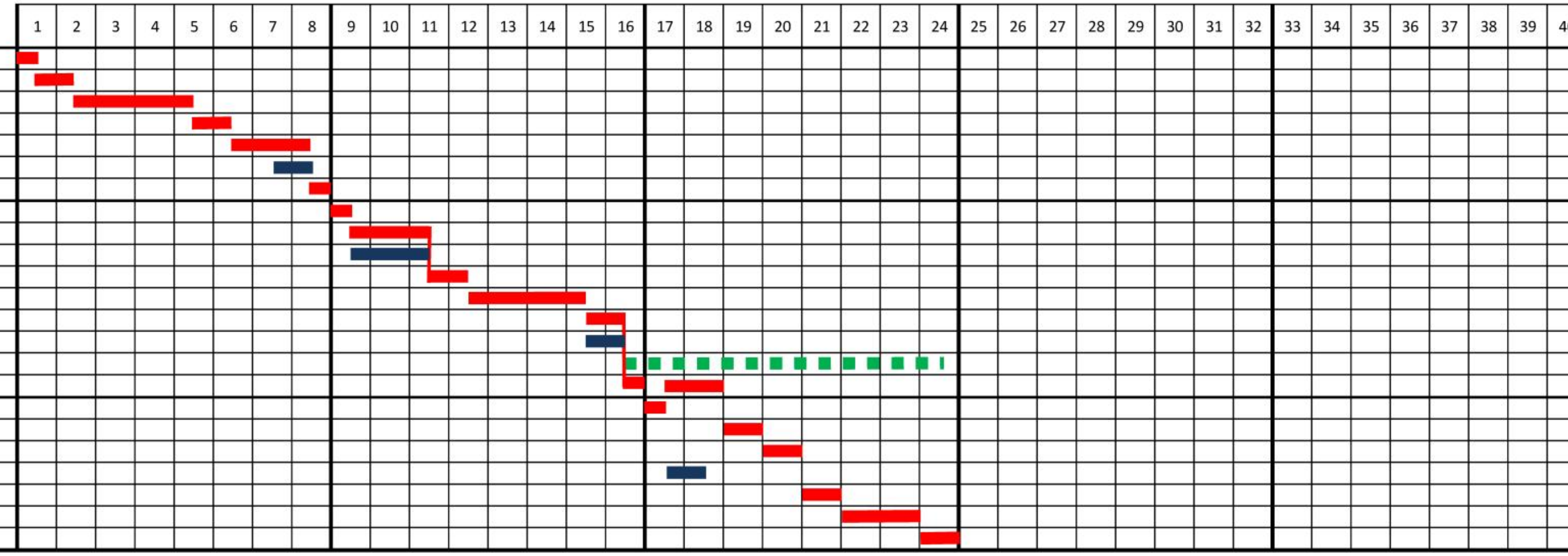


Table A2-11 - Time Motion Schedules (Single DPC Operation Shown) for C-STDc, Vertical DPCs Stored in Vertical Standardized Overpacks and Horizontal DPCs Stored in Horizontal Standardized Overpacks

Vertical DPCs - DPCs in Universal Vertical Overpacks on pad		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0)	Plan of the Day and Safety Meeting																														
1)	Receive transport cask on railcar at Cask Handling Building																														
2)	Remove impact limiters and place in temporary storage																														
3)	Upend and lift transport cask off of railcar and place on unloading cell transfer cart																														
3a)	Replace empty railcar																														
4)	Unbolt and remove transport cask lid using jib crane																														
4a)	Secure Transport cask and transfer cart seismically																														
4b)	Plan of the Day and Safety Meeting																														
5)	Attach lifting lug to top of DPC																														
6)	Position transport cask transfer cart in unloading cell and close shield doors																														
7)	Stage empty universal overpack in receiving cell using VCT																														
8)	Unbolt empty universal overpack lid and hoist on VCT																														
9)	Retract VCT from receiving cell and close shield doors																														
10)	Position shielded transfer sleeve cart over unloading cell																														
11)	Lower shield sleeve hoist and grapple DPC lifting lug																														
12)	Raise DPC into shield sleeve																														
13)	Position shielded transfer sleeve cart over universal overpack in receiving cell																														
14)	Lower DPC into empty universal overpack, release grapple, and retract hoist																														
15)	Open receiving cell shield doors and position VCT at universal overpack																														
16)	Remove lifting lug from DPC																														
17)	Install universal overpack lid																														
17a)	Secure Seismic restraints																														
17b)	Plan of the Day and Safety Meeting																														
18)	Pick up universal overpack and transfer to pad using VCT																														
18a)	Turnover to Operations																														
19)	Return VCT to CHB																														
20)	Open unloading cell shield doors and position transfer cart under jib crane																														
21)	Install transport cask lid																														
22)	Lift transport cask and transfer to maintenance																														
22a)	Survey and Wipedown Transport Cask																														
22b)	Reposition Empty Railcar to Railbay																														
23)	Lift transport cask and place on railcar																														
24)	Install impact limiters on transport cask																														
25)	Release railcar for shipment																														

Table A2-11 - Time Motion Schedules (Single DPC Operation Shown) for C-STDc, Vertical DPCs Stored in Vertical Standardized Overpacks and Horizontal DPCs Stored in Horizontal Standardized Overpacks (cont.)

Horizontal DPCs - DPCs in Universal Horizontal Overpacks on pad		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
0)	Plan of the Day and Safety Meeting																														
1)	Receive transport cask on railcar at Cask Handling Building																														
2)	Remove impact limiters and place in temporary storage																														
3)	Stage Horizontal Cask Transporter in truck bay																														
4)	Upend and lift transport cask off of railcar and downend on HCT																														
4a)	Replace empty railcar																														
4b)	Secure Transport Cask and HCT seismically																														
4c)	Plan of the Day and Safety Meeting																														
5)	Transfer transport cask to Horizontal Storage Module on pad via HCT																														
5a)	Preparation of Module																														
6)	Remove transport cask lid																														
7)	Dock HCT with HSM and push DPC into module																														
8)	Install HSM port cover (Plus Seismic Restraints)																														
9)	Install transport cask lid																														
9a)	Turnover to Operations																														
10)	Return transport cask to Cask Handling Building via HCT																														
10a)	Plan of the Day and Safety Meeting																														
11)	Lift transport cask and transfer to maintenance																														
11a)	Survey and wipedown Transport Cask																														
11b)	Reposition Empty Railcar to Railbay																														
12)	Lift transport cask and place on railcar																														
13)	Install impact limiters on transport cask																														
14)	Release railcar for shipment																														

Figure A2-16
Typical Work Plan for C-STDa, Vertical or Horizontal Cask Handling into Vertical Standardized Overpack

	Week 1					Week 2					Week 3					Week 4				
	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5
Railbay #1	Transport Cask #1 Unload	DPC #1 Transfer to Pad	Transport Cask #1 Reload		Transport Cask #5 Unload	DPC #5 Transfer to Pad	Transport Cask #5 Reload		Transport Cask #9 Unload	DPC #9 Transfer to Pad	Transport Cask #9 Reload		Transport Cask #13 Unload	DPC #13 Transfer to Pad	Transport Cask #13 Reload		Transport Cask #17 Unload	DPC #17 Transfer to Pad	Transport Cask #17 Reload	
Railbay #1		Transport Cask #2 Unload	DPC #2 Transfer to Pad	Transport Cask #2 Reload		Transport Cask #6 Unload	DPC #6 Transfer to Pad	Transport Cask #6 Reload		Transport Cask #10 Unload	DPC #10 Transfer to Pad	Transport Cask #10 Reload		Transport Cask #14 Unload	DPC #14 Transfer to Pad	Transport Cask #14 Reload		Transport Cask #18 Unload	DPC #18 Transfer to Pad	Transport Cask #18 Reload
Railbay #2	Transport Cask #19 Reload		Transport Cask #3 Unload	DPC #3 Transfer to Pad	Transport Cask #3 Reload		Transport Cask #7 Unload	DPC #7 Transfer to Pad	Transport Cask #7 Reload		Transport Cask #11 Unload	DPC #11 Transfer to Pad	Transport Cask #11 Reload		Transport Cask #15 Unload	DPC #15 Transfer to Pad	Transport Cask #15 Reload		Transport Cask #19 Unload	DPC #19 Transfer to Pad
Railbay #2	DPC #20 Transfer to Pad	Transport Cask #20 Reload		Transport Cask #4 Unload	DPC #4 Transfer to Pad	Transport Cask #4 Reload		Transport Cask #8 Unload	DPC #8 Transfer to Pad	Transport Cask #8 Reload		Transport Cask #12 Unload	DPC #12 Transfer to Pad	Transport Cask #12 Reload		Transport Cask #16 Unload	DPC #16 Transfer to Pad	Transport Cask #16 Reload		Transport Cask #20 Unload

NOTES:

1. The highlighted boxes show the critical path activity in the railbays. Note that work is always on going in the railbays.
2. The railcars are removed after the work crews are done with them and replaced by the next railcar to be processed.
3. The cycle is three shifts plus an idle shift to allow for processing two railcars at once. So, the cycle is four shifts long.
4. This process is the same for all C-STD options, i.e., all vertical, all horizontal or a mix.
5. The ISF can process 20 DPCs in four weeks; averaging 5 a week.

Figure A2-17

Typical Work Plan for C-STDb, Vertical Cask Handling into Horizontal Standardized Overpack

	Week 1					Week 2					Week 3					Week 4				
	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5	Shift 1	Shift 2	Shift 3	Shift 4	Shift 5
Railbay #1	Transport Cask #1 Unload	DPC #1 into Transfer Cask	Transport Cask #1 Reload	DPC #1 Transfer to Pad	Transport Cask #5 Unload	DPC #5 into Transfer Cask	Transport Cask #5 Reload	DPC #5 Transfer to Pad	Transport Cask #9 Unload	DPC #9 into Transfer Cask	Transport Cask #9 Reload	DPC #9 Transfer to Pad	Transport Cask #13 Unload	DPC #13 into Transfer Cask	Transport Cask #13 Reload	DPC #13 Transfer to Pad	Transport Cask #17 Unload	DPC #17 into Transfer Cask	Transport Cask #17 Reload	DPC #17 Transfer to Pad
Railbay #1	DPC #18Transfer to Pad	Transport Cask #2 Unload	DPC #2 into Transfer Cask	Transport Cask #2 Reload	DPC #2 Transfer to Pad	Transport Cask #6 Unload	DPC #6 into Transfer Cask	Transport Cask #6 Reload	DPC #6 Transfer to Pad	Transport Cask #10 Unload	DPC #10 into Transfer Cask	Transport Cask #10 Reload	DPC #10 Transfer to Pad	Transport Cask #14 Unload	DPC #14 into Transfer Cask	Transport Cask #14 Reload	DPC #14 Transfer to Pad	Transport Cask #18 Unload	DPC #18 Transfer to Pad	Transport Cask #18 Reload
Railbay #2	Transport Cask #19 Reload	DPC #19 Transfer to Pad	Transport Cask #3 Unload	DPC #3 into Transfer Cask	Transport Cask #3 Reload	DPC #3 Transfer to Pad	Transport Cask #7 Unload	DPC #7 into Transfer Cask	Transport Cask #7 Reload	DPC #7 Transfer to Pad	Transport Cask #11 Unload	DPC #11 into Transfer Cask	Transport Cask #11 Reload	DPC #11 Transfer to Pad	Transport Cask #15 Unload	DPC #15 into Transfer Cask	Transport Cask #15 Reload	DPC #15 Transfer to Pad	Transport Cask #19 Unload	DPC #19 into Transfer Cask
Railbay #2	DPC #20 into Transfer Cask	Transport Cask #20 Reload	DPC #20 Transfer to Pad	Transport Cask #4 Unload	DPC #4 into Transfer Cask	Transport Cask #4 Reload	DPC #4 Transfer to Pad	Transport Cask #8 Unload	DPC #8 into Transfer Cask	Transport Cask #8 Reload	DPC #8 Transfer to Pad	Transport Cask #12 Unload	DPC #12 into Transfer Cask	Transport Cask #12 Reload	DPC #12 Transfer to Pad	Transport Cask #16 Unload	DPC #16 into Transfer Cask	Transport Cask #16 Reload	DPC #16 Transfer to Pad	Transport Cask #19 Unload

NOTES*:*

1. The highlighted boxes show the critical path activity in the Railbays. Note that work is always on going in the railbays.
2. The railcars are removed after the work crews are done with them and replaced by the next railcar to be processed.
3. The loading of the DPC into the adaptor frame takes a more than a full shift to complete. There is not enough time remaining in the third shift to place the DPC in the overpack. The cycle is four shifts to complete.
4. The ISF can process 20 DPCs in four weeks; averaging 5 a week after the first week.

A2-3.0 Pilot ISF Construction

The Pilot ISF will consist of a number of features and structures that will need to be constructed for the facility to operate. They include:

- ISF Site (with access road and utilities)
- Railroad spur and yard
- Storage area
- Cask Handling Building
- Protected Area (security boundary, cameras, intrusion detection and lighting)
- Overpack fabrication area
- Concrete batch plant
- Administration building
- Security/access control building
- Warehouse/maintenance facilities

A2-3.1 ISF Site

The Pilot ISF site is assumed to be placed on approximately one square mile of property. Not all of the land will require construction, only the area for the initial storage area. An access road and electrical utilities will need to be constructed into the property. The site access road will consist of an asphalt paved 2 lane road from the nearest highway into the ISF. The location of the site will determine if mechanical utilities (domestic water, wastewater, natural gas) can be supplied from local means or if these will need to be self-contained. A remote site requiring self-contained utilities can use water wells or trucked-in tanks of water depending on the underground water capability. Wastewater can be discharged through drain fields. Propane gas can be supplied if no natural gas lines are near the site.

The site will require an Owner Controlled Area (OCA) fence which will likely consist of a chain link fence to discourage trespassers from entering the site and keep animals out. The fence requires minimal construction and establishes a good facility boundary. Just inside the fence a gravel security road can be constructed to enable guard patrols around the site.

The purpose of the OCA is to establish the portion of the property that maintains a level of secured control. Within this boundary, security maintains control and patrols for unauthorized individuals. In addition, 10 CFR 72.106 requires that all SNF storage and handling operations be maintained at least 100 meters from the OCA boundary. All CSF functions are contained within this boundary.

A2-3.2 Railroad Spur and Yard

The Pilot ISF will need railroad tracks from the mainline to receive incoming train consists and prepare for outgoing train consists. A rail portal at the Protected Area boundary and a rail yard near the storage area will also be required.

The purpose for the rail yard is to provide adequate railcar storage for incoming and outgoing SNF train consists, and access to the CHB. The rail yard must be designed to allow flexibility for maneuvering yard switchers, railcars, buffer cars, and escort cars.

It is assumed that the rail yard will consist of at least 4 tracks – 2 tracks to receive inbound trains and 2 tracks for staging outbound trains. The yard includes a runaround track to permit the yard switchers access around the tracks. The yard also includes a lead line and a spur off the lead line accessing the Cask Handling Building (see **Figure A2-10** above).

Construction of the rail yards will involve excavation, structural fill, potential geotextile materials to maintain soil stability, gradation to establish various elevations to ease railcar movements, heavy steel rail, ties, several rail turnouts, ballast placement, lighting, and other minor railroad related features.

A2-3.3 Storage Area

For the C-STD storage alternative, the storage area will consist of reinforced concrete storage pads to support all of the standardized overpacks whether vertical storage overpacks, horizontal storage modules or both that house all the DPCs. The storage pads are designed to ensure adequate safety and to mitigate the effects of site environmental conditions, natural phenomena, and accidents including stability and liquefaction caused by earthquake conditions and settling over the life of the facility.

A typical storage pad consists of a reinforced concrete slab 30 to 36 inches thick. The size of the storage pad depends on the type of storage overpack (horizontal or vertical), the number of storage units to support, and the shape and limitations of the physical space where the pad is to be placed.

Horizontal storage overpacks are placed on a storage pad in rows and require an apron in front of the modules so that the transfer cask on the horizontal transporter can be maneuvered to line up with the module. During canister transfer, the canister is pushed into or pulled out of the module with a hydraulic ram mounted on the horizontal transporter. The modules are approximately 10 feet in width by 21 feet in length. These systems use concrete end shield walls 2 feet thick to reduce radiation; therefore, a storage pad supporting two rows of modules in a 2 x 25 array of 50 modules placed back to back would be approximately 260 feet long. The aprons, one on each side of the storage pad, would be 25 feet wide each creating an apron area 50 feet wide between module rows – adequate space for the horizontal cask transporter. The total width of the pad and apron would be 92 feet.

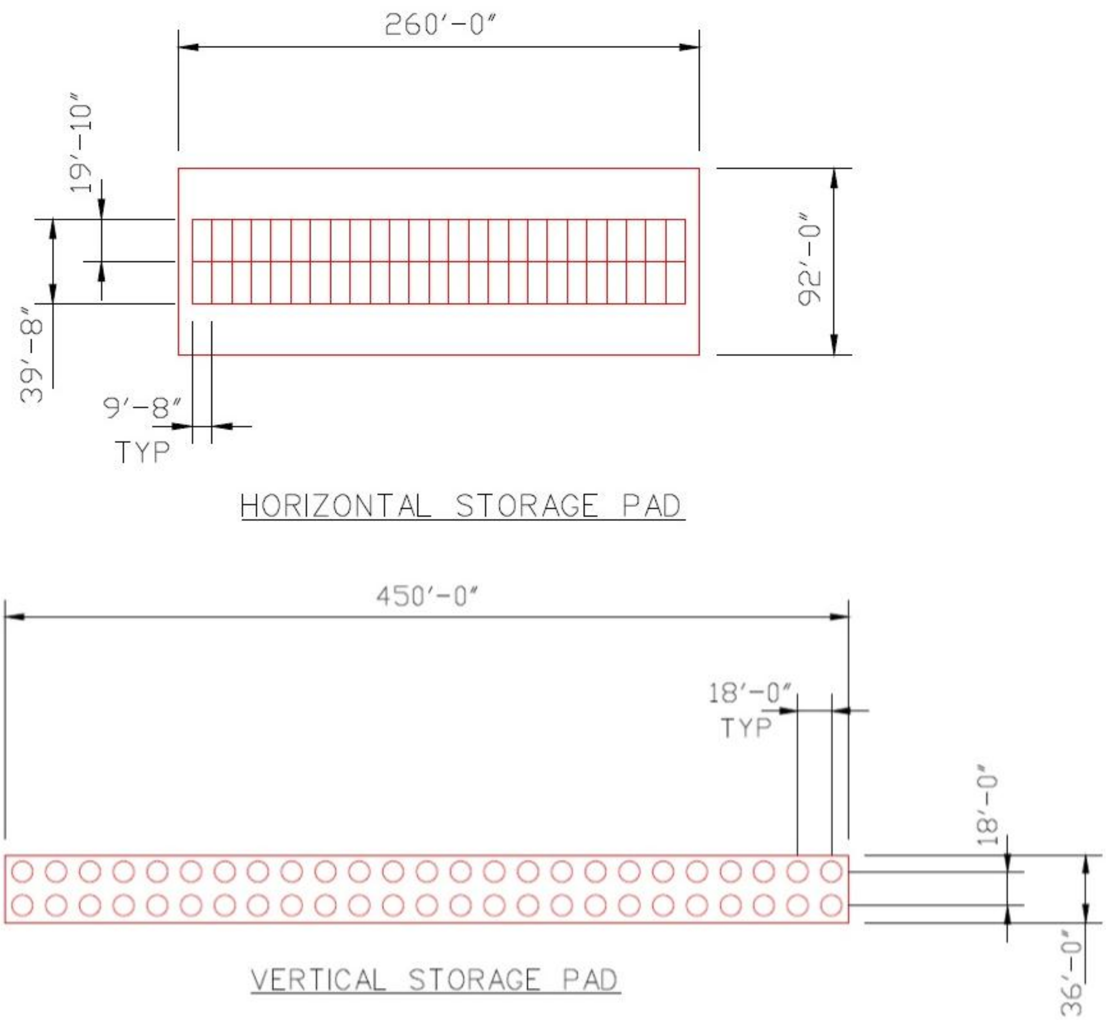
Vertical storage overpacks are typically placed on a storage pad in an array. Any array wider than two overpacks prevents a VCT from ready access to all the overpacks. Many reactor sites with very limited space use high-density arrays when real estate is unavailable. If a canister or overpack located away from the outer edge of the array has a problem, the VCT would need to remove a few overpacks to access the inner overpack. Given adequate real estate, it is preferred to group the overpacks in arrays no wider than two so that all the overpacks are all readily accessible. An overpack requires spacing from adjacent overpacks for heat rejection and VCT maneuverability. For this report, a storage pad sized for an array of 2 by 25 overpacks spaced 16 feet apart center to center is 450 feet long by 36 feet wide with a total capacity of 50 overpacks. Storage pads are spaced at least 40 feet apart to provide ample room for VCT travel and turning between pads.

To store up to 5,000 MTHM of shutdown SNF, the Pilot ISF storage area will need to include at least 250 acres of land. Based on the volume of SNF from shutdown reactors, the ISF will need 9 vertical pads for variation C-STDa, 4 horizontal pads and 5 vertical pads for variation C-STDb, or 9 horizontal pads for variation C-STDc. The pad layout is shown on **Figure A2-18**.

One horizontal pad with aprons requires an area of 92 feet x 260 feet. Four adjoining pads will require a total area of 368 feet x 260 feet.

Three vertical pads with 4 access aisles for the VCT will require 268 feet x 450 feet. The arrangement in **Figure A2-10** has twice that area to accommodate an additional 2 pads.

Figure A2-18
C-STD - Horizontal and Vertical Pads



A2-3.4 Cask Handling Building

The C-STD storage alternative would require some facility in order to offload transport casks from the railcars and perform canister transfer operations for vertical type DPCs. The Cask Handling Building (CHB) provides these functions. The CHB for this report has been designed with 2 rail bays, 2 truck bays, 4 vertical canister transfer cells, 2 - 200 ton single-failure-proof overhead bridge cranes, laydown area for impact limiters, staging area for transport casks and office area. The CHB would be a reinforced concrete structure with thick walls to protect all SNF casks, canisters, overpacks, and cask-handling equipment from the effects of earthquakes, tornado winds, tornado-generated missiles, fire, and explosions.

For C-STDa, where all DPCs are stored in vertical standardized overpacks, some type of canister transfer facility would be required to transfer the DPCs from the transport casks to the storage overpacks. The CHB concept prepared for this report is designed to provide this function considering a mix of 250 vertical DPCs/yr and 200 horizontal DPCs/yr to achieve a throughput of 3,000 MTHM/yr with one shift 5 days per week. Note that horizontal DPCs care transferred at the pad and do not require canister transfer operations in the CHB. Since the C-STDa alternative moves all DPCs into vertical overpacks a 3,000 MTHM/yr throughput could only be achieved by adding a second shift per day. Alternatively, the CHB could be designed with more canister transfer cells to achieve the same throughput with a single work shift per day which would increase the construction effort and cost of the CHB.

For C-STDb, where all DPCs are stored in horizontal standardized overpacks, the CHB is only required to offload the transport casks onto a horizontal cask transporter (HCT). All canister transfer activities would occur at the horizontal storage module on the pad. Although this increases the pad side operations as discussed in the previous section, it would greatly reduce the size of the CHB thereby reducing construction and costs.

For C-STDc, where vertical type DPCs are stored in vertical standardized overpacks and horizontal type DPCs are stored in horizontal standardized overpacks, the CHB would be the same as designed for the C-PAD alternative. The throughput would be 3,000 MTHM/yr with one shift per day, 5 days per week.

A2-3.5 Protected Area

The PA is an area within the OCA large enough to encompass the ISF rail yards, CHB, and underground system storage area. The PA consists of two physical barriers: (1) a security fence and (2) a nuisance fence separated by a 20-foot wide isolation zone. Within the isolation zone is an intrusion detection system that provides ground surveillance to detect any unauthorized entry into the PA. Assessment of unauthorized intruders is provided by illumination along the PA perimeter and throughout the storage area and a CCTV system, consisting of both fixed and pan-tilt-zoom cameras to monitor activities around the PA boundary from the security building.

The PA is surrounded by a passive vehicle barrier system (VBS) that is constructed of large concrete blocks to prevent any vehicles from getting near the PA boundary. The VBS is physically placed at a distance so that a pressure wave from a vehicle-born improvised explosive device cannot affect the storage containers or cask handling activities. Active VBSs are placed at large gates that accommodate railcars loaded with SNF transport casks or vehicles to prevent any unauthorized entry. These VBSs can be lowered once the railcar or vehicles are inspected and cleared for entry.

Security equipment is typically powered from normal off-site power supplies. However, in the event of a loss of off-site power, an Uninterruptable Power System (UPS) consisting of batteries would be used to provide seamless power to all electronic security equipment. The UPS and site lighting would be backed up by an emergency diesel-powered generator located within the PA.

Bullet resistant enclosures would be situated at strategic locations within the PA to provide protected locations for security force personnel during a security event.

A2-3.6 Overpack Fabrication Area

It is likely that all C-STD standardized overpacks would require some level of fabrication. A standardized design has not been determined. However, if the design was similar to the current overpacks then there would be onsite fabrication needs.

Horizontal standardized overpacks could be comparable to existing horizontal storage modules which are made of reinforced concrete blocks that are fitted and bolted together to create a single module. The major pieces are a body, base slab, top slab and door. This construction allows the modules to be manufactured in a qualified QA environment, shipped via railcar from a factory to a nuclear reactor site and fitted together at the ISF.

Vertical standardized overpacks could be comparable to existing vertical storage overpacks which are steel shells that are also manufactured in a qualified QA plant. The shells are designed with a size and weight that allows them to be shipped to an ISFSI via rail. Once at the site, the shells are fitted or filled with concrete for radiation shielding. The placement of concrete is the only fabrication activity that is required onsite. The work is performed on a dedicated fabrication pad. It may also make sense to manufacture the steel shells however, this activity requires overhead cranes, CNC cutting machines, steel rolling mills, heavy welding machines, stress relieving furnaces and other equipment that requires a major commitment.

Both horizontal type modules and vertical type overpacks require a considerable quantity of concrete which would make up much of the fabrication area activities.

A2-3.7 Concrete Batch Plant

Because of large amount of concrete that would be continually need to be supplied for construction of pads and overpack fabrication, the ISF would include a site concrete batch plant. In addition to the batch plant, the ISF would need to include equipment associated with concrete supply operations such as concrete trucks, concrete pumper trucks, mobile cranes, backhoes for excavation, front-end loaders and dump trucks for moving soil, compaction equipment, powered concrete tools and small concrete finishing tools.

A2-3.8 Site Support Buildings

The Pilot ISF will need to include a number of support buildings. An administration building will need to be constructed to house managers, admin staff, engineers, document storage, licensing records, health physics personnel, radiological records, training rooms, etc.

A security/access control building will need to be constructed to house security personnel, security managers, the Central Alarm Station, safeguards information, etc. The building can be sited at the Protected Area boundary to provide access control for personnel entering the storage area. This most likely would include a badging station, explosion detectors, metal detector to monitor persons entering the secured area, x-ray machines to monitor materials brought onsite, and turnstiles delineating the PA boundary.

A warehouse/maintenance building will need to be constructed to stockpile materials shipped to the ISF for overpack fabrication, pad construction, inspection equipment, general supplies, etc. This structure could also double as a maintenance building for general maintenance activities as well as transporter and canister handling equipment maintenance.

The ISF would also include a number of other features such as fire protection, potable water, sanitary drains, electrical power and distribution, and communications.

A2-4.0 Expansion to the Expanded ISF

A2-4.1 Storage Area Impact

The Expanded ISF would store up to 10,000 MTHM, which includes the 5,000 MTHM from the Pilot ISF storage area plus an additional 5,000 MTHM. The expanded ISF would need to double the storage area size from 250 acres to 500 acres of land. An Expanded ISF layout using all vertical standardized overpacks is shown on **Figure A2-19.**

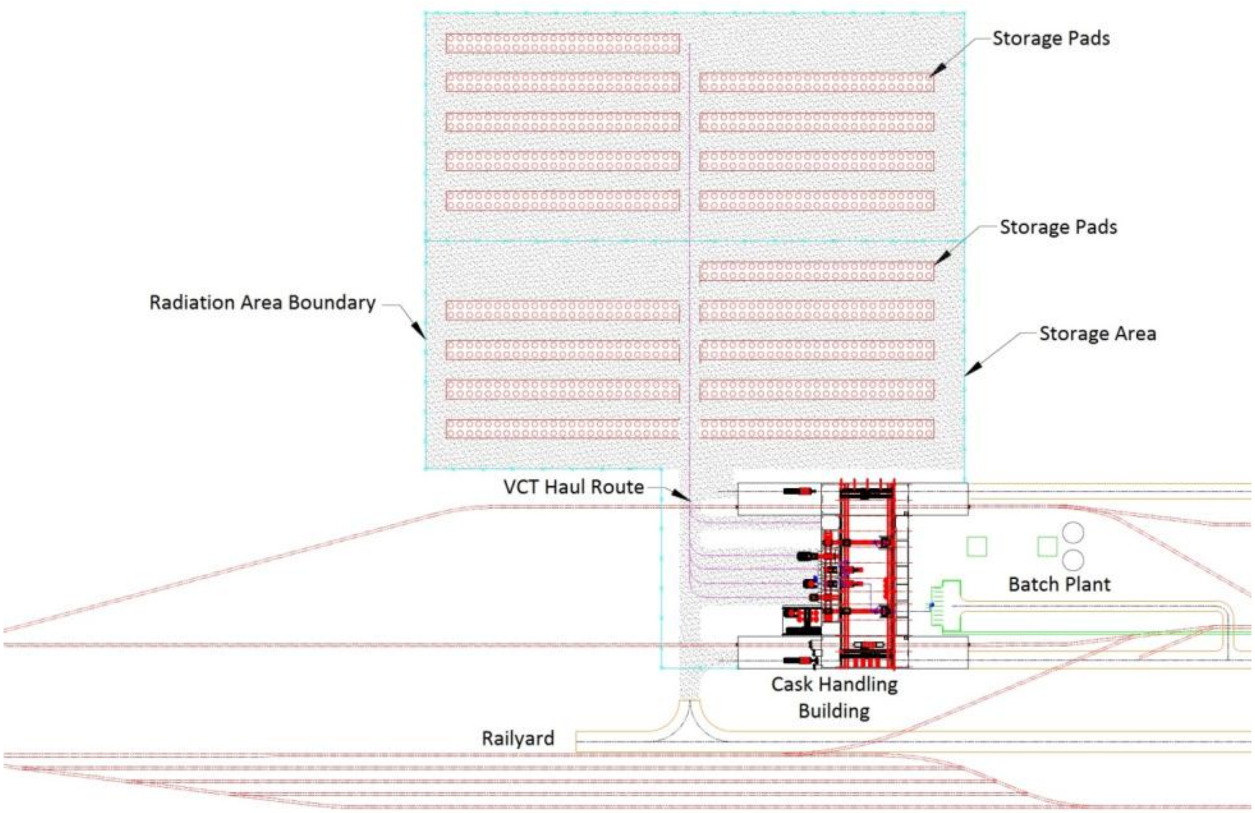
The Pilot ISF has 4 horizontal type storage pads and 5 vertical type storage pads, each pad with a capacity of 50 storage units. The expanded ISF will need twice those numbers – 8 horizontal and 10 vertical storage pads. Access roads and aprons around the pads will also need to be doubled.

Construction of the second 5,000 MTHM storage area could be performed outside of the Pilot ISF Protected Area to facilitate construction activities without stressing security. Once the pads are constructed, the PA would be expanded to encompass the additional storage pads. This type of construction would mean that a significant corridor would need to be placed between storage areas, and large separation corridors to ensure that construction workers receive as low as reasonably achievable (ALARA) radiation dose from the existing loaded storage units.

After the expansion has been completed, the PA would be expanded in size as required to accommodate the new storage pads including fencing, intrusion detection system equipment, number of CCTV cameras and yard illumination. If designed for the expanded area, the vehicle barrier system would not need to be modified for the expanded ISF.

Electrical power would be similar to the Pilot ISF with some increases to account for the additional security and temperature monitoring equipment. The Uninterruptable Power System (UPS) and security backup emergency diesel-powered generator should not need to be modified as they should be sized to account for the expanded ISF during the Pilot ISF construction.

Figure A2-19
Expanded ISF Conceptual Plan of the C-STDa Alternative



A2-4.2 Increased Throughput Impact

The CHB constructed for the Pilot ISF has a throughput capacity of 3,000 MTHM/yr which may be adequate for an Expanded ISF. Even if the throughput requirements are increased to 4,500 MTHM/yr, the CHB would not need to be enlarged. Rather, adding a second shift would effectively double the throughput of the building to 6,000 MTHM.

Alternatively, adding weekend shifts but still maintain only 1 shift per day would effectively increase the CHB throughput to 7 canister transfers per week or 364 canisters per year. This translates into approximately 4,200 MTHM/yr, which is short of the 4,500 MTHM but may still be adequate depending on the shipment rates. Increasing the size of the Expanded ISF beyond a capacity of 10,000 MTHM will require a time and motion analysis to determine the throughput rate necessary to remove canisters from reactor sites. At that time the throughput requirements for the CHB can be assessed and shifts added to meet those requirements.

To expand the Pilot ISF, the rail yards, Administration Building Warehouse/Maintenance Building, Security/Access Control Building and other site infrastructure utilities may not require many modifications. Backup electrical power service for illumination and security of the larger storage area, additional security guards, increased CCTV and intrusion detection equipment are a few modifications that may be required to accommodate the expanded ISF. For example, these additions may require a larger Security/Access Control Building for the additional security personnel as well as a larger CAS for the increased CCTV and intrusion detection systems. However, if the Pilot ISF is designed with the understanding of the expanded ISF that doubles the storage area, then these items could easily be included in the initial design.

After the expansion, the ISF may need to procure additional horizontal cask transporters (HCTs) and vertical cask transporters (VCTs) to accommodate the expansion of the site. Although one HCT and one VCT may be able to handle the throughput, it is recommended that the ISF should employ at least three of each type of transporter. With the continual work, it is very likely one transporter (on average) could be in maintenance status at all times and the third transporter could alleviate any backups that may occur.

A2-4.3 Modular Expansion Impact

For pad storage using standardized overpacks, the only modular construction is the concrete storage pads and overpack fabrication. These modular units are very small which allows construction activities to be conducted over a long period of time. This advantage distributes capital costs over several years which is one reason why this storage alternative is useful at reactor sites since SNF growth also occurs over a long period of time. The cask handling building can handle the Expanded or larger ISF and does not need to be modular.

A2-5.0 Performance of Structures, Systems and Components

A2-5.1 Structural and Seismic Evaluation

Seismic evaluations for pad mounted storage systems are performed to ensure that the storage system is capable of withstanding the accelerations generated by the design earthquake, that the pad is sized to maintain structural integrity under loading applied by the storage systems, that the seismic restraints (if any) will transfer the inertia loading from the storage systems to the pad, and that the pad has sufficient engagement in the soil to prevent soil failure.

Seismic evaluations of the storage systems documented in vendor SARs determine the capacity to resist accelerations applied at the top of the pad that each storage system is designed for. These capacities are compared to the pad accelerations calculated in seismic response analyses to determine whether or not the storage system capacities envelope the pad seismic demands. The results of this comparison indicate that for the 0.25G earthquake, the capacities of both the vertical and horizontal storage systems for the Pilot ISF either envelope or are within 20% of the maximum responses calculated at the top of the pad. In general, there is enough margin between the seismic capacity credited in the vendor SARs and the actual maximum seismic capacity at the material design limits to consider the storage systems qualified for the 0.25G earthquake demands.

For the 0.75G earthquake, the acceleration demands at the top of the pad significantly exceed the accelerations that the storage systems are currently qualified to resist. In this case, the storage system seismic analyses documented in the vendor SARs will have to be revised to evaluate the higher seismic demand. Due to the magnitude of the increase in seismic loading, there is considerable uncertainty as to whether the storage systems will be able to withstand the higher loads. In the event that one or more of the storage systems could not be qualified for the higher demands, then extreme measures to isolate the pads from the seismic ground motion would have to be undertaken, which is considered to be a moderate risk.

The sliding and tip-over resistances of the Pilot ISF storage systems results indicate that for the 0.25G earthquake, the overturning moments for all storage containers are less than the restoring moments, therefore there is virtually no risk of any of the casks tipping over during a seismic event of that magnitude.

For the 0.75G earthquake, the overturning moments for all storage systems are greater than the restoring moments, indicating that tip-overs are credible events. Therefore, seismic restraints which couple the storage systems to the pads must be installed to increase the seismic inertia loading applied to the pad and the storage systems. Individual storage systems will have to be re-qualified for loads caused by restraining the bases, or a different seismic restraint configuration will have to be developed.

The results of the maximum vertical and horizontal reactions on the soil calculated in the springs at the base of the pad models show that for the 0.25G earthquake, the soil has sufficient bearing and shear capacity to resist the deadweight and seismic reactions from the pad. However, for the 0.75G earthquake, seismic reactions on the soil exceed the combined bearing and shear capacities for both horizontal and vertical storage systems. In these cases, additional bearing capacity will have to be developed via micropiles or some other storage anchoring system.

A2-5.2 Thermal Evaluation

The thermal performance of the vertical standardized storage overpack is dependent on design details which have not yet been established. Therefore, there is a degree of uncertainty as to whether an overpack with a single interior diameter and height will, in all cases, be able to establish the required convective flow to maintain centerline cladding temperatures below their required temperature limits.

Thermal models of each different DPC to be stored in a vertical orientation inside of the standardized overpack must be developed and analyzed. Since the amount of free convection flow established inside an overpack is a function of the flow area and the height of the air column between the DPC and the overpack, a single standardized design will reject heat from different size DPC's with varying degrees of success.

Likewise, thermal models of each different DPC to be stored in a horizontal orientation inside of a standardized overpack must be developed and analyzed. If only horizontal DPC's are stored inside the horizontal standardized overpacks the thermal analyses would be expected to be similar as for the thermal evaluations in the NUHOMS SARs and can be used directly to demonstrate that standardized horizontal overpacks will meet thermal performance requirements for all horizontal DPC's.

A detailed discussion of the thermal evaluation is provided in **Section 6.2** of the report.

A2-5.3 Radiological Evaluation

The exposures to radiation for the workers at the ISF were based on the time and motion study and the assumed average dose rates from the DPCs stored at the site. Once installed in their storage overpack, the doses to workers and to the public are quite small. However, during Cask Handling Operations, workers need to work on top of DPCs and near the transport cask and the transfer casks. As a security precaution, the plant security officers need to visually inspect the inside of the transport cask for contraband as soon as it is opened. In addition, workers on vertical cask storage units need to bolt a lifting lug directly onto the DPC and after it has been transferred to the storage overpack, it needs to be unbolted and the storage overpack lid needs to be bolted in place. In areas where the seismic loads are large enough to warrant it, workers sometimes need to bolt the vertical storage overpack to the pad. The air intakes on the vertical overpack are streaming areas with relatively high dose rates.

The cask handling crews on horizontal storage modules need to remove the storage module shield cover over the next location to be loaded. The interiors of the storage modules are not shielded so while the cover is off, radiation from the DPCs already stored in the module streams out of the opening making the area around the opening a high radiation protection zone. All subsequent activities necessary to mate the transport cask to the module are done in this high radiation protection zone. Once the DPC is installed and before the shield cover is reinstalled, a worker needs to reach into the module to install a seismic shear lug in the module to prevent the canister shifting toward the shield cover during a seismic event.

The time and motion study identified all of the steps necessary to be performed in sequence in order to move the DPC from the railbay to the pad. In addition to the sequencing and timing, the staff required for each step was developed from the experience with operating nuclear plant ISFSI operations. In the time and motion study, the number of people and the time required for each step was used to determine the throughput and the total staffing requirement. However, this detail was inappropriate for determining the radiation exposures. So, the staffing for each activity associated with moving the DPC was further decomposed into the individual subactivities necessary and the location of each member of the staff was identified relative to the DPC. For instance, the Supervisor, the Heavy Equipment Operator and the Crane Operator are never near the DPC. While the Mechanics, Riggers and QA/QC Inspectors are often in direct contact or close proximity to the SNF. Also, if a step takes an hour to accomplish, it may only involve a few minutes of exposure to the DPC. Experienced Rad Workers know how to perform work in a way that minimizes their exposures to radiation.

Tables A2-12 through A2-14 below summarize the radiological dose results of this analysis for the vertical and for the horizontal storage concepts as shown in **Table 6.4.4.2 of Section 6.4.** For the detailed radiological information, see **Appendix D-4**. The doses are based on an approximate average design base fuel that could be present at the ISF. The design base dose values are used to evaluate each alternative storage method and provide an accurate comparison between alternatives. Note that after the DPC has been placed in storage, it is assumed that the dose rate to workers in the cask handling areas is near background levels and have a negligible contribution.

Table A2-12
Radiological Dose Per DPC to Worker by Category for C-STDa

Storage Alternative	Craft						
	Mechanics	Riggers	Health Physics	Operators	Security	Quality	**Totals**
Vertical	126	60	51	0	11	3	**251**
Horizontal	69	60	50	0	13	0	**192**

* To the nearest whole person

Table A2-13
Radiological Dose Per DPC to Worker by Category for C-STDb

Storage Alternative	Craft						
	Mechanics	Riggers	Health Physics	Operators	Security	Quality	Totals
Vertical	126	60	51	0	11	3	251
Horizontal	80	47	51	0	11	8	198

* To the nearest whole person

Table A2-14
Radiological Dose Per DPC to Worker by Category for C-STDc

Storage Alternative	Craft						
	Mechanics	Riggers	Health Physics	Operators	Security	Quality	Totals
Vertical	167	91	64	0	18	11	351
Horizontal	80	47	51	0	11	8	198

* To the nearest whole person

These radiation doses represent maximum doses per DPC processing activities and are anticipated to decrease with operating experience.

A2-5.4 Design Life, Aging and Maintenance Evaluation

Currently, storage systems may be designed for 40 to 100 years but are only permitted to be licensed for a period of up to 40 years. Prior to February 16, 2011, when 10 CFR 72.42, Duration of License; Renewal (for specific licenses) and 10 CFR 72.240, Conditions for Spent Fuel Storage Cask Renewal (for CoCs for general licenses) were revised to permit 40 year license durations, licenses and CoCs for storage systems had a duration of 20 years. Therefore, most of the storage systems currently in place at ISFSIs are only licensed for 20 years. In order to renew the license and extend the storage license, NUREG-1927, Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance (Reference A2-16) requires that an applicant demonstrate that the effects of aging will be adequately managed so that the intended safety function(s) of SSCs identified in the scope of license renewal will be maintained consistent with the current licensing basis for the period of extended operation. The NRC requires that an Aging Management Review (AMR) be performed that consists of identifying ISFSI components relied on for safety, susceptible materials in those components, environments to which susceptible materials are exposed, aging effects, and development of an aging management program to manage aging effects and protect against degradation of age-sensitive components (such as by performing inspections of age-sensitive components and replacing components that have a life expectancy of less than the license renewal period being requested in the anticipated environment). For purposes of this section, it is assumed that the original license has a duration of 20 years and a 40 year license extension is requested, so the licensee will need to demonstrate the in-scope component materials will withstand the anticipated environment for a total of 60 years, or provide a plan for replacing age-sensitive components at acceptable analyzed intervals. If the initial license was for a 40 year duration, and a 40 year license extension is requested, then the licensee would need to demonstrate the in-scope components are acceptable for 80 years in the storage environment.

The AMR identifies susceptible materials of subcomponents in the in-scope SSCs that are exposed to environments that could cause age-related degradation. The functions required to be performed by the individual subcomponents of these in-scope SCCs (determined in previous section) are identified in applicable tables in this AMR section of the application for ISFSI license renewal.

The NRC's Draft Revision 1 of NUREG-1927, Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel (Reference A2-17) explains the purpose of the AMR as follows:

> "The purpose of the aging management review (AMR) is to assess the proposed aging management activities (AMAs) for structures, systems, and components (SSCs) determined to be within the scope of renewal. The AMR addresses aging mechanisms and effects[1] that could adversely affect the ability of the SSCs (and associated subcomponents) from performing their intended functions during the period of extended operation. The reviewer should verify that the renewal application includes specific information that clearly describes the AMR performed on SSCs within the scope of renewal."
>
> Footnote 1 in this quotation states: "In order to effectively manage an aging effect, it is necessary to determine the aging mechanisms that are potentially at work for a given material and environment application. Therefore, the aging management review process identifies both the aging effects and the associated aging mechanisms that cause them."

The license application needs to include an Aging Management Review (AMR) that is comprised of four major steps that are summarized as follows:

1) <u>Identification of In-Scope Subcomponents Requiring AMR</u>

Structures, Systems and Components (SSCs) within scope of the aging evaluation are identified as those that are 1) classified as important to safety (ITS), and 2) classified as not important to safety but whose failure could prevent an ITS function from being fulfilled. SSCs within scope are determined based on review of the ISFSI Materials License, ISFSI SAR, ISFSI Tech Specs, NRC's SER for the ISFSI and docketed licensing correspondence related to the ISFSI.

2) Identification of Susceptible Materials and Applicable Environmental Conditions

For the subcomponents of in-scope SSCs that require AMR, the next step is identification of materials of construction susceptible to aging and the environments (e.g., temperature, pressure, radiation, wet vs. dry, etc.) that these materials normally experience.

3) Identification of Aging Mechanisms and Effects Requiring Management

Aging mechanisms potentially at work on susceptible materials in given environments (corrosion, cyclic stress fatigue, radiation embrittlement, etc.) are determined. Aging effects (manifestation of aging mechanisms) of material / environment combinations are compiled from industry and plant operating experience through use of industry standards and reference materials, including metallurgical literary references. During this process, the question is asked, are the potential aging effects credible given the identified materials and environmental conditions of storage?

4) Determination of Activities Required to Manage Aging Effects (Aging Management Program)

The final step in the AMR process involves the determination of activities necessary to manage the effects of aging. If the aging review determines that certain materials may not be able to support a 60 year life in the environment that they are normally exposed to, then an Aging Management Program needs to be established for those subcomponents to extend the life of the storage system to 60 years (such as by performing inspections of vulnerable subcomponents to determine their continued adequacy, or replacing the associated subcomponent at specified intervals).

Each of the four above steps of the AMR process are discussed in more detail in the following paragraphs.

A2-5.4.1 Aging Management Review (AMR)

Identification of In-Scope Components Requiring AMR

During this first step in the AMR process, the in-scope SSCs are further reviewed to identify and describe the subcomponents that support the SSC intended function. Intended functions of interest in the AMR are sub-criticality control, pressure boundary integrity (confinement of fission products), heat transfer, structural support (protection against environmental phenomena) and shielding. The subcomponents and associated intended functions are identified by reviewing the applicable current licensing basis (CLB) documentation sources.

SSCs and associated subcomponents within the scope of renewal fall into the following scoping categories:

(1) They are classified as important to safety (ITS), as they are relied on to do one of the following functions:

i. Maintain the conditions required by the regulations, specific license, or CoC to store spent fuel safely;

ii. Prevent damage to the spent fuel during handling and storage; or

iii. Provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

These SSCs ensure that important safety functions are met for (1) confinement, (2) radiation shielding, (3) sub-criticality control, (4) heat-removal capability, (5) structural integrity, and (6) retrievability of the spent fuel.

(2) They are classified as not important to safety but, according to the design bases, their failure could prevent fulfillment of a function that is important to safety.

Subcomponents that perform or support any one of the identified intended functions will require an AMR. Those components that do not support an intended function can be excluded from further evaluation in the AMR with supporting justification. The SSCs within the scope of renewal are screened to identify and describe the subcomponents with intended functions. It should be recognized that SSC subcomponents may degrade by different modes, or have different criteria for evaluation from the overall component (i.e., different materials or environments). SSC subcomponents may also have different performance requirements for support of safety functions.

Typically, the application for ISFSI license renewal tabulates the results of the AMR, including a listing of subcomponents and the intended function provided by each subcomponent, material group, environment, aging effects requiring management and aging management activity required. The AMR results tables also identify subcomponents that did not support the SSC intended function and are not subject to AMR, with justification for their exclusion.

Identification of Materials and Environments

The second step of the AMR process requires the identification of materials of construction and the environments to which these materials are exposed, for the in-scope ISFSI subcomponents that require an AMR. Environmental data may include: temperature, wind, relative humidity, relevant atmospheric pollutants and deposits, exposure to precipitation, marine fog, salt, or water exposure, radiation field (gamma and neutron), the service environment (e.g., embedded, sheltered, or outdoor), and gas compositions (e.g., external: air; internal: inert gas such as helium).

The environments to which components are exposed play a critical role in the determination of potential aging mechanisms and effects. A documentation review is required to quantify the environmental conditions to which the in-scope ISFSI SSCs are continuously or frequently exposed (conditions known to exist on a recurring basis). As noted in the next section, normal operating conditions are evaluated and not accident conditions.

The storage system FSAR is typically used to determine the intended functions and materials of construction for cask subcomponents that are in-scope of ISFSI license renewal. Additional documentation, drawings and technical reports should also be reviewed during the AMR process as required to obtain clarifications of the intended materials of construction and functions performed by in-scope ISFSI subcomponents.

The specific materials of construction for the cask and fuel assembly subcomponents requiring aging management review are identified and evaluated for the renewal period.

Identification of Aging Mechanisms and Effects Requiring Management

The third step in the AMR process is to identify the aging mechanisms and effects requiring management. A Material Aging Effects Report (MAER) is typically prepared for the storage system in question. This report needs to include aging mechanisms and effects that theoretically occur as well those that have actually occurred based on industry operating experience and the ISF operating experience for the appropriate material and environmental conditions. Aging effects are presented in this report in terms of material / environment combinations.

The environments considered in the evaluation are the environments that the subcomponents normally experience. Environmental stressors that are conditions not normally experienced, such as accident conditions, or that may be caused by a design problem, are considered event-driven situations and are not characterized as sources of aging. Such event-driven situations would be evaluated at the time of event, with corrective actions taken as necessary.

To effectively manage an aging effect, it is necessary to determine the aging mechanisms that are potentially at work for a given material and environment application. Therefore, the AMR process needs to address both the aging mechanisms as well as the aging effects. Selective mechanisms are only applicable under certain environmental conditions, such as high temperature or moisture. The identified aging mechanisms need to be characterized by a set of applicable conditions that must be met for the mechanism to occur and/or propagate. The application for ISFSI license renewal should identify aging effects based on the aging mechanisms potentially at work in given environments on susceptible subcomponent materials (e.g., general corrosion of carbon steel, stress corrosion cracking and crevice and pitting corrosion of stainless steel, cyclic stress fatigue, radiation embrittlement, boron depletion of neutron absorber due to neutron flux, etc.). Aging effects (manifestation of aging mechanisms) of material / environment combinations are compiled from industry and plant operating experience through use of industry standards and reference materials, including metallurgical literary references. The majority of aging mechanisms will be extracted from industry documents (including NRC and EPRI) for the applicable material/environmental combinations. For instance, the EPRI Dry Cask Characterization Project final report (Reference A2-18) is a primary source for fuel assembly and dual purpose canister internals aging mechanism evaluations. During the process of identifying aging effects the question is asked, are the potential aging effects credible given the identified materials and environmental conditions of storage?

Appendix D, Table D-1, of NUREG-1927 lists potential aging effects and possible aging mechanisms that should be considered. This information is also available from a table in Appendix C to NUREG-1557 (Reference A2-19). Section 3.4 of the NRC's Draft Revision 1 of NUREG-1927 lists the following sources of information that should be used to identify applicable aging mechanisms and effects:

- site maintenance, repair, and modification records;
- corrective action reports, including root cause evaluations;
- lead system inspection results (see Appendix C);
- maintenance and inspection records from ISFSI sites with similar SSC materials and operating environments;
- industry records;
- applicable operating experience outside the nuclear industry;
- applicable consensus codes and standards;
- NRC reports;
- other applicable guidance for determining if an aging mechanism or effect should be managed for the period of extended operation.

Section 3.4 of the NRC's Draft Revision 1 of NUREG-1927 gives the following examples of potential aging mechanisms and effects that may be identified by reviewing the above sources of information:

> "(1) cracking or loss of strength as a result of cement aggregate reactions in the concrete, (2) cracking or loss of material as a result of freeze-thaw degradation of the concrete (requires the presence of moisture combined with temperatures below freezing), (3) reinforcement

corrosion and concrete cracking as a result of chloride ingress, (4) accelerated corrosion of steel structures and components and stress corrosion cracking of austenitic stainless steels as a result of atmospheric deposition of chloride salts."

Other possible aging effects are settlement, change in dimension and change in material properties. The applicant for renewal of an ISFSI specific license is not required to take further action if an SSC is determined to be within the scope of renewal but is found to have no potential aging effects for the period of extended operation.

The AMR defines two methods for addressing potential aging mechanisms and effects: TLAA and AMP, both of which are discussed below.

Time-Limited Aging Analyses to Identify Aging Effects

Time-Limited Aging Analyses (TLAAs) are calculations performed to evaluate the life of subcomponents of interest. TLAAs are defined in Section 3.5 of the NRC's Draft Revision 1 of NUREG 1927, as those licensee calculations and analyses that meet all of the following criteria:

1. Involve SSCs important to safety within the scope of the specific-license renewal, as delineated in Subpart F of 10 CFR Part 72;

2. Consider the effects of aging;

3. Involve time-limited assumptions defined by the current operating term;

4. Were determined to be relevant by the specific licensee or certificate holder in making a safety determination;

5. Involve conclusions or provide the basis of conclusions related to the capability of SSCs to perform their intended safety functions (analyses that do not affect the intended functions of the SSCs are not considered TLAAs); and

6. Are contained or incorporated by reference in the design bases.

The defined operating term should be explicit in the analyses. Simply asserting that the SSC is designed for a service life or ISFSI life is not sufficient. The assertions must be supported by a calculation, analyses, or testing that explicitly include a time limit.

Examples of TLAAs described in the past applications for license renewal are: 1) cracking of the dual purpose canister (DPC) shell due to fatigue from thermal cycling; 2) change in material properties of epoxy seal in DPC penetration (for temperature monitoring) due to exposure to ionizing radiation; and 3) canister basket poison plate depletion of boron due to increase in neutron exposure for 60 year life of ISFSI; change in properties of boron-polyethylene front access cover plate due to increased radiation exposure over 60 year life of ISFSI.

Operating Experience Review for Process Confirmation

Typically, the potential aging effects for the ISFSI material and environment combinations are compiled from common industry and plant operating experience through the use of accepted industry standards and reference materials, including various metallurgical literary references relating specific materials and environments to aging effects and mechanisms.

A further review of industry and plant specific operating experience for the ISFSI should also be performed in order to confirm the applicability of previously identified potential aging mechanisms/effects and to identify any aging effects not previously addressed.

The application for ISFSI license renewal will need to address the various observations resulting from ISFSI operating experience with the storage systems. This information should address items specific to the subcomponents. As an example; Dominion identified corrosion of lid bolts and outer metallic lid seals on some of the TN-32 casks stored at the Surrey ISFSI. The corrosion was most prevalent on the down-slope side of the cask lid. As part of the investigation, the bolt torque was checked and it was determined that there had been no torque relaxation. The corrosion of the lid bolts and outer metallic seal was the result of external water intrusion in the vicinity of the lid bolts and outer metallic seal. It was determined that the connector seal for the electrical connector in the cask protective cover was leaking due to improper installation of the connectors. Therefore, this degradation was not related to aging.

Activities Required to Manage Aging Effects (Aging Management Program)

The fourth and final step in the AMR process involves the determination of the aging management activities or Aging Management Programs (AMPs) to be credited or developed for managing the effects of aging. Section 3.6 of Draft Revision 1 of NUREG-1927 states the following regarding AMPs:

> "Aging management programs (AMPs) monitor and control the degradation of SSCs within the scope of renewal so that aging effects will not result in a loss of intended functions during the period of extended operation. An AMP includes all activities that are credited for managing aging mechanisms or effects for specific SSCs. An effective AMP prevents, mitigates, or detects the aging effects and provides for the prediction of the extent of the effects of aging and timely corrective actions before there is a loss of intended function."

> "Aging management programs should be informed, and enhanced when necessary, based on the ongoing review of both site-specific and industry-wide operating experience. Operating

> experience provides direct confirmation of the effectiveness of an AMP and critical feedback for the need for improvement. As new knowledge and data become available from new analyses, experiments, and operating experience, licensees and CoC holders should revise existing AMPs (or pertinent procedures for AMP implementation) to address program improvements or aging issues."

Section 3.6.1 of the NRC's Draft Revision 1 of NUREG-1927 indicates that an AMP should contain the following elements:

1. Scope of Program,
2. Preventive actions,
3. Parameters monitored or inspected,
4. Detection of aging effects,
5. Monitoring and trending,
6. Acceptance criteria,
7. Corrective actions,
8. Confirmation process,
9. Administrative controls, and
10. Operating experience.

To the extent practical, existing ISFSI programs and/or activities are credited for the management of aging effects that could cause a loss of component intended function during the license renewal period. If the aging review determines that certain materials cannot support the required life in the environment that they are normally exposed to, then an AMP needs to be established for those subcomponents to extend the life of the storage system for the duration of the license renewal period (such as by performing inspections of vulnerable subcomponents to determine their continued adequacy, or replacing the associated subcomponent at specified intervals). The application for ISFSI license renewal will need to discuss development of AMPs to address subcomponents whose materials are susceptible to age-related degradation. AMPs for ISFSIs typically include visual inspections of cask external surfaces to look for signs of deterioration due to corrosion (general corrosion for carbon steel subcomponents due to moist atmospheric environments, and crevice and/or pitting corrosion for stainless steel surfaces that are subject to wetting), and monitoring area radiation levels, airborne and smearable contamination levels at selected areas of the ISFSI. Increased radiation / radioactivity levels could indicate reduction in shielding, breach of the SFA cladding or loss of cask confinement. Inspection intervals are established at frequencies that provide confidence the subcomponents of interest will not experience age-related adverse effects that could prevent them from performing their intended functions.

A2-5.5 Postulated Accident Evaluation

The accident descriptions to follow refer to "Design Event" levels given in ANSI/ANS 57.9, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)" (Reference A2-20). As explained in NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities" (Reference A2-21): "Off-normal events are those expected to occur with moderate frequency or once per calendar year. ANSI/ANS 57.9 refers to these events as Design Event II. Accident events are considered to occur infrequently, if ever, during the lifetime of the facility. ANSI/ANS 57.9 subdivides this class of accidents into Design Event III, a set of infrequent events that could be expected to occur during the lifetime of the ISFSI, and Design Event IV, events that are postulated because they establish a conservative design basis for SSCs important to safety. The effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches, are considered to be accident events."

Section 15.4 of NUREG-1567 identifies acceptance criteria for accidents, including the following:

> Criticality: 10 CFR 72.124(a) requires that the spent fuel must be maintained in a subcritical condition (i.e., keff $\leq$ 0.95), and at least two unlikely, independent and concurrent or sequential changes must be postulated to occur in the conditions essential to nuclear criticality safety before a nuclear criticality accident is possible (double contingency).
>
> Confinement: 10 CFR 72.128(a)(3) requires that the systems important to safety must be evaluated, using appropriate tests or by other means acceptable to the Commission, to demonstrate that they will reasonably keep radioactive material confined under credible accident conditions. NUREG-1567 states that “A breach of a confinement barrier is not acceptable for any accident event.”
>
> Retrievability: 10 CFR 72.122(l) requires that “Storage systems must be designed to allow ready retrieval of spent fuel, high-level radioactive waste, and reactor-related GTCC waste for further processing or disposal.” The definition for Important to Safety SSCs in 10 CFR 72.3 includes those features whose function is to “provide reasonable assurance that spent fuel, high-level radioactive waste, or reactor-related GTCC waste can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.”
>
> Instrumentation: 10 CFR 72.122(i) states in part: “Instrumentation systems for dry storage casks must be provided in accordance with cask design requirements to monitor conditions that are important to safety over anticipated ranges for normal conditions and

off-normal conditions. Systems that are required under accident conditions must be identified in the Safety Analysis Report."

Radiological Dose: 10 CFR 72.104 requires that for off-normal events, annual dose equivalent to any individual located beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ as a result of exposure to planned discharges to the general environment, direct radiation from operations of the ISFSI, and cumulative radiation from uranium fuel cycle operations in the area. 10 CFR 72.106(b) requires that any individual located at or beyond the nearest controlled area boundary must not receive a dose greater than 5 rem to the whole body or any organ from any design basis accident.

A2-5.5.1 Earthquake

An earthquake is classified as a natural phenomenon Design Event IV as defined in ANSI/ANS-57.9. Earthquakes are associated with faults in the upper crust of the earth's surface. SSCs classified as Important to Safety are required to be designed to resist the effects of the design basis ground motion in accordance with the requirements of 10 CFR 72.122(b).

10 CFR Part 72.103, "Geological and Seismological Characteristics for Applications for Dry Cask Modes of Storage on or after October 16, 2003," gives requirements for determining Design Earthquake Ground Motion (DE) at sites for spent fuel storage, and NRC Regulatory Guide 3.73, Site Evaluations and Design Earthquake Ground Motion for Dry Cask Independent Spent Fuel Storage and Monitored Retrievable Storage Installations, (Reference A2-22) provides guidance on applying the rules in Part 72.103 to arrive at an acceptable DE that satisfies the requirements of Part 72. In general, Part 72.103 allows use of a standardized DE described by an appropriate response spectrum anchored at 0.25 g for sites in non-seismically-active areas east of the Rocky Mountain Front and requires a seismic evaluation elsewhere. For the ISF, a probabilistically-derived horizontal ground acceleration design value of 0.75 g is used to provide a bounding value for all potential ISF sites.

Depending on the specific storage system, the acceptance criteria for seismic design may include some or all of the following:

i. The loaded overpacks will not impact each other during the DE event.

ii. The loaded overpack will not slide excessively.

iii. The loaded overpack will not tip over.

iv. The confinement boundary will not be breached.

A2-5.5.2 Tornado Winds and Missiles

The storage system is designed to withstand loads associated with the most severe meteorological conditions, including extreme winds, pressure differentials, and missiles generated by a tornado. The extreme design basis wind is derived from the design basis tornado. Extreme wind is classified as a natural phenomenon Design Event IV as defined in ANSI/ANS-57.9. The design basis tornado loading is defined for a given region (identified in NRC Regulatory Guide 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants" (Reference A2-23). It is conservatively assumed that Region I design basis tornado loading applies to the ISF. The design basis tornado wind loading for this region is defined as a tornado with a maximum wind speed of 230 mph and a 1.2 psi pressure drop occurring at a rate of 0.5 psi/sec.

In addition, the ISF is designed to withstand the effects of tornado-generated missiles that could be created by the passage of the tornado as identified in Regulatory Guide 1.76, Rev. 1, and discussed in Sections 3.3.2 (Tornado Loadings) and 3.5.1.4 (Missiles Generated by Extreme Winds) of NUREG 0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, (Reference A2-24). Tornado-driven missiles, identified in the following table, are assumed to impact a storage system in a manner that produces maximum damage. Regulatory Guide 1.76, Rev. 1, identifies the following design basis missiles for Region I:

Missile Description	Total Mass (lbs)	Velocity (mph)
Automobile	4000	92
Schedule 40 Pipe (6. 625 inch-diameter), 15 ft long	287	92
Solid Sphere (1-inch-diameter)	0.147	17.7

Alternatively, there are other spectrums of tornado missiles that have been accepted by the NRC (for which spent fuel storage systems have been qualified) that could be reviewed for potential use at the ISF.

The combination of tornado winds with the most massive missile, a 4,000 lb automobile traveling at 92 mph, needs to be evaluated in accordance with Section 3 of NUREG-0800, since it tests storage system stability. The wind tip-over moment is applied to the cask at its maximum rotation position following the worst-case missile strike. The schedule 40 pipe missile tests the capacity of the storage system to resist penetration, and the small solid steel sphere missile tests barrier openings. Canister tip-over potential and reduction in shielding from tornado-borne projectile strikes are evaluated.

A2-5.5.3 Flood

Flooding is classified as a natural phenomenon Design Event IV as defined in ANSI/ANS-57.9. 10 CFR 72.122(b)(2) requires that SSCs Important to Safety must be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, lighting, hurricanes, floods, tsunami, and seiches, without impairing their capability to perform safety functions.

The probable maximum flood (PMF) is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation, and where applicable, snow melt, coupled with the worst flood producing catchment conditions.

Other potential sources of flooding considered include effects from an upstream dam breach, seismically induced flooding due to landslides in the site area, occurrence of the PMF with superposition of wind-wave activity on nearby water bodies, flooding due to tsunamis and ice conditions, and flooding from local intense precipitation.

The storage system is designed to withstand severe flooding, including pressure and water forces associated with deep and moving flood waters. Resultant loads on the storage system consist of buoyancy effects, static pressure loads, and velocity pressure due to water velocity. The flood is assumed to deeply submerge the storage system without the canisters collapsing, buckling, or allowing water in-leakage under the hydrostatic pressure from the flood; and, where applicable, without sliding and cask tip-over occurring. Full blockage of the air inlets by submergence in water is addressed by emergency action planning based on the individual storage device's capabilities. For more information on blockage of air inlets, refer to "Loss of Cooling Accident."

A2-5.5.4 Fire

Fire is classified as a human-induced Design Event IV as defined in ANSI/ANS-57.9. The storage system must withstand elevated temperatures due to a fire event. Credible fires from various sources such as buildings, fuel spills, and other combustible materials are analyzed for heat flux using standard analysis techniques from NFPA and compared with acceptance criteria for the storage system. Possible effects from wildfires are also evaluated, addressing fire magnitude, duration, propagation, and heat generation.

Fires analyzed include those that could occur during transfer operations and those affecting stored fuel. Canister integrity during smaller fire events is qualified by heat flux comparison with a bounding fire for which an approved canister analysis has been performed. Fires affecting structures in which transfer operations and storage of fuel occur have been analyzed to ensure continued reliability.

Based on the analyses, the canister storage and transfer systems meet the general design criteria of 10 CFR 72.122(c), which states that SSCs Important to Safety must be designed and located so that they can continue to perform their safety functions effectively under credible fire exposure conditions. A fire at the ISF (or a wildfire adjacent to the ISF Protected Area) would not cause a radioactive release, even if no credit were taken for firefighting by personnel or for automatic fire detection/suppression systems.

A2-5.5.5 Explosion

Explosion is classified as a human-induced Design Event IV as defined in ANSI/ANS-57.9. The ISF storage system must withstand loads due to an explosion. Potential onsite (internal and external) and offsite explosions are investigated.

NRC Regulatory Guide 1.91, "Evaluations of Explosions Postulated to Occur on Transportation Routes near Nuclear Power Plants" (Reference A1-24) provides guidance for calculating safe distances from transportation routes, based on calculated overpressures at various distances created by postulated explosions from accidents. The Regulatory Guide indicates that overpressures which do not exceed 1 psi at the storage site would not cause significant damage and states:

> under these conditions, a detailed review of the transport of explosives on these transportation routes would not be required.

In lieu of the 1 psi overpressure selected in the Regulatory Guide, the overpressure for which the storage system is qualified (e.g., 3 psi, 5 psi, 10 psi) is used to determine the safe standoff distance from the source of the potential explosion.

There are no credible internal explosive events since the canister is comprised of non-explosive materials, it is filled with an inert gas, and materials are compatible with the operating environment. Likewise, the mandatory use of the protective measures at the ISF site to prevent fires and explosions and the absence of any need for an explosive material during canister loading, transfer, and unloading operations eliminates the scenario of an onsite explosion as a credible event, except during canister movement, which requires investigation of any nearby onsite-specific potential explosive sources.

Any design basis overpressure from an offsite explosion (e.g., from a truck, rail car, barge, fuel storage tank, munition depot, chemical processing plant, petroleum refinery, natural gas facility, etc.) must be investigated and, if credible, analyzed.

Based on the analyses, the canister storage and transfer systems meet the general design criteria of 10 CFR 72.122(c), which states that SSCs Important to Safety must be designed and located so that they can continue to perform their safety functions effectively under credible explosion exposure conditions.

A2-5.5.6 Canister Drop Accident

NUREG-1567 considers both off-normal cask drops and more severe cask drop accidents. With regards to an off-normal event involving a cask drop that is less than the design allowable lift height, Section 15.5.1.1 of NUREG-1567 states:

> The drop of the confinement cask at less than design allowable height is one of the hypothetical off-normal scenarios that the applicant must evaluate. The evaluation must show that the cask integrity and fuel spacing geometry are not compromised if the cask is dropped from a relatively low height. It must also show that the cask will continue to store fuel safely after such a drop.

For accident conditions, the hypothetical drop of a storage canister is classified as Design Event IV as defined by ANSI/ANS-57.9.

With regards to a cask drop accident, Section 15.5.2.2 of NUREG-1567 identifies the key items to be evaluated assuming a cask drop, including decelerations, evaluation of calculated stress intensities against the allowable stresses identified in the applicable code, evaluation of buckling stability for each component of the cask confinement subjected to compressive loading, and evaluation of deformation of cask internal members that could contribute to fuel assembly spacing geometry (for criticality concerns). While this guidance may apply to transport casks that do provide a confinement boundary, it may not be directly applicable to the transfer casks that are used to transfer canisters from transport casks to storage overpacks. In addition, in the event the spent fuel cask handling systems meet the NRC criteria for "single-failure-proof" (discussed in Section 9.1.5 of NUREG-0800, "Overhead Heavy Load Handling Systems"), the NRC does not require a cask drop accident to be postulated nor its consequences to be analyzed.

Within the alternative storage systems, there are two basic drop situations, with certain potential drop accidents that necessitate analysis and/or operational restrictions, as identified below:

(1) Handling inside the transport cask receiving structure and canister transfer facility:

- A drop of the transport cask with its impact limiters removed prior to being handled by the single-failure-proof crane requires analysis and operational restrictions.

- Transport cask drop accidents (other than above) and transfer cask drop accidents are precluded by the use of a single-failure-proof handling system, consisting of an overhead crane whose main hoist meets the NRC criteria for a single-failure-proof crane (i.e., NUREG-0554, "Single-Failure-Proof Cranes for Nuclear Power Plants," (Reference A2-26) or ASME NOG-1, "Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)" (Reference A2-27)).

(2) Handling outside the transport cask receiving structure and canister transfer facility (i.e., during cask transfer to the storage area):

- For some transport systems, it is required to assume a cask drop and, therefore, the lift height is limited to a height that has been fully analyzed for the assumed cask drop accident (e.g., TransNuclear transfer casks and NAC storage casks).

- For other systems (e.g., Holtec Vertical Cask Transporter), the lifting apparatus is required to meet ANSI N14.6 "American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10 000 Pounds (4500 kg) or More" (Reference A2-28) criteria for allowable stresses and to have redundant drop protection features. For these systems, no height restriction is required for cask transfer.

- For potential drops when a canister is being handled, lifts of canisters loaded with spent nuclear fuel are performed using single-failure-proof equipment and lifting devices that comply with the stress limits of ANSI N14.6 and have redundant drop protection to render an uncontrolled lowering of the payload non-credible, so a canister drop accident need not be postulated.

A2-5.5.7 Loss of Cooling Accident (LOCA)

The various spent fuel storage system alternatives all use passive air cooling of the dry storage canisters. The cooling air flow is driven by natural convection with cool air at ambient temperature entering the canister storage area near the bottom of the canister(s), rising as it is heated by the relatively hot outer surface of the canister(s), and exiting the canister storage area by outlet vents above the canisters.

It is credible that various types of debris or materials such as plastic sheets could blow into the canister storage area and block some of the air vents, thus reducing air flow and causing canister temperatures and spent fuel cladding temperatures to increase. Complete blockage of the air inlet ducts is classified as a Design Event IV accident condition as defined by ANSI/ANS-57.9. In addition, partial blockage of the cooling air vents is also analyzed as an off-normal condition, such as by assuming that one-half of the area of the air inlet vents is blocked. Thermal analyses are required to be performed to determine storage system temperatures, including canister and spent fuel cladding temperatures. The resulting temperatures are compared with the applicable temperature limits for off-normal (partial vent blockage) and accident or faulted conditions (complete blockage of air inlets).

Typically, the thermal analysis of partial blockage determines final steady-state temperatures of the storage system that result from the reduced air flow rates and these are compared to the maximum allowable temperatures of the various components to demonstrate the storage system can acceptably withstand this partial blockage with no operator actions.

For the accident condition involving postulated complete blockage of the air inlet vents, a transient thermal analysis is performed that determines the time at which temperatures of storage system components that are classified as Important to Safety exceed their maximum allowable temperatures for accident conditions, such as spent fuel cladding, canister confinement or canister basket material temperatures. This time is then used to establish a conservative required frequency of inspection or temperature monitoring of the storage system that ensures temperature limits will not be exceeded. This inspection frequency is then incorporated into the Technical Specifications that govern operations of the spent fuel storage facility. With regard to this inspection frequency requirement, Section 6.5.1.1 of NUREG-1567 recommends the following paragraph be incorporated into the Technical Specifications, based on results of the accident analysis that assumes complete blockage of air inlet vents:

> Surveillance requirement: Periodic surveillance will be performed to ensure that there is no blockage of cooling air flow in the heat removal system. This surveillance [typically based on the minimum time for stored material cladding or other material Important to Safety (e.g., shielding) to reach a threshold temperature in the event of a complete blockage occurring immediately following the prior surveillance.

Surveillance of cooling air vents for blockage can either be performed by visual inspection of the air inlet and outlet vents or by checking temperature readings of the temperature monitoring system to verify temperatures for each storage system are within allowable limits. ISFSIs frequently use temperature detectors mounted in the outlet vents to assess the performance of the natural convection air cooling system, since blockage of cooling air vents will result in reduced airflow with consequent increased air outlet temperatures. For ISFSIs with a relatively large number of storage systems, temperature monitoring is used to ensure worker doses are ALARA, since significant dose can be accrued by workers performing routine inspections of storage system air vents (typically, daily inspections are required), which requires the inspector to be in the near vicinity of the spent fuel storage systems.

A2-5.5.8 Off-Normal and Extreme Environmental Temperature

Ambient environmental temperatures must be evaluated for periods during which handling operations take place and also for the long time period over which spent fuel storage will occur. The various cask vendors have analyzed their products for intended use typically to cover all ISFSI sites in the continental U.S.

Minimum short-term temperature limitations are specified to ensure a sufficient safety margin against brittle fracture during handling. A typical operational limitation would be around 0°F, so it is likely that operational temperature restrictions imposed for other reasons may be more stringent (e.g., the minimum allowable temperature for crane operation). The lower bound off-normal temperature limit, applicable to long-term storage, is typically about -40°F.

Storage systems are designed for upper bound off-normal temperatures in the range of about 100°F, which is assumed to persist for a sufficient duration to allow the system to reach thermal equilibrium. The accident condition extreme ambient environmental temperature is typically around 125°F. Upper bound limitations are based on analyses that determine the storage system's ability to properly convey heat away from the spent fuel. Extreme environmental temperature is classified as a natural phenomenon Design Event IV as defined in ANSI/ANS-57.9.

A2-5.5.9 Lightning

Lightning is classified as a natural phenomenon Design Event III as defined in ANSI/ANS-57.9. Because a direct lightning strike of a storage SSC is a credible occurrence, the ISF storage system must withstand loads due to lightning, with the canister retaining its confinement integrity, and thereby preventing release of radioactivity. The lightning path to ground will vary, depending on the storage system alternative; but for each alternative, the canister will be protected from the effects of a lightning strike. (For example, for above-ground vertical cask storage, the steel shell of the overpack will convey the lightning to ground and the lightning will not pass through the canister, which is surrounded by the cask steel, so the strike will not affect the canister integrity.) Therefore, no offsite doses would result from this accident.

A2-5.5.10 C-STD Alternative Applicability

Each of the previously discussed design basis accidents for each alternative will be slightly different since each of the alternatives' design handles each of the accidents differently. The below list summarizes the applicability of the accidents with regard to C-STD:

1. Seismic (A2-5.5.1)

   The C-STD overpack design would need to be analyzed and proven to perform adequately for the sites seismic condition before it could be licensed. Since the existing pad supported systems have already been seismically qualified to high seismic criteria it is reasonable that a standardized overpack will perform similarly. A site-specific seismic analysis would need to be performed to ensure all components of the C-STD are qualified for the chosen ISF site's seismic input.

2. Tornado Winds / Missiles (A2-5.5.2)

   The C-STD overpack design would need to be analyzed and proven to perform adequately for the sites tornado condition before it could be licensed. Since the existing pad supported overpacks have been qualified to the NRC's tornado winds and missile criteria as discussed in A2-5.5.2. it is reasonable that a standardized overpack will perform similarly.

3. Flooding (A2-5.5.3)

   The C-STD would need to comply with all flooding requirements discussed in A2-5.5.3 and would also need to be designed such that the upper surfaces of the storage pads are situated above the elevation of the PMF from offsite sources.

4. Fire (A2-5.5.4)

   The C-STD would need to comply with all fire protection requirements discussed in A2-5.5.4, including fire sources from nearby buildings, fuel spills, combustibles, and wildfires. Since the existing pad supported overpacks have met the NRC's fire criteria as discussed in A2-5.5.4 it is reasonable that a standardized overpack will perform similarly.

5. Explosion (A2-5.5.5)

   The C-STD would need to comply with all explosion requirements from NRC Reg Guide 1.91 as discussed in A2-5.5.5. Since the existing pad supported overpacks have met the NRC's explosion criteria as discussed in A2-5.5.5 it is reasonable that a standardized overpack will perform similarly.

6. Canister Drop Accident (A2-5.5.6)

   The C-STD system would need to comply with all canister drop requirements from NUREG-1567 as discussed in A2-5.5.6. All material handling systems at the Pilot ISF are expected to use single-failure-proof cranes and redundant or overdesigned components and thus not require postulation of a dropped canister.

7. Loss of Cooling Accident (LOCA) (A2-5.5.7)

   The C-STD would need to comply with all LOCA requirements discussed in A2-5.5.7. A standardized overpack would need to be designed to use passive air cooling of the dual purpose canisters. Since the existing pad supported overpacks have met the NRC's passive cooling criteria as discussed in A2-5.5.7 it is reasonable that a standardized overpack will perform similarly.

8. Off-Normal and Extreme Environmental Temperature (A2-5.5.8)

   The C-STD would need to comply with all off-normal and extreme environment temperature requirements discussed in A2-5.5.8. Since the existing pad supported overpacks have met the NRC's off-normal and extreme temperature criteria for anywhere in the U.S. it is reasonable that a standardized overpack will perform similarly.

9. Lightning (A2-5.5.9)

   The C-STD would need to comply with all lightning requirements discussed in A2-5.5.9. Since the existing pad supported overpacks have met the NRC's lightning criteria as discussed in A2-5.5.9 it is reasonable that a standardized overpack will perform similarly.

A2-5.6 Licensing Evaluation

A2-5.6.1 Overview

10 CFR Part 72 governs ISFSI licensing. There are two options for licensing an ISFSI: (1) a specific license and (2) a general license. However, 10 CFR 72.210 only authorizes the use of a general license at a power reactor site with a 10 CFR Part 50 or 10 CFR Part 52 license. Since it is not anticipated that the ISF would be located at the site of a nuclear power plant, the ISF would be governed by a 10 CFR Part 72 specific license.

The process for obtaining a specific ISFSI license is similar to that for obtaining a license for a fuel cycle facility under 10 CFR Part 70 (Reference A2-29). The applicant submits a License Application (LA) in accordance with 10 CFR 72.16 that includes the information required by 10 CFR 72.22 through 10 CFR 72.28. The primary documents comprising the LA are as follows:

- Safety Analysis Report (SAR) that assesses safety of the storage system and the ISFSI facility (used as basis for NRC preparation of the Safety Evaluation Report)
- Environmental Report (used as basis for NRC preparation of the Environment Impact Statement)
- Proposed Technical Specifications
- Quality Assurance (QA) program
- Decommissioning Plan
- Emergency Plan
- Security Plan

A2-5.6.2 Licensing Process

Upon receipt of the application, the NRC establishes a docket number and reviews the application for completeness. If the application is deemed complete, the NRC prepares and publishes a notice of docketing in the Federal Register (FR). The notice of docketing identifies the site of the ISF and includes either a notice of hearing or a notice of proposed action and opportunity for hearing pursuant to 10 CFR 72.46. 10 CFR 72.46 provides the regulations governing the hearing process with references to 10 CFR Part 2 (Reference A2-30), as appropriate.

The NRC will request a hearing upon the notice of docketing if a statute specifically requires it, or if they believe it to be in the public interest, notwithstanding any requests for hearing submitted by parties who believe they having standing in the licensing action. 10 CFR 2.105(a)(7) specifies that if the NRC is not required by statute to conduct a hearing and does not find that a hearing is in the public interest, a notice of proposed action is instead published in the FR.

The notice of proposed action includes the time frame for any person whose interest may be affected by the proceeding to file a request for a hearing or a petition for leave to intervene if a hearing has already been requested. A request for hearing on a 10 CFR Part 72 License Application must be submitted, with the contentions upon which the hearing would be litigated, within 60 days of the notice of docketing. It is worth noting that if the 10 CFR Part 72 specific license applicant is incorporating design information pertaining to a previously NRC-certified spent fuel storage cask design by reference into the application, any hearing held to consider the application will not include any cask design issues pursuant to 10 CFR 72.46(e).

If any requests for hearing are received on the notice or proposed action, the NRC will establish an Atomic Safety Licensing Board (ASLB) to review the hearing requests and contentions for admittance. For the ASLB to admit a contention and grant a hearing, the requestor needs to have standing in the proceeding per 10 CFR 2.309(d), and at least one contention must meet the criteria in 10 CFR 2.309(f). The NRC may also permit discretionary intervention of someone not having standing under the strict requirements of 10 CFR 2.309(e).

Admitted contentions are litigated through a review of documents submitted by the petitioner and may require court testimony and/or documents to be submitted by the applicant, at the discretion of the ASLB. Hearings would take place after issuance of the Final Environmental Impact Statement (EIS). The ASLB may decide to start the hearings prior to completion of the NRC staff Safety Evaluation Report (SER). A license would not be granted until all hearings are completed and the contentions resolved in favor of the applicant. At that point, the Director of the Office of Nuclear Material Safety and Safeguards would request Commission authorization to issue the license pursuant to 10 CFR 72.46(d). While petitioners may appeal the resolution of contentions in the courts, the license would likely be issued without awaiting resolution of those court appeals.

The NRC reviews the application for a specific license, and generally there are several rounds of requests for additional information.

10 CFR 72.42, Duration of License; Renewal, paragraph (a) states the following:

> Each license issued under this part must be for a fixed period of time to be specified in the license. The license term for an ISFSI must not exceed 40 years from the date of issuance. The license term for an MRS must not exceed 40 years from the date of issuance. Licenses for either type of installation may be renewed by the Commission at the expiration of the license term upon application by the licensee for a period not to exceed 40 years and under the requirements of this rule.

A2-5.6.3 License Application

NUREG-1571, "NRC Information Handbook on Independent Spent Fuel Storage Installations," (Reference A2-31) summarizes key requirements for a specific license application, as follows:

- Siting Evaluation Factors (10 CFR 72 Subpart E)—The site characteristics, including external, natural, and manmade events, that may directly affect the safety or the environmental impact of the ISFSI.
- General Design Criteria (10 CFR 72 Subpart F)—Applies to the design, fabrication, construction, testing, maintenance, and performance requirements for structures, systems, and components important to safety.
- Quality Assurance (10 CFR 72 Subpart G)—The planned and systematic actions necessary to provide adequate confidence that a structure, system, or component will perform satisfactorily in service as applied to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, modification, and decommissioning.
- Physical Protection (10 CFR 72 Subpart H)—The detailed plans for ISFSI security.
- Personnel Training (10 CFR 72 Subpart I)—The program for training, proficiency testing, and certification of ISFSI personnel who operate equipment or controls important to safety.

The NRC will review the specific license application and complete an evaluation of potential environmental impacts of the ISFSI in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended (Reference A2-32). The NRC will prepare an EIS in accordance with 10 CFR Part 51 (Reference A2-33). Following its safety review and resolution of comments, the NRC issues a Materials License along with its SER and final EIS. The SER describes the conclusions of the staff's safety review based on the applicant's SAR and assesses the technical adequacy of the ISFSI and the spent fuel storage system(s).

Safety Analysis Report

The level of effort associated with preparation of the ISFSI SAR for a specific license can be reduced considerably by taking advantage of the permission granted in 10 CFR 72.46(e) to select storage systems with SARs that have been reviewed and approved by the NRC (with Certificate of Compliances [CoC] having been issued for the storage systems), or storage systems that are currently undergoing NRC review per 10 CFR 72, Subpart L. 10 CFR 72.46(e) states: "If an application for (or an amendment to) a specific license issued under this part incorporates by reference information on the design of a spent fuel storage cask for which NRC approval pursuant to subpart L of this part has been issued or is being sought, the scope of any public hearing held to consider the application will not include any cask design issues." With this approach, the NRC will focus its review on site-specific issues and storage system/site interface issues. This helps streamline the specific licensing process. Should the applicant select a storage system that has neither been reviewed and approved by the NRC nor is currently undergoing NRC review, the NRC must review information associated with the proposed spent fuel storage system as part of the specific license application, which would extend the review time.

Detailed guidance as to information that needs to be included in the ISFSI SAR that is submitted with the license application is provided by Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)" (Reference A2-34). Additional information to enable the NRC staff review in accordance with NUREG-1567 should also be included in the SAR, along with information from any applicable NRC Interim Staff Guidance (ISG). The SAR for the ISF will need to identify and evaluate each of the storage systems that will be used at the ISF to store SNF. For each individual system, the ISF SAR will need to address the following key topics specified in the NUREG-1567 Standard Review Plan:

- General description of the storage system
- Design criteria
- Structural evaluation
- Thermal evaluation
- Shielding evaluation
- Criticality evaluation
- Confinement evaluation
- Material evaluation
- Operating procedures
- Acceptance tests and maintenance program

- Radiation protection (occupational exposures, public exposures, ALARA measures)
- Accident analyses
- Operating controls (technical specifications)
- Quality assurance
- Decommissioning

The previous topics are addressed in the storage system vendors' SARs that have been approved by the NRC for general and specific ISFSI licenses; these documents can be incorporated by reference into the ISF SAR. It is envisioned that the ISF SAR will have a main body that describes and analyzes the ISF design and generic operations, with a separate appendix that serves as the SAR for each individual storage system. The ISF SAR will benefit in that it will primarily use SNF storage systems that have already been licensed under the provisions of 10 CFR Part 72, Subpart K, and have existing Final Safety Analysis Reports (FSARs) that have been approved by the NRC and can be referenced. A specific revision of the vendors' FSARs would need to be chosen for incorporation into the ISF ISFSI SAR. Changes to the vendors' FSARs thereafter would not automatically be incorporated by reference into the ISF SAR, but would require evaluation by the ISF license applicant for incorporation.

The SAR would include descriptions of the safety analyses and other technical evaluations for the ISFSI in each SAR chapter, incorporating by reference any required information for the storage system designs. The format and content would coincide with the chapters of the SRP in NUREG-1567 and any applicable Interim Staff Guidance documents amending that guidance. Formatting the ISFSI SAR in this manner sets the stage for a more efficient NRC technical review because the SRP establishes the format and content template for the NRC's SER.

Environmental Report

The Environmental Report (ER) that is submitted with the License Application is prepared to address the requirements of Subpart E of 10 CFR Part 72, Siting Evaluation Factors, and Subpart A of 10 CFR Part 51, National Environmental Policy Act - Regulations Implementing Section 102(2), using the guidance provided in NRC NUREG-1748, "Environmental Review Guidance for Licensing Actions Associated with NMSS Programs," (Reference A2-35). The ER contains the following key topics:

- General description of the proposed activities and discussion of need for the facility
- Site interfaces with the environment, including geography, demography, land use, ecology, climatology, hydrology, geology and seismology, historical and cultural features, and background radiation levels.

- Description of the facility, including appearance, construction, operations and effluent control
- Environmental effects of facility construction and operation, including transportation of radioactive material, and effects of decontamination and decommissioning
- Environmental effects of accidents involving radioactive materials, including transportation accidents
- Proposed environmental monitoring programs
- Economic and social effects of facility construction and operation, including cost benefit analysis
- Facility siting (site selection process) and design alternatives
- Environmental approvals including federal, state, and local regulations and permits

As noted above, the NRC will need to prepare a complete EIS for the ISF based on the ER submitted by the licensee, in accordance with 10 CFR Part 51 requirements.

A2-5.6.4 Licensing of Alternative Systems

The approach to licensing of the different alternative systems would be the same as that described above. Key differences involve the information that would be required in the License Application are discussed in the following paragraphs.

Pad Storage with Standardized Storage Overpacks

C-STD exchanges the existing storage overpacks or modules with standardized overpacks that consist of a single design. The standardized overpack could be a vertical or horizontal storage method or even one of each in an effort to reduce the design and operation variables and permit a more simplified process at the ISF. This alternative would also use a reinforced concrete storage pad to support the storage systems. The concrete pad design would only need to consider one storage type rather than 13, reducing the analyses, design and licensing time.

If the standardized overpack were a horizontal module to store all the canisters, a canister transfer facility would not be required, which could simplify the licensing by obviating the need for evaluation of canister transfers and associated facilities. It should be noted that in order to transfer “vertical” dual purpose canisters (DPCs) into a storage module, the transport cask would need a removable port on the bottom side to engage the ram that slides the DPCs into the horizontal storage module. This would require licensing effort under 10 CFR 71 to revise the design and safety analysis of transport casks that are currently licensed for shipment of vertical DPCs.

Another advantage involved with selection of a horizontal storage module as the standardized overpack from a licensing standpoint is that analysis of a cask tipover accident, which is required for a vertical overpack, is not required for a horizontal storage system. It is sometimes necessary to use concrete in the storage pad that has relatively low strength (e.g., 3,000 psi) to ensure the pad acts as a shock absorber and cask decelerations are limited so canister stresses remain within allowable limits.

If a vertical orientation is selected for the standard overpack, special features will need to be designed and licensed for handling horizontal DPCs. Horizontal DPCs cannot be lifted by their lid, as is the case for vertical DPCs, and therefore lifting of horizontal DPCs would require some type of lifting cage to lift the DPC and place it into a vertical position. Like Alternative 1; a canister transfer facility would be required to accommodate vertical canister transfer and to re-package the horizontal canisters into a lifting cage.

A one-size-fits-all overpack would have to accommodate 13 different DPCs, for the Pilot ISF, with varying sizes and permissible spent fuel characteristics (that impact decay heat loading and radiation source). There are also more DPC designs beyond the 12 shutdown reactors that would use the ISF which would need to be figured into the single overpack plan. The overpack would need to be constructed for the largest DPC. This would in turn necessitate design and fabrication provisions to accommodate the smaller DPCs such as shims or spacers to insure they would not: 1) rattle around excessively during an earthquake, or 2) require special ventilation ducting to insure adequate heat removal.

Since no standardized overpack currently exists that is designed and licensed to store several different DPC types, it would take several years to design and license standard overpacks that could store different canisters. Since the overpack could house a number of different DPC types, the design would need to be analyzed and licensed to demonstrate that various parameters (structural, thermal, radiological) are acceptable under normal, off-normal and accident conditions. Since the sizes and weights of the canisters vary, which would impact the center of gravity of the storage system, structural analyses would need to be performed to demonstrate storage overpack stability for various conditions including seismic, tornado wind/missiles, explosion overpressures that are specific to the ISF. The size of the canisters would affect the flow area in the annulus between the DPC and inner shell of the overpack, so thermal analyses would need to be performed to demonstrate adequate heat removal capability for each different DPC, also considering the maximum permissible decay heat loadings (which could vary) for the different DPCs. Shielding analyses would also need to consider not only DPC design features (thickness of steel shell, bottom plate and closure lid), but also gamma and neutron source strengths of the spent fuel permitted to be stored in the different DPCs, which varies with allowable spent fuel enrichment, burnup and cooling time.

Obtaining a single license could be difficult with the four vendor's proprietary designs since it is unlikely that any of the vendors would be willing to release design information to one of its competitors or even a third party. From a licensing standpoint it might be more prudent to let each vendor develop and license their own standardized overpack which would need to conform to specifications required for the ISF standard overpack (e.g., size and weight) but would be able to store any DPC designed and licensed by that vendor.

Storing vertical DPCs in a horizontal position or horizontal DPCs in a vertical position would require significant analysis and licensing effort. DPC design features would need to be accommodated in a difference storage positions. A structural analysis would need to be performed to determine, for example, how a vertical canister responds to an earthquake when stored in a horizontal module. Concentrated loads where the canister contacts the rails would need to be analyzed. Thermal analysis would need to be performed to show adequate heat removal from the DPC in the different orientation such that all the SNF and DPC materials are below design limits. Shielding would need to be reanalyzed for the changed DPC orientation. Dose rates may not be prohibitive when a vertical canister is stored in a horizontal module, and vice versa, however, dose rates would need to be evaluated and documented in the ISF SAR and ER. The analysis and re-licensing efforts could be reduced significantly by use of a single standardized vertical overpack and a single standardized horizontal storage module, so that the DPCs could be placed in the orientation for which they were originally designed and licensed. It is considered that this would be most efficient and avoid unnecessary analyses and licensing review.

A2-5.7 Security Evaluation

The purpose of security at an interim storage facility is to protect the SNF against acts of radiological sabotage and theft or diversion that could lead to an unreasonable risk to the health and safety of the public. The ISF must meet the requirements of 10 CFR 73 (Reference A2-36). In order to accomplish this task the ISF will need to establish and maintain a physical protection system which consists of the following:

- Controlled access
- Visual surveillance
- Detection and assessment of unauthorized individuals
- Adversary response
- Measures to resistance explosive devices

The physical security systems must be designed to protect against loss of control of the ISF.

Controlled Access

Controlled access is maintaining control of a clearly demarcated area and isolation of the material or persons within it. The features at the ISF that afford controlled access include a fenced Owner Controlled Area (OCA) typically established at the property boundaries, vehicular access gates into the property where security personnel can verify the identification and authorization of all persons and vehicles entering the site, a Protected Area (PA) with two physical barriers (fences or structures) designed to thwart physical intrusion, and personnel and vehicle access barriers into the PA. All of these features are required of the ISF regardless of the storage system utilized. However, the area required may vary depending on the storage alternative used thus affecting the OCA and PA boundary distances.

For standardized overpack storage, the PA will need to be approximately 250 acres in size which would require a perimeter fence roughly 2- 3 miles in length.

Visual Surveillance

Visual surveillance is establishing security guards around the PA who maintain an unobstructed view of the PA at all times. This may be performed from bullet resistant enclosures (BREs) placed around the PA which are occupied by security guards, closed circuit TV (CCTV) cameras that are viewed by security guards at the Central Alarm Station (CAS) or secondary Alarm Station (SAS) or security guards patrolling the site. BREs are situated at strategic locations within the PA to provide protected locations for security force personnel during a security event.

Standardized overpack on pad storage will primarily impact the number of BREs or cameras that are required to maintain line of sight around the vertical and horizontal systems. Horizontal storage modules can be placed in rows which allow BREs or cameras to be placed in such a manner as to allow line of sight across the aprons. Vertical storage overpacks are much more difficult to maintain visual surveillance. A matrix of 20-foot high silos affords an unauthorized person the ability to hide between the overpacks. Placing BREs or cameras at every row and column of the matrix would be excessive. However, the arrangement of the vertical overpacks will likely require some additional BREs or cameras to ensure that visual coverage throughout the cask pad is maintained. Having a wide space between the storage area and the PA fence could also assist in providing adequate assessment should an intruder penetrate the PA boundary.

Detection and assessment of unauthorized individuals

Detection of unauthorized individuals is maintained by establishing an intrusion detection system that can detect unauthorized penetration through the isolation zone located between the PA boundary fences and tamper devices on doors and equipment that send an alarm to alert security staff when the PA or security equipment is breached. Assessment of unauthorized individual is established by illuminating the PA with sufficient lighting that security guards can adequately determine the nature of the intrusion either visually or by the CCTV system. The intrusion and CCTV systems are monitored continually by security staff at the CAS and SAS.

Standardized overpack storage will only affect the detection and assessment capabilities based on the size of the PA discussed above. A longer PA boundary means more intrusion detection equipment and more cameras.

Adversary Response

Adversary response is the ability to prevent or delay the attempted theft of SNF or radiological sabotage by armed response personnel. Adversary response also includes the ability to provide timely communication to a designated response force such as the local law enforcement agency whenever necessary.

Standardized overpack storage will not affect adversary response since this is primarily a function of security staff and communication equipment.

Measures to resistance to explosive devices

Resistance to explosive devices intended to disable security personnel or radiological sabotage is maintained by establishing engineered barriers that prevent such explosions from damaging SNF storage containers or disabling security personnel. Engineered barriers consist of access points designed to slow the speed of approaching vehicles by turns, speed humps, or a serpentine design and a vehicle barrier system (VBS) made of thick reinforce concrete walls or heavy steel portal gates that are installed at a prescribed distance from the SNF or cask handling activities. The VBS prevents entry of vehicle-borne explosive devices. Its distance from the storage area minimizes the impact of an explosion if one were to occur.

Resistance to explosive devices is also maintained by passing persons through explosive and metal detectors, checking all hand-carried items by X-ray machines and inspecting all vehicles and deliveries by security personnel.

Existing horizontal storage modules and vertical storage overpacks have been extensively analyzed and tested to show that they can withstand high explosion pressure waves. It is very likely that any standardized overpack design will also have the same ability to withstand high explosion pressure waves due to the nature of the thick concrete and steel design. This ability would enable the VBS to be placed much closer to the PA which effectively reduces the overall footprint of the PA.

A2-6.0 Summary

In summary, the pros and cons to this alternative, listed from the highest most significant impact to the lowest least significant impact are as follows:

Pros

- A single overpack design would simplify overpack fabrication. Up to 6 overpacks or modules would need to be fabricated in C-PAD yet C-STD could lower that number to one and reduce equipment as well as the number of variations that the crew would need to be trained for and execute.
- The concrete pad design would only need to consider one storage type rather than 23, reducing the analyses, design and licensing time.
- The standardized overpacks and associated pads can be implemented over time, reducing their initial capital costs. As it is created, the SNF can be shipped to the Pilot ISF where concrete storage pads and standardized overpacks housing the DPCs can be installed over several years.

Cons

- No standardized overpack exists so it would take at a year or two to design and two to three more years to license. Since the overpack would house a number of DPC types, the design would have to prove to the NRC how all parameters (structural, thermal, radiological) are accomplished within a single design. DOE’s Strategy for an operational Pilot ISF by 2021 could be challenged.
- Vertical systems require a more extensive DPC transfer process that most likely would require a canister transfer facility. This facility is a large structure that increases the cost of the pad storage alternative. There are methods of canister transfer that can be performed without such a structure but they are more involved with increased manual steps that increases transfer time and personnel radiation dose.
- Placing vertical DPCs in a horizontal position or horizontal DPCs in a vertical position requires analysis and licensing time. Performing the new analyses required to store DPCs in a different position would be very involved and possibly difficult. Design features would need to be accommodated in a difference storage positions. A thermal analysis would need to be performed to show the DPC could release enough heat to keep all the SNF and DPC material below design limits as an active cooling system may be required. A structural analysis would need to be performed to determine, for example, how a vertical canister responds to an earthquake when stored in a horizontal module. Significant loads where the canister contacts the rails would need to be analyzed. A shielding analysis would need to be redone for each case. Dose rates may not be

prohibitive when a vertical canister is stored in a horizontal module, and vice versa. The dose rate numbers associated with each case would be different and they would need to be determined by analysis and documented. Therefore, the use of a single vertical overpack and a single horizontal module would be most efficient and avoid unnecessary analyses.

- A one-size-fits-all overpack would have to accommodate 13 different sizes of DPCs. There are also more DPC designs beyond the 12 shutdown reactors which would need to be figured into the single overpack plan. The overpack would need to be constructed for the largest DPC. This would in turn necessitate design and fabrication provisions for the smaller DPCs such as shims or spacers to insure they would not: 1) be battered around during an earthquake, or 2) require ventilation ducting to insure adequate heat removal.
- Horizontal DPCs cannot be lifted from the lid and would therefore require some type of lifting cage to lift and place into a vertical position. This is not a difficult task but it would add steps to the canister transfer process and the lifting cage would accrue additional costs.
- Obtaining a single license could be difficult with the four vendor's proprietary designs. The industry is highly competitive so it is unlikely that any one of the four vendors would be willing to release design information to one of its competitors or even a third party. To force such a move would cost time due to legal challenges. Because of this, it might be more prudent to let each vendor develop and license their own standardized overpack that is universal in size with all the overpacks. Of course, this raises the potential of 4 distinct fabrication processes which is better than 6 but not as efficient as one. Increasing the number of overpack designs eventually defeats the advantage of having a standardized overpack.

A2-7.0 References

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3. AREVA TN Final Safety Analysis Report for the NUHOMS HD Horizontal Modular Storage System for Irradiated Nuclear Fuel, NRC Docket No. 72-1032.
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5. FuelSolutions W74 Canister Storage Final Safety Analysis Report, NRC Docket No. 72-1026.
6. Holtec International Final Safety Analysis Report for the HI-STAR 100 Cask System, NRC Docket No. 72-1008.
7. Holtec International Final Safety Analysis Report for the HI-STORM 100 Cask System, NRC Docket No.: 72-1014.
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27. ASME NOG-1, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder), 2007.
28. ANSI N14.6 American National Standard for Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10 000 Pounds (4500 kg) or More, 1993.
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32. National Environmental Policy Act of 1969 (NEPA), as amended.
33. 10 CFR 51, Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions.
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