Initial Site-Specific De-Inventory Report for La Crosse

RPT-3022657-001

Prepared by: Orano Federal Services LLC

REVISION LOG

Rev.	Date	Affected Pages	Revision Description
000	11/05/19	N/A	Initial Issue
001	5/30/23	Disclaimer	Updated disclaimer per DOE GC recommendations
		Acronyms	Added Atomic Energy Act to acronym list
		Executive Summary	• Deleted first paragraph • Clarified some text • Updated here and throughout the report to “Security Plan” • Updated throughout the report “Emergency Response Plan”
		Section 1	• Editorial changes made to clarify text • No GTCC waste to be found at the site • Added “Possible” to caption of Figure 1-2
		Section 2	• Identified that the on-site coal-fired plant (Genoa #3) was retired in 2021.

Rev.	Date	Affected Pages	Revision Description
			• Updated status of remaining portion of site under 10 CFR Part 50 license. • Updated Figures 2-2 and 2-3 • Added Figures 2-3a and 2-3b • Update on potential availability of on-site barge facility formerly used for receipt of coal • Update to status of CoC • Update to haul path for use of existing rail spur • Updated Figures 2-8 and 2-18 • Update on potential availability of on-site barge facility formerly used for receipt of coal • Update on NAC-STC cask usage in China • Correction on leak test for port plugs in Table 2-11 • Minor updates on NAC-STC information
		Section 3	• Minor clarifications made throughout • Inclusion of information on approximate cost of new rail tracks • Update on potential availability of on-site barge facility formerly used for receipt of coal • Tables 3-3 and 3-5 added on-site barge dock to list
		Section 4	• New introductory text has been added to identify the temporal nature of the information in this chapter • Two new paragraphs provided by the Department of Energy's General Counsel have been added • Clarified entities and persons in bulleted list
		Section 5	Minor changes and clarifications
		Section 6	• Correction on leak test for port plugs • Corrected number of TSCs in campaign in Table 6-7 • Minor grammatical changes throughout • Added new footnote to clarify NRC route approval is not typically required for DOE shipments • Deleted text related to the superseded DOE Manual 460.2 • Deleted paragraph related to NRC oversight • Deleted material in section 6.6 related to the QAP
		Section 7	• Minor grammatical updates made • Revised title of Section 7.6
		Section 8	• Revised section title (removed “”Safety” • Clarifications made to the text • Removed GCUS from this section

Rev.	Date	Affected Pages	Revision Description
			• Clarified protection of Safeguards Information • Renamed sections 8.4, 8.11, 8.12, 8.13 • Deleted text related to the superseded DOE Manual 460.2 and DOE Order 460.2A and associated bullets in Sections 8.11, 8.12 & 8.13 • Added new bullets to Sections 8.11, 8.12 & 8.13 covering in-transit protection
		Section 9	• Modified section and sub-section titles • Minor grammatical updates made • Section 9.1 revised to reflect requirements associated with emergency response information that is commonly incorporated into an Emergency Response Plan • Corrected weather information in Section 9.2 • Updated information required for an emergency contact telephone number • Provided some clarifying remarks on the example index of an ERP and corrected some items in the index
		Section 10	• Added new item #2 • Clarified item #5 • Added new item #14
		References	Updated and added some new references

DISCLAIMER

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AAR	Association of American Railroads
AEA	Atomic Energy Act
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
ASNT	American Society for Nondestructive Testing
BNSF	Burlington Northern Santa Fe Railway
BWR	Boiling Water Reactor
CAD	Computer Aided Drawing
CFR	Code of Federal Regulations
CHF	Canister Handing Facility
CO	Crane Operator
CoC	Certificate of Compliance
COSS	Cask Operations Shift Supervisor
COTP	Captain of the Port
CRCPD	Conference of Radiation Control Program Directors, Inc.
CS	Carbon steel
CY	Connecticut Yankee Nuclear Power Plant
DFC	Damaged Fuel Cans
DHS	Department of Homeland Security
DOE	Department of Energy
DOT	Department of Transportation
DPC	Dairyland Power Cooperative
EO	Tractor/JCB Driver and Equipment Operator
ERP	Emergency Response Plan
FA	Fuel Assembly
FME	Foreign Material Exclusion
FRA	Federal Railroad Administration
FSAR	Final Safety Analysis Report
FSO	Facility Security Officer
FSP	Facility Security Plan
ft	feet

GCUS	Geographical Center of the 48 Contiguous United States
GPS	Global Positioning System
GTCC	Greater Than Class C
HAZMAT	Hazardous Material
HBU	High Burnup Fuel
HHT	Heavy Haul Truck/Trailer
HLW	High-Level Radioactive Waste
HRCQ	Highway Route Controlled Quantity
HTUA	High Threat Urban Areas
IL	Illinois
in	inch
ISFSI	Independent Spent Fuel Storage Installation
ISR	Independent Safety Review
kW	Kilowatt
LACBWR	La Crosse Boiling Water Reactor
lbs	Pounds
LLC	Limited Liability Corporation
LLEA	Local Law Enforcement Agency
LLW	Low-Level Radioactive Waste
LTP	License Termination Plan
MCC	Movement Control Center
MPC	Multi-Purpose Canister
mph	miles per hour
MTHM	Metric Tons Heavy Metal
MTSA	Maritime Transportation Security Act
MUA	Multi-Attribute Utility Analysis
NOAA	National Oceanic and Atmospheric Administration
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act
OJT	On the Job Training
OM	Operations Manager
OSHA	Occupational Safety and Health Administration
PHMSA	Pipeline and Hazardous Materials Safety Administration

PIH	Poisonous Inhalation Hazard
POL	Possession Only License
PPE	Personal Protective Equipment
PW	Procedure Writer
PWR	Pressurized Water Reactor
QA	Quality Assurance
QAP	Quality Assurance Program
QC	Quality Control
QS	QA/QC Specialist
RCT	Radiation Control Technician
RM	Rigger/Cask Operations Technician/Mechanic
RP	Radiation Protection
RSAT	Risk and Security Assessment Team
RSSM	Rail Security Sensitive Materials
RWP	Radiation Work Permit
SAR	Safety Analysis Report
SME	Subject Matter Expert
SNF	Spent Nuclear Fuel
SP	Security Personnel
SS	Stainless Steel
START	Stakeholder Tool for Assessing Radioactive Transportation
TC	Transport and Waste Management Coordinator
TFR	Transfer cask
TIH	Toxic Inhalation Hazards
TPE	Training Program Evaluation
TS	Technical Specification
TS	Training Specialist
TSA	Transportation Security Administration
TSC	Transportable Storage Canister
TWIC	Transportation Worker Identification Credential
UP	Union Pacific
U.S.	United States
USCG	U.S. Coast Guard

VCC	Vertical concrete cask
VDS	Vacuum Drying System
VSP	Vessel Security Plan
WVDP	West Valley Demonstration Project
YR	Yankee Rowe Nuclear Power Station

EXECUTIVE SUMMARY

The purpose of this report is to assist the United States (U.S.) Department of Energy (DOE) in laying the groundwork for implementing an integrated nuclear waste management system. This includes preparing for future large-scale transport of Spent Nuclear Fuel (SNF), High-Level Radioactive Waste (HLW), and Greater Than Class C (GTCC) Low-Level Radioactive Waste (LLW). This report addresses the tasks, equipment, and interfaces necessary for the complete de-inventory of the La Crosse Boiling Water Reactor (LACBWR) independent spent fuel storage installation (ISFSI) site located near the town of Genoa, WI, approximately 19 miles south of La Crosse, WI. As such, this report is intended to provide information useful for planning options within an integrated nuclear waste management system.

Multiple modes of transport of the existing SNF were considered as part of this report (i.e., heavy haul truck (HHT), rail, and barge). Barge-to-rail, HHT-to-rail, and direct rail access were evaluated as viable modes of transport by this assessment. To assess the identified routes and modes, a Multi-Attribute Utility Analysis (MUA) was performed. In addition to subject matter expert (SME) input, data from the DOE's Stakeholder Tool for Assessing Radioactive Transportation (START)[1] program was utilized to support the evaluation of the routes in the MUA. The MUA established a ranking of routes and modes of transport for shipping the existing SNF from LACBWR to the hypothetical destination near the geographical center of the 48 contiguous United States (GCUS).

1) Barge Only taking the Mississippi direct to GCUS (i.e., referred to as "A. Barge Only" route in the MUA).
2) Heavy Haul Truck (HHT) Minimum Distance to GCUS (i.e., referred to as "B. HHT Only" route in the MUA).
3) Burlington Northern Santa Fe, LLC (BNSF) only rail on-site loading direct to GCUS (i.e., referred to as "C. Rail Only (BNSF Only)" route in the MUA).
4) HHT from LACBWR ISFSI to French Island, WI and then by rail to the GCUS (i.e., referred to as "D. HHT/Rail Transload at French Island, WI" route in the MUA).
5) HHT from LACBWR ISFSI to Merrillan, WI and then by rail to the GCUS (i.e., referred to as "E. HHT/Rail Transload at Merrillan, WI" route in the MUA).

Sensitivity analyses were performed on the MUA results to examine the impact on the rankings of the routes created by changes in the weighting of metrics used to evaluate those routes (e.g., cost of rental equipment, ease of permitting, etc.) and by suppressing the evaluation range of some specific metrics (e.g., cumulative worker exposure). The sensitivity analyses showed fairly consistent rankings, with the highest ranked route remaining such during virtually all manipulations, despite slight variations in the ranking of the remaining assessed routes, depending on the sensitivity analyzed. For example, if both the public acceptability and security metrics were removed from consideration, there is no change from the original rankings, with the direct rail route remaining the highest ranked route.

Using the primary MUA result, a concept of operations and recommended budget and spending plan are detailed for the removal of existing SNF from the LACBWR site using the most attractive shipment route: by rail on the BNSF direct to the GCUS (Route C. Rail Only (BNSF Only). The total estimated budget for the entire LACBWR campaign organized over 16 calendar weeks is

$5.6M (2021). Also documented in this assessment are aspects of a Security Plan and associated procedures, as well as an Emergency Response Plan (ERP) and associated preparedness for the prospective shipments. Finally, the recommended next steps are identified for the process of initiating the removal of the existing SNF from the LACBWR site.

1.0 INTRODUCTION

This report provides an assessment of the tasks, equipment, and interfaces that would be necessary to remove the SNF from the LACBWR ISFSI located near the town of Genoa, WI, approximately 19 miles south of La Crosse, WI. The objective of this removal activity would be to transport the existing SNF to a Class I railroad, where it could then be transported to a future consolidated interim storage facility or geological repository. A railroad hub in the central U.S. with connections to all other major rail carriers was used as the route endpoint for the purposes of this study, because it could serve as a connection point to storage or disposal facilities located in any region of the U.S. The use of GCUS as a hypothetical destination is not to imply that this location is being considered for a future consolidated interim storage facility, geological repository, or a transportation hub but was used, for purposes of this report, as a basis for scheduling and costing estimates assessed in this report.

In performing this assessment, the results are expected to support the laying of groundwork for implementing an integrated nuclear waste management system for the U.S. DOE. This includes preparing for future large-scale transport of SNF. This assessment specifically examines the removal of the existing SNF contained within the LACBWR ISFSI using Orano's and our teaming partners' experiences in the shipping of like and similar materials. For the purposes of this assessment, it is assumed that DOE would be responsible for a federal consolidated interim storage facility or geological repository to which the material would be shipped and would be the shipper of record; it is also assumed that the shipments would be regulated by the U.S. Nuclear Regulatory Commission (NRC) and the Department of Transportation (DOT) like comparable commercial shipments. There is no greater than Class C low level waste (GTCC) located on the LACBWR site requiring transport.

To lay the foundation of the assessment, the report begins by examining the pertinent site information in **Section 2.0**, including a description of the site and its characteristics, the characteristics of the existing SNF to be shipped from the site, a description of the NAC standardized system used to store this material onsite and the associated transportation packaging system, the NAC-STC. The site information is vital to establishing whether sufficient space exists to perform transfer activities and to assessing and identifying the potential need for site infrastructure modifications (e.g., fence line modifications to optimize/streamline transfer operations and/or loading activities) and/or hardware requirements (e.g., need for a transfer cask) to facilitate the shipment of these NAC-STC from the LACBWR ISFSI. Although accessing the site was not within the scope of this activity, sufficient sources of information existed for an informed assessment of the site to be performed, but ultimately a formal inspection would be necessary to verify assumed site criteria. Identification of the characteristics of the existing SNF at the LACBWR ISFSI provide the information necessary to verify compliance with the transportation licenses of the transportation package(s) as identified in their NRC Certificates of Compliance (CoCs). Similarly, the description of the NAC STC to be shipped are also verified to be compliant with their CoCs, allowing, if necessary, either a NAC-STC to be brought into compliance or identification of exemptions requiring approval from the regulator.

After the pertinent site information was assessed, a transportation route analysis was performed, as described in **Section 3.0**, identifying transportation routes from the LACBWR ISFSI to a Class I railroad, which would then be used for subsequent shipment to a repository or interim storage facility. Multiple modes of transport of the existing SNF were considered (i.e., HHT, rail, and barge). From the LACBWR ISFSI site itself, all three modes were evaluated to be viable options for shipment of the existing SNF. **Figure 1-1** depicts the major steps of the potential transfer scenarios considered. As shown in this figure, the direct to rail scenario appears to be the least complicated approach, with the minimum number of times the NAC-STC are handled, whereas the barge scenario appears to be more complicated, with additional handling activities. The result of the assessment of the transportation routes is a listing of multiple viable routes with various attributes, both positive and negative, that require evaluation to identify the optimal and/or favored route to transport the existing SNF from the LACBWR site.

An MUA was selected as the means to assess the various routes and modes and identify a ranking of these routes. Due to the large number of routes and associated modes initially identified, performing the MUA for all possible routes would be burdensome, so initial screening criteria were established to allow for less attractive routes to be screened from further consideration based on attributes associated with a particular mode of transport (i.e., screening is performed only between routes associated with a particular mode of transport). These screening criteria were applied in **Section 3.5** to reduce the number of identified routes from greater than 20 to a manageable number of five; these routes are presented in **Figure 1-2**. After the participating entities were identified in **Section 4.0**, these five routes (using all three common modes from the site: HHT, barge, and direct loading on to rail) were evaluated using the MUA to rank the routes for shipping the existing SNF from LACBWR to the hypothetical destination of GCUS by Class I rail in **Section 5.0**.

Based on the results from the MUA, a concept of operations and recommended budget and spending plan are detailed for the highest ranked shipment route in **Section 6.0** and **Section 7.0**, respectively. This assessment also includes information on a Security Plan and associated procedures in **Section 8.0** and an Emergency Response Plan and associated preparedness for the prospective shipments in **Section 9.0**. Finally, **Section 10.0** identifies the recommended next steps to initiate removal of existing SNF from LACBWR.

The routes are described in further detail through-out this report. These figures were produced using results from START software[1]. The colored lines indicate the routes analyzed by the MUA as explained in the figure.

Figure 1-1: Loading Operations For Transport Modes Considered

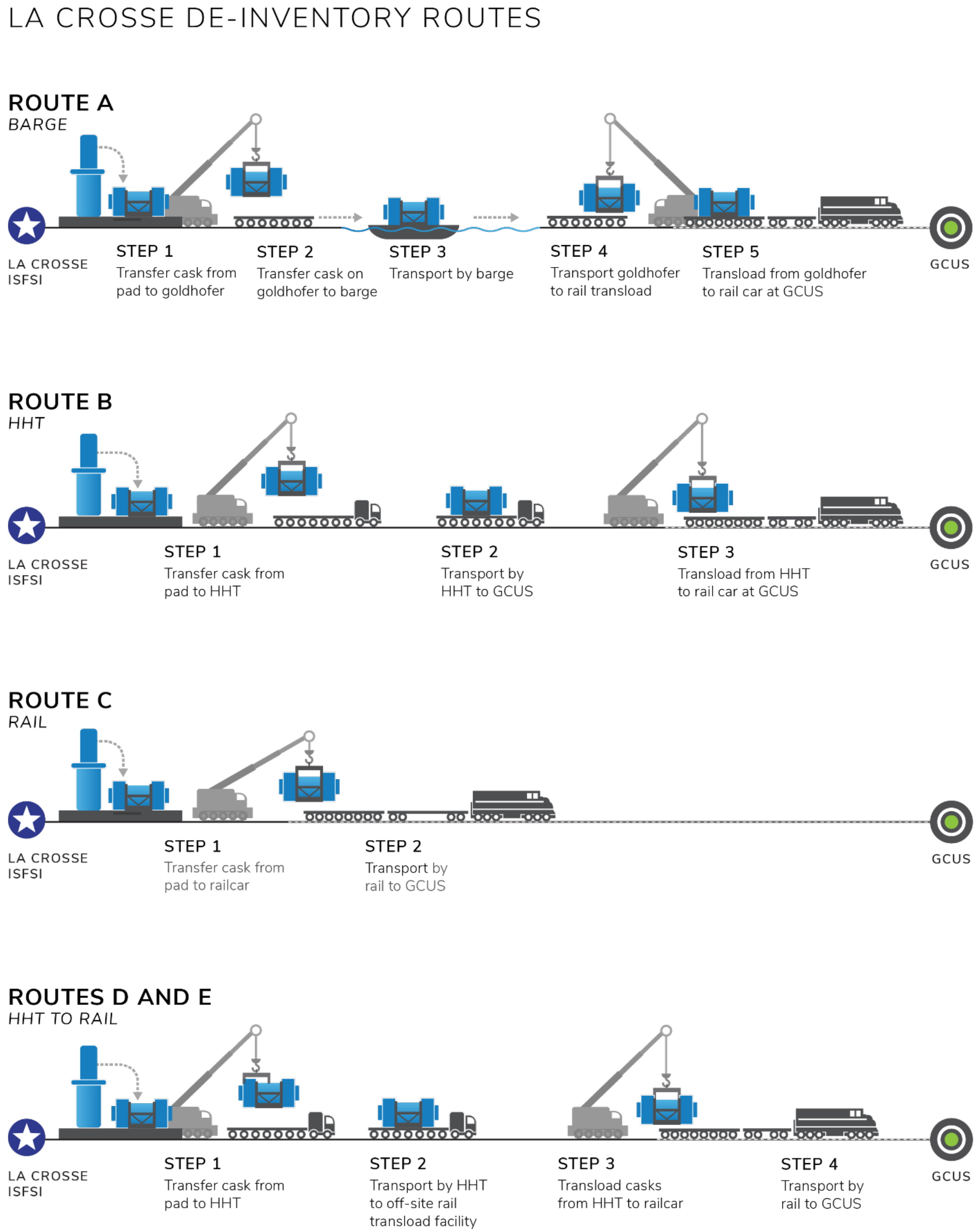
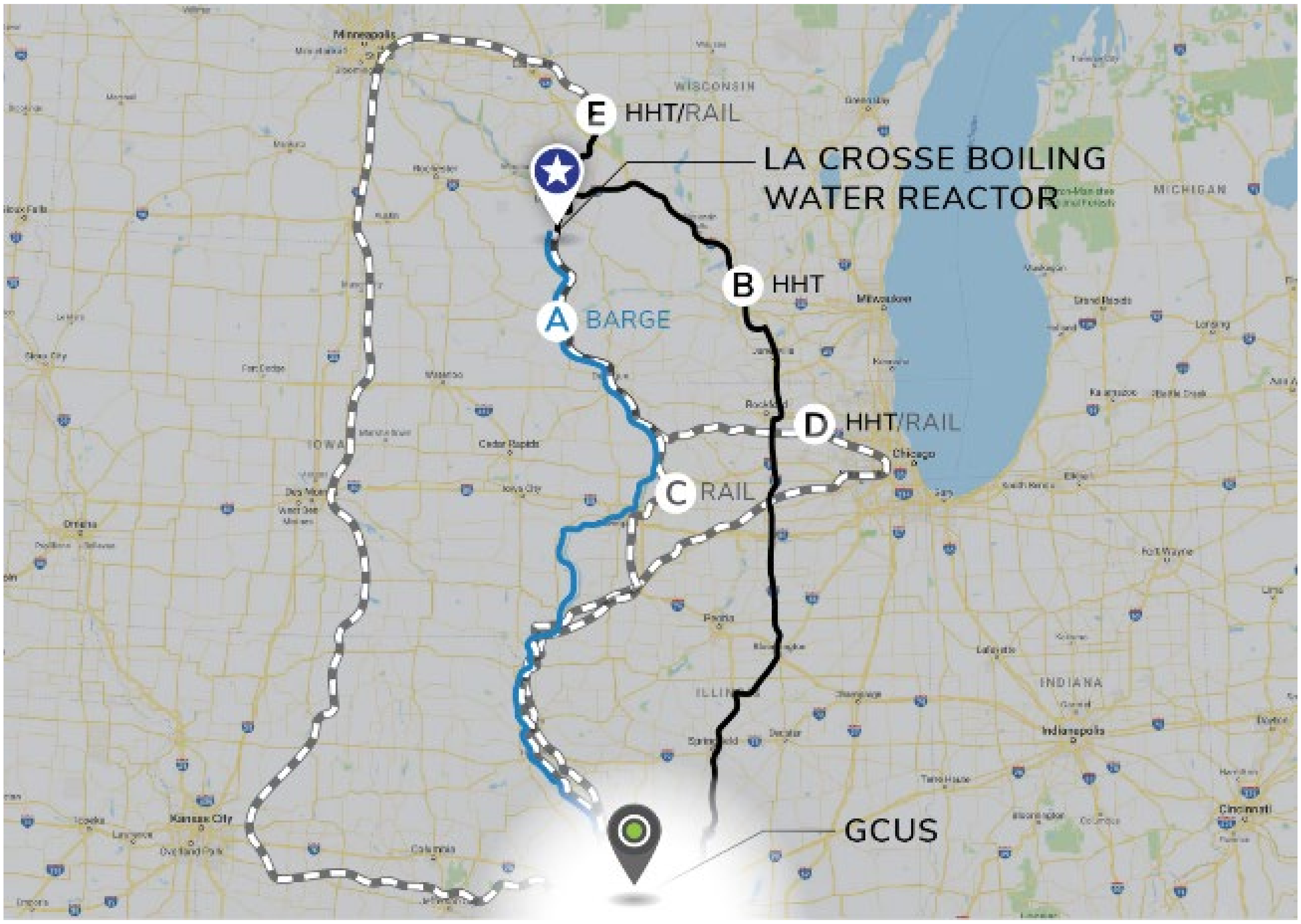


Figure 1-2: Possible Shipment Routes Of SNF From LACBWR ISFSI Evaluated By The MUA



2.0 PERTINENT SITE INFORMATION

2.1 Description of Site/Characteristics

The La Crosse Boiling Water Reactor (LACBWR), owned by Dairyland Power Cooperative (DPC), is located on the Genoa site on the east shore of the Mississippi River about 1 mile south of the Village of Genoa, Wisconsin and approximately 19 miles south of the city of La Crosse, Wisconsin as shown in **Figure 2-1**. The LACBWR, also known as Genoa Station #2, is part of the Genoa site which includes the retired fossil generating station (Genoa #3) and the site switchyard. In 1989, the coal and later oil fueled power plant (Genoa #1) was removed from the site.[1] On June 1, 2021, the coal-fired power plant (Genoa #3) was retired and is undergoing decommissioning and demolition activities and is scheduled to be completed in late 2024.[56]

The LACBWR site was approximately 163 acres prior to the 2017 partial site release of 88 acres and the 2023 partial site release of 36.5 acres as shown in **Figure 2-2**. Currently, the LACBWR licensed site is the approximately 39-acre ISFSI as shown in **Figure 2-3**. The terrain near the site is generally flat with some small rises. Elevations range from about 635 to 670 feet above sea level. The normal pool elevation of the Mississippi River near the plant is 620 feet above sea level. The site is bordered to the west and north by the Mississippi River, and by Highway 35 to the east. The southern portion of the site is bordered by the Mississippi River National Wildlife and Fish Refuge's Pool 9 area. The area around the site is mainly rural and undeveloped. The closest community is the village of Genoa, with a population less than 300.[3]

The LACBWR was a demonstration boiling water reactor (BWR) that went critical in 1967 and began commercial operation in 1969 as part of a joint project between the federal Atomic Energy Commission (AEC) and the DPC to demonstrate the peacetime use of nuclear power. The LACBWR was an Allis Chalmers 50 megawatt (electric) nuclear power plant (10 CFR Part 50 Facility Operating License DPR-45, Docket No. 50-409)[4]. The Allis-Chalmers Company was the original licensee of LACBWR; the AEC later sold the plant to DPC on August 28, 1973. LACBWR was shut down for economic reasons on April 30, 1987 and was defueled by June 1987. A possession only license (POL) was issued by the NRC in 1988. LACBWR was placed in SAFSTOR on August 7, 1991. The NRC issued an order to authorize decommissioning of LACBWR and approve the licensee's proposed Decommissioning Plan (DP) on August 7, 1991. The DP and Post-Shutdown Decommissioning Activities Report have been combined into a D-Plan/PSDAR document which is also considered the FSAR and DSAR for LACBWR and is updated every 24 months.[3] All spent fuel and fuel debris were placed into dry cask storage at an on-site ISFSI in September, 2012 as shown in **Figure 2-3**. The ISFSI is generally licensed under the provisions of 10 CFR Part 72, Subpart K (Docket No. 72-046). Subpart K grants a general license to holders of 10 CFR Part 50 licensees to construct and operate an ISFSI on a site licensed under 10 CFR Part 50. The spent nuclear fuel will remain in storage under amended 10 CFR Part 50 licenses and the associated 10 CFR Part 72 license until the fuel is transferred to a federal repository, offsite interim storage facility, or licensed temporary monitored retrievable storage facility. On June 1, 2016, the license was transferred from DPC to LaCrosse*Solutions* and DECON activities began. The License Termination Plan (LTP) was also submitted for NRC review in June 2016. The LTP details final decommissioning and dismantlement activities including site remediation and survey of residual contamination. LaCrosse*Solutions* requested a partial site release of 88 acres of non-impacted land from the Part 50 license. The NRC approved the partial site release in April 2017. On September 24, 2019, the NRC issued an order approving the transfer of the POL from LaCrosse*Solutions* back to DPC once all NRC reviews are completed and approved.[43] On February 14, 2020, LaCrosse*Solutions* requested another partial site release of approximately 36.5 acres, leaving approximately 39 acres associated completely with the ISFSI.[59] LaCrosse*Solutions* and its subcontractors completed all decommissioning and demolition activities November 2021 as shown in **Figure 2-4** and **Figure 2-5**. On February 24, 2023, the NRC approved the final site survey reports and announced the release of all site areas outside of the ISFSI for unrestricted public use.[54][55] DPC has responsibly under the 10 CFR Part 50 license for the security, protection, and nuclear liability insurance coverage of the approximately 39-acre ISFSI area shown in **Figure 2-3**.

Figure 2-1: LACBWR Site Location[8]

Figure 2-2: LACBWR Site Boundary Prior to 2017 and 2023 Partial Site Releases[8]

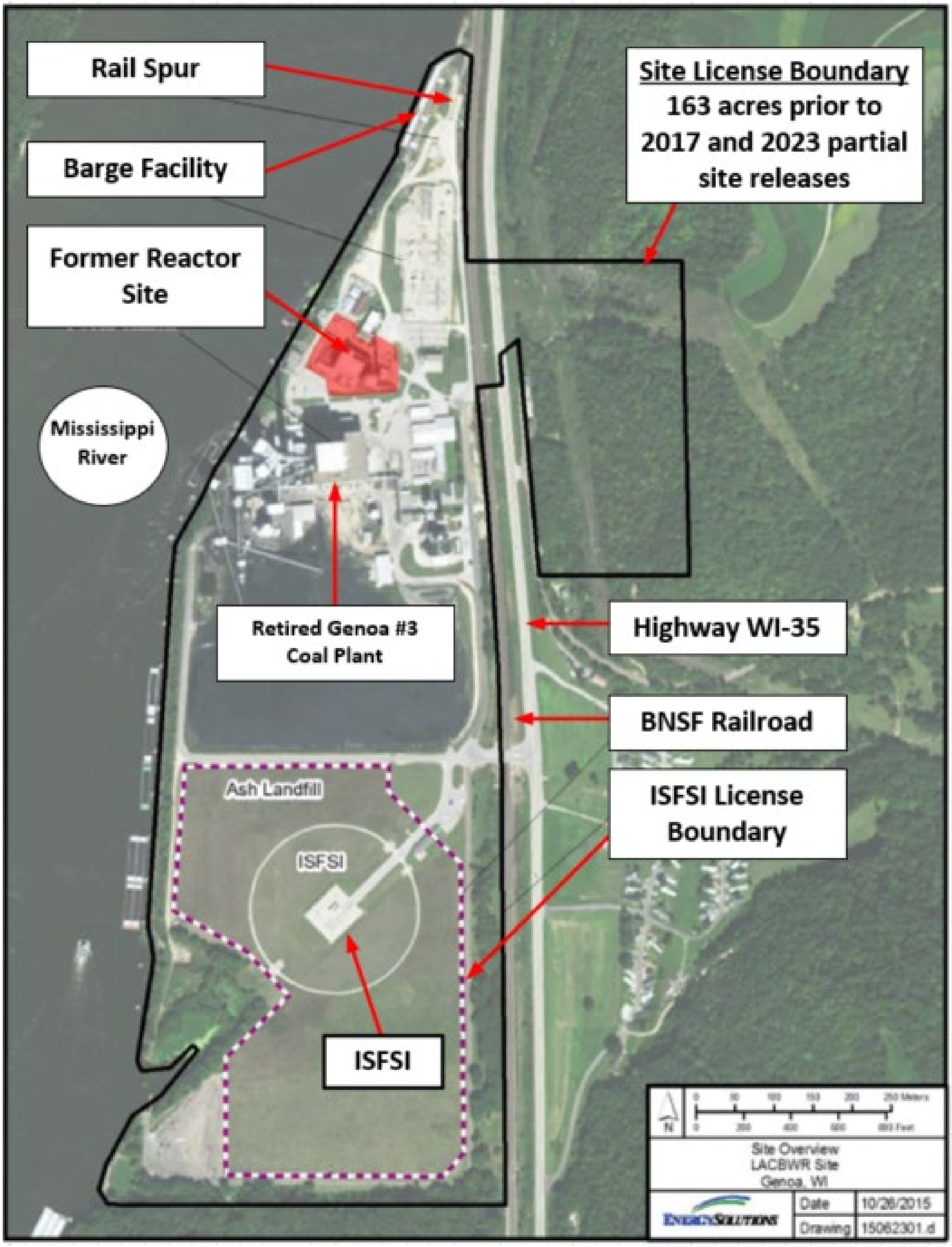


Figure 2-3: LACBWR Site Boundary[8]

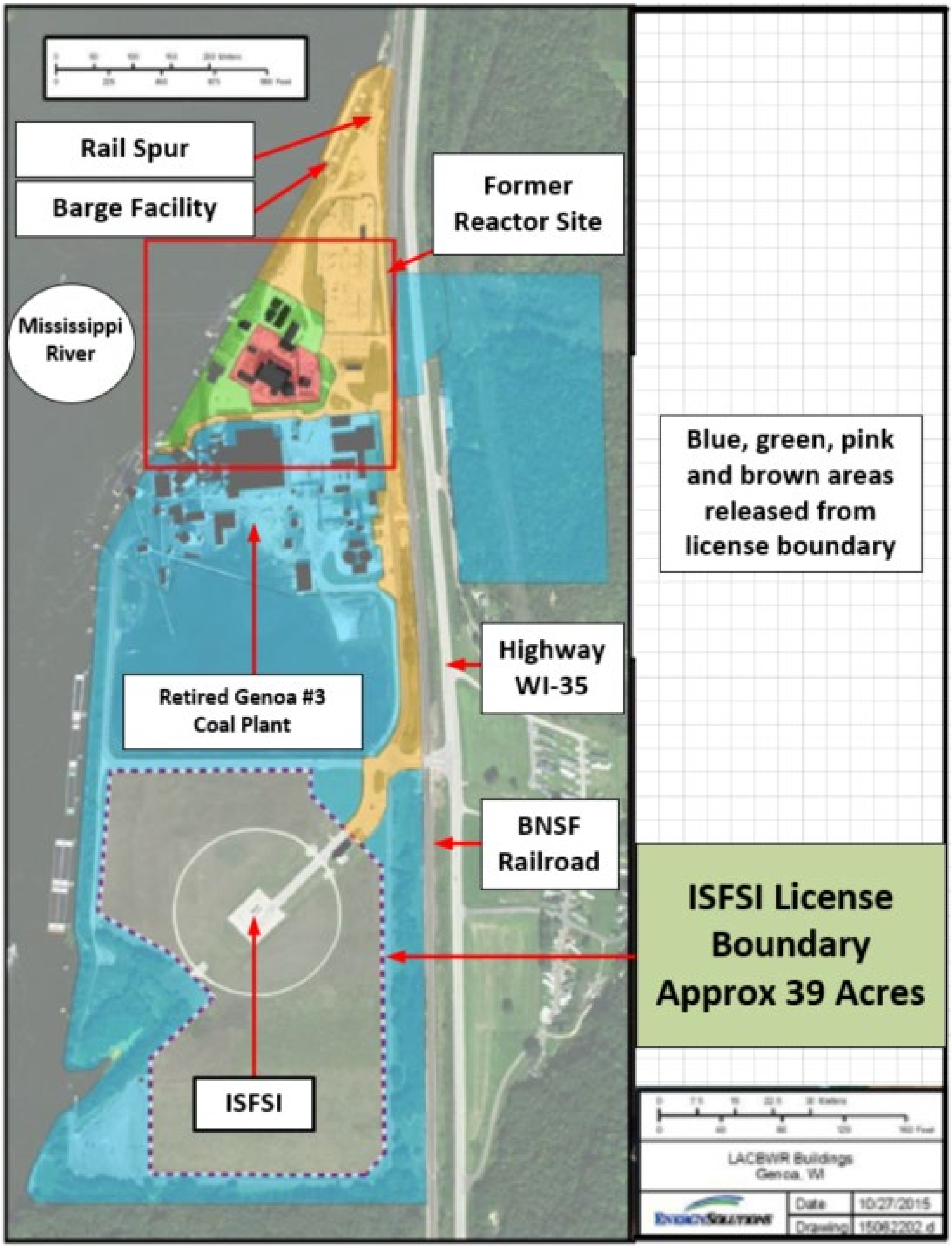


Figure 2-4: LACBWR Site South View[60]

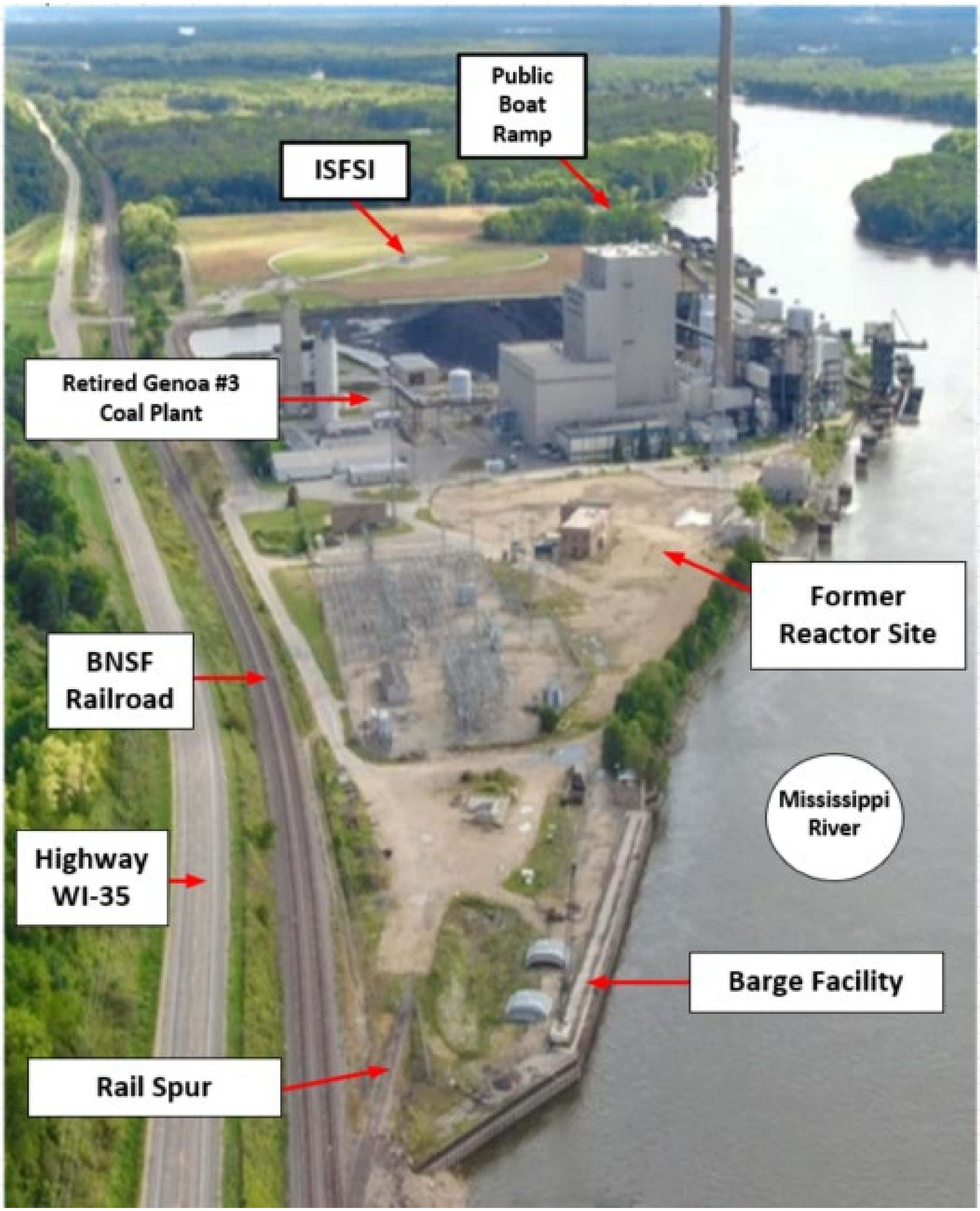


Figure 2-5: Former Reactor Site North View

Photo courtesy of La Crosse

The site is directly served by the BNSF Railroad running along the eastern boundary of the site. A short on-site rail spur enters the site at the north end of the property just off the BNSF main line. The on-site rail spur would require refurbishment and an extension for de-inventory shipments. The LACBWR site has an active barge facility located on the Mississippi River in the same area as the rail spur and had previously been used for inbound coal shipments while the G-3 plant was operating. The barge facility was used because the rail and truck modes were not suitable for moving large quantities of coal onto the site. The barge facility is currently being maintained and used as needed for outbound steel and iron shipments from G-1. It is possible the barge facility docks could be used to roll on loaded casks. An assessment of the dock capacity and structural integrity would be required to confirm that the dock could withstand the combined weight of the ramps, goldhofer trailers, and loaded casks and also handle the shifting transfer of the weight while loading the barges.

There is a public boat ramp area southwest of the ISFSI licensed area that may be suitable for a barge landing. An evaluation of the severity of the slope in the boat ramp area would be needed to confirm the feasibility of roll-on operations. At one time, this boat ramp area was part of the La

Crosse site. There is a paved road that leads from the ISFSI to the boat ramp, which could be used to transport the casks from the ISFSI to the water for loading onto a grounded barge. The on-site road system connects to highway WI-35 east of the site with access to interstate I-90, an east-west highway about 22 miles north of the site.

The storage system used at the LACBWR site is the NAC International Multi-Purpose Canister storage system (NAC-MPC) (Docket No. 72-1025), designated as MPC-LACBWR, which consists of a transportable storage canister (TSC) with a spent fuel assembly (SFA) fuel basket, a vertical concrete cask (VCC) storage module, and a transfer cask (TFR). The TSCs can be loaded into a NAC Storable Transport Cask (NAC-STC) (Docket No. 71-9235) to enable transporting the contents from the LACBWR site. Refer to **Section 2.2** and **Section 2.3** for information regarding the details of the SNF to be shipped and for canister and overpack details.

All of the SNF and fuel debris was removed from the Fuel Element Storage Well (FESW) and moved to the on-site ISFSI.[1] The intact fuel assemblies were loaded into the TSCs. Damaged fuel assemblies and fuel debris were first loaded into Damaged Fuel Cans (DFCs) and were then loaded into TSCs in fuel basket locations designated for damaged fuel. The TSCs were then loaded into VCCs and moved to the ISFSI Storage Pad. There is no GTCC waste stored at the LACBWR ISFSI. The total inventory of the LACBWR SNF stored in MPC-LACBWR systems is presented in **Table 2-1**.

Table 2-1: SNF TSC Inventory Summary for LACBWR Site[18][19]

LACBWR TSC Canisters SNF	# SNF Assemblies (BWR)	# Damaged Fuel Cans	# Damaged SNF Assemblies
5	333	160 (158 loaded + 2 empties)	157 + 1 DFC with Fuel Debris

The 5 NAC-MPC canisters of spent nuclear fuel are currently registered to NAC-MPC Certificate of Compliance (CoC) No.1025, Amendment 6 and NAC-MPC FSAR Revision 11[12]. It is expected that the MPC-LACBWR systems will be re-registered to CoC No. 1025, Amendment 9 and FSAR Revision 13 once the CoC renewal is completed in mid-2023 to bring the systems up to date with the current CoC and Technical Specification requirements. Use of the ISFSI for storage and handling of spent fuel is granted upon compliance with the conditions of the General License issued under 10 CFR 72, Subpart K.

The MPC-LACBWR dry cask storage system and the ISFSI provide long-term on-site storage of LACBWR SNF as shown in **Figure 2-6, Figure 2-7**, and **Figure 2-8.** The configuration of the loaded VCCs on the ISFSI pad is shown on **Figure 2-9**.

The ISFSI is located 2,232 feet south of the former reactor building and currently stores five loaded vertical concrete casks on a 32 feet x 48 feet x 3 feet thick concrete storage pad.[58] There is an approach pad approximately 60 feet long x 14 feet wide directly adjacent to the southeast side of the ISFSI pad for truck and trailer VCC loading/unloading operations. A 30 feet long x 12 feet wide ramp is located on the southwest end going up from the paved ISFSI area onto the ISFSI pad. The pad is surrounded by two security fences and supporting utility fixtures, as well as an ISFSI Security Administration Building that provides security, monitoring, equipment, and support for the ISFSI. DPC will provide operations, maintenance, access control, and security services for the LACBWR ISFSI site. In addition to the two security fences, the ISFSI pad is located in the middle of a circular concrete barrier of approximately 650 feet diameter. A 28 feet wide asphalt road runs approximately 325 feet from the ISFSI pad in a northeast direction to the ISFSI access gate.[6]

Figure 2-6: LACBWR ISFSI Aerial View[5]

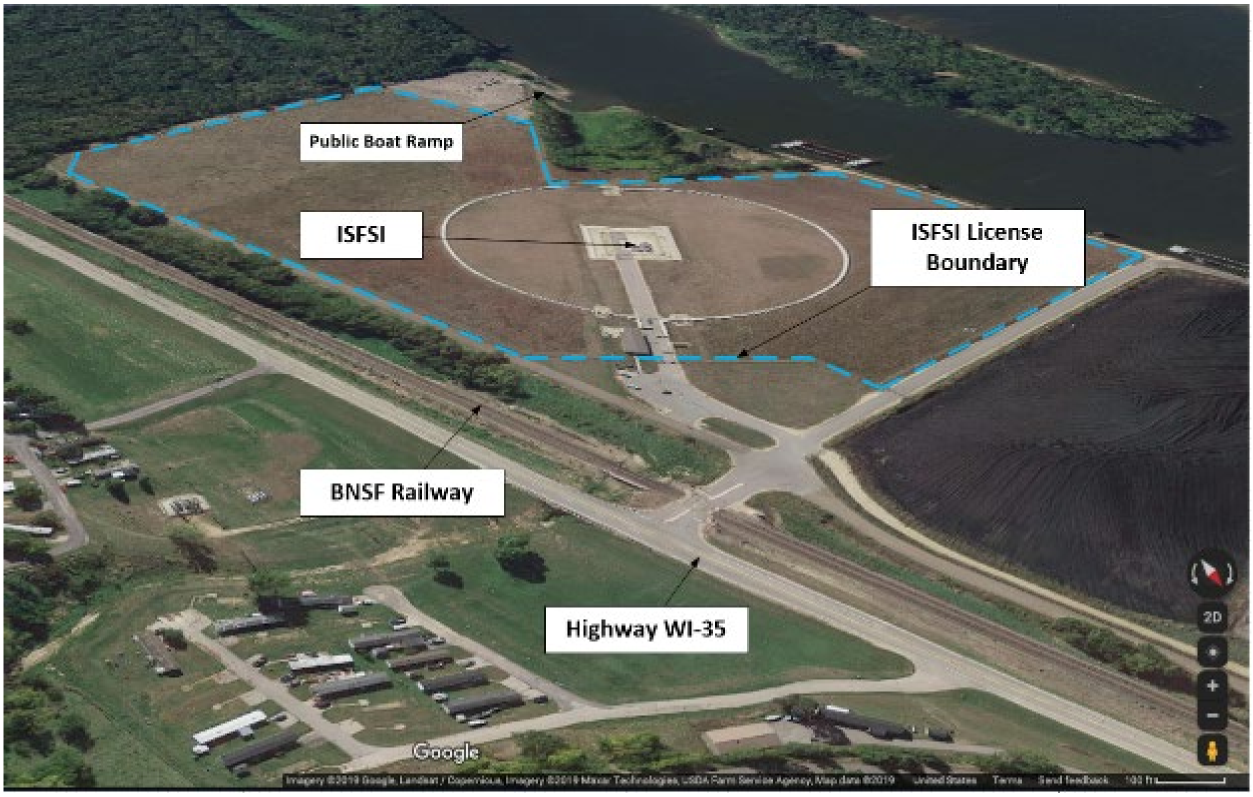


Figure 2-7: LACBWR ISFSI[5]

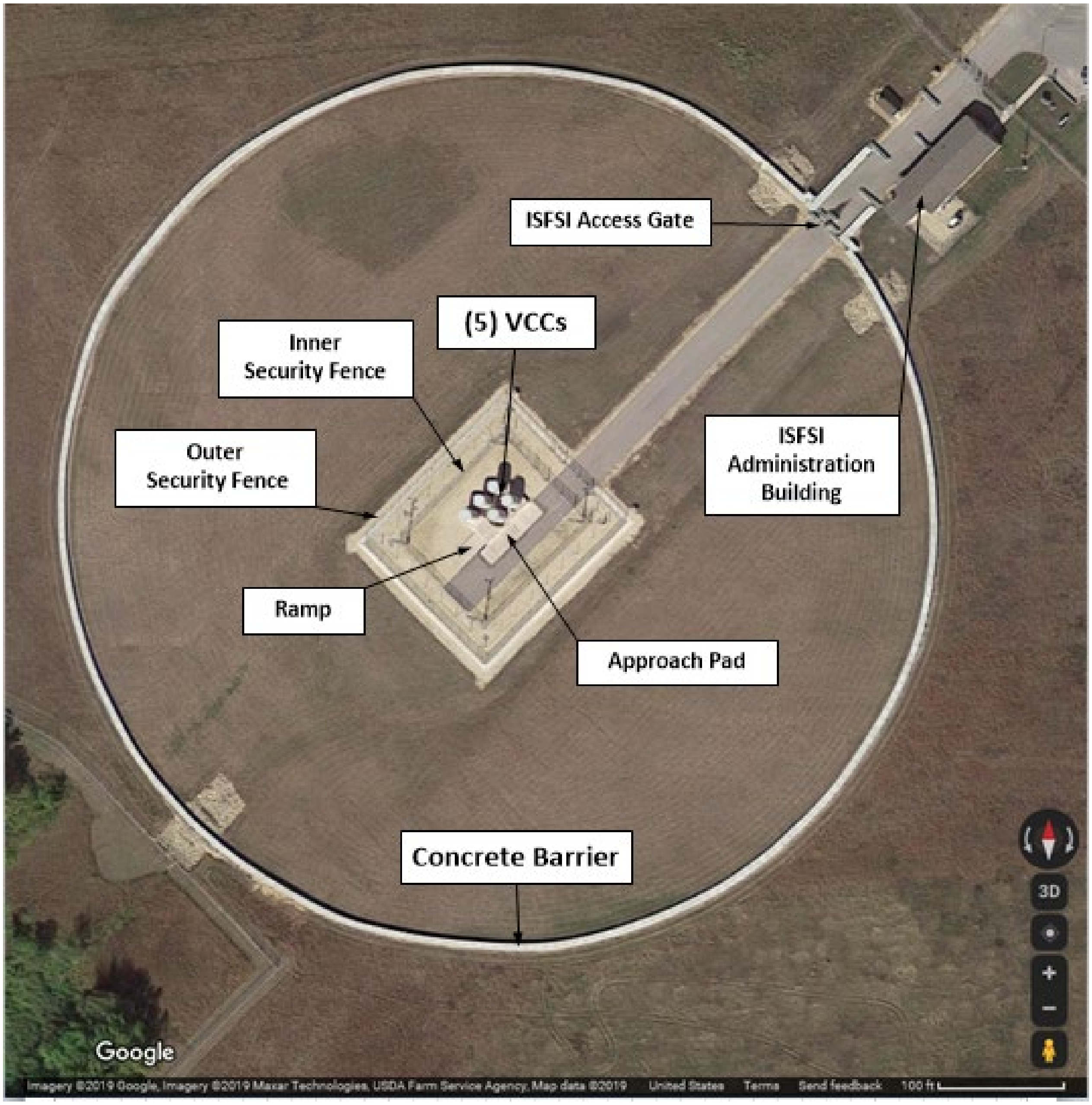
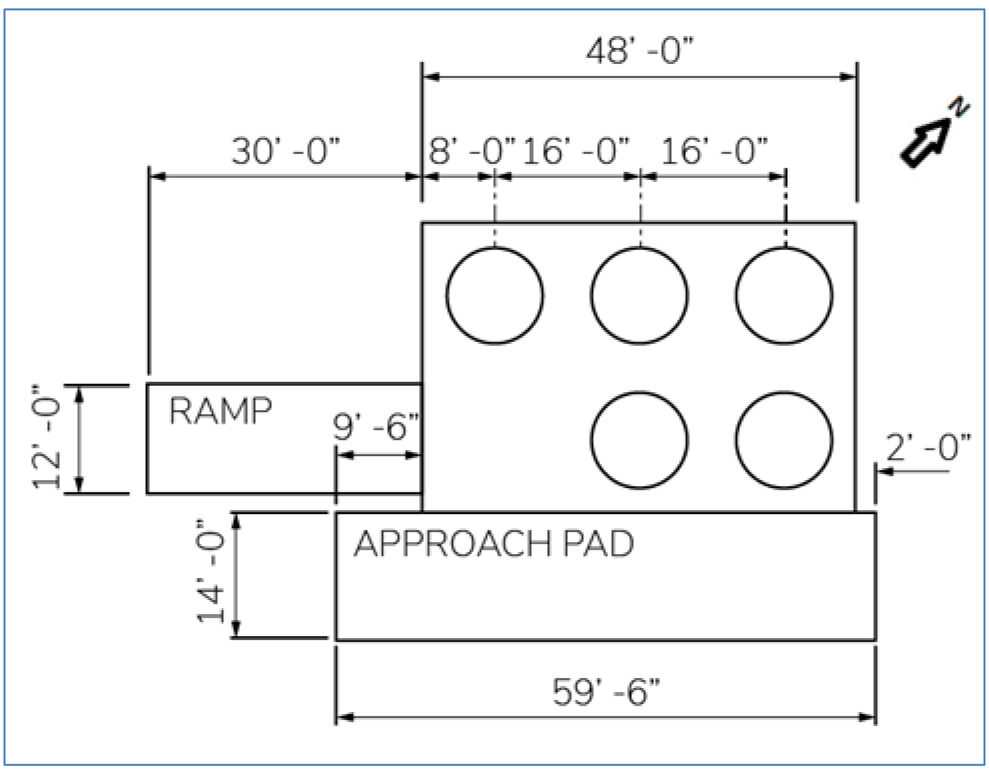


Figure 2-8: LACBWR VCCs[6]

Photo courtesy of La Crosse

Figure 2-9: LACBWR ISFSI Pad Layout[42]



2.1.1 Site Infrastructure

Figure 2-10 provides an aerial view of the LACBWR site, including the former reactor site, ISFSI, on-site rail spur, on-site barge facility, and the retired Genoa #3 power plant. The LACBWR site started undergoing dismantling and decommissioning in 1994. The NRC approved the final site surveys and released the site outside of the ISFSI area for unrestricted public use on February 24, 2023. The only facilities and infrastructure remaining in place are those that once supported the Genoa No. 3 (G-3) Fossil Station activities (e.g., crib house, switchyard, roadways, and security station) and the ISFSI.[57] DPC has long-term commitments to the transmission facilities, the ISFSI, and the public boat landing.[56]

The on-site rail spur, **Figure 2-11** through **Figure 2-14,** extends approximately 425 feet from the BNSF rail line (point of switch) into the north corner of the LACBWR site near the eastern Mississippi river shoreline. The on-site rail spur was originally installed and used during the construction of LACBWR site and transport of the reactor pressure vessel to Barnwell, SC. Prior to 2015, the on-site rail spur was used by BNSF to back equipment on it. The rail spur was not used during the decommissioning and demolition activities for the LACBWR. Much of the track is covered with asphalt or dirt and the entire system will require refurbishment prior to use. There are wide, flat, grassy and dirt areas with no overhead restrictions over the length of the spur. The rail spur lies on utility property and connects with the BNSF rail line approximately 100 feet north of the site protected area fence.[3] An extension of the on-site rail spur to a length of approximately 1200 feet would be required to load the entire train consist. The distance from the on-site rail spur area to the ISFSI is approximately 0.7 miles using the existing paved road paths. A heavy haul path would need constructing to move the fuel from the ISFSI pad to the rail spur. The new heavy haul path would be different from the heavy haul path used for transferring the fuel from the reactor building to the ISFSI. A portion of the heavy haul path from the reactor building to the ISFSI on the east side of the coal pile no longer exists due to a coal pile expansion. As another option, extension of the on-site rail spur approximately 0.7 miles to the ISFSI would allow the cask to be put onto the railcar and placed into its transportation configuration while within the Part 72 regulated and protected area. The justification of extending the rail track to the ISFSI for loading within a regulated area versus leasing a goldhofer for transport to the rail spur area and extending or establishing a new regulated loading area would need to be evaluated. As a possible alternative, the BNSF main line runs in north-south direction approximately 750 feet east of the ISFSI pad, however, a rail spur would have to be built to tie into the main line at that location.

The LACBWR site has an operational barge facility on the Mississippi River that was used to deliver plant components during construction as shown in **Figure 2-15**. The barge facility is located at the north end of the site adjacent to the rail spur area. The barge facility, approximately 500 feet long x 100 feet wide with a minimum 9-foot water depth, had been used daily to handle, stage, and remove covers from coal barges. Approximately 450 to 500 barges were received annually at the barge facility.[7] The barges were unloaded a few hundred yards downstream for the Genoa #3 coal plant. Roll-on/roll-off operations at the on-site barge facility may be complicated by strong currents created by the nearby lock and dam on the river. Barges have not been used for radioactive shipments from this site and it is suggested that another barge site would be better suited for conducting roll-on/roll-off operations for loading used nuclear fuel casks. The distance from the barge facility to the ISFSI is approximately 0.7 miles using the existing paved and dirt road paths. As with the on-site rail spur, a heavy haul path would need constructing to move the fuel from the ISFSI to the barge facility. Alternatively, a public boat ramp area located approximately 400 feet southwest of the ISFSI as shown in **Figure 2-16** through **Figure 2-18** could be used to ground a barge to support roll-on/roll-off operations. The distance from the ISFSI to the boat ramp area is approximately 0.75 miles using the existing paved road as shown in **Figure 2-19**. The road would need evaluation for moving the fuel from the ISFSI to the boat ramp area. In addition, release of the public boat access area would also be required. The typical barge delivery season is from March through October due to weather conditions where the Mississippi River usually partially freezes in the winter.

An evaluation of the on-site roads to support transport cask movement by heavy haul trucks (HHT)/tractor trailers onto off-site roads will be required. Low level waste shipments (Class A) via HHTs have been made from the LACBWR site.[2]

The proposed heavy haul paths from the ISFSI pad to the proposed transload locations at the on-site rail spur, the barge facility dock, and the boat ramp areas are shown on **Figure 2-20**. These are the locations where it is recommended to transload the casks onto rail cars or barges for movement from the site to GCUS. In addition, the on-site path for HHT transport from the ISFSI to local highway WI-35 is also shown in **Figure 2-20**.

Once the G-3 coal plant completes decommissioning and demolition activities, the former G-3 area will be under consideration and assessment for use as a potential transloading facility area.

Figure 2-10: Aerial View of LACBWR Site[6]

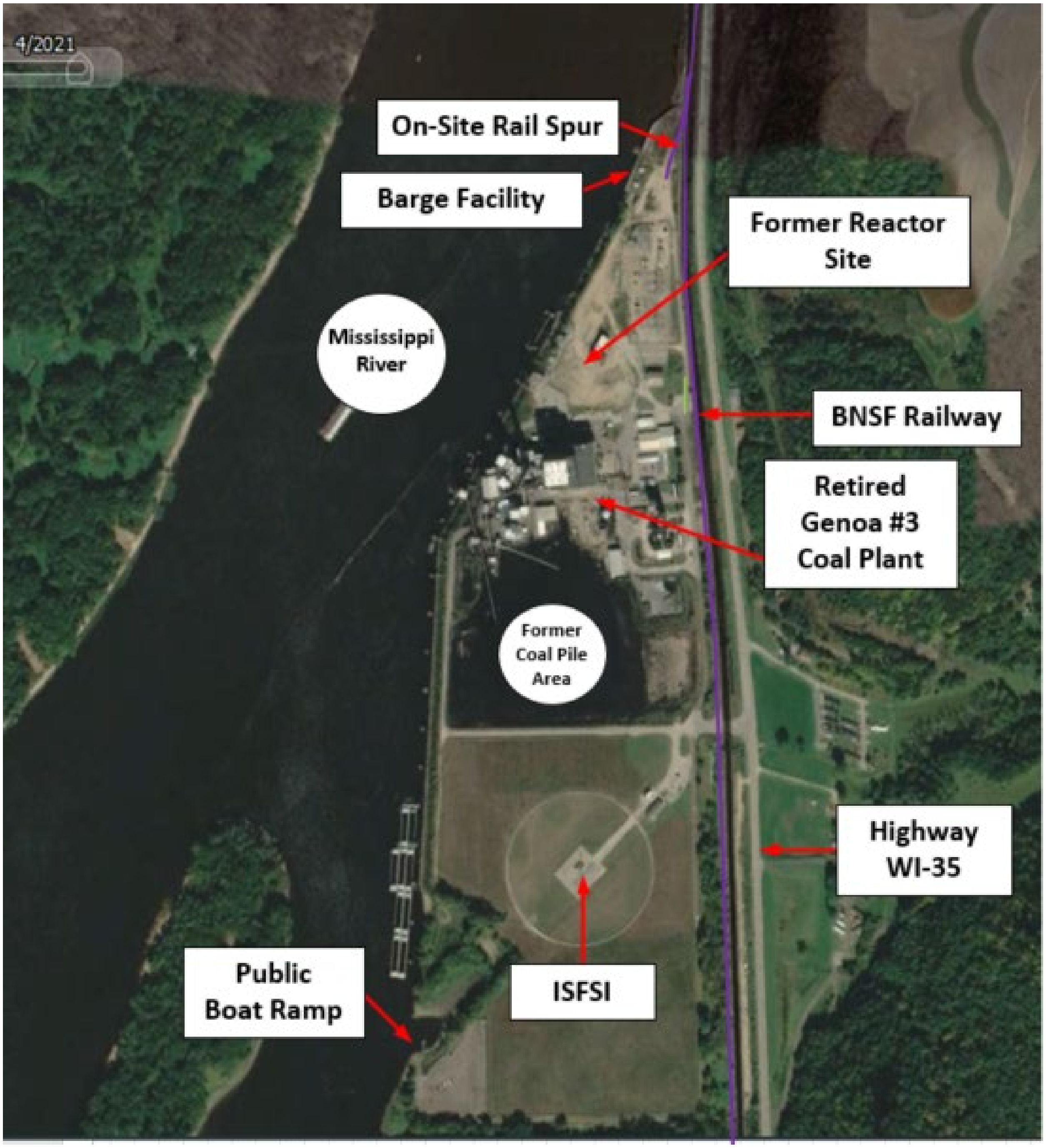


Figure 2-11: On-Site Rail Spur Area[6]

Figure 2-12: BNSF Main Line and On-Site Rail Spur

Photo courtesy of La Crosse

Figure 2-13: On-Site Rail Spur South View

Photo courtesy of La Crosse

Figure 2-14: On-Site Rail Spur North View

Photo courtesy of La Crosse

Figure 2-15: Barge Facility[7]

Photo courtesy of La Crosse

Figure 2-16: Public Boat Ramp Area[6]

Figure 2-17: Pier at Boat Ramp Area

Photo courtesy of La Crosse

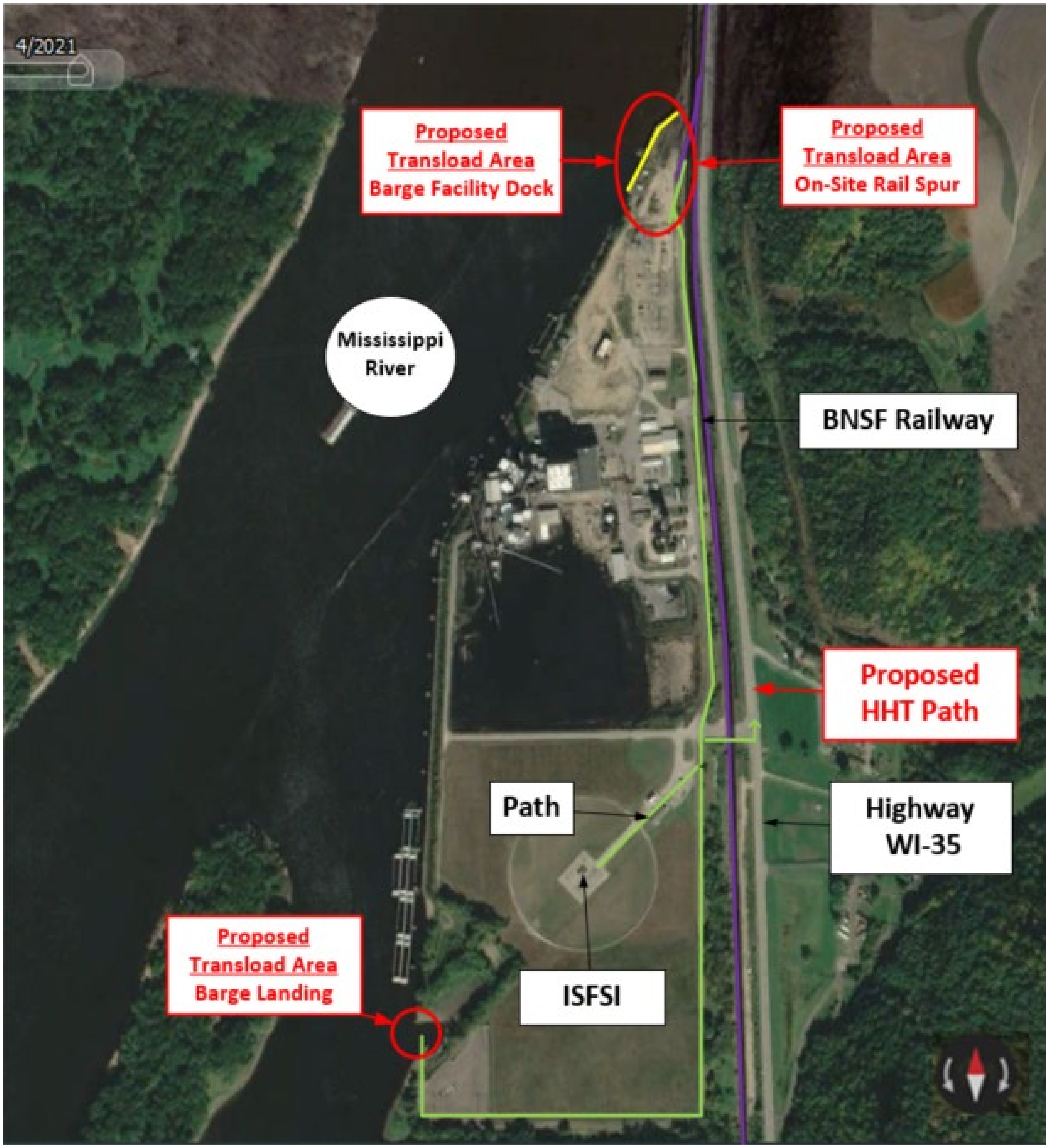
Figure 2-18: Boat Ramp

Photo courtesy of La Crosse

Figure 2-19: Path Leaving ISFSI Going South to Boat Ramp

Photos courtesy of La Crosse

Figure 2-20: Proposed Paths from ISFSI to Transload Areas[6]



2.1.2 Near-site Transportation Infrastructure

The LACBWR site has an on-site rail spur that provides access to the BNSF rail line at the north end of site as shown in **Figure 2-20**. The BNSF main line runs along the eastern boundary of the site in a north-south direction and passes within 100 feet of the site's protected area fence. Traffic on the rail line is heavy, including numerous unit trains of crude oil per day. The BNSF rail line, designated as track class 4, carries commercial freight over these lines and there are no passenger trains. There are two sets of tracks and both are in good condition. In 2007, the on-site rail spur and BNSF rail line were used during the transport of the La Crosse reactor pressure vessel to the Barnwell, South Carolina low-level radioactive waste disposal facility. The reactor pressure vessel was transported on a specially designed 20-axle railcar and the shipment weighed 310 tons.[7] LACBWR shipped most of its low level radioactive waste (LLW) waste via railcar to the EnergySolutions site in Clive, Utah; however, it did not move directly from the site for operational reasons. The LLW was trucked from La Crosse to Winona, MN where it was transloaded into private rail cars at a facility served by the Union Pacific Railroad. At the time of the LLW shipments, the BNSF did not have time in between the loaded unit trains to pull the LLW cars.

The on-site barge facility sits on the eastern shore of the Mississippi River as shown in **Figure 2-20.** The Mississippi River has a guaranteed depth of at least 9 feet in this area. Dredging of the barge facility area has not been done for several years. It is available for shipments about 8 months during the year due to freeze conditions. Approximately 0.5 miles north of the site is the Lock and Dam 8 and approximately 30.8 miles south of the site is Lock and Dam 9. The Mississippi River is used for recreation, fishing, and commercial barge and ship traffic. As discussed earlier, there is a public boat ramp area southwest of the ISFSI, as shown in **Figure 2-20**, that may be a potential location for barge roll-on/roll-off operations.

The primary road route to the LACBWR site is via highway WI-35 that runs north-south along the eastern part of the site as shown in **Figure 2-20**. The on-site road leaves the plant gate and passes about 309 feet across the two tracks of the BNSF rail line. It then intersects WI-35 about 200 feet past the rail tracks. The nearest interstate highway to the plant is I-90 which passes approximately 22 miles north of the site. The annual average daily traffic for Highway 35 in the vicinity of LACBWR is 4500 vehicles. LACBWR transported its LLW (Class A) offsite via truck to the Seven Rivers Intermodal Facility in Winona, Minnesota. The intermodal containers were loaded onto railcars and transported to EnergySolutions in Clive, Utah. In 2017, LACBWR made 918 rail and truck shipments of solid waste to Utah.[3]

Direct rail transport from the site can be achieved by extending the on-site rail spur. The NAC-STC transportation casks will be moved on rail cars loaded at an on-site TSC Transfer Station adjacent to the extended on-site rail spur. A suitable on-site HHT vehicle will be used for the vertical transport of the loaded and empty VCCs from / to the TSC Transfer Station from the ISFSI pad. A new TSC Transfer Station pad will be required for off-loading of the TSC from the VCC into the TFR and subsequent loading of the TSCs into the NAC-STC. The transfer and loading of the TSCs would be performed in a vertical orientation at the TSC Transfer Station. After loading and leak testing of the NAC-STC, the loaded cask will be directly loaded (downended) onto the transport cradle positioned on the rail car where the impact limiters and tiedown will be installed for transport. Alternatively, the NAC-STC can be downloaded onto the transport cradle followed by installation of the impact limiters and tiedowns and then lifted by a horizontal lift beam for placement on the rail car. Refer to **Section 6.1.3** for specific details of the canister transfer and cask preparation operations for the MPC-LACBWR and NAC-STC systems.

2.1.3 NAC-MPC Storage System Details

The SNF located at the LACBWR ISFSI was loaded into NAC International's Multi-Purpose Canister (NAC-MPC) Storage Systems. The system is comprised of the following components: a specially designed MPC-LACBWR TSC with a 68 boiling water reactor (BWR) Spent Fuel

Assembly (SFA) fuel basket assembly (See **Table 2-3** and **Figure 2-21**) including up to 32 damaged fuel assemblies in Damaged Fuel Cans (DFC), a MPC-LACBWR Vertical Concrete Cask (VCC), and a Transfer Cask (TFR), which was purchased from Yankee Rowe Nuclear Power Station (YR) by DPC. The MPC-LACBWR TSCs can be loaded into a NAC Storable Transport Cask (NAC-STC) to enable transporting the contents off of the LACBWR site. The LACBWR TSCs incorporates features implemented for the MAGNASTOR System including a thinner TSC shell, single closure lid, closure ring and redundant port covers, and for the VCC a single VCC Lid provided with integral neutron shield thereby eliminating the VCC shield plug.

The MPC-LACBWR VCCs, shown in **Figure 2-22**, were fabricated on site and loaded with canisters at an outdoor location adjacent to the fuel building. There are 5 MPC-LACBWR systems at the LACBWR ISFSI, with details as follows:

- The MPC-LACBWR VCCs are 162 inches high including VCC lid with a liner inside diameter of 79.0 inches and an outer diameter of 128.0 inches[10].
- The walls of the MPC-LACBWR VCC are 24.5 inches thick and consist of a 2.5-inch thick inner steel liner surrounded by 22 inches of reinforced concrete[11].
- The approximate weights of the MPC-LACBWR VCC are 141,200 pounds empty and 196,000 pounds loaded for the SNF TSC [12].
- The MPC-LACBWR VCC lid weighs approximately 8,125 pounds and is secured to the cask liner with 6 ½-inch bolts. Three of the lid bolt holes are threaded (3/4”-10 UNC-2B) to provide for attaching swivel hoist rings for lifting [13].
- The MPC-LACBWR VCCs can be moved in a vertical orientation through the use of an air pad system. The system includes four air pads that are placed under the VCC base plate by jacking the VCC and installing the air pads between the four ventilation inlets. The air pads are then inflated and the cask can be maneuvered with a modified fork truck, or similar equipment. Once in the designated position on the ISFSI, the air pads are deflated and the jacks are installed in the four air inlets to lift the VCC to allow removal of the air pads. The VCC is then lowered to the ISFSI surface.

The MPC-LACBWR TSCs, used to confine the SNF and shown in **Figure 2-21**, are stainless steel and provide confinement of the contents. Details of the MPC-LACBWR TSCs are as follows:

- The MPC-LACBWR TSCs are 116.3 inches high with an outer diameter of 70.64 inches[14].
- The maximum loaded weight of the MPC-LACBWR SNF TSCs are 54,800 pounds.
- The MPC-LACBWR TSC closure lid includes six threaded holes (2-4 ½ UNC-2B) to install swivel hoist rings and redundant sling sets or alternate TSC lifting system, which are used for lifting the loaded MPC-LACBWR TSC [15].

To enable transferring a MPC-LACBWR TSC from a storage cask (i.e., MPC-LACBWR VCC) to a transportation overpack (i.e., NAC-STC), a TFR, shown in **Figure 2-23** with the transfer adapter, will be used. The TFR utilized at LACBWR was originally supplied to YR and procured by LACBWR for the MPC-LACBWR loading campaign. The TFR is retained at the LACBWR site. Details of the TFR are as follows:

- The TFR is 132.05 inches high without retaining ring and 132.8 inches high with retaining ring installed and an outer diameter of 86.5 inches.
- The walls of the TFR have neutron and lead shielding encapsulated by carbon steel (CS) inner and outer shells[16].
- The inner annulus of the TFR has a nominal diameter of 71.5 inches and a cavity length of 123.5 inches[16].
- The approximate weight of the TFR is 80,745 pounds empty and 135,475 pounds loaded with a dry welded MPC-LACBWR TSC[16].
- The top of the TFR is provided with a retaining ring which is bolted to the top of the TFR during MPC-LACBWR TSC transfer operations to prevent a MPC-LACBWR TSC from being accidentally withdrawn from the TFR cavity[16].
- Attached to the bottom of the TFR is a set of hydraulically operated shield doors mounted on door rails to permit passage of a MPC-LACBWR TSC[16].
- The cask includes a set of two lifting trunnions for engagement to the lift yoke.
- There is a TFR available at the LACBWR site as the original TFR was sold to DPC for use on the La Crosse BWR dry storage program utilizing NAC's MPC-LACBWR storage system.

The fuel assemblies from LACBWR were loaded into NAC-MPC system (MPC-LACBWR) and placed on the ISFSI beginning on July 12, 2012 with the final loaded fuel system placed on the ISFSI on September 18, 2012.

The MPC-LACBWR TSC (**Table 2-2** and **Figure 2-21**) is used for storing the SNF on-site and for future transport in the NAC-STC [21]. The MPC-LACBWR TSC consists of a cylindrical SA240 Type 304/304L stainless steel shell with welded bottom plate, closure lid and closure ring, and a fuel basket.

The bottom is a 1.25-inch thick SA240 Type 304/304L stainless steel plate. The shell is constructed of 1/2-inch thick rolled steel plate with a nominal outer diameter of 70.64 inches. The closure lid is a 7-inch thick SA240/SA182 Type 304/304L stainless steel plate/forging and contains drain and fill penetrations for accessing the TSC cavity following closure lid to TSC shell welding. The canister contains a stainless steel and aluminum fuel basket that can accommodate 68 LACBWR class Boiling Water Reactor (BWR) spent fuel assemblies including up to 32 damaged fuel assemblies and fuel debris in damaged fuel cans (DFCs). All of the Allis Chalmers SNF (155 assemblies) were designated as damaged fuel due to fuel cladding issues and two Exxon SNF assemblies were also designated as damaged fuel. There is also one DFC containing fuel debris in TSC-05. The MPC-LACBWR TSC has a maximum content weight limit of 28,870 lbs including DFCs. A 4-inch thick aluminum spacer is bolted to the underside of the closure lid to limit potential movement of the 36 non-DFC SNF assemblies in the central section of the fuel basket.

The MPC-LACBWR TSC and integral fuel basket provides heat transfer paths, criticality control, and structural support. One MPC-LACBWR TSC is loaded per MPC-LACBWR VCC. The MPC-LACBWR TSC is configured to hold 68 LACBWR class stainless steel-clad BWR SNF assemblies including up to 32 SNF and debris in DFCs.

The following weights are used to calculate the total content weights:

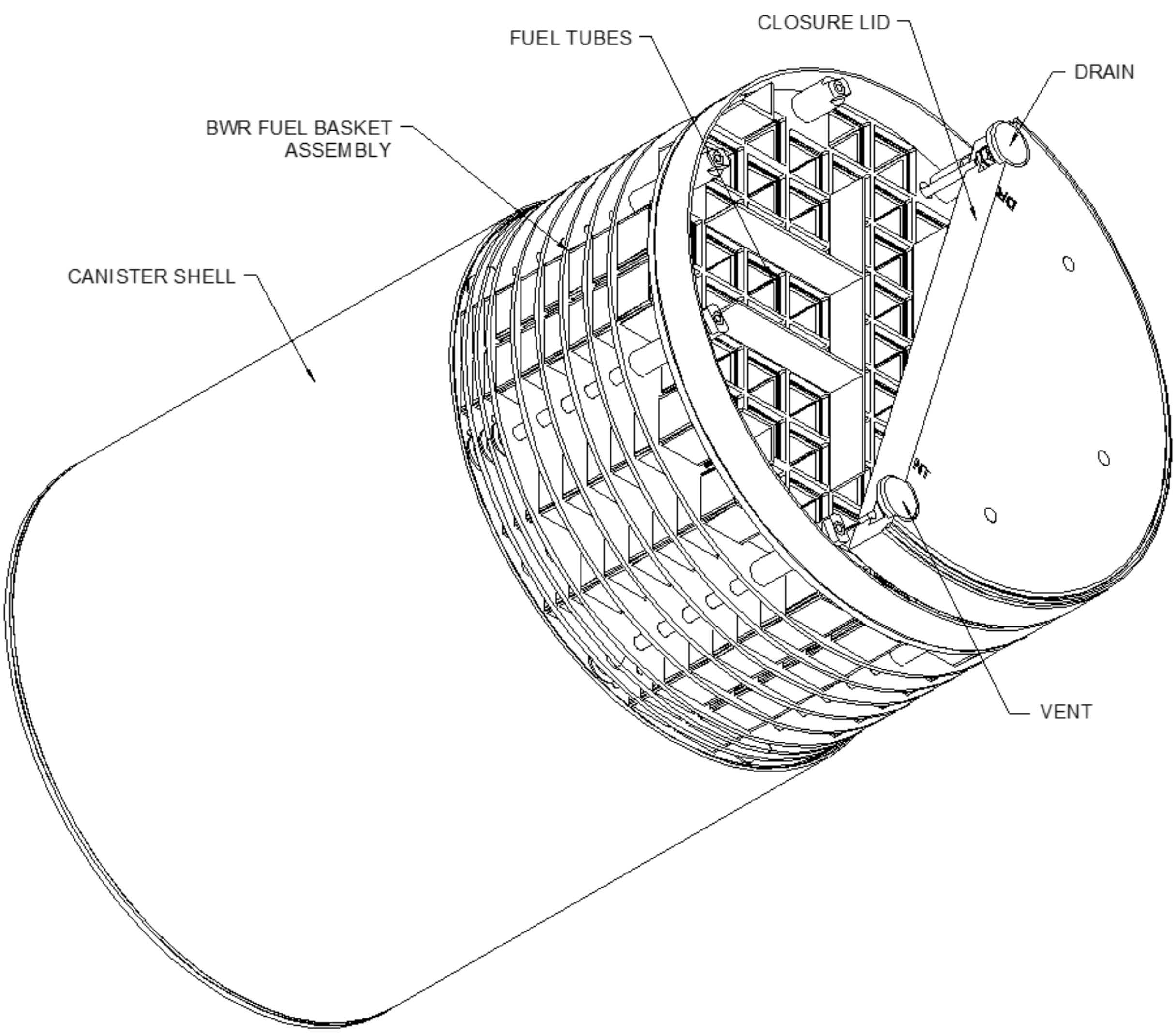
- Maximum SFA content weight utilized for design and certification: 400 lbs.

Table 2-2: MPC-LACBWR TSC[12][14]

Attribute	MPC-LACBWR 68 BWR Assy TSC
a. Capacity (intact assemblies)	68 LACBWR Class BWR SNF Assemblies
b. Maximum Weight (lbs) Empty	28,200
Loaded	54,800
c. Thermal Design Heat Rejection (kilowatt (kW))	4.5 storage/4.5 transportation
Max. Per Assy. Heat Load (W)	63 storage / 63 transportation
Maximum Burnup (GWD/Metric Tons Uranium (MTU))	22 for Allis Chalmers SFA / 21 for Exxon SFA
d. Shape	Cylindrical
e. Dimensions (in.) Overall Length	116.3
Outside Diameter	70.64
Wall Thickness	0.5
Closure Lid Thickness	7
Internal Aluminum Spacer Thickness	4
Bottom Thickness	1.25
Basket Length	107.5
f. Materials of Construction Canister Body	304/304L Stainless Steel (SS)

Attribute	MPC-LACBWR 68 BWR Assy TSC
Basket	SS, Boral and Al
Port Covers and Closure Ring	304/304L SS
g. Cavity Atmosphere	He
h. Maximum Lid Leak Rate (cm^3/sec, helium)	$\leq 2 \times 10^{-7}$

Figure 2-21: MPC-LACBWR Transportable Storage Canister (TSC) Assembly[12][14]



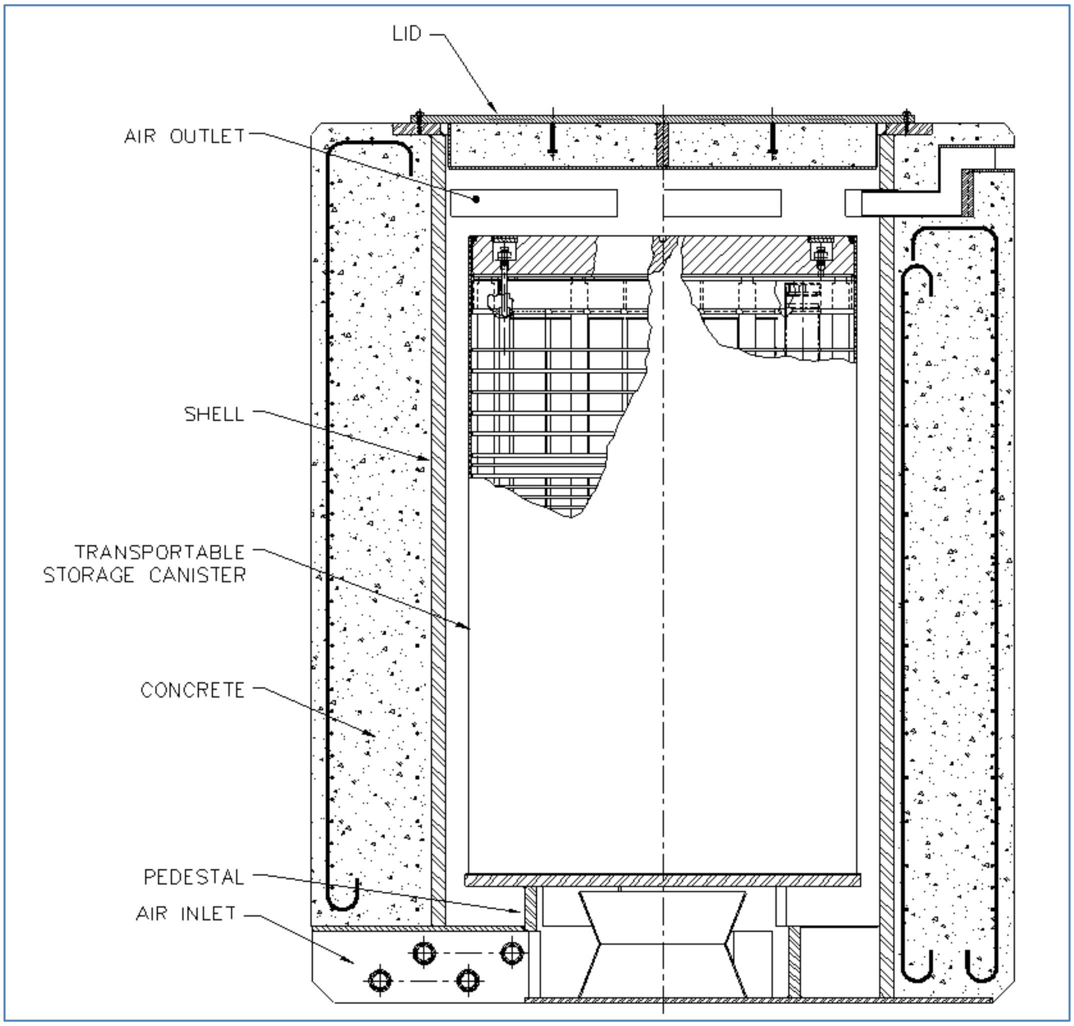
The MPC-LACBWR VCC (**Table 2-3** and **Figure 2-22**) is the storage overpack for the MPC-LACBWR TSC and provides structural support, shielding, protection from environmental and accident conditions, and natural convection cooling of the TSC during storage. The VCC is a reinforced concrete structure with a carbon steel inner liner. It contains an annular air passage with inlet and outlet vents to allow for natural air circulation around the TSCs. The MPC-LACBWR TSC is axially positioned on the VCC base plate and baffle weldment with the MPC-LACBWR TSC baseplate protected by a stainless-steel cover sheet.

Table 2-3: MPC-LACBWR VCC[10]

Attribute	MPC-LACBWR VCC
a. Capacity (TSC)	1
b. Weight (lbs) Empty (nominal)	 141,200
Loaded	196,000
c. Shape	Cylindrical
d. Dimensions (in.) Overall Length	 160
Outer Diameter	128
VCC Liner Inside Diameter	79
Wall Thickness	24.5 (2.5-in CS and 22-in reinforced concrete)
VCC Lid Thickness	9.9
e. Neutron Shield (in.) Side Thickness (Concrete)	 22
Lid Thickness (Concrete)	8
Bottom Thickness	N/A
f. Materials of Construction Cask Body	 Concrete (Type II Portland Cement), CS Reinforcing Steel (A615 Grade 60), and CS Liner Assembly (A36)

Attribute	MPC-LACBWR VCC
Neutron Shield, Radial	Concrete
Neutron Shield, VCC Lid	Concrete
g. Outside Surface Dose (mrem/hr)	≤ 20 Side, ≤ 25 Top, ≤ 100 Inlet/Outlet Average

Figure 2-22: MPC-LACBWR Storage System - VCC[10]



The YR-TFR (see **Table 2-4** and **Figure 2-23**) is used for transfer operations on-site. The TFR was procured from YR by DPC for use on the LACBWR ISFSI transfer operations and is available for the de-inventory project. The TFR and the TFR lift yoke are currently in storage at the LACBWR ISFSI. The cylindrical TFR has a bolted top retaining ring to prevent a loaded MPC-

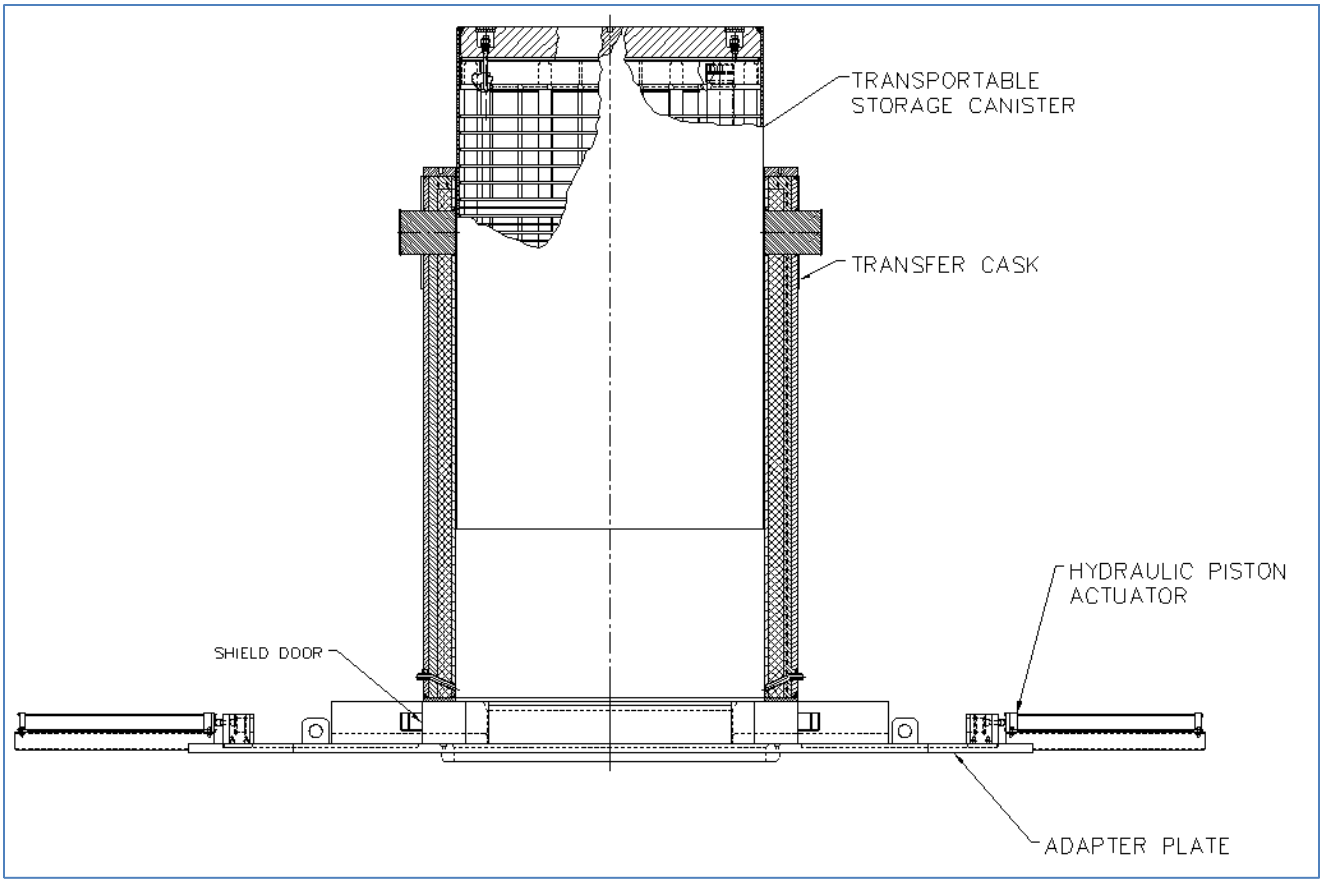
LACBWR TSC from inadvertently being removed through the top of the TFR and becoming unshielded. The TFR is stacked on top of the VCC. The retractable bottom shield doors are opened during unloading/loading operations using a Transfer Adapter. Then the MPC-LACBWR TSC is retrieved/retracted into the TFR using the appropriate lifting device and crane.

Table 2-4: TFR[16]

Attribute	Metal TFR w/ MPC-LACBWR TSC
a. Capacity (TSC)	1
b. Weight (lbs) Empty	 80,745
Loaded	135,475
c. Shape	Cylindrical
d. Dimensions (in.) Overall Length	 132.88
Outer Shell Outside Diameter	86.5
Cavity Length	123.5
Cavity Internal Diameter	71.5
Wall Thickness CS/Pb/NS-4-FR/CS)	7.5
Retaining Ring Thickness	0.75
Bottom Shield Door Thickness	9.5
e. Neutron Shield (in.) Side Thickness	 3.5
Lid Thickness	N/A
Bottom Thickness	N/A
f. Materials of Construction	

Attribute	Metal TFR w/ MPC-LACBWR TSC
Cask Body	CS/Pb
Neutron Shield	NS-4-FR
g. Outside Surface Dose (mrem/hr)	≤300 side

Figure 2-23: MPC-LACBWR MPC in On-Site TFR with Transfer Adapter[16]



2.1.4 Transport Equipment

At the current time, there may not be enough space on the LACBWR ISFSI pad to perform the set-up and positioning of equipment in order to perform the MPC-LACBWR TSC transfer operations in a safe and efficient manner. It is recommended that an evaluation of the available elevated pad area for a TSC Transfer Station be conducted adjacent to the planned rail line for TSC transfer and loading into NAC-STC transport casks. It is estimated that a TSC Transfer

Station pad of approximately 30 feet x 40 feet elevated to approximately 27 inches will be required to be constructed.

A TSC Transfer Station and seismic support structure in accordance with NAC-MPC CoC Technical Specification (TS) B.3.5, or an acceptable alternative secure lifting/transfer capability will be required for off-loading of the MPC-LACBWR TSC from the VCC into a TFR, and subsequent transfer and loading of the MPC-LACBWR TSCs into the NAC-STC. The transfer and loading of the MPC-LACBWR TSCs would be performed in a vertical orientation with the VCC and NAC-STC positioned adjacent to each other at the TSC Transfer Station. As an alternative to the TSC Transfer Station and mobile or fixed crane systems, a seismically qualified gantry system provided with TFR lifting slings and an integrated chain hoist system could be used to efficiently transfer and load the MPC-LACBWR TSCs into the NAC-STC casks. This operational alternative is discussed in further detail in **Section 6.0** and **Section 10.0**.

During MPC-LACBWR TSC transfer and loading operations, a loaded VCC can be brought from its' storage on the ISFSI pad to the designated transfer/unloading position on the pad using the air pads and appropriate maneuvering equipment to position the VCC on the on-site HHT. After the VCC is positioned, an empty NAC-STC transport cask is positioned adjacent to the TSC Transfer Station/ISFSI pad and the NAC-STC positioned on a transport frame on the rail car is prepared for off-loading, uprighted and set down on the TSC Transfer Station pad. If operationally preferred, the NAC-STC on its intermodal transport cradle can be lifted off of the railcar, set on the ground and the up-righting performed.

At the completion of the NAC-STC loading with a MPC-LACBWR TSC and preparation of the package for transport, the NAC-STC is downloaded onto the intermodal transport cradle on the railcar. The empty VCC is repositioned on the ISFSI pad using the hydraulic jacks and air pad systems to move the empty VCC onto the on-site HHT. Then the next VCC is lifted and maneuvered onto the HHT for movement to the TSC Transfer Station for unloading and transfer of the MPC-LACBWR TSC to the next NAC-STC.

2.2 Characteristics of SNF to be Shipped

This section describes the inventory of SNF including intact and damaged fuel for the LACBWR site and summarizes the information contained in the Preliminary Evaluation of Removing Used Nuclear Fuel from Shutdown Sites, SFWD-IWM-2017-000024 (PNNL-22676 Rev. 10)[7], the NAC-MPC Final Safety Analysis Report (FSAR)[12], and NRC CoC No. 1025[17] including TSs and Approved Contents and Design Features.

The fuel assemblies are 10 x 10 rod arrays as described in **Table 2-5**.

Table 2-5: LACBWR Fuel Design Information[18]

Fuel Supplier / Design	Cladding Material	Max. and Min. Enrichment (wt. % U235)	Maximum Burnup (GWd/MTU)	Assembly Dry Weight (lbs.)	Total No. Loaded in MPC-LACBWR TSCs
Allis Chalmers (AC) 10 x 10 LACBWR Class	Stainless Steel	3.64 / 3.94[1] 3.6	22	400	155
Exxon (EX) 10 x 10 LACBWR Class	Stainless Steel	3.712[2] 3.6	21	400	178

1. Enrichments are for Type 1 and Type 2 Allis Chalmers fuel respectively.
2. Represents maximum planar average enrichment.

Table 2-6 and **Table 2-7** provide data associated with the fuel assemblies loaded in the LACBWR ISFSI. The fuel was discharged from the reactor vessel between 1972 and 1987. The lowest burnup is 4.68 GWd/MTHM and the highest burnup is 21.53 GWd/MTHM. There is no high burnup SNF (i.e., greater than 45 GWd / MTHM) stored at LACBWR ISFSI. More details on the SNF are contained within the Preliminary Evaluation of Removing Used Nuclear Fuel from Shutdown Sites[7], the NAC-MPC FSAR, and NRC CoC. In addition to the 333 spent fuel assemblies (including 157 damaged fuel assemblies placed in DFCs and 1 DFC containing fuel debris) loaded into the 5 MPC-LACBWR TSCs. There are also 2 empty DFCs loaded into TSC-05.

Table 2-6: LACBWR Fuel Discharge Data[7]

Year	No. of Assemblies Discharged
1972	6
1973	50
1975	25
1977	32
1979	28
1980	12
1982	30
1983	22

Year	No. of Assemblies Discharged
1985	28
1986	28
1987	72
Total	**333**

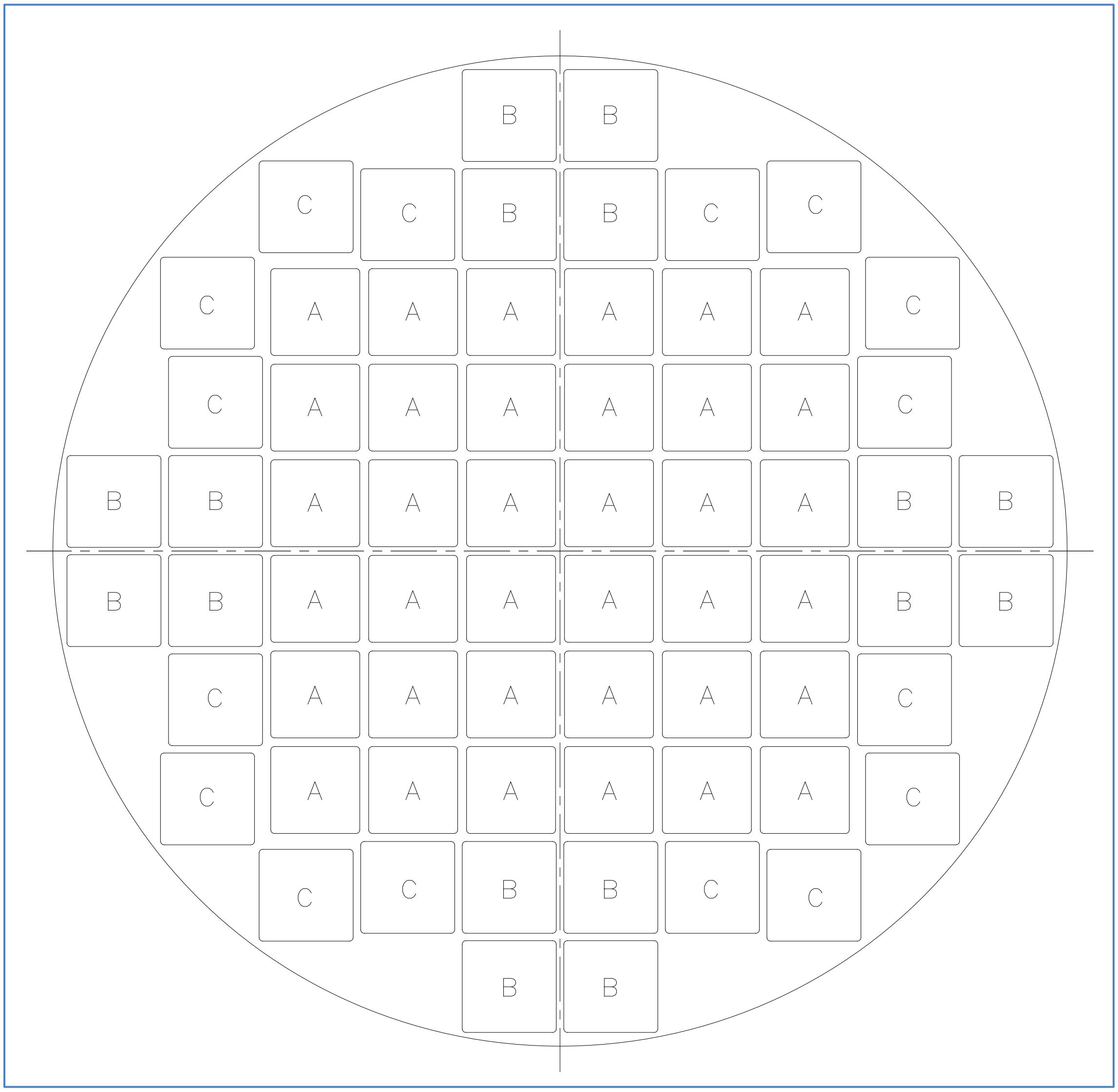
Table 2-7: LACBWR Fuel Burnup Data[7]

Burnup (GWd/MTHM)	Number of Assemblies
0-5	8
5-10	31
10 - 15	107
15 - 20	180
20 - 25	7
Total	**333**

The reactor experienced a number of failed fuel rods. Damaged, potentially damaged and failed fuel was packaged into DFCs, which were then loaded into designated locations of the fuel basket as shown in **Figure 2-24**.

The summary of contents for the LACBWR ISFSI is as shown including the location of damaged fuel in specific TSCs is provided in **Table 2-8**.

Figure 2-24: MPC-LACBWR Loading Pattern[16]



Slot A Undamaged Exxon fuel maximum planar average enrichment 3.71 wt % ^{235}U.

Slot B Undamaged or damaged Exxon fuel maximum planar average enrichment 3.71 wt % ^{235}U, up to four slots maximum, B and C combined.

Damaged Allis Chalmers fuel maximum enrichment 3.64 wt % ^{235}U.

Slot C Undamaged or damaged Exxon fuel maximum planar average enrichment 3.71 wt % ^{235}U, up to four slots maximum, B and C combined.

Damaged Allis Chalmers fuel maximum enrichment 3.94 wt % ^{235}U.

Table 2-8: LACBWR ISFSI Contents[18]

Fuel Load Sequence No.	MPC-LACBWR VCC / TSC Serial Number	TSC Contents	Heat Load[1] (kW)	Date Loaded into ISFSI
1	TSC-001 / LACBWR-VCC-01	36 Intact SNF Assemblies + 32 Damaged SNF Assemblies in DFCs	2.616	7/12/12
2	TSC-002 / LACBWR-VCC-02	36 Intact SNF Assemblies + 32 Damaged SNF Assemblies in DFCs	2.690	7/27/12
3	TSC-003 / LACBWR-VCC-03	36 Intact SNF Assemblies + 32 Damaged SNF Assemblies in DFCs	2.773	8/7/12
4	TSC-004 / LACBWR-VCC-04	36 Intact SNF Assemblies + 32 Damaged SNF Assemblies in DFCs	2.574	8/16/12
5	TSC-005 / LACBWR-VCC-05	32 Intact SNF Assemblies + 29 Damaged SNF Assemblies + 1 Fuel Debris in DFCs + 2 empty DFCs	1.586	9/18/12

1. Heat load values are for the entire system based on LACBWR data from 2003.

Fuel Assembly content limited to 28,870 lbs. including DFCs. Maximum fuel assembly weight 400 lbs.

2.3 Description of Canisters/Overpacks to be Shipped

The inventory of MPC-LACBWR TSCs at the LACBWR ISFSI to be evaluated for shipment includes the 5 MPC-LACBWR TSCs listed in **Table 2-8**. The MPC-LACBWR TSCs are certified by the NRC for transportation of SNF in the NAC-STC under CoC 71-9235, Revision 22, which expires on May 31, 2024[20] (refer to **Section 10.0**). The characteristics of the LACBWR SNF contents authorized in CoC 71-9235, per Paragraph 5.(b)(1)(v) and 5.(b)(1)(vi) are provided in **Table 2-9.** Based on current NAC-STC transport cask CoC criteria, the MPC-LACBWR TSC contents are acceptable for transport at the current time.

Table 2-9: Description of Authorized MPC-LACBWR TSC Contents for NAC-STC Transport[19]

Parameter	Units	Allis Chalmers	Exxon
Number of Assemblies per Canister[1]	---	32	68
Maximum Assembly Weight[6]	lbs	400	400
Assembly Length	In	103	103
Fuel Rod Cladding	---	Stainless Steel	Stainless Steel
Maximum Initial Uranium Mass[2]	kgU	121.4	111.9
Maximum Initial Enrichment	wt% ^{235}U	3.64/3.94[5]	3.71[3]
Minimum Initial Enrichment	wt% ^{235}U	3.6	3.6
Maximum Burnup	MWd/MTU	22,000	21,000
Maximum Assembly Decay Heat	W	63	62
Minimum Cool Time	Yr	28	23
Assembly Array Configuration	---	10X10	10X10
Number of Fuel Rods	---	100	96
Maximum Active Fuel Length	in	83	83
Rod Pitch	in	0.565	0.557
Rod Diameter	in	0.396	0.394
Pellet Diameter	in	0.350	0.343
Clad Thickness	in	0.020	0.0220
Number of Inert Rods[4]	---	0	4
Inert Rod OD	in	N/A	0.3940

1. Maximum 68 assemblies per canister. Allis Chalmers fuel is restricted to Damaged Fuel Cans (DFCs). Therefore, Allis Chalmers fuel is limited to 32 assemblies per canister.
2. DFCs have been evaluated for 2% additional fuel rod mass.
3. Represents planar average enrichment.
4. Inert rods comprised of stainless-steel clad tube containing zirconium alloy slug. Inert rods not required for fuel assemblies located in DFC.
5. Two Allis Chalmers fuel types: Type 1 at an enrichment of 3.64 wt% ^{235}U and Type 2 at 3.94 wt% ^{235}U.
6. Not including weight of DFC. DFCs may contain optional inner container subject to maximum weight and fissile material limits in this table.

The NAC-STC is designed to be compatible with all NAC-MPC Storage Systems currently deployed at three ISFSIs in the U.S. including Yankee Rowe (YR-MPC), Connecticut Yankee

(CY-MPC) and DPC's La Crosse Boiling Water Reactor (MPC-LACBWR). In addition, the NAC-STC is also certified for the transport of Vitrified High Level Waste (HLW) loaded into MPC-WVDP Overpacks, which have the same outer diameter as the other MPC TSCs, and are currently in storage at the DOE's West Valley Demonstration Project (WVDP). The NAC-STC is also certified for the direct loading (uncanistered) and transport of undamaged standard and high burnup (HBU) pressurized water reactor (PWR) spent fuel assemblies. NRC CoC No. 71-9235 authorizes the transport of undamaged HBU spent fuel assemblies with decay heat loads of up to 1.7 kW/assembly with an increase in total authorized cask decay heat of 24 kW.

The original two NAC-STC casks systems have been transporting bare intact PWR spent fuel assemblies from reactor stations to a centralized reprocessing center for the last 20 years. Ten NAC-STC casks have been supplied to China for the transport of directly loaded intact HBU SNF assemblies and have been in operation for less than five years. An additional four NAC-STC casks will be supplied to China over the next year for the transport of directly loaded intact HBU SNF assemblies. The NAC-STC casks supplied to China include all required package components and auxiliaries including impact limiters, vertical lift yoke, horizontal lift beam, intermodal transport cradle and personnel barrier, vacuum drying and helium leak test system, and cask and auxiliary equipment spare parts.

The NAC-STC is designed with an inner stainless-steel shell with XM-17 transition sections, a poured-in-place lead gamma shield, a stainless-steel outer shell, and a solid neutron shield encased in a stainless-steel closure with SS/Cu fins. The NAC-STC is the only current transport cask system compatible with the transport of NAC-MPC canister systems and is not dimensionally suitable for the transport of NAC-UMS or NAC MAGNASTOR TSCs. However, it is the long-term intent of NAC to recertify the MAGNATRAN Transport Cask (CoC 71-9356) for the transport of all NAC-MPC and NAC-UMS TSCs.

The weights of the MPC-LACBWR system and NAC-STC transport packaging components are shown in **Table 2-10** and the overall characteristics and dimensions are shown in **Table 2-11**.

Table 2-10: NAC MPC-LACBWR Storage and NAC-STC Transport Cask Weights[12][21]

MPC-LACBWR and NAC-STC Component Description	MPC-LACBWR Fuel TSC and NAC-STC Weights (pounds)
LACBWR Maximum Assembly	400
TSC Contents (SNF / DFC)	28,870
Loaded / Closed Canister	54,800
VCC Loaded	196,000
VCC Lid	7,000
TFR (empty)	80,745
TFR w/TSC	135,475
Transfer Adapter	12,700
TFR Lift Yoke (nominal estimated weight)	6,500

MPC-LACBWR and NAC-STC Component Description	MPC-LACBWR Fuel TSC and NAC-STC Weights (pounds)
TFR Under-the-Hook Weight (1)	141,975
NAC-STC MPC-LACBWR Content Weight	54,800
NAC-STC Transport Spacers for MPC-LACBWR	1,115
NAC-STC Top Impact Limiter (Balsa)	5,800
NAC-STC Bottom Impact Limiter (Balsa)	5,650
NAC-STC Inner Lid	10,690
NAC-STC Outer Lid	8,120
NAC-STC without Inner and Outer Lids	157,160
NAC-STC with Inner and Outer Lids	175,970
NAC-STC with Inner and Outer Lids + Spacers	176,830
Loaded NAC-STC with MPC-LACBWR Contents	231,630
NAC-STC Lift Yoke (nominal estimated weight)	2,150
Loaded NAC-STC Under-the-hook Weight (dry) (2)	233,780
NAC-STC Package Transport Ready Weight (3)	245,230
NAC-STC Package Design Transport Weight (4,5)	260,000
Intermodal Transport Cradle/Personnel Barrier (estimated weight)	32,000

1 TFR Under-the-hook weight: TFR with loaded MPC-LACBWR TSC and TFR lift yoke.

2 NAC-STC Under-the hook weight: NAC-STC loaded with MPC-LACBWR TSC contents, inner and outer lids, transport cavity spacers, and NAC-STC lift yoke.

3 NAC-STC Package – Transport-ready weight: loaded cask w/ MPC-LACBWR TSC containing SNF and balsa impact limiters.

4 Design Maximum NAC-STC Package Transport Weight based on MPC-LACBWR contents and use of balsa impact limiters.

5 The NAC-STC is designed to accommodate various contents including YR-MPC PWR SNF TSCs, CY-MPC PWR SNF TSCs, MPC-LACBWR BWR SNF TSCs, MPC-WVDP Vitrified HLW Overpacks, and uncanistered (bare fuel) and undamaged PWR standard and HBU SNF fitting within the cavity length of 165.0 inches.

Table 2-11: NAC-STC Transport Cask Characteristics and Component Dimensions[21]

Design Characteristic	Value	Material
Maximum Design NAC-STC Package Weight	260,000 lbs.	--
Maximum NAC-STC Package Weight w/LACBWR Contents	231,630 lbs.	--
NAC-STC Overall Length without Impact Limiters	193 in.	--
NAC-STC Overall Length with Balsa Impact Limiters	273.3 in.	--
NAC-STC Body Maximum Cross-Section Diameter		
• Across corners of neutron shield plates	99 in.	--
• Across flats of neutron shield plates	98.2 in.	--
NAC-STC Upper Forging Diameter	85.3 in.	--
NAC-STC Bottom Forging Diameter	82.6 in.	--
Balsa Impact Limiter Diameter	128 in.	--
Balsa Limiter Height	52.2 in.	--
NAC-STC Cavity Length	165.0 in.	--
Cask Cavity Diameter	71.0 in.	--
Cask Capacity (no. of assemblies)		
• Directly Loaded PWR SNF	26	--
• MPC-LACBWR TSC SNF	68	--
Inner Shell Thickness		
• Center Shell Section	1.5 in.	Type 304 Stainless Steel
• Upper and Lower Transition Rings (max.)	2.0 in.	Type XM-19 Stainless Steel
Gamma Shield Thickness		
• Center Shell Section	3.7 in.	Chemical-Copper Lead
• Transition Sections (min.)	3.2 in.	Chemical-Copper Lead
Outer Shell Thickness	2.65 in.	Type 304 Stainless Steel
Top Forging – Radial Thickness at Cavity Diameter	7.85 in.	Type 304 Stainless Steel

Design Characteristic	Value	Material
Bottom Thickness (total) • Bottom Forging • Bottom Outer Forging (Radial at Bottom N/S) • Bottom Plate/Forging Neutron Shielding (N/S)	13.65 in. 6.2 in. 3.9 in. 5.45 in. 2.0 in.	 Type 304 Stainless Steel Type 304 Stainless Steel Type 304 Stainless Steel NS-4-FR, Solid Synthetic Polymer
Neutron Shield Assembly - Thickness • Neutron Shielding • Outer Shell • Bottom / Top End Plates	 5.50 in. 0.25 in. 0.472 in.	 NS-4-FR, Solid Synthetic Polymer Type 304 Stainless Steel Type 304 Stainless Steel
Lifting Trunnion (Primary and Secondary) • Base Diameter • Shaft Diameter • Lip Diameter	 10 in. 5.5 in. 6 in.	 Type 17-4 PH Stainless Steel (welded)
Rotation Pocket Thickness (reference)	5.75 in.	Type 17-4 PH Stainless Steel (welded)
NAC-STC Inner Lid • Total Thickness • Lid Rim • Central Sections • Neutron Shield • Neutron Shield Coverplate • Bolts (42) • Torque • O-Rings • Interseal Port Plug	 9.0 in. 7.12 in. 6.0 in. 2.0 in. 1.0 in. 1-1/2 - 8 UN 2,540 ± 200 ft-lb. 2 1	 Type 304 Stainless Steel Type 304 Stainless Steel NS-4-FR Type 304 Stainless Steel SB-637, GR N07718, Nickel Alloy Steel Double Metallic (for TSCs) Seal – Metallic /Torque 30 ± 3 ft-lbs.

Design Characteristic	Value	Material
NAC-STC Outer Lid • Lid Rim • Central Sections • Bolts (36) • Torque • O-Ring	2.5 in. 5.25 in. 1 – 8 UN 550 ± 50 ft-lb. 1	SA205, Type 630 Stainless Steel SA564, Type 630, Class A or B Metal (for TSCs)
Inner Lid Vent and Drain Port Coverplates • Body thickness • Bolts (4) • Torque • O-Ring • Leak Test Port Plug	1.0 in. 1/2 - 13 UNC 300± 20 in-lb 2 1 each	Type 304 Stainless Steel SA-193, GR B6, Type 410 SS Double Metallic (for TSCs) Seal – Metallic / Torque 70 ± 5 in-lbs
Interlid and Pressure Port Covers • Bolt Lip • Total Cover Depth • Bolts (4) • Torque • O-Ring • Leak Test Port Plug	1.0 in. 3.135 in. 3/8 – 16 UN 140 ± 10 in-lbs. 2 1 each	17-4 pH Stainless Steel SA-193, GR B6, Type 410 SS 140±10 in-lbs. PTFE Seal – Viton / Torque 70 ± 0.5 in-lbs.

Figure 2-25 shows a representation of a NAC-STC cask on an intermodal cradle secured to a 12-axle railcar, where the top and bottom images show the cask with and without the personnel barrier installed. **Figure 2-26** shows a picture of a NAC-STC transport package being placed on a heavy haul trailer (HHT) with personnel barrier which was designed/used for transport in China.

As the impact limiters do not exceed 128 inches in diameter, a railcar loaded with the NAC-STC cask and supporting components is expected to fit within the Association of American Railroads

(AAR) Plate C requirements found within the AAR Manual of Standards and Recommended Practices.

The overall transport weight and dimensions for each NAC-STC transport cask load, including transport cradle and margins, is estimated to be: 300,000 pounds, 23 feet long, 11 feet wide, and 11 feet high (measured from base of the cradle).

The NAC-STC packages at LACBWR will be loaded with TSCs containing SNF. The major components of the NAC-STC package are shown in **Figure 2-27** and include the cask body, primary and secondary lifting trunnions, rear rotation trunnion pockets, cask inner and outer lid, vent and drain ports and coverplates, transport-only pressure and interlid port covers, and a loaded and welded MPC-LACBWR TSC containing SNF inserted into the NAC-STC cavity provided with upper and lower transport cavity spacers. The MPC-LACBWR TSC consists of the canister shell, a spent fuel basket, a closure lid with redundant vent and drain port covers and closure ring. The closure lid is designed for the safe handling and transfer of the loaded TSC to and from the VCC, and to the NAC-STC for off-site transport. The MPC-LACBWR TSCs are constructed of stainless steel and after loading, are welded closed, vacuum dried, backfilled with high-purity helium, and the inner port covers are leakage tested. The closure lid, redundant port covers, and closure ring provide the containment boundary for transport.

Figure 2-25: NAC-STC on Transport Frame Mounted on Railcar

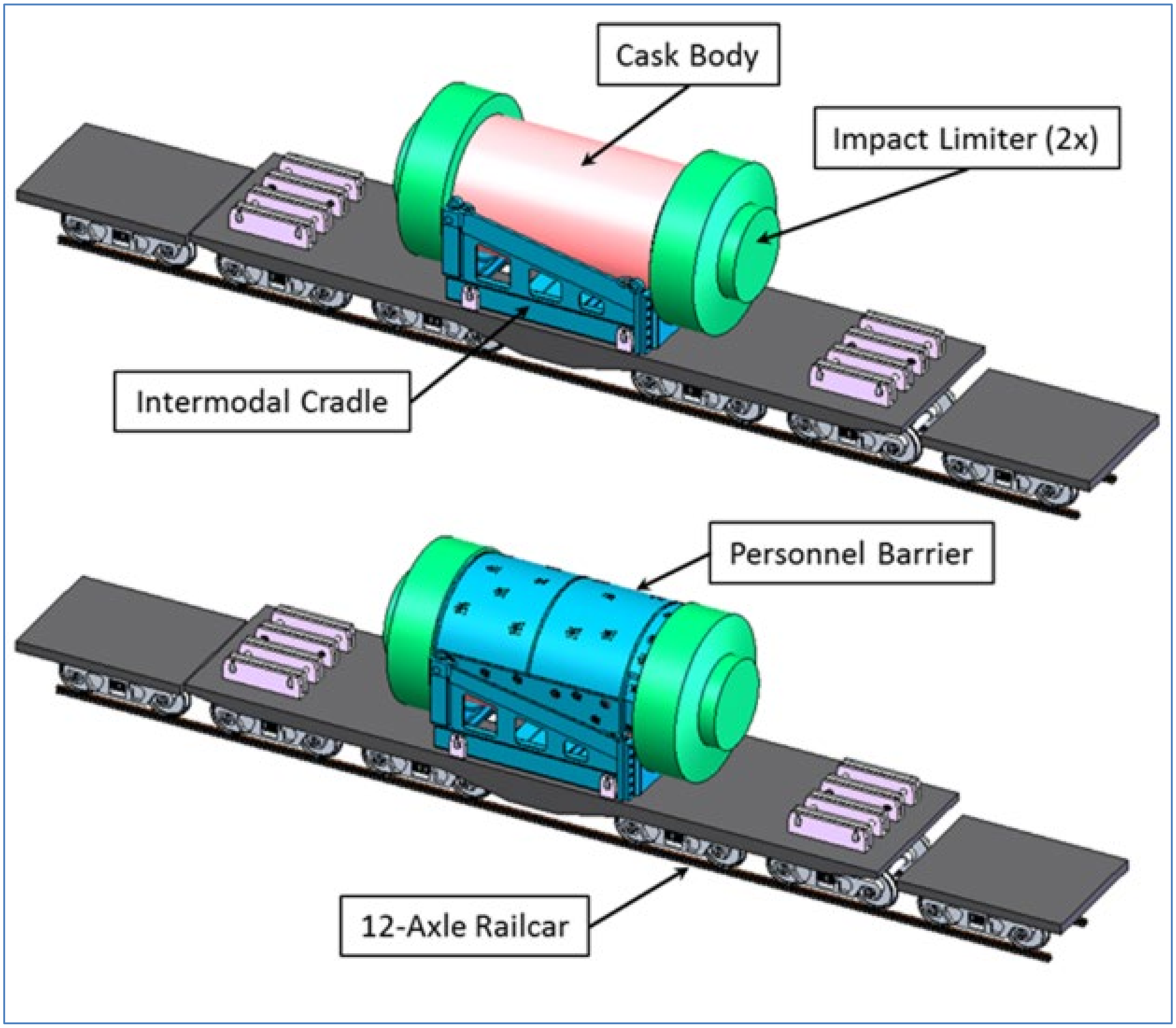


Figure 2-26: NAC-STC Package Ready for Transport

Following the transfer of the MPC-LACBWR TSC from the VCC into the NAC-STC, the cask inner lid is installed with metallic inner (containment) and outer O-ring seals. The NAC-STC cavity is then evacuated and backfilled with high-purity helium and the containment boundary O-ring seals (inner seals of lid and vent and drain port coverplates) are leakage tested using a helium Mass Spectrometer Leak Detection (MSLD) system to leak-tight criteria in accordance with ANSI N14.5-1997.[26][27] Following completion of inner lid containment leakage rate testing, the outer lid fitted with a single Viton O-ring and the transport pressure port cover fitted with double PTFE O-rings are installed to provide a secondary boundary. The volume between the inner and outer lid is evacuated through the interlid port by a vacuum pump and backfilled with helium. Pressure drop testing of the interlid volume is performed to show no leakage at a sensitivity of 10^{-3} atm-cm^3/s. Finally, the transport interlid port cover is installed with double PTFE O-rings and pressure drop tested to a sensitivity of 10^{-3} atm-cm^3/s. After loading of the TSC in the NAC-STC cask and inner lid closure helium leakage testing, the NAC-STC provides the transport containment boundary under normal and accident conditions of transport.

The NAC-STC transportation package containment boundary, shown in **Figure 2-28**, includes the NAC-STC body, cask inner lid, drain and vent port coverplates, and inner lid and port coverplate metallic O-ring seals. The containment boundary consists of the cask's inner shell, the top and bottom inner shell transitions, the cask bottom forging, the upper cask forging, the inner lid, the vent and drain port coverplates, and the inner lid and port coverplates inner metallic O-ring containment seals. The NAC-STC containment seals are each individually inspected, replaced, and leakage tested prior to each loaded transport. During fabrication the cask containment boundary weldment including the inner shell, the top and bottom shell transitions, bottom forging, upper forging and inner lid are hydrostatically tested per the American Society of Mechanical Engineers (ASME) Code, Section III, NB-6000 followed by helium leakage testing to confirm a total leakage rate of ≤ 2.0 x 10^{-7} cm^3/sec, helium (leak-tight in accordance with ANSI N14.5-1997). At the completion of fabrication, the inner lid and vent and drain port cover containment components and metallic O-ring seals are fabrication leakage rate tested to confirm that the individual leakage rate are ≤ 2.0 x 10^{-7} cm^3/sec, helium, in accordance with ANSI N14.5-1997 as specified in the NAC-STC SAR Containment Evaluation.

Figure 2-27: NAC-STC Section Views[21]

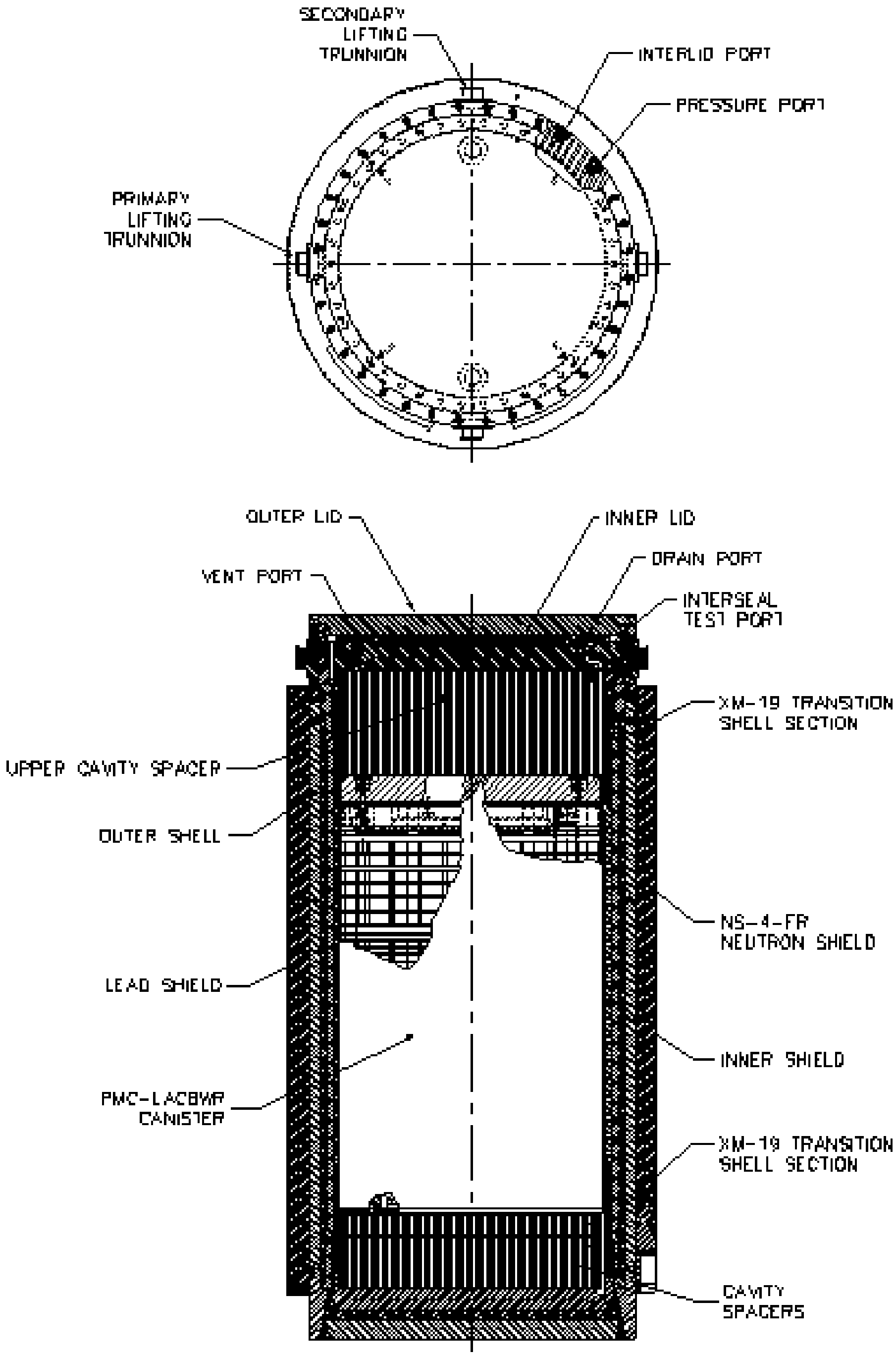
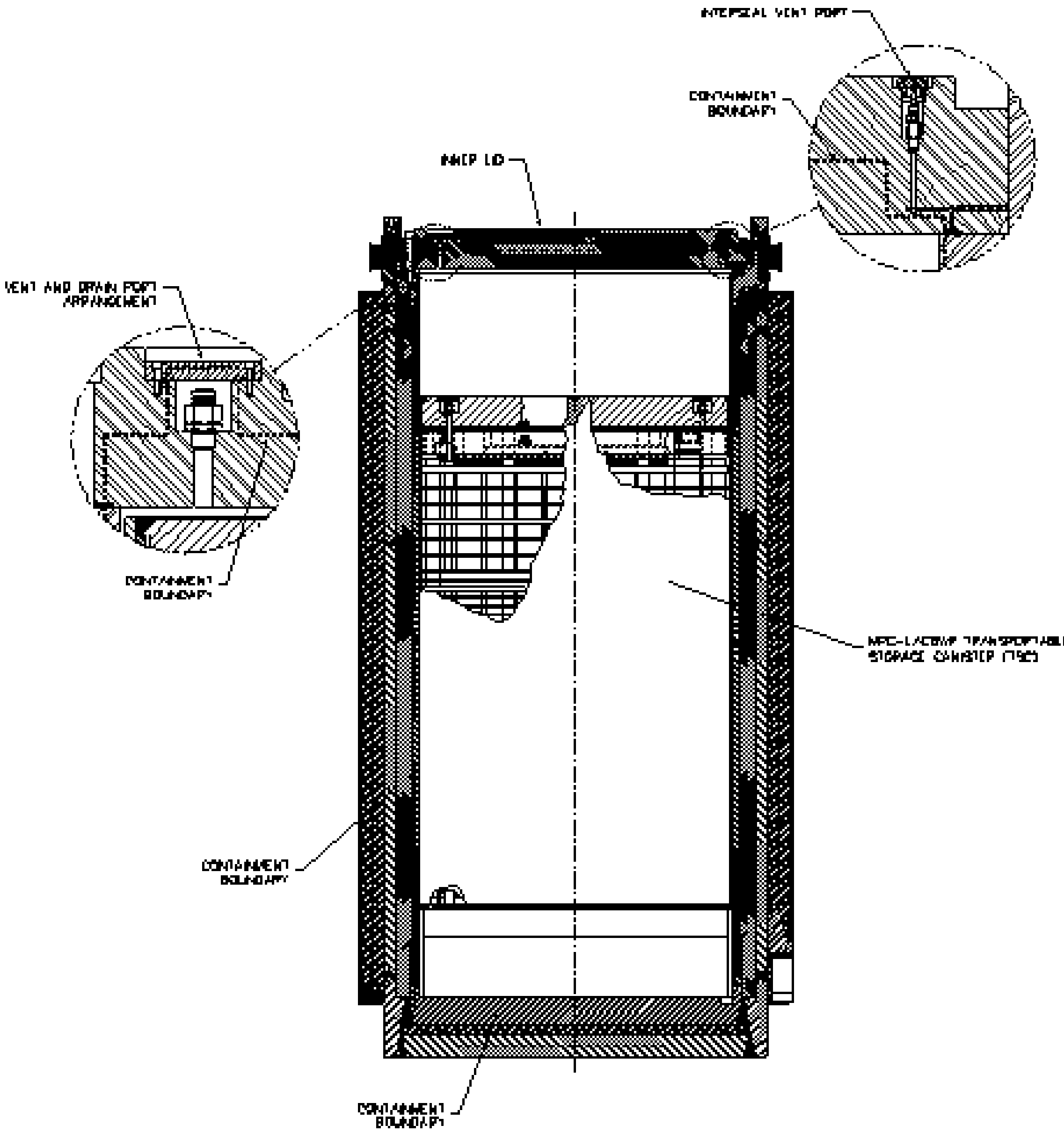


Figure 2-28: NAC-STC Containment Boundary[21]



Following MPC-LACBWR TSC loading operations into the NAC-STC at LACBWR, the new inner lid containment metallic O-ring seals of the inner lid and vent and drain port covers are maintenance leakage tested using a helium MSLD to confirm a leak tight containment closure in accordance with ANSI N14.5-1997[26].

Figure 2-29 presents the operational equipment requirements for retrieving a loaded MPC-LACBWR TSC from a MPC-LACBWR VCC. Following VCC lid removal, the transfer adapter is installed on the top of the VCC. The swivel hoist rings and lifting slings, or alternative TSC lifting adapter plate, are installed in the six bolt holes of TSC closure lid. The TFR, with the retaining ring installed, is then placed on top of the adapter plate using a TFR lift yoke combined with a qualified mobile The Canister Handing Facility (CHF), or alternative restraint system is required per the CoC TSs to restrain or maintain the TFR on top of the VCC or the NAC-STC cask during the TSC transfer operations. (See **Figure 2-30** of TFR restraints during MPC-LACBWR VCC loading operations.) Alternatively, a seismically qualified gantry system with lifting slings and incorporating a hydraulic or air-operated chain hoist TSC lifting system may be used to satisfy the CoC requirements. The gantry system would be qualified to maintain the stability of the TFR and TSC during the TSC transfer operation. Additional details on the CHF requirements and the alternative gantry/chain hoist system are provided in **Section 6.0**. Once the CHF is in place to restrain and maintain the seismic stability of the TFR and a lifting system is attached to the TSC closure lid, the shield doors are then opened using the auxiliary hydraulic actuation system. The lifting slings are then retrieved using tag lines through the annulus of the TFR and connected to a suitable mobile crane hook, or the gantry system chain hoist TSC lifting system is connected to the TSC lid lift adapter. The TSC is then slowly lifted from the VCC cavity by the mobile crane or gantry system's chain hoist into the TFR annulus until the TSC is approximately 1 inch below the TFR retaining ring. The shield doors are then closed and secured with lock pins. The TSC is then lowered to rest on the shield doors.

Figure 2-29: MPC-LACBWR MPC VCC Unloading Transfer Operation with TSC Partially Removed[11]

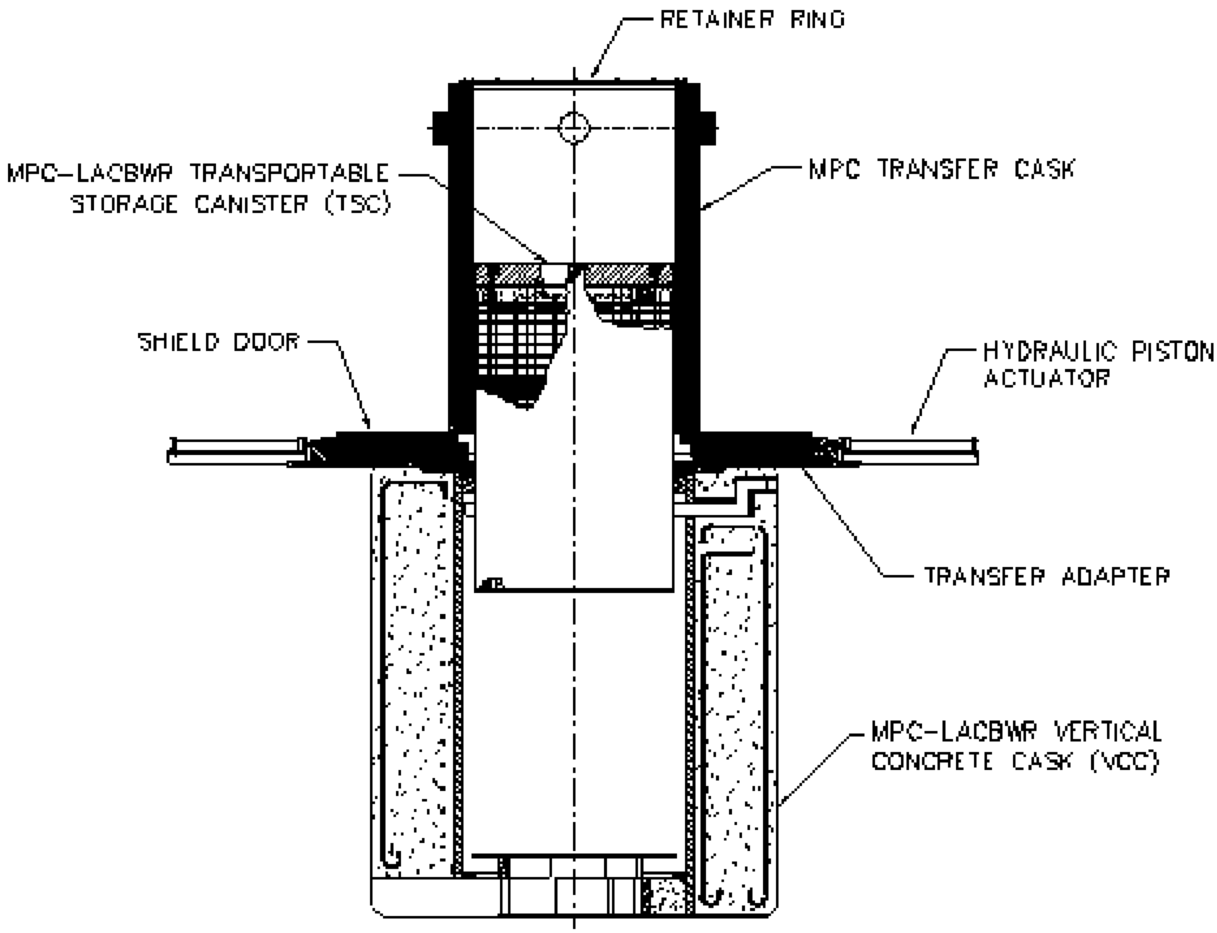


Figure 2-30: MPC-LACBWR TFR Moving to Transfer Position on VCC and TFR Restraint System

Figure 2-31 shows the next operational sequence where the TSC is transferred into the NAC-STC cavity. After the NAC-STC is uprighted from its shipping cradle, the cask is set down at the TSC Transfer Station location using the NAC-STC vertical lift yoke and a mobile crane. The outer lid bolts are removed and the outer lid is removed using the outer lid lifting sling set and hoist rings, and temporarily stored while protecting the outer lid O-ring. The inner lid bolts are detorqued and removed and the inner lid alignment pins are installed. The inner lid lifting slings and hoist rings are installed and the inner lid is removed and temporarily stored. The inner lid inner and outer metallic O-rings are removed. The O-ring grooves will be cleaned and inspected, and new seals installed on the inner lid prior to re-installation of the inner lid after TSC loading. The lower MPC-LACBWR and YR-MPC Transport Canister Spacers are then installed in the bottom of the TSC-STC cavity. The canister spacers axially position the MPC-LACBWR TSC in the analyzed position based on the SAR hypothetical accident conditions (HAC) of transport.

The NAC-STC adapter ring, designed to protect the casks upper sealing surface and provide additional shielding, is installed and bolted in place. A second transfer adapter plate is used and bolted to the NAC-STC adapter ring bolt circle. The TFR containing a loaded TSC is then lowered in place on the top of the adapter plate and into the CHF or gantry system with an integrated chain hoist. The TFR door lock pins are then removed, the TSC lifting slings or TSC lid adapter plate are engaged to the mobile crane or gantry system's hydraulic TSC chain hoist, and the MPC-LACBWR TSC is lifted off the shield doors, the doors opened with the auxiliary hydraulic system, and the TSC is slowly lowered into the NAC-STC cavity to rest on the transport cavity spacers. **Figure 2-31** shows a MPC-LACBWR TSC partially inserted into the NAC-STC during transfer from the TFR. **Figure 2-38** shows a MPC-LACBWR TSC loaded into the TFR. After the removal of the TFR from the of the NAC-STC the upper cavity spacer is installed on top of the TSC to ensure appropriate positioning and weight distribution during transport. **Figure 2-32** shows the Transfer Adapter required to align the TFR to the VCC and NAC-STC during TSC transfer operations.

Figure 2-31: NAC-STC Transfer Operation with MPC-LACBWR TSC Partially Inserted[12]

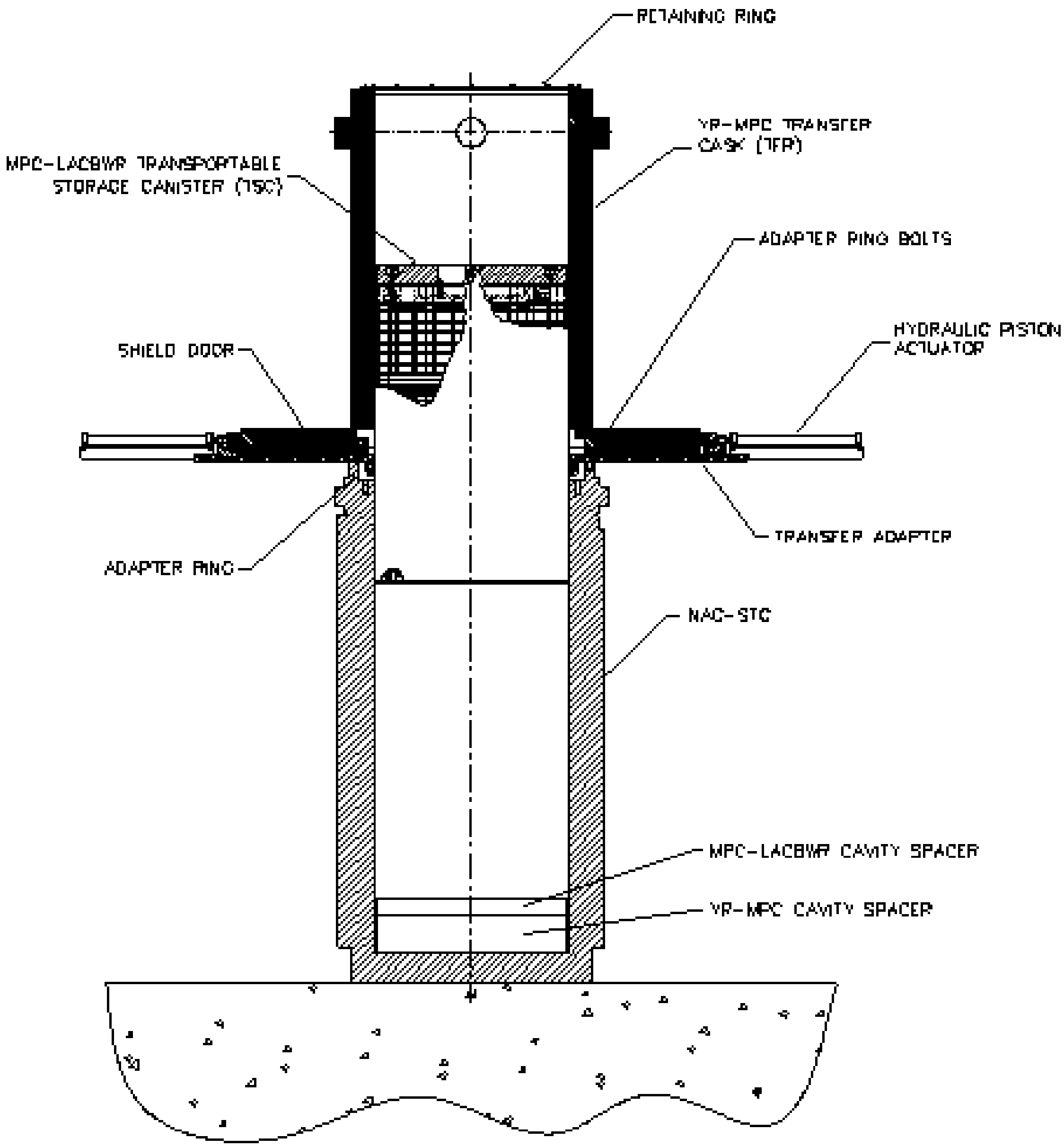
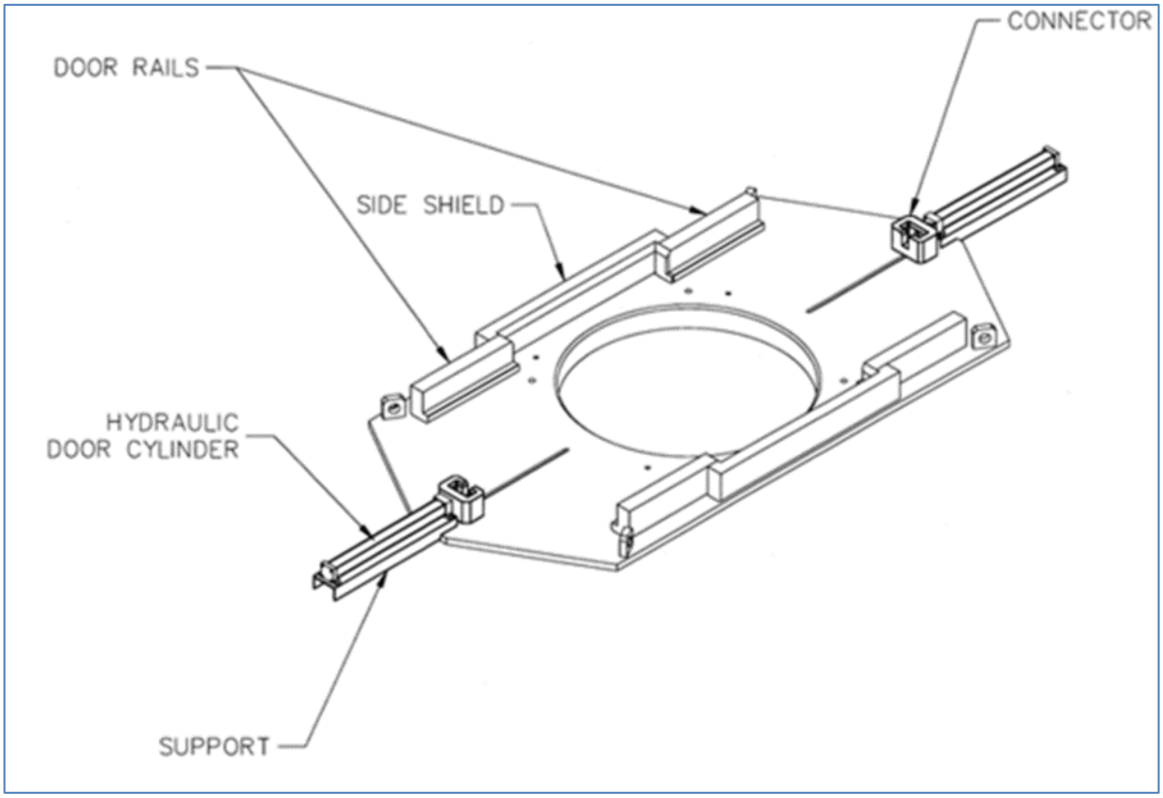


Figure 2-32: MPC TFR Adapter Plate[22]



As shown in **Figure 2-27**, the NAC-STC cask includes a vent port and drain port in the inner lid. The vent and drain ports each consist of a 1-inch quick disconnect fitting with a seal and a cover plate with redundant metallic O-ring seals that are secured with four ½-inch diameter bolts. However, for MPC-LACBWR TSC transports there is no drain tube installed and connected to the drain port as all loading operations are performed dry. The NAC-STC inner lid contains redundant metallic O-ring seals and is secured to the cask body with 42 1-1/2-inch diameter bolts. The lid also includes a test port; with a $^{3}/_{8}$-inch diameter quick disconnect fitting and seal that is used to test the NAC-STC inner lid containment seal integrity. The inner lid and vent and drain port covers are all provided with redundant sets of metallic O-rings. **Figure 2-28** depicts the vent and drain ports and cover plates, as well as the lid test port configuration.

The unloading of a TSC from a VCC and transfer to a NAC-STC, and preparation of a NAC-STC for transport, will include the following high-level activities (detailed operations are described in **Section 6.1.3** and NAC-STC SAR [21] and NAC-MPC FSAR [12]):

1. At receipt on the site perform radiation and removable contamination surveys and record results. Inspect NAC-STC packaging for possible transport damage and record inspections results on cask receiving/loading report.
2. Using a horizontal lift beam, lift intermodal transport cradle containing the NAC-STC off of the rail car with impact limiters and tie-downs installed and position the cradle on the TSC Transfer Station pad.

3. At the CHF on the TSC Transfer Station pad prepare the NAC-STC packaging for loading by removing the front and rear impact limiters, releasing front tie-downs, and cleaning the cask exterior of road dirt. Install the NAC-STC lift yoke to a suitable crane or gantry system and engage the yoke arms to the front lifting trunnions. Use the NAC-STC vertical lift yoke to upright the cask and position it on the TSC Transfer Station pad.
4. Remove 36 outer lid bolts and store. Using outer lid lift slings and hoist rings, remove the outer lid and store. Visually inspect outer lid bolts and seal.
5. Detorque and remove the 42 inner lid bolts and store. Install the two lid alignment pins in their designated locations. Install inner lid lift slings and hoist rings and remove the inner lid and store. Note: Prior to inner lid re-installation the inner lid metallic O-rings will be replaced. Store inner lid and inner lid bolts to prevent damage to O-ring grooves/surfaces and threads.
6. Install NAC-STC cask adapter ring to protect cask body sealing surfaces and bolt to cask body.
7. Install YR-MPC and MPC-LACBWR lower transport cavity spacers in the base of the cavity.
8. Install Foreign Material Exclusion (FME) cover over open NAC-STC cavity to prevent intrusion of foreign materials and to protect from weather.
9. Prepare MPC-LACBWR VCC for movement to the TSC Transfer Station location by performing radiation surveys and disconnecting temperature monitoring system.
10. Position the on-site HHT adjacent to the ISFSI pad loading dock position. Lower HHT jacks/pads, and install wheel chocks, aluminum drop restraints, and HHT to pad bridge plates.
11. Remove the MPC-LACBWR VCC inlet vent screens and install hydraulic jacks in the four vent openings.
12. Lift MPC-LACBWR VCC approximately 4-5 inches using hydraulic pump and jacks.
13. Install four air pad units under the MPC-LACBWR VCC bottom plate between the four vents (see **Figure 2-33**).
14. Lower the MPC-LACBWR VCC onto the top of the air pads by lowering and removing the hydraulic jacks.
15. Position JCB telescope handler, or equivalent, adjacent to the HHT and extend the boom across HHT loading bed. Connect handling clamp and straps to MPC-LACBWR VCC (see **Figure 2-35** and **Figure 2-36**).
16. Inflate air pads using a diesel-powered air compressor (minimum capacity 750 ft^3/min) to lift MPC-LACBWR VCC off of ISFSI surface.
17. Using the JCB, pull and position the MPC-LACBWR VCC on the HHT bed surface, and deflate the air pads. Disconnect from air supply and disconnect JCB from MPC-LACBWR VCC.

18. Prepare HHT (See **Figure 2-33**) for movement by removing chocks, aluminum drop restraints, and retracting hydraulic jacks/pads.
19. Move HHT with loaded MPC-LACBWR VCC to TSC Transfer Station (see **Figure 2-36**).
20. Position the HHT adjacent to the TSC Transfer Station. Lower HHT jacks/pads and install wheel chocks, aluminum drop restraints, and HHT to pad bridge plates.
21. Inflate air pads and use JCB or equivalent to move the loaded MPC-LACBWR VCC to the transfer position.
22. Remove the 6 MPC-LACBWR VCC lid bolts and install lifting slings hoist rings to three lifting holes identified on the lid. Using a small crane, remove and store VCC lid and lid bolts.
23. Remove closure lid lifting hole plugs and install and torque six special hoist rings in the TSC closure lid bolt holes. Install redundant lifting sling sets or install TSC lifting adapter plate if gantry system with single failure proof secure lift yoke with chain hoist system will be used.
24. Prepare TFR for receipt of the TSC by performing pre-use inspection and installing retaining ring and bolting to the TFR top forging.
25. Remove FME cover from the top of the NAC-STC cask opening the cask cavity for receipt of the loaded MPC-LACBWR TSC.
26. Install the transfer adapter plate (See **Figure 2-32**) on top of the VCC. Connect auxiliary hydraulic actuating system to the transfer adapter door hydraulic cylinders. If second transfer adapter plate is available, install the plate on the top of the NAC-STC cask resting on the cask adapter ring and install engagement bolts to secure adapter plate to the adapter ring. (*Note: It is recommended that a second transfer adapter plate be procured to support the TSC transfer operation. A 2nd adapter plate would allow the TFR to be moved directly from the VCC to the NAC-STC without the need to set the TFR down to move the transfer adapter plate from the VCC to the NAC-STC*).
27. Using a TFR lifting yoke connected to a suitable crane or gantry crane system with chain hoist system, lift TFR, with retaining ring installed, and set TFR down on top of the transfer adapter with connectors extended into the engage position (to engage the shield door mating connectors) on the MPC-LACBWR VCC. (*Note: The retaining ring bolted to the top of the TFR by 32 bolts prevents the TSC from being accidentally lifted out of the TFR cavity during TSC handling. The retaining ring is designed to lift the entire weight of the loaded TSC and TFR without failure*).
28. Using the transfer adapter hydraulic system, open the two TFR shield doors allowing access to the TSC lifting equipment.
29. From the top of the TFR, using a man-lift and retrieving device, engage the redundant lifting rig sets to the mobile or fixed crane hook, or use hoist system (discussed further in **Section 6.0**) to engage TSC lifting adapter plate. Take up slack on TSC lifting slings or engage hoist system to TSC lift adapter plate.

30. Using the mobile/fixed crane, or hoist system, slowly withdraw TSC from VCC into the TFR ensuring the TSC is vertical. When TSC approaches retaining ring, stop lift and using the transfer adapter hydraulic system, close the shield doors and set TSC down on shield doors. Install shield door lock pins.
31. Disengage lifting slings from the crane hook and set them down on top of the TSC.
32. Using the lifting yoke or secure lift yoke on gantry system, lift the TFR off the top of the VCC and move the TFR to rest on the second transfer adapter plate installed on the NAC-STC cask. Set TFR down while engaging the connectors of the shield doors to the extended connectors on the transfer adapter plate. (*Note: If second adapter plate is not used or available, it may be necessary to set the TFR down on the TSC Transfer Station pad to allow movement of the transfer adapter plate from the VCC to the NAC-STC cask*).
33. Disengage lift yoke and engage the crane hook to the TSC lifting slings or connect chain hoist to TSC lift adapter plate while maintaining TFR on the secure lift yoke. Remove the TFR shield door lock pins.
34. Lift TSC off of shield doors approximately 1 inch and open the shield door hydraulics to open shield doors, and slowly lower the TSC into the cask cavity to rest on cavity spacers.
35. Disengage the TSC lifting slings from the crane hook and lower them on to the top of the TSC, or disengage TSC adapter plate from chain hoist.
36. When lifting equipment is clear, close shield doors, install door lock pins, and remove TFR from the top of the NAC-STC.
37. Remove the lid slings or TSC lifting adapter and store. Remove transfer adapter and unbolt cask adapter ring and remove and store.
38. Install the upper transport impact limiter into the NAC-STC cavity in position on the top of the MPC-LACBWR TSC.
39. Clean inner lid metallic seal grooves and install new inner and outer metallic O-ring seals and retention clips.
40. Install inner lid alignment pins and using NAC-STC inner lid lifting slings and crane install the closure lid.
41. Install 10 lid bolts equally spaced and tighten to hand tight. Remove alignment pins and install remaining 32 lid bolts. Torque all bolts to 2,540 ± 200 ft-lbs in accordance with the torqueing sequence marked on the inner lid in 3 passes until all bolts are verified at final torque.
42. Remove vent port coverplate and connect vacuum pumping and helium backfill system to the vent port quick disconnect valve.
43. Operate vacuum pump until a final vacuum of ≤ 3 torr is reached and then turn off vacuum pump.
44. Backfill NAC-STC cavity with high-purity helium to a pressure of 1 atm and disconnect the vacuum and helium backfill system from the vent port.

45. Clean vent port coverplate metallic seal grooves and install new inner and outer metallic O-ring seals and retention clips.
46. While preparing loaded NAC-STC for transport, reinstall VCC lid and move empty VCC to appropriate location using the HHT and air pads and prepare to retrieve the next VCC to be unloaded.
47. Install vent port coverplate and torque to 300 ± 20 in-lbs. (*Note: As drain port is not required to be removed for access to the cavity there is no need to replace the drain port coverplate seals*).
48. Remove vent port test plug, connect helium MSLD system to the port and evacuate the interseal volume to a pressure of < 0.1 torr to allow performance of the maintenance leakage rate test. Test is acceptable if detected leakage rate is ≤ 2 x 10^{-7} cm^3/s, helium with a test system sensitivity of ≤ 1 x 10^{-7} cm^3/s, helium. If test is acceptable, re-install the vent port coverplate test plug with new O-ring. (*Note: Although not specifically required as port coverplate is not removed, it is recommended per latest NRC guidance* [26] *that a leakage test be performed on the drain port as it is unknown when the coverplate was last removed and potentially not tested at that time*).
49. Remove vent port test plug, connect helium MSLD system to the port and evacuate the interseal volume to a pressure of < 0.1 torr to allow performance of the maintenance leakage rate test. Test is acceptable if detected leakage rate is ≤ 2 x 10^{-7} cm^3/s, helium with a test system sensitivity of ≤ 1 x 10^{-7} cm^3/s, helium. If test is acceptable, re-install the vent port coverplate test plug with new O-ring.
50. Remove closure lid interseal test port plug, connect helium MSLD system to the port and evacuate the inter seal volume to a pressure of < 0.1 torr to allow performance of the maintenance leakage rate test. Test is acceptable if detected leakage rate is ≤ 2 x 10^{-7} cm^3/s, helium with a test system sensitivity of ≤ 1 x 10^{-7} cm^3/s, helium. If test is acceptable, re-install the inner lid interseal test port plug with new O-ring.
51. Using the NAC-STC lift yoke, lift loaded cask and engage cask rear trunnion recesses on transport cradle rear supports positioned on the rail car. Rotate the cask from vertical to horizontal orientation. (*Note: The intermodal transport cradle can be located on the ISFSI pad surface or on the rail car. As required, the intermodal transport cradle can be lifted horizontally using a horizontal lifting yoke to move the loaded cradle from the pad surface to or from the rail car or to the barge*).
52. Install front tie down over cask upper forging.
53. Install top and bottom impact limiters and install tamper indication device (TID) between upper impact limiter to cask to detect tampering during transport.
54. Perform final radiation and contamination surveys. Apply fissile material labels on the package.
55. Install personnel barrier and install padlock barrier access portal.
56. Apply applicable placards to transport vehicle.
57. Complete all shipping documentation and provide special instruction to carrier/shipper for an Exclusive Use Shipment.

Note: The NAC-STC transport cask systems provided to perform MPC-LACBWR TSC transports from the LACBWR site will be in full compliance with the maintenance program as specified in Chapter 8 of the NAC-STC Safety Analysis Report (SAR), which specifies the required maintenance program for the cask (see NAC-STC Maintenance Schedule Table in **Section 6.1.3**). NAC or the cask supplier would certify that the cask is in compliance with the current annual maintenance program, which would include dye penetrant [penetrant testing (PT)] examination of the lifting trunnion surfaces and welds, and replacement of quick disconnects and neutron shield relief devices.

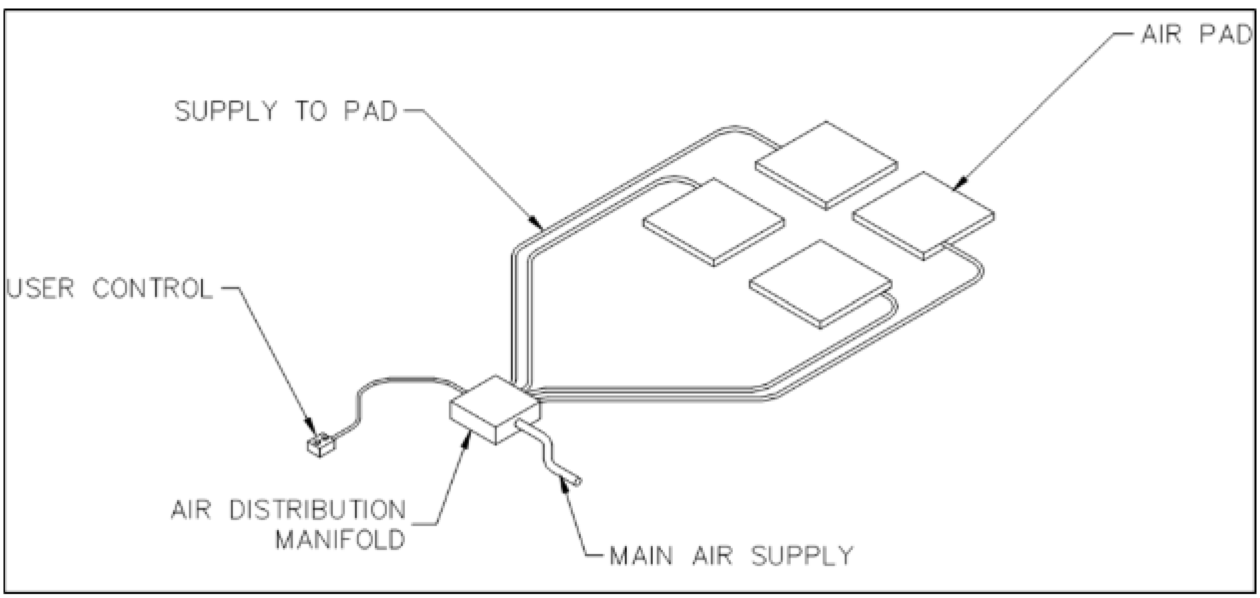
Equipment and Auxiliary System Requirements:

In order to perform the above sequence of operations, a number of ancillary devices, equipment, and systems would be required. These ancillary equipment and systems, along with a description of their purposes and availability are listed below. In addition, see **Section 10.0** for a recommendation to compile a complete listing of all equipment, components, supplies, M&TE, miscellaneous materials, etc. The listing will also address responsibility for providing the equipment and components and provides a cross reference to the applicable CoC requirement.

Heavy-Haul Trailer and Tractor (Prime Mover):

A special onsite HHT design has been developed to transport the loaded and empty MPC-LACBWR VCC to and from the ISFSI pad and TSC Transfer Station. Jacks are provided to raise the trailer deck height level with the ISFSI pad height (approximately 27 inches), and to provide stability to the trailer during MPC-LACBWR VCC loading and movement. The HHT is analyzed and reinforced to support the loaded MPC-LACBWR VCC weight, in addition to the weight of the TFR and Transfer Adapter, during the original TSC loading operations at LACBWR. The trailer and tractor combination has been designed to limit the maximum ground loading during transport to 100 psi or less. (See **Figure 2-34** and **Figure 2-36**). (*Note: As the identical HHT will be required for de-inventory projects at Maine Yankee, Connecticut Yankee, and, it is recommended that a new HHT be procured from the original manufacturer, Talbert Manufacturing, Inc. of Rensselaer, IN to original NAC Fabrication Specification requirements).*

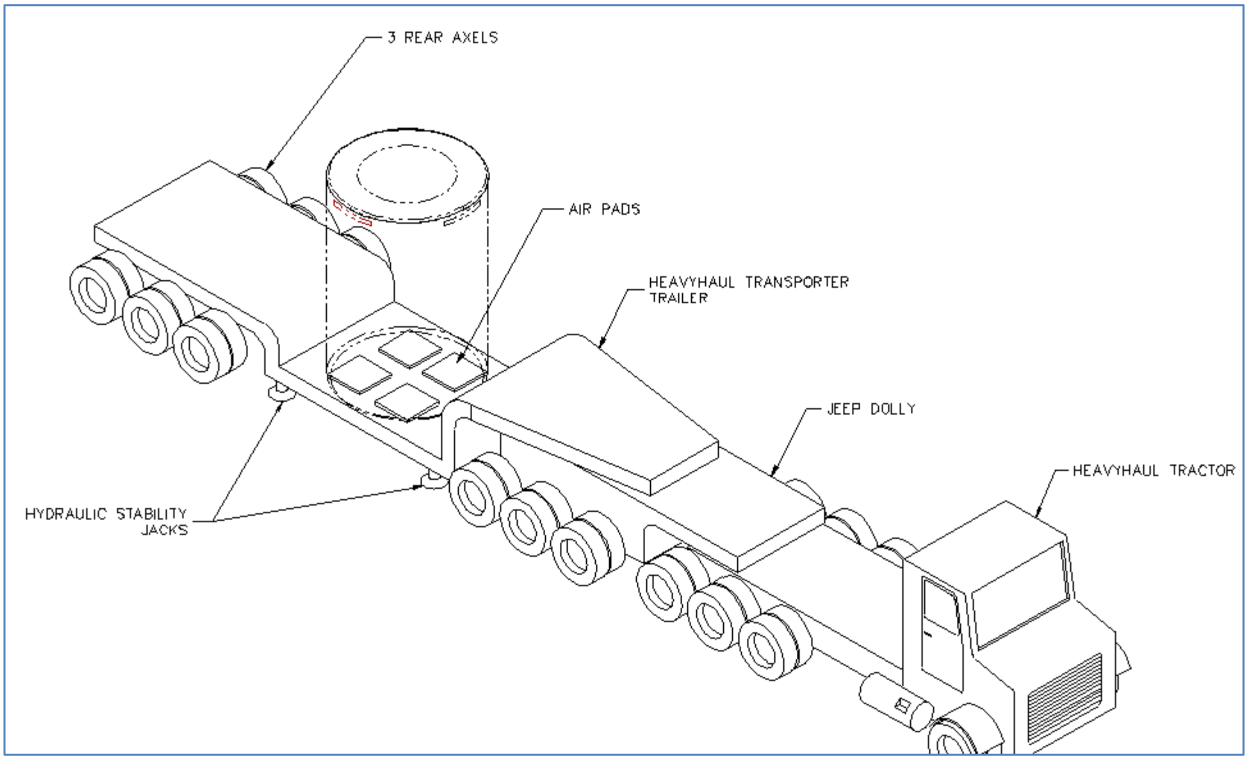
Figure 2-33: NAC MPC-LACBWR Air Pad System[12]



TFR and Retaining Ring:

There currently is a TFR at the LACBWR site. YR sold the TFR to DPC LACBWR, where it was refurbished and re-load tested/inspected. Prior to the de-inventory campaign, the TFR will need to be inspected in accordance with the applicable Aging Management Program as it is over 20 years old and is covered under the recertification of the NAC-MPC Systems. In addition, the TFR lift yoke is also available and would also require inspection and potentially re-load testing in accordance with ANSI N14.6[23].

Figure 2-34: NAC MPC-LACBWR Heavy-Haul Trailer System[12]



TFR Transfer Adapter:

The Transfer Adapter Plate (**Figure 2-32**) is used to hydraulically operate the TFR shield doors. The adapter incorporates two hydraulic cylinders mounted on each end of the plate that extend female connectors that are used to engage the male connectors on the shield doors. The hydraulic cylinders are operated by a separate auxiliary hydraulic system including hydraulic pump, hoses, and valves. Currently, it is unknown if the transfer adapter used for the fuel loading campaign is available at the LACBWR site. It is expected that a minimum of a least one new Transfer Adapter Plate will need to be procured and fabricated for use during the TSC transfer operation in accordance with NAC's approved Design Drawings and Fabrication Specification. As noted in the operational sequence, it is recommended that two transfer adapter plates be available to support the TSC transfer operation. A 2nd adapter plate would allow the TFR to be moved directly from the VCC to the NAC-STC without the need to set the TFR to be set down to move the transfer adapter plate from the VCC to the NAC-STC. *Note: Transfer Adapter Plates fit all NAC-MPC*

VCCs and NAC-STC adapter ring so a set of two adapters could be used for the YR, Connecticut Yankee Nuclear Power Plant (CY) and LACBWR de-inventory projects.

Auxiliary Hydraulic System for Transfer Adapter:

An electrically powered, high-pressure hydraulic pump, hoses, valves, and connectors are required to operate the hydraulic cylinders mounted on the transfer adapter to open and close the TFR shield doors to allow the TSC to be lowered into or lifted from the VCC or the NAC-STC. The auxiliary hydraulic system is installed after the transfer adapter is placed on the VCC and/or NAC-STC. An auxiliary hydraulic system is available for lease from NAC and was last utilized at the DPC LACBWR project. A single hydraulic system with a second set of supply and return hoses would be capable of operating two separate transfer adapter plate hydraulic cylinder sets.

Auxiliary Lifting Rigs:

A number of slings and rigging attachments are required to handle various MPC-LACBWR components and to safely operate the system. The sling systems are designed to meet the requirements of ANSI N14.6[23] and ASME B30.9[24] as applicable, and to comply with the guidance provided in NUREG-0612[25] for handling heavy loads. Sling sets for critical loads are designed to provide a load rated capacity of at least 600% of the load being lifted. Each sling set for critical loads is load tested to 300% of the design lifting capacity prior to delivery. Redundant sling sets are designed to 300% of the load and tested to 150%. There are no lift rigs currently at the LACBWR site and a complete set of new lifting rigs including associated hoist rings and turnbuckles will need to be procured and tested prior to the start of the LACBWR de-inventory campaign.

The following auxiliary lifting rigs are utilized to operate the system for transfer and loading operations at LACBWR:

- MPC-LACBWR TSC Redundant Lifting Rig. This lifting rig uses a redundant (2X) three-point lift connected to a master link(s). This lifting rig is used to retrieve loaded TSCs from the MPC-LACBWR VCC and for transfer to the NAC-STC Transport Cask. Each of the two sets of three-legged slings is designed for a load capacity of 300% of the weight of a loaded TSC. Alternative lifting slings or equipment arrangements may be used based on facility requirements such as a TSC Transfer Adapter Plate used in conjunction with a chain hoist system.
- MPC-LACBWR Transfer Adapter Lifting Rig. This lifting rig is used to place and remove the Transfer Adapter assembly onto the VCC or NAC-STC using a four-point lift. The four-legged sling set is attached to the four lifting lugs or hoist rings on the Transfer Adapter using shackles.
- MPC-LACBWR VCC Lid Lifting Rig. This lifting rig is used to install and remove the VCC lid using a three-point lift. The three-legged sling is attached to the VCC lid by three hoist rings.
- TFR Retaining Ring Lifting Rig. This lifting rig is used to install and remove the retaining ring using a three-point lift. The three-legged sling set is attached to the retaining ring by hoist rings.

- NAC-STC Outer Lid Lifting Rig. This lifting rig is used to install and remove the cask lid using a four-point lift. The four-legged sling is attached to the cask lid by four hoist rings.
- NAC-STC Inner Lid Lifting Rig. This lifting rig is used to install and remove the cask lid using a four-point lift. The four-legged sling is attached to the cask lid by four hoist rings.
- NAC-STC Transport Cask YR-MPC and MPC-LACBWR Cavity Spacer Lifting Rig. This lifting rig is used to install and remove the YR-MPC and MPC-LACBWR transport cavity spacers using a three-point lift. The three-legged sling is attached to the spacer by three hoist rings. The lift rig will be used to install the appropriate cavity spacer prior to TSC loading and remove it after TSC unloading from the NAC-STC. The YR-MPC and MPC-LACBWR cavity spacers will be required to be removed from the empty NAC-STC prior to return shipment and shipped separately in an IP-1 box/container.
- NAC-STC Impact Limiter Lifting Rig. This lifting rig is used to remove and install the impact limiters to the front and rear of the NAC-STC. The four-legged sling is attached to the four lifting lugs welded to the top of the impact limiter using shackles.

Lifting Jacks and Air Pad Rig Set:

The jacking system and the air pad system (**Figure 2-33**) are required for movement of the VCC. The hydraulic jacking system is used to lift the MPC-LACBWR VCC to allow placement of the air pad rig set under the VCC. The air pad set allows movement of the VCC to and from the transporter, and on the ISFSI pad. A set of four hydraulic jacks is used, one placed under each of the four air inlets. The hydraulic jacking system includes a control panel, an electric hydraulic oil pump, an oil reservoir, and necessary hydraulic hoses, valves, and fittings. The jacks have a limited lift height to ensure the loaded MPC-LACBWR VCC does not exceed a 6-inch lift height. In normal operation, the jacks are used to raise the cask approximately 4 to 5 inches to permit installation and removal of the four air pads under the VCC base plate. The air pad set lifts the VCC off the surface using a compressed air flow (minimum of 750 ft^3/min) provided by a diesel-driven air compressor, which provides a thin layer of air between the VCC and the surface. The complete air pad set has a lifting capacity of 366,000 lbs. The VCC can then be moved by a JCB telescope handler, suitable towing vehicle or forklift provided with an appropriate VCC attachment device. A control system is provided to regulate the compressed air flow to each of the four air pads and to maintain a uniform lifting height. Upon completion of the planned VCC movement, the air pad set is deflated and the jacking system is then re-installed to raise the VCC to allow removal of the air pads and to lower the VCC into position (see **Figure 2-33** and **Figure 2-36**). There are no jack or air pad systems currently at LACBWR. Both the hydraulic jack and air pad systems are available for lease from NAC after refurbishment, or new systems can be procured. **Figure 2-36** shows the MPC-LACBWR in the TFR ready for lowering to top of VCC and

Figure 2-37 shows the first MPC-LACBWR VCC ready for movement from HHT to ISFSI pad on air pads.

MPC-LACBWR VCC Attachment Device and Associated Strapping and HHT Bridge Plates:

VCC attachment device consisting of essentially a 120 to 150-degree curved piece of steel with a special designed attachment connection for connecting the steel curved VCC capture device to the

JCB telescope handler or equivalent VCC push vehicle. A strapping system is utilized to connect the two ends of the curved steel device to positively capture the VCC to allow it to be moved to and from the ISFSI pad and HHT in a controlled manner (see **Figure 2-35**).

<u>Mobile Diesel-Powered Air Compressor:</u>

A diesel-powered air compressor with a rated capacity of approximately 900 ft^3/min is required to properly operate the air pad system. The air compressor will need to be located in proximity to the TSC Transfer Station. There are currently no diesel air compressors at LACBWR. NAC has a single KAESER Mobilair 260 T air compressor meeting project requirements available for lease.

<u>Diesel Electric Generator:</u>

A small electric generator will be required to operate electrically powered equipment including the transfer adapter auxiliary hydraulic system pump, lifting jacks hydraulic pump, vacuum pump, Helium MSLD, etc. A new generator may need to be purchased to provide electrical power at the TSC Transfer Station pad as a generator or electric power may not be available at the LACBWR site.

<u>Vacuum Pumping and Helium Backfill System:</u>

Following loading of the MPC-LACBWR TSC into the NAC-STC and installation and torquing of the lid, the cask cavity is evacuated to ≤ 3 torr using a vacuum pumping system connected to the vent port quick disconnect coupling. This allows backfilling of the cask cavity to 1 atm with high-purity helium. The vacuum pump skid generally includes a high-efficiency, large-capacity vacuum pump, pressure and vacuum gauges, isolation valves, and high vacuum piping and hoses for connecting the vacuum pumping system to the TSC vent port opening. The potentially contaminated exhaust of the vacuum pump will require routing to a portable HEPA system. If contamination is detected during evacuation of the NAC-STC cavity loaded with an MPC-LACBWR TSC, the source of the contamination will be required to be determined prior to final preparations for shipment of the package. (*Note: The* MPC-LACBWR *TSCs may have residual removable contamination as a result of in-pool loading as allowed NAC-MPC TS LCO 3.2.1*). The high-purity helium supply is connected directly to the vacuum pumping skid to allow helium backfill after isolation of the vacuum pump without the need to disconnect and reconnect piping and uses the same vacuum/pressure gauges. A supply of helium bottles and a bottle rack will need to be supplied and stored at the TSC Transfer Station location. A Vacuum Drying System (VDS) and Helium Backfill System are not currently available at the site. A NAC system may be available at the time of the de-inventory project but is not currently available for lease. If required, a new VDS and Helium Backfill System can be procured and delivered to the site in accordance with NAC Design Drawings and approved test procedures. *Note: The VDS and Helium Backfill System would be suitable for use at all NAC-MPC and NAC-UMS sites as connecting quick disconnects are identical between the two systems*.

<u>Helium Mass Spectrometer Leak Detection (MSLD) System:</u>

Prior to transport of the loaded NAC-STC transport cask, the containment boundary seals of the inner lid, and vent and drain port coverplates will require replacement and maintenance leakage rate testing to leak tight criteria as specified in the NAC-STC SAR[21] using a helium MSLD system including a calibrated leak. The non-containment seals of the outer lid, and interlid and pressure port covers will be verified as properly assembled by performance of gas pressure drop leakage tests to confirm no leakage past the seals at a minimum leakage test sensitivity of $1x10^{-3}$ cm^3/sec.

These tests will require a gas pressure drop leakage test system. Additional equipment required for pressure drop and helium evacuated envelope leakage testing would include a pressurized gas supply, high purity helium (≥ 99.1%), appropriate tubing, valves, calibrated pressure and vacuum gauges of the appropriate sensitivity, connectors to mate with the vent, drain and interlid port quick disconnect valves, and leak test port connecters.

Replacement O-Ring Seals:

Following replacement of the inner lid and vent and drain port coverplates metallic O-ring seals, a helium leakage rate test is required to be performed on each containment closure component using a helium MSLD. The maintenance leakage rate testing of the NAC-STC package containment inner lid and vent and drain port coverplate O-ring seals is to confirm a leakage rate of ≤ 2.0 x 10^{-7} cm^3/sec, helium at a test sensitivity of ≤ 1.0 x 10^{-7} cm^3/sec, helium. The testing requirements and procedural guidance are specified in Chapter 7, Section 7.4 of the NAC-STC SAR. There is no MSLD or gas pressure drop test systems currently available at the LACBWR site and a new system will be required to be leased or procured and specialized connectors for and connection to the NAC-STC containment leakage test ports will need to be procured. *Note: The MSLD and pressure drop leak test systems can be utilized at all sites loading a NAC-STC or NAC-UMS packaging*.

Cranes:

A number of overhead lifting devices would be required for the operations of sufficient capacity to meet the requirements of the NAC-MPC CoC 1025 TSs Appendix B, Section B 3.5, "Canister Handling Facility (CHF)" located at a TSC Transfer Station. It is estimated that a Canister Transfer Facility pad (or an extension of the current ISFS pad) of approximately 30 x 40 feet elevated to approximately 27 inches will be required to be constructed adjacent to the on-site rail tracks at the transload location. The design loading capacity for the pad would be required to support a stack-up loading of approximately 400,000 lbs over the NAC-STC baseplate cross section of 5,800 in^2 (baseplate diameter of 86.7 inches).

At the TSC Transfer Station pad, a CHF will be required to meet the criteria specified in Section B 3.5 of the TSs, and any stationary or mobile crane utilized to lift and handle the loaded TFR and NAC-STC must meet the requirements of TS B 3.5.2.1.3 or B 3.5.2.2, respectively. **Figure 2-30** shows the TFR restraint system used to stabilize the TFR on top of the VCC and HHT during original TSC loading operations at LACBWR. The restraint system was attached to a plant building structure and connected to attachments welded to the outer shell of the TFR. In addition, if a stationary crane is not single-failure-proof, an impact limiter is required to ensure a TSC drop does not breach the canister. One large-capacity crane would be required for vertical lifting and movement of the TFR, the vertical lifting and movement of the NAC-STC, and the upending and down-ending of the NAC-STC from and to the intermodal transport cradle located on the rail car, or on the ground and subsequently lifted horizontally and loaded onto the rail car. A smaller crane would be required for lifting ancillary items, such as the VCC lid, transfer adapter, NAC-STC inner and outer lids, transport impact limiters, and personnel barrier.

An alternative to the location and use of mobile cranes would be to design and deploy a seismically qualified, single-failure-proof gantry crane system provided with a Secure Lift Beam provided with an integral hydraulic or air-powered chain hoist system. This system would allow the direct movement of the loaded TFR from the top of the VCC to the top of NAC-STC cask for TSC transfer without the need to set down the TFR on the pad surface, with the TSC lowered by the chain hoist with the TFR maintained attached to the lift yoke arms. A similar system is currently being deployed at the Taiwan Power Company's Kuosheng Nuclear Station in Taiwan, and a Secure Lift System with integral chain hoist was used for MAGNASTOR System TSC transfer operations at Dominion's Kewaunee Nuclear Station. The system would also be adaptable to other storage and transport cask system designs.

Man-lift:

A minimum of one man-lift capable of accessing the top of the TFR when in stack-up position on the VCC or NAC-STC will be required for retrieval of the TSC lifting slings. Minimum lift height would be approximately 35 feet.

Impact limiters:

The NAC-STC will arrive with two impact limiters according to the requirements of the SAR. The impact limiters would be fabricated as part of the transport cask procurement and fabrication.

Intermodal Transportation Cradle and Tie-down Straps/Restraints:

The NAC-STC casks currently being used in China utilize an Intermodal transportation skid/shipping frame, tie-down straps, and restraints. This equipment allows for horizontal transfer of the NAC-STC between transport modes. If these designs continue to perform satisfactorily in transport operations, these components would be fabricated for use in the US.

Personnel Barrier:

As required by the NAC-STC CoC, a personnel barrier would be placed around the loaded transport package. The personnel barrier matches the outer diameter of the impact limiters and spans the distance between them. The NAC-STC intermodal transport skid and personnel barriers are used with ten of the NAC-STC casks in China. The other four NAC-STC casks being fabricated will be supplied with them. If these designs continue to perform satisfactorily in transport operations, these components would be fabricated for use in the US. There are no unique requirements that would present expected complications with the lead time and cost of obtaining personnel barriers.

Hydraulic Bolt Torquing Equipment and Standard Tools:

In order to properly install and torque the 42 NAC-STC inner lid bolts to the required torque of 2,540 ± 200 ft-lb, a hydraulic torquing device capable of torques up to 3,000 ft-lbs may be required. A number of standard tools and equipment will be required to remove and install other NAC-STC components, VCC components, TFR retaining ring, cradle tie-downs, etc. A final listing of required fittings, connectors, and tools will be prepared as part of the final preparation for project performance.

TFR Lift Yoke and NAC-STC Lift Yoke:

Lifting yokes for both the vertical handling of the TFR and rotation and vertical handling of the NAC-STC are required. Designs exist for both lifting yokes, but the TFR lifting yoke is not available on site and may not be available for lease. No NAC-STC Lift Yokes have been fabricated to date for use in the US. Designs fabricated for use in China have operated satisfactorily and similar designs could be readily fabricated for use in the US. The NAC-STC lifting yoke would be supplied as part of the NAC-STC cask supply package and would be procured and fabricated as part of the cask fabrication project.

Horizontal Intermodal Transport Cradle Lift Beam:

The horizontal intermodal transport cradle lift beam would be used to lift and move an empty or loaded transport cradle containing an empty or loaded NAC-STC package with impact limiters and personnel barrier installed at the loading site, transloading (intermodal transfer) site, and/or at the cask receiving and unloading location. A design for the intermodal transport cradle and the horizontal cradle lift beam has been developed and fabricated for the NAC-STC deployments in China and similar designs could be fabricated for use in the US.

NAC-STC Transport Cask YR-MPC and MPC-LACBWR Cavity Spacers:

Two YR-MPC cavity spacers and one lower MPC-LACBWR cavity spacer in accordance with the approved NAC-STC SAR License Drawing will be required for each NAC-STC cask. The lower YR-MPC cavity spacer is 14.0 inch in height and 70.6 inch in diameter and weighs approximately 350 lbs. The upper YR-MPC cavity spacer is 28.0 inch in height and 70.6 inch in diameter and weighs approximately 520 lbs. The lower MPC-LACBWR spacer is 4.0 inches in height and 70.6 inch in diameter and weighs approximately 200 lbs. Each spacer will be required to be removed from the cavity of the NAC-STC prior to empty return shipment and stored and shipped in an IP-1 shipping box/container.

Based on the demobilization or disposal of essentially all cask loading equipment from the LACBWR site upon completion of the fuel loading campaign, it is expected that essentially all of the identified equipment and systems will be required to be procured or leased from NAC, as described above.

Note: The TFR, transfer adapter, HHT, lifting yokes, mobile and fixed lifting and handling equipment, lifting rig sets, and other auxiliary equipment and systems will be required to be maintained, inspected, load and/or functionally tested as required by the NAC-MPC and NAC-STC Operations Manuals, SAR and FSAR, and component specific maintenance manual, as appropriate, prior to use on the LACBWR site.

Figure 2-35: NAC VCC Movement from HHT to ISFSI Pad on Air Pads and Engaged to JCB Telescopic Handler

Figure 2-36: NAC VCC Movement From HHT to/from ISFSI Pad on Air Pads

Figure 2-37: Loaded VCC on HHT

Figure 2-38: Loaded MPC-LACBWR TSC in TFR

Figure 2-39: Loaded MPC-LACBWR VCC on HHT Ready for Movement to ISFSI Pad

3.0 TRANSPORTATION ROUTE ANALYSIS

This section describes the available routes investigated to transport the loaded transportation casks from La Crosse for delivery to the closest Class I railroad and the subsequent movement to the GCUS. Although there is an existing switch and minimal rail infrastructure at the site to facilitate on-site transloading of the cask onto railcars, all potential transportation modes were considered for outbound movement of the loaded casks. A number of routes were identified and as discussed in **Section 3.5**, the options available were down-selected using specific criteria, resulting in a total of five scenarios to consider further using the MUA process, as covered in detail in **Section 5.0**, including one direct rail, one direct heavy haul truck, one barge direct, and two HHT to rail options.

3.1 Heavy Haul Trucking Routes

LACBWR is located in Genoa, Wisconsin directly on the Mississippi River. Highway WI-35 runs parallel to the site property. The site is located approximately 1 mile south of the village of Genoa, Wisconsin and 19 miles south of the city of La Crosse. There is access to interstate I-90 via Highway WI-35. There are no other interstate roads with direct access to the site.

In order to exit the site from the ISFSI by HHT, one would follow the access road from the enclosed area through the gate and travel approximately 287 feet to the intersection, turn right, travel approximately the 70 feet crossing another access road and preceding straight 152 feet to cross the BNSF double mainline to the intersection with Highway WI-35. Therefore, the short travel distance from the ISFSI gate to highway access is 509 feet.

During decommissioning activities, truckloads of low-level waste were routinely transported off-site in 20-foot intermodal containers moving on an intermodal chassis. These IP1 containers were highway legal weight shipments. A total of 70 million pounds of waste was transported from the site to Winona, MN to a Union Pacific (UP) served intermodal terminal where the containers were loaded onto private ABC flatcars for rail movement to the EnergySolutions' Clive, Utah disposal site.

There is an existing paved road leading from the ISFSI along the eastern boundary of the site which could be used to travel north to reach the existing and recommended expanded rail siding. There is an improved, paved road leading from the site to the boat ramp area which is located southwest of the ISFSI; this path is shown on **Figure 2-20**. It is reported that this unnamed road is a public road leading to the boat ramp area which has been returned to the public.

Although not entirely practical, an HHT direct route from La Crosse to GCUS was investigated due to the close proximity between the site and GCUS: 513 miles according to START data.

Two potential private rail tracks were identified for possible use as off-site transload areas where loading the train may be possible in the event it was not possible to use the on-site rail track; these are listed in **Table 3-1**. If an off-site rail transload facility was selected, HHT would be required from La Crosse to the transload facility.

Table 3-1: Nearest Off-Site Rail Tracks Suitable for Transload Operations Outside of the La Crosse Site

Track Location	Siding Length (ft)	HHT Mileage to Track	Site Description	Challenges/Considerations
817 Bainbridge St La Crosse, WI 54603	1,587’	23.0	Private facility: scrap reload	Served by CP, an active rail shipper, good amount and configuration of track, somewhat congested area, would have to avoid interfering with company loading patterns & share the track.
W10899 Cherry Rd Merrillan, WI 54754	26,519’	81.0	Private facility: Badger Mining Corp	Active rail shipper of unit trains. Extensive rail infrastructure with several tracks that are long enough to load the entire train; however, would have to avoid interference with rail operations for the site – for 1 train it may be doable for a long-term shipping campaign it would be difficult.

START was utilized to create truck routes to the two rail served sites listed in the above table which are within close proximity to the La Crosse site. The third rail site investigated was the transload facility in Winona, used for the outbound legal load waste shipments. This option was screened due to the fact it would be difficult to load the train without interruption of the on-going commercial business at the site. Also, the track configuration presented challenges that were not encountered with the above potential transload sites.

Routes were configured to use interstate highways wherever available to avoid using two-lane country or local roads and potentially to alleviate road construction during tourist seasons. Although the identified off-site options for transload may be viable alternatives, since the site is rail served and there are a limited number of casks to be removed, direct rail from LACBWR is the recommended and most economical option for a transload location. The fact that the site currently has rail service will eliminate the need for over the road HHT permits, extended transit times, leasing private rail served property and other related expenses involved with establishing an off-site rail transload facility.

3.2 Rail Routes

As described in **Section 2.0**, the LACBWR site is directly rail served by the Class I railroad, BNSF. The remains of the original siding are evident in the northern most section of the site. The switch is intact and the double mainline track runs along the eastern perimeter of the site parallel to highway WI-35. The existing siding is approximately 385 feet from the point of switch and enters the site across from/ parallel to the barge dock. Only 336 feet of the existing siding is usable for loading and additional track would be required to load the 5 casks.

BNSF is the only railroad with direct access to the LACBWR site. There are no other freight railroads located in the immediate vicinity. Route C is the direct rail option loading on the site. An extension of 790 feet was included in the analysis so that the entire train could efficiently be loaded in the least amount of time and staged for easy operational access for the serving carrier. Agreeing to provide the train in an assembled fashion without additional switching is paramount in gaining agreement of BNSF to interrupt unit trains to pull the one loaded cask train involved with this campaign. START data indicates a 12-hour transit time traversing 495 miles from the site to GCUS.

In 2007 this rail spur was used to load the reactor pressure vessel on a 20-axle railcar for movement to the low-level radioactive waste disposal facility located in Barnwell, South Carolina. The loaded car weighed 310 tons, and is shown in **Figure 3-1**.[7]

Figure 3-1: LACBWR Reactor Pressure Vessel on the LACBWR Rail Spur (2007)[7]

During decommissioning LaCrosse*Solutions* attempted to ship low-level radioactive waste by rail directly from the site using the existing rail spur. Due to the heavy volume of HAZMAT unit trains moving on the BNSF mainline through this corridor, it was impractical for the railroad to interrupt continuous service to enter the site to pull one or two cars, multiple times per week. As a result of the operating complications, the decision was made to truck the low-level radioactive waste approximately 50 miles from the site to a private intermodal terminal in Winona, Minnesota called Seven Rivers Intermodal Terminal (see **Figure 3-2**).

Figure 3-2: Intermodal Terminal in Winona, MN

Although this location worked very well for the LLW shipments being transported in containers on ABC cars (which is not dimensional), it will present some challenges in loading the casks onto the train, which are considered dimensional cargo. Specifically, the lack of rail infrastructure in the proper configuration for loading a train without interfering with the existing transload facility operation. This transload site is used to handling high volume container transloading which is a less complex operation than the cask shipments.

Considering the limited number of casks to be shipped in this campaign, BNSF has indicated it would be willing to schedule service to the site to pull the loaded train as it will be only one shipment.

Currently there is no scheduled service for the site and no rail shipments have taken place since 2007, when the reactor pressure vessel was shipped from the site.

In the event the site is no longer rail served or there are complications with extending the siding, two other options were considered for HHT to existing, private rail served facilities where transloading the casks would be possible. Transload could occur at French Island, WI, a private industrial facility located on the Canadian Pacific Railroad as shown in **Figure 3-3**; this site has an active rail siding of approximately 1,587 feet where scrap metal is being loaded into gondola cars for outbound movement. The rail shipment from this site would involve two Class I carriers in the route to reach GCUS. It would also require leasing the private track and careful coordination to avoid interrupting the company's loading operation.

Figure 3-3: French Island, WI Transload Site

An alternate HHT to rail transload option involves another private company located in Merrillan, WI as shown in **Figure 3-4**. This is another active shipper located on the Union Pacific with extensive rail infrastructure where covered hoppers are being loaded for outbound unit train movements.

Figure 3-4: Merrillan, WI Transload Site

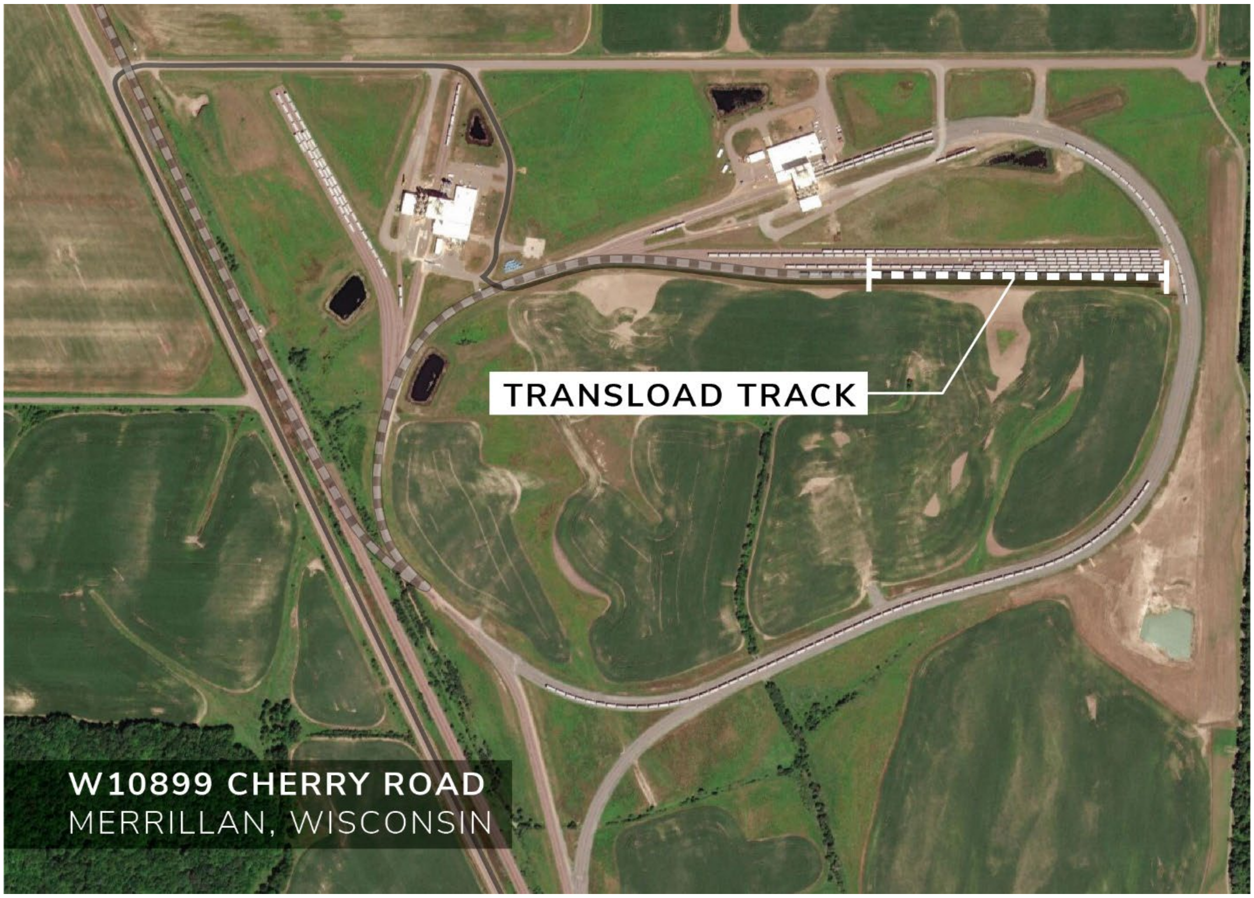


Table 3-2 lists the railroads in the geographic area.

Table 3-2: Class I Railroads Near La Crosse

Railroad	Railroad Class	Notes
BNSF	Class I	Direct access to La Crosse, switch is in place, plant located just off the mainline which is an active line.
Canadian Pacific Railway	Class I	Relatively close existing rail-served plants with viable rail infrastructure for loading a cask train.
Union Pacific Railroad	Class I	Two locations: one is relatively close with an existing rail-served plant with good rail infrastructure for loading a cask train. The second location is farther away and has a more challenging track configuration for loading the cask train.

In order to efficiently load the entire train consist on-site, laying additional track would be necessary. It is recommended that the track be extended 790 feet along the eastern boundary of the site.

In October 2022, site personnel have been discussing the possibility of using the site as a transload facility in the future. This plan would include laying new rail track from the existing track on the northern portion of the site to the ISFSI (installing approximately 4,093 feet of new track and refurbishing the existing track, where necessary). Due to the location of the switch yard on the site, the track extension must carefully be planned to avoid severe curves in order for the BNSF railroad to agree to operate over the track and do so safely. There is a very detailed process whereby the railroad will approve any addition of track to the existing site. There are two options:

> (1) Extension of the current track solely for the purpose of loading the outbound fuel train at a cost of approximately $197,500.
>
> (2) Extension of the current track to the ISFSI at a cost of approximately $1,023,250 (without grading).

If the track has been extended by the time the SNF fuel campaign commences, the additional track will allow for easy loading of the one train for outbound fuel to the GCUS.

3.3 Barge

LACBWR is located on the Upper Mississippi River, approximately 0.5 miles south of Lock and Dam 8, which is located at mile 679.2 on the Mississippi River. The river is maintained by the United States Army Corps of Engineers to a depth of 9 feet. This portion of the river is part of The Upper Mississippi River 9-Foot Channel Project which includes 42 locks across 1,200 miles through Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The maintenance needs of this aging infrastructure have surpassed annual operations and maintenance funding and has resulted in a "fix-as-fail" strategy. Depending on the nature of a failure and the extent of required repairs it is not unusual for extended delays to take place. Another area of impact includes longer tows in the 1,200-foot range which must split and lock through in two stages within the project 600-foot chambers. This doubles and triples blockage times, increases costs and wear to lock machinery, and exposes deckhands to higher accident rates[28].

There is an existing barge dock at the site that had been used for receiving and unloading barges of coal. As late as in 2017, it was estimated that 450-500 barges of coal were received per month.[7] There was no other economical way for coal to be delivered to the site because there was not enough rail track in place to land a unit train. The barge dock had also routinely been used for the removal of covers from coal barges and for cleaning the empty barges after unloading. Since the coal plant ceased operations in 2021, it may be possible to use the existing barge dock for outbound cask shipments. An evaluation of the dock would be necessary to determine its strength and ability to withstand the combined weight of a goldhofer[1] trailer and the loaded cask for the roll on operations. The United States Army Corps of Engineers map of the area is provided in **Figure 3-5**.

When the inbound coal barges were being received at the coal dock and to provide a process for more efficient loading closer to the ISFSI, it was recommended that the public boat ramp at the

[1] In this report, a goldhofer equates to a heavy-duty, self-propelled trailer/module.

south end of the plant be considered as the optimum location for grounding a barge to load the outbound loaded casks.

As of October 2022, new information is available which confirms the coal plant, Genoa #3, ceased operation as of June 1, 2021. As a result, the majority of the coal stockpile has been removed. Furthermore, site personnel have indicated an interest in using the site for a transload facility. Currently, steel is being transloaded onto barges for outbound movement from the site (decommissioning materials).

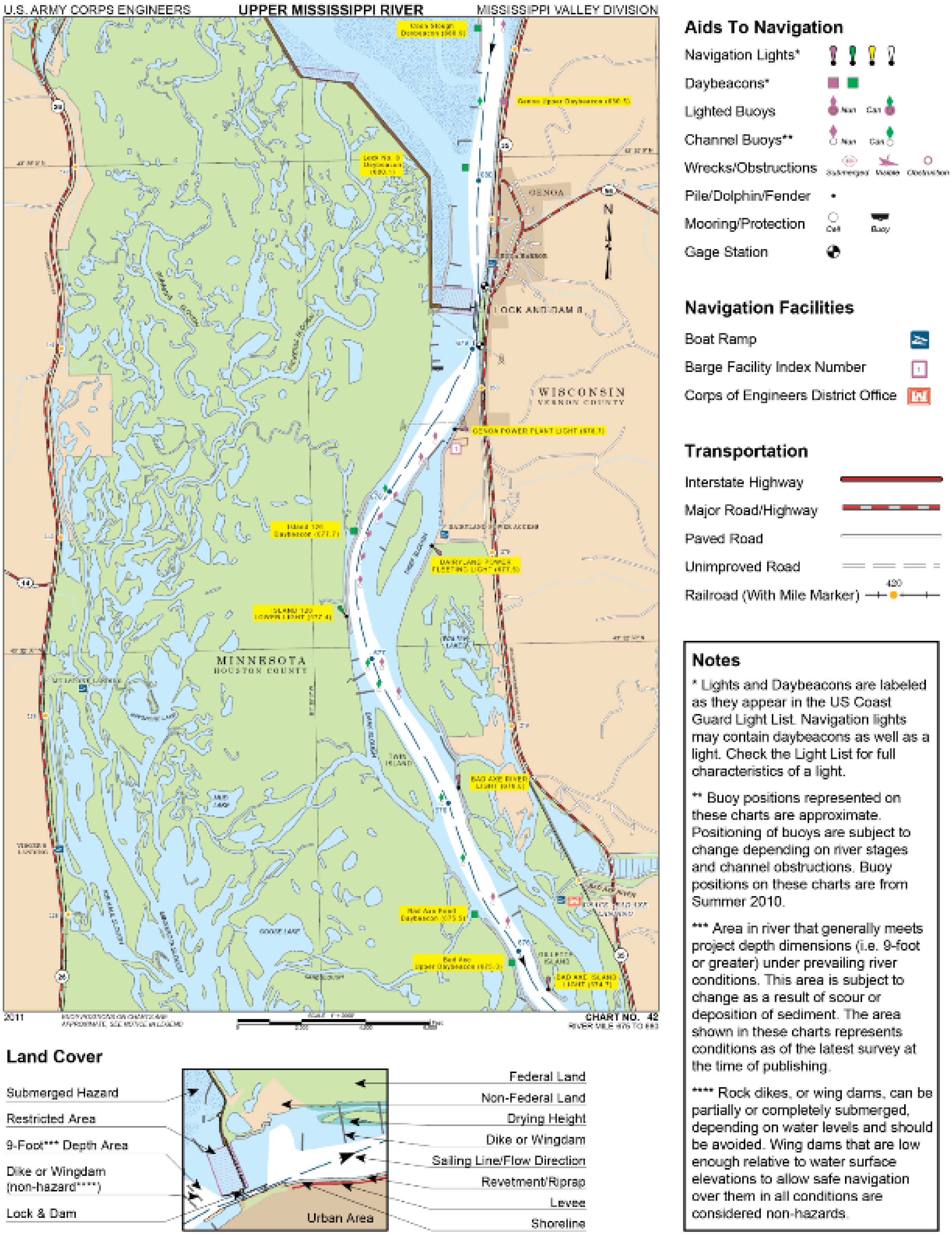
It is possible for the barge dock to be used to load one barge for the outbound movement of the SNF. However, as noted above, further investigation is necessary to determine the stability of the dock/pier to hold the substantial combined weight of the loaded casks on goldhofer equipment and the related accessory weight of the ramps, etc. for loading the barge.

The HHT transport from the ISFSI to the barge dock is 3,056.77 feet (all on-site) versus to the public boat ramp which is 3,247.32 feet.

As with the shorter extended rail siding, both loading locations would be outside the existing 10 CFR Part 72 boundary.

A barge shipment from the site will involve additional handling to load the casks onto a Class I railroad for final delivery, since the site is already served by a Class I carrier. The barge would travel through 17 locks to reach GCUS and will require 2 additional transloads to place the casks onto a Class I railroad. Traveling through this many locks will add to the overall transit time. Nevertheless, pending the structural evaluation, this route may be worth further investigation in the future.

Figure 3-5: USACE Map



One barge route was considered, which started with loading at the LACBWR site via a roll-on/roll-off operation and continued through 17 locks (according to START data) to reach the GCUS. This voyage is estimated to take 72 hours to traverse 500 miles. The route is described in **Table 3-3.**

Table 3-3: Potential Barge Routes

Route Identification	Total Distance (Miles)	Total Travel Time (min/hrs)	Route Description	Challenges / Considerations
Route A - On-site grounding barge	500	4320/72	Barge from La Crosse ISFSI along the Mississippi River directly to GCUS	17 locks in the route to GCUS
Route A – On-site use of existing barge dock	500	4320/72	Barge from La Crosse ISFSI along the Mississippi River directly to GCUS	17 locks in the route to GCUS

3.4 Barge Unloading Locations

Several options for potential barge unloading locations were identified in the vicinity of GCUS; however the majority of the barge slips in this area are privately owned and interference with ongoing operations would therefore need to be coordinated and permission obtained from the owner of the slip. **Table 3-4** lists the barge unloading locations that provide an adequate barge unloading site and rail loading tracks close to the barge site. Of these, the most feasible docking location near the GCUS is shown in **Figure 3-6**.

Additional lifts, which add cost and time, will be required with a barge shipment from the site to the identified locations for loading onto rail.

Table 3-4: Possible Barge Unloading Ports at GCUS

Rail Transload Facility	Distance from Barge	Comments / Details
Intersection of Hog Haven Road & rail yard Sauget, IL 62201	1,333 ft	Portion of track inside rail yard not secured by a fence Congested
Gavion 10 Pitzman Ave	2392 ft	1490' of private track

Rail Transload Facility	Distance from Barge	Comments / Details
Sauget, IL 62201		
Lawn & Garden Midwest 3414 Hog Haven Road Sauget, IL 62201	1.09 miles	3,392’ of track
Eastman Chemical Plant / Solutia 500 Monsanto Avenue Sauget, IL 62201	2.1 miles	Secure

Note: the use of any existing barge slip or dock should be evaluated and a marine survey conducted to determine if there are any submerged conditions that would present complications to the operation. If a pier were used, its condition to hold the combined weight of the cask, cradle, and goldhofer would need to be evaluated. A pier or dock was not considered in either the loading or unloading operations for the recommended barge campaign.

Figure 3-6: Hog Haven Area for Barge Off-Load in the Vicinity of GCUS

3.5 Down-Selected Transportation Routes

Considering the large number of potential transportation routes identified in the previous sections, a set of screening criteria was developed and applied to down-select a small group of options considered to be viable for further investigation. This down-select was based on comparing routes containing the same modes of transport (i.e., truck routes were not screened based on characteristics of barge routes). This results in one or more routes identified for each mode of transport to be evaluated by the MUA. The criteria utilized are as follows:

1. The time and/or distance to be traveled by the conveyance/barge would be significantly more than alternate viable routes without significant/substantial benefit.
2. Clearance limits on routes (e.g., through tunnels, around curves, or through heavily forested roads) are not met without significant/substantial upgrading.
3. Route includes substantial distances with steep grades.
4. Bridges/overpasses to be used would not sustain weight of conveyance without significant/substantial upgrading.
5. Natural features make barge landings, overpack loading, etc. difficult to perform without significant/substantial upgrading or infrastructure development.
6. No available loading facility or insufficient track for performing loading of a full consist.
7. Transload and/or port facility does not permit receipt of Class 7 materials.
8. Number of interchanges between carriers.
9. Avoidance of high-density transit areas (i.e., regions with significant rail traffic) that would require interruption of traffic if shipment were to transit region.
10. Characteristics of HHT that would require preapproval for Highway Route Controlled Quantity (HRCQ) shipments.[2]

Some of the potential transportation routes had unique characteristics that did not correlate with any of the ten listed criteria above. These characteristics greatly reduced the viability of the transportation route; therefore, an 11th category, "Other", was added to the screening criteria so that the unique criterion could be captured.

The above criteria was applied to a number of potential routes, to screen them before they are assessed in the MUA process. After applying the above screening criteria (see **Table 3-5**), a total of five possible routes were identified and are included for further evaluation in the MUA (**Section 5.0**):

A. Barge Only taking the Mississippi direct to GCUS (i.e., referred to as "A. Barge Only" route in the MUA; **Figure 3-7**).

B. Heavy Haul Truck (HHT) Minimum Distance to GCUS (i.e., referred to as "B. HHT Only" route in the MUA; **Figure 3-8**).

[2] For routes where HRCQ applies, screening may occur due to the more restrictive requirements of NRC approval of such a route and its associated requirements for armed security, disabling devices, secure communication, HAZMAT bill of laden, safe haven identification, safe-secure shipments, emergency response planning, etc.

C. Burlington Northern Santa Fe Railway (BNSF) only rail on-site loading direct to GCUS (i.e., referred to as “C. Rail Only (BNSF Only)” route in the MUA; **Figure 3-9**).

D. HHT from LACBWR ISFSI to French Island, WI and then by rail to the GCUS (i.e., referred to as “D. HHT/Rail Transload at French Island, WI” route in the MUA; **Figure 3-10**).

E. HHT from LACBWR ISFSI to Merrillan, WI and then by rail to the GCUS (i.e., referred to as “E. HHT/Rail Transload at Merrillan, WI” route in the MUA; **Figure 3-11**).

Table 3-5: Routes Versus Screening Criteria

Route	1	2	3	4	5	6	7	8	9	10	Other
LACBWR Rail Only BNSF Direct (Route C)											
LACBWR to GCUS rail only	X										Interchanges with too many carriers
LACBWR Rail Only BNSF/NS less distance								X			Lesser distance but Interchanges with too many carriers
LACBWR Rail Only to GCUS least distance								X			Least distance by rail but Interchanges with too many carriers
Barge to Rail	X										Too many transfer operations
LACBWR HHT Only Min Distance (Route B)											Truck mode doesn’t meet the objective of the study & GCUS is artificial “destination”
LACBWR HHT Only Min Pop	X										Similar to route B
LACBWR HHT Only Min TT	X										Similar to route B
LACBWR HHT to Dubuque to Barge								X			Too many transfer operations & additional lifts
LACBWR HHT to Dubuque to Rail											Too many transfer operations
LACBWR HHT route	X										Excessively long route
HHT to BNSF	X										Transload site unavailable

Route	1	2	3	4	5	6	7	8	9	10	Other
HHT/Rail French Island (Route D)											
HHT/Rail Merrillan#2 (Route E)											
HHT/Rail La Crosse									X		Located in a too densely populated area
HHT/Rail Merrillan#2									X		Rail portion went through Springfield, IL; undesirable
Barge Only (Route A)											Note: this route is from the public boat ramp site
Barge Only (Route A)											Using existing on-site barge dock, needs structural evaluation

Screening Criteria Legend:

1. The time and/or distance to be traveled by the conveyance/barge will be significantly in excess
2. Clearance limits on routes
3. Sustained travel on routes with steep grades
4. Bridge(s)/overpass(s) weight limitation
5. Natural features make barge landings, overpack loading, etc., difficult
6. No available loading facility or insufficient track for performing loading of a full consist
7. Transloading and/or port facility does not permit receipt of Class 7 materials.
8. Number of interchanges between carriers
9. Avoidance of high-density transit areas
10. Characteristics of HHT Requiring Preapproval for HRCQ

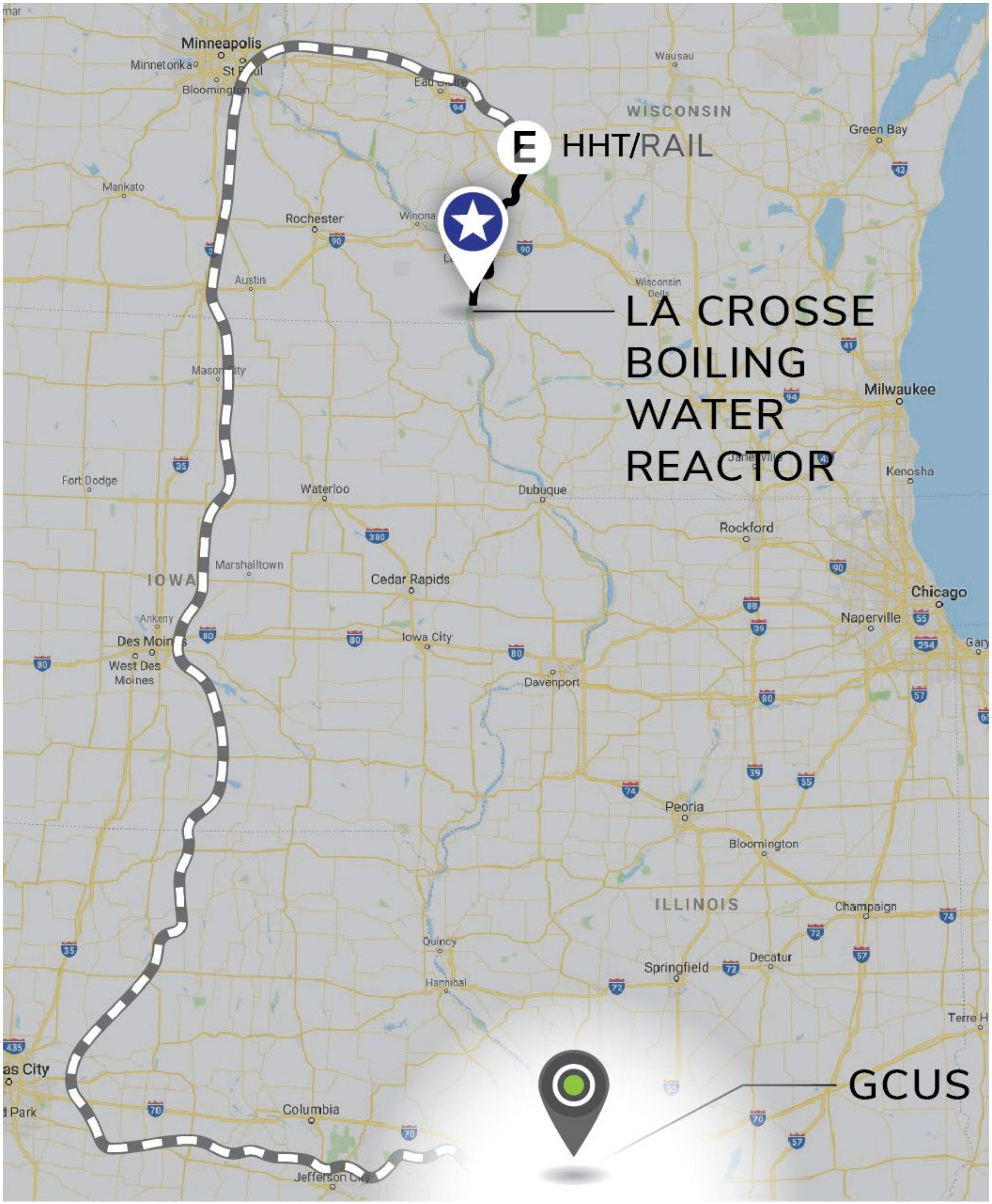
Figure 3-7: Route A. Barge Only

Figure 3-8: Route B. HHT Only

Figure 3-9: Route C. Rail Only

Figure 3-10: Route D. HHT/Rail Transload at French Island, WI

Figure 3-11: Route E. HHT/Rail Transload at Merrillan, WI



4.0 PARTICIPATING ENTITIES

This section identifies participating entities/persons this report assumed would be involved in the overall de-inventory implementation for the La Crosse ISFSI and summarizes some aspects of their potential roles. By providing this information, which is current as of the date of this report but can be out of date with new events (e.g., elections), an initial means for identifying these entities/persons in the future is considered to be provided.

Various federal agencies would have regulatory authority over the types of shipments of SNF and GTCC contemplated by this report. This report assumes that DOE would be responsible for a federal consolidated interim storage facility or geological repository to which the material would be shipped from the nuclear power plant site and that DOE would be the shipper. DOE has broad authority under the Atomic Energy Act of 1954, as amended (AEA), to regulate activities involving radioactive materials undertaken by DOE or on its behalf, including transportation of radioactive materials. However, in most cases not involving national security, DOE typically uses commercial carriers for its shipments and does not exercise its AEA authority. The DOT and the NRC jointly regulate commercial transportation of radioactive materials in the United States. Most DOE radioactive materials shipments are typically transported by commercial carriers and are subject to regulation by DOT and NRC, as appropriate.

Assuming DOE would use commercial carriers to conduct the shipments, regulatory authority over the shipments can be summarized as follows. In general, DOT would regulate the areas identified in the Memorandum of Understanding between the NRC and the DOT,[3] including package and conveyance radiological controls, routing, hazard communication, and carrier training. Assuming DOE takes custody of the material at the nuclear power plant site, DOE would have authority to regulate other aspects of the shipments (e.g., physical security), except as otherwise required by law.[4] Even where DOE does exercise its AEA authority over its shipments, DOE's general policy is that all DOE shipments must be conducted in a manner that achieves an equivalent level of safety and security to that required by DOT and NRC for comparable commercial shipments. For purposes of this report, it is assumed that the shipments to de-inventory the site would be conducted like typical commercial shipments in accordance with DOT and NRC regulatory requirements.[5]

In addition to the federal agencies described above, participating entities and persons expected to be involved in the de-inventory of the site would include:

- Utility employees

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[3] Memorandum of Understanding, Transportation of Radioactive Materials, 44 Fed. Reg. 38690 (July 2, 1979).

[4] For example, one such exception is the requirement in Section 180(a) of the Nuclear Waste Policy Act of 1982, as amended (NWPA), which requires DOE to use casks certified by the NRC for NWPA shipments. In addition, Section 180(b) of the NWPA requires DOE to follow the NRC regulations on providing advance notification of shipments to jurisdictions through which the shipments will be transported. For further discussion, see letter from Chairman Richard A. Meserve, Nuclear Regulatory Commission, to Senator Richard J. Durbin (May 10, 2002), https://www.nrc.gov/docs/ML0210/ML021060662.pdf.

[5] Although this report assumes that DOE would be the responsible entity for a consolidated interim storage facility or geological repository, this report also recognizes that if a separate management and disposal organization were to be responsible for such a facility some aspects of the regulatory regime for the shipments could differ from that which would apply if DOE were the responsible entity.

- Subcontractors: crane suppliers, riggers, etc.
- Transportation personnel: truck operator, rail carrier, barge transportation operator, private escorts for dimensional loads, State Police or Local Law Enforcement Agency (LLEA)
- Cask suppliers
- U.S. Coast Guard (USCG) (if a marine mode of transport is used, or if the rail transload facility is located on or adjacent to water)
- Security personnel
- Communication personnel associated with participating entities (e.g., local authorities, escorts, etc.) needed for advance notification of shipments as required by 10 CFR 73.37, 10 CFR 71.97, and as recommended in NUREG-0561 Revision 2[48]
- TRANSCOM or similar satellite and associated continuous in-transit communication service provider(s)
- Transportation emergency responders.

The participating entities/persons can be categorized into the functional groups identified in **Table 4-1**. Please note that an evaluation of tribal entities that might be impacted during de-inventory operations was performed. None were identified within the transportation routes analyzed for this report, although the START program[1] did identify some very small fraction of land (< 0.1 square miles) crossed by some of the routes analyzed in **Section 5.0**.

Table 4-1: Participating Entity Functional Identification

Function Group	Entity/Persons
Site	Site Management
	Safety
	Quality
	Document Control
	Security
	Craft support
	Support functions

Function Group	Entity/Persons
Transportation	Transportation Supervision
	Equipment Operator (driver)
	Security
	Shipment Response/Tracking
	Support Functions
Rail Transload Facility	Operations Supervisor
	Security
	Craft Support
	Shipment Response/Tracking
	Quality
Authorities	DOE
	State
	Local
	Federal Railroad Administration (FRA)
	U.S. Transportation Security Administration (TSA)*
	NRC

Function Group	Entity/Persons
	DOT
	Pipeline and Hazardous Materials Safety Administration (PHMSA)

*TSA operates under the direction of the Department of Homeland Security and acts on their behalf.

Per NRC's regulation 10 CFR 71.97 "Advance notification of shipment of irradiated reactor fuel and nuclear waste," the following would be required:

> (a)(1) As specified in paragraphs (b), (c), and (d) of this section, each licensee shall provide advance notification to the governor of a State, or the governor's designee, of the shipment of licensed material, within or across the boundary of the State, before the transport, or delivery to a carrier, for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage.
>
> (2) As specified in paragraphs (b), (c), and (d) of this section, after June 11, 2013, each licensee shall provide advance notification to the Tribal official of participating Tribes referenced in paragraph (c)(3)(iii) of this section, or the official's designee, of the shipment of licensed material, within or across the boundary of the Tribe's reservation, before the transport, or delivery to a carrier, for transport, of licensed material outside the confines of the licensee's plant or other place of use or storage.

Similarly, NRC regulations in 10 CFR 73.37 and guidance in NUREG-0561 address the provision of advance notification of shipments to States and Tribes as well as other aspects of shipment coordination and communication with participating entities. Therefore, notification of governing authorities is required to coordinate transport in an actual de-inventory campaign. For transport of radioactive material[46], the government agencies listed in **Table 4-1** ("Authorities") issue regulations concerning the packaging and transport of radioactive materials.

Listed below is contact information for some of the relevant state (Wisconsin) government authorities, a U.S. Coast Guard point of contact for the area, and transportation services for the various modes of transport anticipated. During the development of this report, most information was obtained through public domain. In preparation for an actual de-inventory campaign, this contact information would need to be updated with current information closer to the time of shipments, as coordination and communication with appropriate participating entities would be instrumental in the execution of the shipments.

Wisconsin - Office of the Governor

Listed below is the contact information for the Wisconsin Governor's Office.

Wisconsin Governor Tony Evers

115 East State Capitol

Madison WI 53702

Phone: 608-266-1212

https://www.evers.wi.gov

Wisconsin — Governors Designee for Notification of SNF Shipments (DHS 157.9719)

Governor's Designee for Notification of SNF Shipments

Brian Satula, Administrator

Wisconsin Emergency Management

PO Box 7865

2400 Wright Street

Madison, WI 53770-7865

Phone: 608-242-3210

Fax: 608-242-3313

24 hours: 800-943-0003

Brian.satulawisconsin.gov

Wisconsin — Department of Transportation (DOT)

Wisconsin Department of Transportation

Hill Farms State Transportation Building

4802 Sheboygan Avenue

Madison, WI 53705

http://www.wisconsindot.gov/pages/home.aspx

The Oversize-Overweight Permits Unit issues permits for oversize/overweight loads to travel on state and federal highways. For more information, contact:

Wisconsin Department of Transportation

Motor Carrier Services

PO Box 7980

Madison, WI 53707-7980

Phone: 608-266-7320

Fax: 608-264-7751

Army Corp of Engineers

US Army Corp of Engineers
St Paul District
Lock and Dam No 8
4405 Hwy 35 (box 10)
Genoa, WI 54632-0265
Phone: 608-689-2625

Wisconsin — Department of Military Affairs Division of Emergency Management

Wisconsin — Department of Military Affairs Division of Emergency Management
2400 Wright Street
PO Box 7865
Madison, WI 53707-7865
Phone: 608-242-3000
Fax: 608-242-3247
24 hours: 800-943-0003
wempio@wisconsin.gov

Site Management Provider

Cheryl Olson
ISFSI Manager
Dairyland Power Cooperative
54601 State Hwy 35
Genoa, WI 54632
Phone: 608-689-4207

Heavy-Haul Transportation Service Providers

Heavy Haulers
2252 Burlington Pike #200
Burlington, KY 41005
800-908-9206
dispatch@heavyhaulers.com

Railroad Transportation Contacts

BNSF Railway

1645 Oak Street

La Crosse, WI 54603

608-781-7423

www.bnsf.com

Barge Operators

Vincent Schu

Ceres Barge Line

3808 Cookson Rd.

East Saint Louis

Illinois 62201-2126

Phone: 314-602-5752

Cask Supplier

NAC International

NAC Atlanta Corporate Headquarters

3930 East Jones Bridge Road

Peachtree Corners, GA 30092

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5.0 MULTI-ATTRIBUTE UTILITY ANALYSIS

As noted in **Section 3.0**, there are several potential routes for shipping the NAC TSCs from the LACBWR ISFSI to a railcar on a Class I railroad that can take the NAC TSCs to their penultimate or ultimate destination (e.g., a consolidated interim storage site or a repository, respectively). The diversity of these routes reflects the multiple viable approaches to shipping the NAC TSCs (i.e., by direct rail, HHT, or barge), and the access of La Crosse to these modes of transport. Furthermore, these routes potentially have both positive attributes (e.g., safe and secure transport) and negative attributes (e.g., expense) meriting an assessment approach that can evaluate these attributes in a combined manner that may distinguish one route from another and/or rank and prioritize routes.

The MUA is a structured methodology designed to handle the trade-offs among multiple objectives (i.e., attributes). The MUA provides a transparent, rational, and defensible analysis that is easy to explain and communicate. MUA methods have been used for decades to provide logically consistent analyses of options (i.e., modes and routes) that are intended to achieve more than one objective, where no single option dominates the others on all those objectives. Utility theory is a systematic approach for quantifying an individual's or team of individuals' ratings/preferences (*note: when "preference" is used together with "route" there is a specific connotation not intended to be covered in this analysis, thus "rating," "ranking," or "priority" will be used in its stead when associated with a route*). It is used to assign a numerical value on some measure of interest (e.g., metric of an attribute) and rescale it onto a normalized (0 to 1) scale with 0 representing the worst rating/option and 1 the best rating/option. This allows the direct comparison of many diverse objectives. The result is a rank-ordered evaluation of options that reflects the decision makers' preferences.

The MUA has been selected as the assessment approach for purposes of this report to evaluate the viable modes and routes (options) for moving the NAC TSCs containing SNF from the LACBWR ISFSI. In this section, an MUA using a value model, which identifies preferences of attributes, relative importance of meeting an attribute, and/or tradeoffs between attributes, will be used to establish a prioritized list of modes and routes from the La Crosse ISFSI.

5.1 Description of MUA Applied to the LACBWR ISFSI

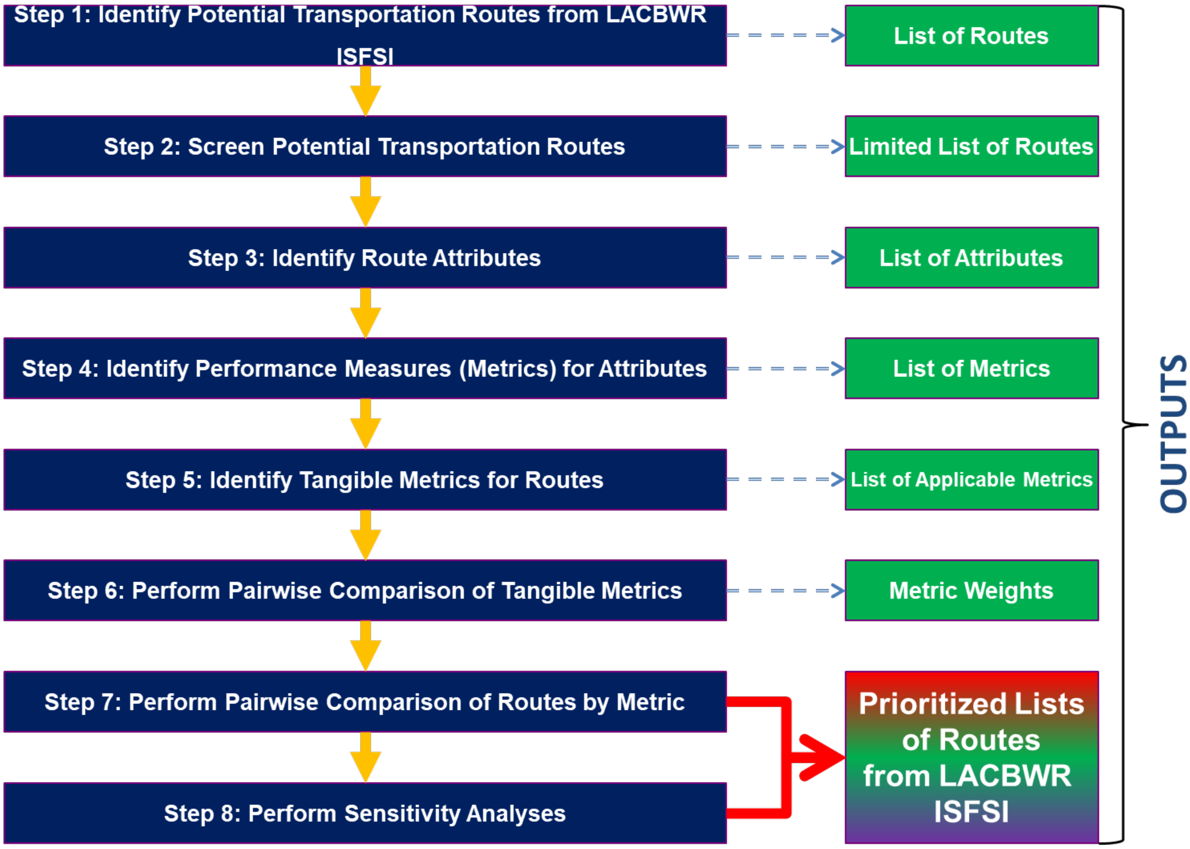
MUA is a straightforward concept. The three primary steps typically followed to frame the analysis are: (1) identify a set of objectives/attributes that an 'ideal' option will achieve; (2) define a set of performance measures (i.e., metrics) that provide a clear definition of each objective/attribute; and (3) identify or define alternative options that should be considered. Once alternative options (routes and modes), objectives (attributes), and performance measures (metrics) have been clearly defined, the preferences for the performance measures are subsequently established from a pairwise comparison between one another to establish a relative weight for each performance measure. The rating for each route per metric is established by performing another pairwise comparison between the performance measures for each route against one another. The rating of each route can then be established by using a value model to create a single metric that can be used to compare each route against one another and provide a ranking of the routes.

The main steps of the MUA applied to the routes from the La Crosse ISFSI are identified in **Figure 5-1** and are as follows:

1) Identify the potential modes and routes for transporting the NAC TSCs from the La Crosse ISFSI, see **Section 3.0**.
2) Due to the larger number of potential routes identified in Step 1 from the LACBWR ISFSI, a set of screening criteria was developed to reduce the number of routes per mode to a limited group for further evaluation; see **Section 3.5** (if this step were not performed, then the pairwise evaluations of the routes by metric would be too cumbersome to be practical due to the number of evaluations that would need to be performed).
3) Identify the general attributes associated with the routes and the activity of shipping the NAC TSCs from the La Crosse ISFSI; see **Section 5.3.1**.
4) For each identified attribute, identify the metrics that describe performance measures, which could contrast one mode and route from another; see **Section 5.3.1**.
5) Considering the limited list of routes to be evaluated, examined each attribute's metrics and identified the ones that could tangibly differ between two or more of these modes and routes; see **Section 5.3.1**.
6) Each team member performed a pairwise comparison between each of the tangible metrics, which was subsequently quantified and resulted in a relative ranking of the metrics based on individual ratings and were also combined to establish a weight for each of the tangible metrics based on an equivalent team rating; see **Section 5.3.2** (the individual rankings also provided the basis for the sensitivity analyses).
7) The collective team performed another pairwise comparison between the tangible metrics for each route (to ensure the SMEs' preferences were incorporated and not diluted by the ratings of other individuals), and the results were quantified and evaluated to establish a relative ranking of each of the routes based on SME ratings; see **Section 5.3.3**.
8) Finally, sensitivity analyses were performed to examine the sensitivity of the ranking to different weighting of the tangible metrics; this includes evaluating the metric weights at the minimum and maximum values identified by the individual members of the team; see **Section 5.5.**

Details of the analyses and the results produced from each of these steps are described in the following portion of this section of the report.

Figure 5-1: Overview of MUA Applied to LACBWR ISFSI



5.2 Description of Evaluated Routes

As noted in **Section 3.0**, there are numerous possible routes from the LACBWR ISFSI (Step 1). The general sequences of the transportation operations for these routes fall into the following categories:

- Transfer directly to onsite rail siding (onsite rail)
- Transport by HHT directly to GCUS to an existing rail transload facility (HHT to rail)
- Transport by on-site HHT to a barge, barge transport to a port, and transfer to a railcar (HHT to barge to rail)

Due to the numerous possible routes identified in **Section 3.0**, a set of screening criteria was used to reduce these routes to a number that can be reasonably evaluated by the MUA (Step 2). If the routes were not reduced by performing this screening activity, then the MUA could take an inordinate amount of time to perform and the pairwise comparison may not be able to distinguish between many of the routes due to the compression of results between the favored routes relative to the evaluated metrics. That is, if the difference between a favored route and another route that clearly has some disadvantages is identified at an extremity of the evaluation range, then the MUA will show a distinct difference between these two routes. However, if there are other favored routes with only slight differences between one another, these differences may be difficult to distinguish from one another as the large differences will have compressed the slight differences identified between two or more favored routes and thereby prevent distinguishing between them in the overall evaluation.

The following screening criteria were used per mode of transport (i.e., routes having the same mode of transport were only contrasted against one another for screening purposes) to reduce the routes to the five routes identified in **Section 3.5**:[6]

1) The time and/or distance to be traveled by the conveyance/barge would be significantly more than alternate viable routes without significant/substantial benefit.
2) Clearance limits on routes (e.g., through tunnels, around curves, or through heavily forested roads) are not met without significant/substantial upgrading.
3) Sustained travel on routes with steep grades.
4) Bridge(s)/overpass(s) to be utilized would not sustain weight of conveyance without significant/substantial upgrading.
5) Natural features make barge landings, overpack loading, etc. difficult to perform without significant/substantial upgrading or infrastructure development.
6) No available loading facility or insufficient track for performing loading of a full consist.
7) Transloading and/or port facility does not permit receipt of Class 7 materials.
8) Excessive number of interchanges between rail carriers.
9) Avoidance of high-density transit areas (i.e., regions with significant rail traffic) that would require interruption of traffic if shipment were to transit region.
10) Characteristics of HHT that would require preapproval for HRCQ shipments.
11) Other (as specified in **Table 3-5**).

The reasons for the screening of potential routes identified in **Section 3.0** are documented in **Table 3-5**. The routes unscreened and remaining to be evaluated by the MUA are as follows:

1) Barge from La Crosse ISFSI on to the Mississippi River then down through Quincy, IL, Alton, IL, Guttenberg, IA, Dubuque, IA, Davenport, IA, and ending with a transfer to rail at GCUS (i.e., referred to as "A. Barge Only" route in the MUA).
2) HHT from the La Crosse ISFSI to a transload site in GCUS via La Crosse, WI, Tomah, WI, Madison, WI, Rockford, IL, Bloomington, IL, Springfield, IL, Litchfield, IL, and ending with a transfer to rail at GCUS. (i.e., referred to as "B. HHT Only" route in the MUA).
3) Rail directly from the La Crosse site on the BNSF line to GCUS via the Village of Lynxville, WI, Dubuque, IA, Orion, IL, Keokuk, IA, Quincy, IL, and Elsberry, MO (i.e., referred to as "C. Rail Only (BNSF Only)" route in the MUA).

[6] Several of these screening criteria use the term "significant." This term is frequently justified through a relative comparison between identified routes (e.g., one route may be identified as requiring a single bridge to be upgraded, whereas another route may require several bridges to be upgraded). In a few cases, the opinions of the SMEs were used to screen a route using this term or not to screen a route based on, for example, historical experiences.

4) HHT to the city of La Crosse to transload site at private siding located on CPRS: 817 Bainbridge St, La Crosse, WI 54603, the rail route will interchange with IHB and BNSF to GCUS via La Crosse, WI, Lansing, IA, Marquette, IA, Clayton, IA, Dubuque, Sabula, IA, Plum, IL, Adeline, IA, Genoa, IL Elgin, IL, Bensenville, IL, Galesburg, IL, Fort Madison, IA, and Elsberry, MO (i.e., referred to as "D. HHT + Rail at French Island" route in the MUA).
5) HHT to private siding at Badger Mining Corp W10899 Cherry Road, Merrillan, WI 54754. Rail UP direct to GCUS via La Crosse, WI, Black River Falls, WI, Merrillan, WI, Eau Claire, WI, St.Paul, MN, Des Moines, IA, Kansas City, MO, and Jefferson City, MO (i.e., referred to as "E. HHT + Rail at Merrillan" route in the MUA).

5.3 Evaluation of Routes

To evaluate each of these five routes, attributes used to define an 'ideal' route and associated shipping activities were identified, and for each attribute, metrics were identified that describe the performance measures and allow for the quantification of the assessment through pairwise comparisons. With these five routes in mind, the metrics were evaluated to identify those that are tangibly different between two or more routes. These tangibly different metrics were then pairwise compared against one another to identify a level of importance for each metric (i.e., a metric hierarchy) and provide a range of values against which sensitivity analyses were performed. An additional pairwise comparison was performed between the tangible metrics for each route, and using the metric hierarchy, a hierarchy for the routes was established. Finally, sensitivity analyses were performed to examine the impact changes to the weighting of the metrics had on the route hierarchy.

5.3.1 Identification of Attributes and Metrics

The attributes identified that can characterize the 'ideal' route are identified in **Table 5-1** (Step 3). These attributes were established based on solicitation of the members of the de-inventory team, past de-inventory studies[29][30][31][32][33][34], and also based on the large body of past MUA activities having been performed on nuclear waste management evaluations[35][36][37][38].

For each attribute, one or more performance measures (metrics) was established (Step 4). These metrics provide a means for estimating how well each route performs against each attribute, defined in terms that can be evaluated by technical experts and compared meaningfully by decision makers. **Table 5-1** also lists the identified metrics per attribute.

To minimize the number of evaluations performed in the next set of MUA activities, the team was surveyed to establish which metrics identify a potentially tangible difference between one or more of the remaining five routes (Step 5). **Table 5-1** shows the results of this survey and some subsequent team discussions. Those metrics identified as having the potential to differentiate between one or more of the routes are identified in **Table 5-1** with a "Y" (yes). Comments are provided in the last column of the table to indicate how the "applicable metric" assessment was performed/concluded. The results of this assessment identified at least one metric for each attribute, with the exception of the Waste Generation and Resource Requirements attributes, for which no tangible differences in the waste productions were identified between the routes (e.g., the waste generated during the de-inventory activities, such as personnel protection equipment, is considered to essentially result in the same quantity and type of waste and hence, will not identify a tangible difference between the evaluated routes) and the resource requirements for the different routes are either the same (e.g., quantity of hardware needed) or covered by other metrics (e.g., number of personnel involved in the transfer). A total of 24 metrics will be evaluated for each route and contrasted against the other routes.

Table 5-1: Attributes and Associated Metrics

Attribute	Metric	Y/N	Comments
Cost[7]	ISFSI Rental Equipment Costs (e.g., mobile cranes)	Y	Mobile cranes may be required for barge, but could instead use goldhofer and stands. Mobile cranes needed for loading on to railcar and HHT trailer for direct rail and HHT routes.
	ISFSI Hardware Procurement Costs (e.g., transfer cask)	Y	Hardware is expected to be relatively the same for all routes, with stands for barging being negligible exception.
	Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)	Y	Improvements, such as preparing a barge transfer site, upgrading of on-site heavy haul paths to the rail line and barge loading site may be necessary and may pose measurable differences.
	Labor and Permitting Costs	Y	Labor and permitting costs are expected to vary by route, as on-site transfer to rail is expected to be minimal, offsite transfer by HHT to be more burdensome, and barge somewhere in-between.
	Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	Y	The different modes of transport from the site of HHT or barge will result in different shipment costs and different transload costs.

[7] Casks, railcars, and associated equipment are assumed to be government furnished equipment and therefore the cost of this equipment is not included in this assessment.

Attribute	Metric	Y/N	Comments
	Cost of Rail Transport (e.g., costs associated with use of multiple railroads in route)	Y	Rail routes take different length routes and will have different numbers of interchanges.
	Total Overall Costs	N	The above broken-down elements of the total cost are expected to cover this metric and hence, this metric is not expected to provide any significance to this assessment.
Environmental Impact	Gaseous Effluent Release	N	Although vehicle and barge emissions will be different between the routes, there are no radiological releases associated with the routes and hence, this metric is not going to provide a tangible difference between the routes.
	Liquid Effluent Release	N	No liquid effluent release is associated with any route from this site.
	Route Aesthetic Changes Needed (e.g., tree trimming)	N	Aesthetic changes not needed to support the routes to be evaluated.
	Route Impact to or Proximity to Historical, Archaeological, and/or Cultural Features	N	Evaluated routes are not expected to impact historical, archaeological, or cultural features.
	Route Environment Characteristics (e.g., terrain, grade, tunnels, etc.)	N	Evaluated routes are not expected to traverse steep grades and/or utilize tunnels that may pose a challenge to the shipments of the material from the La Crosse site.

Attribute	Metric	Y/N	Comments
	Impact of Weather to Route (e.g., limited availability of route or instability of weather)	Y	Weather (e.g., snow, ice, fog) may impact when shipments from La Crosse can be made depending on mode of shipment.
	Number of Water Areas Nearby Route (e.g., number of bridges crossed)	Y	According to START[1], the number of water crossings shows some differences between the routes.
	Number of Sensitive Environmental Areas Nearby Route (e.g., endangered species habitats)	Y	START[1] identified distinguishable differences for number of environmentally sensitive areas traversed between the evaluated routes.
Institutional Considerations	Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churches)	Y	Based on results from START[6], the routes show significant differences between the number of these mass gathering places along the routes.
	Number of Tribal Lands Crossed	Y	Based on results from START[1], the routes show some small fraction of tribal lands are crossed by the routes.
	Public Acceptability of Route	Y	This subjective metric will be evaluated as done in the previous evaluations based on our experts opinions and will consider nearby features of the routes.
Permitting	Ease of Permit Procurement	Y	As the HHT route travels through many different jurisdictions, it will be the hardest to procure permits for, with Barge and Rail providing only minor differences.

Attribute	Metric	Y/N	Comments
	Number of Permits	Y	Number of permits for HHT are considered to be greater then the other routes, thus this metric was evaluated.
	Insurability of Route	N	All routes to be indemnified by DOE (Price Anderson Act).
Resource Requirements	Number of Personnel involved in Transfer	N	As the barge route will require on-site transfer to the barge site and then at the conclusion of the barge route will require off-loading from the barge and subsequent transload to rail, whereas the rail routes did not require any transloading and the HHT only required transload upon arrival at GCUS, this metric was identified as showing differences between the routes.
	Quantity of Hardware Needed	N	Hardware is expected to be relatively the same for all routes, with stands for barging being negligible exception.
	Availability of Specialty Equipment (e.g., rigging, transfer cask)	N	Specialty equipment such as a transfer cask, rigging, and a heavy haul truck (goldhofer) will be required for each route. Barges and tugs will only be needed for barge routes, but their inclusion will be captured in the transport to rail costs identified above.
Safety	Cumulative Worker Exposure (proportional to handling time & number of workers)	Y	Some routes will involve greater cumulative worker exposure as a result of an additional transload activity (for barge routes) and/or the longer transient duration or cumulative duration for the shipment of single casks by HHT.

Attribute	Metric	Y/N	Comments
	Cumulative Population Dose along Route (proportional to population density)	Y	According to START[1], the population exposed along a route may vary significantly between various routes (noting all exposures will meet regulatory limits and be negligibly small).
	Risks Associated with Number of Lifting Activities	Y	Risks associated with lifting activities will vary between modes of transportation.
	Average Accident Frequency on Route	Y	According to START[1], the average accident frequency along a route may vary significantly between various routes (noting the frequencies are very small overall).
	Hazards (Occupational Safety and Health Administration (OSHA) & Radiological) associated with Route Duration	N	The OSHA risks are expected to be negligible and comparable for each of the routes and any difference will be covered by the worker exposure and transit duration metrics.
	Number of Fire Stations & Trained Personnel Nearby Route	Y	According to START[1], the number of fire stations and trained personnel nearby a route may vary significantly between various routes.
Schedule	Transit Duration per Conveyance and Consist	Y	START[1] identified distinguishable duration differences between the evaluated routes.
	Ease of Access to Transload Site (e.g., consider usage of existing site)	Y	Based on current usage the transload sites for HHT and barge are not expected to pose a constraint to operations.

Attribute	Metric	Y/N	Comments
	Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)	Y	Potential differences may be expected between, for example, improving the heavy haul path to the barge.
	Immediacy of Ability to Perform Transfer (e.g., ability to train crew)	N	The team decided there was no tangible difference between the routes as all routes were deemed equally immediately ready for performing a transfer with some potential requirements to coordinate with other site activities, such as train or barge arrival with a load of coal.
	Size of conveyance (# of casks per shipment)	N	This metric is covered by the cost and duration metrics and is not needed to be separately assessed.
Security/ Vulnerability	Security Vulnerability of Route	Y	Some routes may transit urban areas viewed as a higher risk, where as other routes may remain in mostly lower risk rural areas.
	Availability of Security Escort for Route	N	Security escort is assumed to always be available.
	Number of Police Stations Nearby Route	Y	START[1] identified distinguishable differences for the number of police stations nearby route metric between the evaluated routes.
Waste Generation	Quantity of Radiological Waste Produced from Normal Ops	N	A minimum amount of rad waste is expected and will likely be nearly the same for all routes.
	Quantity of Non-Radiological Waste Produced from Normal Ops	N	A minimum amount of non-rad waste is expected and will likely be nearly the same for all routes.

5.3.2 Evaluation of Individual Metrics

With the tangible metrics established in **Section 5.3.1**, a pairwise comparison between these metrics was performed by each of the 12 members of the Orano-led team to establish a relative weighting of the metrics and a range for the metric weight over which a sensitivity analyses was performed (Step 6). In a pairwise comparison, each metric is evaluated for its favorability against the other metrics. This exercise was performed by each of the 12 individuals of the Orano-led team to ensure a reasonable cross-section of preference samples was taken from the collective team, which allowed for an average metric weighting to be established and a prioritized list of metrics identified.

An example of the pairwise comparison performed by an individual is shown in **Table 5-2**. In this example, the "Public Acceptability of Route" metric (e.g., the opinion of the team which route would be more publicly acceptable over another considering a composite of inputs such as total population, cumulative safety of the route, cumulative security of the route, cumulative environmental impact, proximity to historical features, etc.) is pairwise compared against the other metrics on a favorability scale. For example, the "Public Acceptability of Route" metric is rated more favorable against the "Ease of Permit Procurement," but is rated more unfavorable against "Cumulative Worker Exposure." These ratings are interpreted to mean that this evaluator believes there is a benefit seen to taking a route where the permit procurements may be more difficult to attain, but whose route is deemed more publicly favorable. However, this evaluator also believes if there were a means to improve the public acceptability of a route that resulted in an increase to the cumulative worker exposure along the route (e.g., utilizing a much longer route that results in, for example, a truck driver receiving significantly more worker exposure than an alternative route), then this will not be a favored/encouraged outcome.

With 24 tangible metrics to be evaluated, 276 pairwise evaluations had to be performed by each individual. **Attachment A** shows the entire pairwise evaluation for these metrics. Note, if the original 40 metrics were evaluated, then 780 pairwise evaluations will have had to have been performed to establish the weight for the metrics (burdensome).

The favorability scale, shown in **Table 5-2** (e.g., "Strongly Favorable"), allows for quantification of the comparison when weights are assigned to the scale. In this MUA, the relative weighting is assessed as follows:

- Strongly favorable as 11 (+5).
- More favorable as 9 (+3).
- Mildly favorable as 7 (+1).
- Neutral is rated as 6 (0).
- Mildly unfavorable as 5 (-1).
- More unfavorable as 3 (-3).
- Strongly unfavorable as 1 (-5).

Using this weight scheme, **Figure 5-2** shows the results for the relative weighting of the tangible metrics as established from the evaluation of twelve individual pairwise comparisons. **Table 5-3** shows the numerical values associated with these tangible metrics. Three sets of data are shown in this figure and four sets of data are shown in this table:

1) The "Minimum" value as established from the twelve individual assessments.
2) The "Average Weight" value, which is an average of normalized results from each of the individual assessments (i.e., each individual's assessment is equally weighted and the results combined).

   $$\bar{R}_m = \sum_{p=1}^{P} \left\{ \frac{\sum_{i=1}^{7} N_{m,p}^{i} W_i}{\sum_{m=1}^{M} [\sum_{i=1}^{7} N_{m,p}^{i} W_i]} \right\} / \text{P}$$

   where R = average relative weight, N = number of times rank selected, W = weight of rank (see above), M = number of metrics to be evaluated, P = number of evaluators, m. = metric, i = rank (e.g., "strongly favorable"), p = person evaluating metrics.
3) The "Biased Weight" value, which is an average of the unnormalized results from each of the individual assessments (i.e., the raw scores are used to establish overall average values, so if an individual scored significant differences between the metrics, then these results could skew the overall average in favor of this individual's assessment).

   $$\bar{B}_m = \left\{ \frac{\sum_{p=1}^{P} \left(\sum_{i=1}^{7} N_{m,p}^{i} W_i \right)}{P} \right\} \Bigg/ \sum_{m=1}^{M} \left\{ \frac{\sum_{p=1}^{P} \left(\sum_{i=1}^{7} N_{m,p}^{i} W_i \right)}{P} \right\}$$

   where B = averaged biased relative weight.
4) The "Maximum" value as established from the twelve individual assessments.

Results from all twelve of the individual assessments are shown in **Attachment B**.

Table 5-2: Example of a Portion of a Pairwise Comparison for Metrics Assessment

Column A Metrics	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Metrics
Public Acceptability of Route		x						Ease of Permit Procurement
Public Acceptability of Route		x						Number of Permits
Public Acceptability of Route						x		Cumulative Worker Exposure
Public Acceptability of Route						x		Cumulative Population Dose along Route
Public Acceptability of Route				x				Number of Fire Stations & Trained Personnel Nearby Route
Public Acceptability of Route			x					Transit Duration per Conveyance
Public Acceptability of Route			x					Duration for Infrastructure Improvement

Column A Metrics	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Metrics
Public Acceptability of Route						x		Security Vulnerability of Route
Public Acceptability of Route			x					Number of Police Stations Nearby Route

As shown in **Figure 5-2** and **Table 5-3**, the tangible metrics with the highest preferences (based on average weighting method) are Cumulative Worker Exposure, Cumulative Population Dose, and Risk Associated with Number of Lifting Activities which rated at about 5.61%, 5.56%, and 5.30% of the total weight, respectively. The tangible metrics with the least preferences (based on average weighting method) are Number of Water Areas Nearby Route, Number of Sensitive Environmental Areas Nearby Route, and Number of Police Stations Nearby Route which rated at about 3.02%, 3.45%, and 3.46% of the total weight, respectively. The preferences/ranking and weights of all the tangible metrics in descending order (based on average weighting method) are shown in **Table 5-3**.

These results also show negligible differences between the average weighting method and the biased weighting method, which indicates a fairly uniform assessment by the 12 individuals. However, at the extremities of the individual assessments (i.e., the minimum and maximum values), there are some significant findings including:

- The Ease of Access to Transload Site metric, which ranked 5th overall, was ranked highest overall by an individual at 7.34% (as seen in **Figure 5-2**) indicating a wide range of importance levels for this metric between the individual evaluators. This metric also was ranked very low by another individual at 3.41% giving it the largest range between maximum and minimum.
- The Security Vulnerability of Route metric, which ranked 4th overall, had the second highest favorable ranking by an individual at 7.28%, but was also ranked fairly low by another individual at 3.71% (having the third highest range between the minimum and maximum).
- Overall, the safety and security metrics ranked near the top in preference for everyone’s assessment.
- The metrics with the least difference between minimum and maximum values were the Infrastructure Improvement Costs metric and the Labor and Permitting Costs metric, which ranked towards the lower half of importance of all the metrics and hence, showing a fairly robust rating.
- Overall, the cost metrics had the least difference between minimum and maximum values, indicating the evaluators were fairly consistent in their ranking

Finally, the minimum and maximum values listed in **Table 5-3** provide ranges of values to be used in the sensitivity analyses performed in **Section 5.5**.

Figure 5-2: Weighting of the Tangible Metrics Based on Pairwise Comparisons

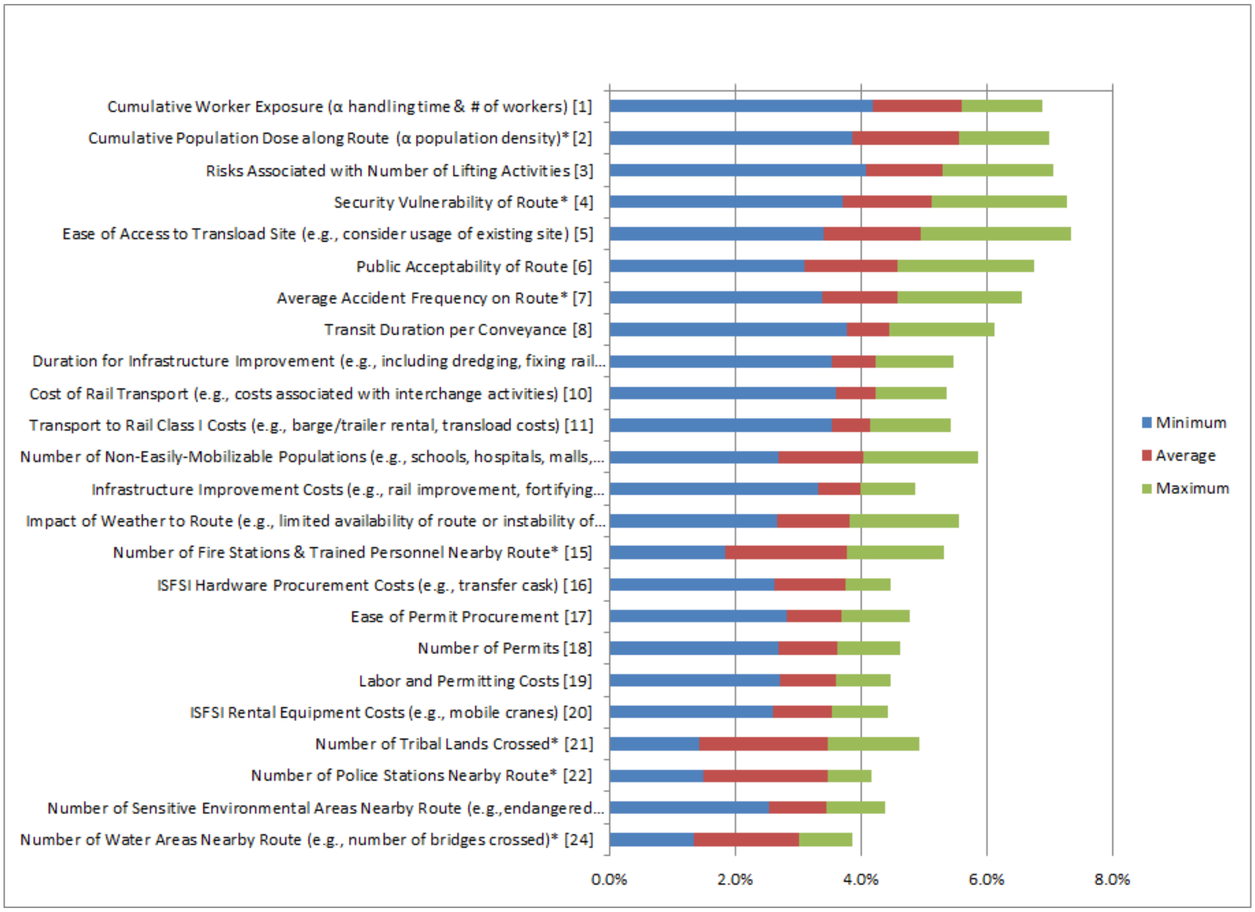


Table 5-3: Weighting of Tangible Metrics

Rank	Minimum	Average Weight	Biased Weight	Maximum	Metric
1	4.20%	5.61%	5.61%	6.88%	Cumulative Worker Exposure
2	3.86%	5.56%	5.56%	7.00%	Cumulative Population Dose along Route
3	4.08%	5.30%	5.30%	7.07%	Risks Associated with Number of Lifting Activities
4	3.71%	5.13%	5.13%	7.28%	Security Vulnerability of Route
5	3.41%	4.94%	4.94%	7.34%	Ease of Access to Transload Site

Rank	Minimum	Average Weight	Biased Weight	Maximum	Metric
6	3.11%	4.59%	4.59%	6.76%	Public Acceptability of Route
7	3.38%	4.58%	4.58%	6.55%	Average Accident Frequency on Route
8	3.77%	4.45%	4.45%	6.13%	Transit Duration per Conveyance
9	3.53%	4.24%	4.24%	5.46%	Duration for Infrastructure Improvement
10	3.59%	4.22%	4.22%	5.37%	Cost of Rail Transport
11	3.53%	4.15%	4.15%	5.43%	Transport to Rail Class I Costs
12	2.69%	4.04%	4.04%	5.86%	Number of Non-Easily-Mobilizable Populations
13	3.32%	3.99%	3.99%	4.86%	Infrastructure Improvement Costs
14	2.66%	3.81%	3.81%	5.56%	Impact of Weather to Route
15	1.84%	3.78%	3.78%	5.31%	Number of Fire Stations & Trained Personnel Nearby Route
16	2.63%	3.75%	3.75%	4.47%	ISFSI Hardware Procurement Costs
17	2.81%	3.68%	3.68%	4.77%	Ease of Permit Procurement
18	2.69%	3.62%	3.62%	4.62%	Number of Permits
19	2.72%	3.60%	3.60%	4.47%	Labor and Permitting Costs
20	2.60%	3.54%	3.54%	4.44%	ISFSI Rental Equipment Costs
21	1.42%	3.47%	3.47%	4.92%	Number of Tribal Lands Crossed
22	1.48%	3.46%	3.46%	4.17%	Number of Police Stations Nearby Route

Rank	Minimum	Average Weight	Biased Weight	Maximum	Metric
23	2.54%	3.45%	3.45%	4.38%	Number of Sensitive Environmental Areas Nearby Route
24	1.33%	3.02%	3.02%	3.86%	Number of Water Areas Nearby Route

5.3.3 Route Assessments

With the ranking/preference of the tangible metrics calculated, another pairwise comparison was performed to compare the tangible metrics for a route against those of each of the other routes (Step 7). Unlike the pairwise comparison performed for the tangible metrics, which were performed by multiple individuals, this pairwise comparison was performed by the collective team to ensure the responses from SMEs were properly weighted against responses from the other team members when a metric(s) (e.g., cost) was addressed in that SME's discipline(s). In this manner, for example, in the ranking of a safety-related metric, the safety SME's preference was afforded greater influence than were the preferences of the other individuals on the team if there was a difference.

An alternative approach would have been to let each SME separately perform a pairwise comparison on only the metrics within the SME's discipline(s). However, by having a team assessment, productive discussions can take place on each metric, which may change, challenge, concur, etc., on the evaluation of the metric. Furthermore, by acting as a team, the rationale for the pairwise comparisons preferences can be established and this will lend itself to ensuring a fairly consistent basis in the selection of the preferences (e.g., this may temper extreme assessments in cases where differences in rankings of a metric may not be that significant on a relative basis).

Before performing this pairwise comparison between the tangible metrics for a route against those of each of the other routes, some cursory/preliminary data is required for each of the routes to inform this assessment. **Section 3.0** contains some of this information, but a summary of the cursory/preliminary data used to perform this comparison by metric is provided here.

5.3.3.1 On-Site Rental Equipment Costs

For the on-site rental equipment costs, the majority of the rental costs for on-site equipment are expected to be the same for each route (e.g., mobile crane and trailer), however for the barge routes goldhofers are recommended. The goldhofers would be able to transport the NAC TSC canister loaded in a transportation cask to the barge from the ISFSI. The goldhofers would then drive on to the deck of the barge and be aligned with stands designed to hold the transportation casks during the barging portion of the trip. Once aligned, the goldhofers would lower their deck in a manner that would leave the transportation casks sitting in their stands (with their weight no longer supported by the goldhofers) and then drive off the barge. The use of goldhofers would eliminate the need for mobile cranes at the barge landing site. Normally the rental rate of goldhofers is higher than mobile cranes, but due to the limited number of casks to be transported from this site no significant differences are expected in the overall rental costs and hence, the routes are judged to have relatively equal on-site rental costs.

5.3.3.2 On-Site Hardware Procurement Costs

For the on-site hardware procurement costs, the majority of the hardware would be the same for each route with only minor differences in the routes (e.g., stands for barge and bolts and the like for affixing the transportation cask cradle to a trailer). Hence, no significant differences in the costs for each of the routes are expected.

5.3.3.3 Infrastructure Improvement Costs

For the infrastructure improvement costs, the potential on-site improvements needed would be for the haul path to the barge loading site and the extension of the on-site rail spur combined with a transloading area. The estimated cost for the additional track is approximately $197,500. Other infrastructure improvements considered for the La Crosse site included: the need to dredge the barge site, development of transload sites, and improvements of the HHT routes. However, the barge site was deemed not to require dredging as noted in **Section 3.3**. The on-site rail spur was assessed to require to be extended and a transload site developed. The on-site HHT transload site was deemed sufficient for operations. The off-site HHT to rail transload sites were deemed to require some improvements (e.g., transload area and perimeter security fencing). Finally each of the HHT and rail routes will require clearance assessments of the off-site routes prior to their use to verify this assessment, considering this assessment is temporal. The net result is the team's assessment determined the on-site rail route (rail only) is considered to have the highest infrastructure improvement costs followed by the off-site HHT to rail routes, the barge only route, and finally the HHT only route.

5.3.3.4 Labor and Permitting Costs

For the labor and permitting costs, the HHT routes are expected to have higher costs relative to the on-site rail and on-site barge costs. The HHT routes are expected to have higher permitting costs relative to the evaluated rail and barge routes, as local permits for the HHT are required whereas no local permits are necessarily needed for the rail and barge routes, with the longer HHT routes having higher permitting costs. Furthermore, labor costs for the HHT routes are expected to be higher per cask as HHT would only move one cask per trip, whereas rail and barge would move all five casks in one trip. In addition, HHT and barge would require off-site transload activities to rail, which the rail only route would not require. Thus, the HHT routes would have the highest labor and permitting costs followed by barge routes and with rail routes having the least labor and permitting costs relative to HHT and barge.

5.3.3.5 Transport to Rail Class I Costs

For the transport to rail costs (not including on-site costs), each of the five routes were evaluated by the team to have a cost benefit or cost penalty relative to the other routes based primarily on composite costs associated with rental of barges, tugs, and HHTs and number of transload activities. For rail routes, no transport to rail costs were identified beyond those already covered by the on-site rental costs. For barge routes, the costs are associated with: (1) the rental of a barge and tugs to ship five transportation casks at a time placed on specialty racks on the barge or left on the trailer (rolled on) and (2) the rental of a crane(s) to move the transportation cask from the trailer onto a stand on a barge (if applicable) or to move the transportation cask from the barge or trailer (rolled off) to a railcar. For HHT routes, the costs are associated with: (1) an HHT to move one transportation cask from the ISFSI to the rail transload facility at GCUS and (2) the rental of a crane to move the transportation cask from the HHT to railcar at the transload site at GCUS. In addition to these rental costs, costs associated with the distance required to be covered by the route and the five separate shipments required to be performed for this route will impact this assessment. Based on this assessment, the HHT route was considered to have the highest transport to rail costs followed by the barge route and finally the rail route, which was deemed to have negligible costs and was favored over the other routes for this metric.

5.3.3.6 Cost of Rail Transport

For the cost of rail transport, the barge and HHT route with essentially no rail (they are directly off-loaded to rail in GCUS) are favored over the rail routes. Since the rail routes follow the nearly the same paths, these routes all evaluate neutrally against one another.

5.3.3.7 Impact of Weather to Route

The impact of weather in this area of the country is considered to be either directly impacting on the routes (e.g., ice/snow covered roads or rough waters) or indirectly impacting on the routes (e.g., vacationer traffic on the roads and waterways). For example, the barge route traversing significant distances of the Mississippi River likely would be subject to more impact by personal boat traffic during the summer than the HHT route traveling south from the La Crosse site. The barge route also traverses the potentially heavily utilized Mississippi River (especially by commercial traffic) that can be impacted by the weather (e.g., periodic flooding). However, considering the Mississippi River is a large body of water, these potential impacts by the weather to the barge route are expected to be minimal, except for the flooding that can stop commerce on the river. The weather impact can also have an adverse impact on the HHT route, primarily due to snow and ice. Hence, the barge and HHT routes are considered to be at a disadvantage relative to the rail only route.

5.3.3.8 Number of Water Areas Nearby Route

Using data produced from the START program[11-1], each route could be evaluated for the number of water crossings the route traverses. Based on these results (see **Attachment D**), the number of water crossings ranged from 0 to 101, with the caveat that the route with 0 water crossings was the barge route which is continuously on the water. The route with the least number of water crossings is the HHT only route (39 crossings) followed by the HHT plus rail route from French Island (51 crossings), the rail only route (52 crossings), and the HHT plus rail route from Merrillan (101 crossings).

5.3.3.9 Number of Sensitive Environmental Areas Nearby Route

Using data produced from the START program[11-1], each route could be evaluated for the quantity (square miles) of environmentally sensitive areas crossed. Based on these results (see **Attachment D**), the quantity of environmentally sensitive areas crossed by each route ranged from 13 to 92 square miles[8] which is small compared to the total land crossed by the entire route. Nevertheless, according to START[11-1], some routes do have advantages over other routes: the HHT only route impacts the least amount of environmentally sensitive areas (13.3 mi^2); the HHT plus rail route from Merrillan has the next least impact (22.2 mi^2); the rail only route is next (43.8 mi^2); the HHT plus rail route from French Island (50.6 mi^2); and the barge route has the highest impact (92.4 mi^2).

5.3.3.10 Number of Non-Easily-Mobilizable Populations

Using data produced from the START program[11-1], each route could be evaluated for the number of non-easily-mobilizable populations, such as those found at schools, hospitals, malls, stadiums, churches, and retirement homes along the routes. Based on these results (see **Attachment D**), the number of non-easily-mobilizable populations along each route was lowest for the barge route followed by the rail only route and then HHT only route, the HHT plus rail route from French Island and the HHT plus rail route from Merrillan producing the highest number.

5.3.3.11 Number of Tribal Lands Crossed

Using data produced from the START program[11-1], each route could be evaluated for the quantity (square miles) of tribal land crossed. Based on these results (see **Attachment D**), the quantity of tribal land crossed by each route was essentially negligible (i.e., less than 0.14 square miles[9]) relative to the total land crossed by an entire route. Nevertheless, according to START, the routes did have some differences over one another: the barge route did not cross any tribal lands, the routes using rail crossing 0.07 square miles of tribal land; and the HHT only route crossing 0.14 square miles of tribal land.

5.3.3.12 Public Acceptability of Route

The public acceptability of the five routes to be evaluated varied significantly between each of the routes. The rail only route was judged to be favorable over the barge and all the HHT routes due to the lack of off-site activities (e.g., HHT and transloading), utilizing rail lines with regular commercial service, and not utilizing public waterways and crossing their associated environmentally sensitive areas. The barge route was judged to be mildly favorable over the HHT route as the barge travels on a route with a lower population density with a lower accident likelihood that is partially countered by travel on public waterways and their associated environmentally sensitive areas. The HHT plus rail routes were favored over the HHT only route due principally to the shorter distance covered by the HHT and its associated drawbacks.

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[8] START establishes the square miles of sensitive environmental areas crossed by a route by determining the number of miles a route crosses through these areas and assuming 800 meters on either side of the route, as a buffer region, then multiplying these values together to establish the number of square miles of sensitive environmental area.

[9] START establishes the square miles of tribal land crossed by determining the number of miles a route crosses through tribal land, assuming 800 meters on either side of the route, as a buffer region, then multiplying these values together to establish the number of square miles of tribal land crossed.

5.3.3.13 Ease of Permit Procurement

The rail and barge routes from the La Crosse ISFSI either do not require permits or the permits were deemed relatively easy to obtain compared to the HHT route, which will require multiple local permits through jurisdictions potentially not receptive to these types of shipments.

5.3.3.14 Number of Permits

As noted in the prior section, the rail and barge routes from the La Crosse ISFSI do not require permits whereas the HHT route would require multiple local permits to travel through those jurisdictions and hence, the longer the HHT route the greater the number of permits will be required.

5.3.3.15 Cumulative Worker Exposure

The cumulative worker exposure metric assessment relies heavily on the number of handling events (e.g., transloads) involving the transportation casks and, to a lesser degree, on the distance traveled for each route. These handling events are outlined below and result in the rail only route (equivalent of two on-site transload activities) favored over the HHT routes (equivalent of one on-site transload activity and one off-site transload activity) and the barge route (equivalent of one to two on-site transload activities and one to two off-site transload activities). Worker exposure levels would also not approach regulatory limits as the shielding afforded by the transportation casks and the remote operations involved with these handling activities would result in low exposure levels. Furthermore, the larger fraction of the cumulative worker exposure would occur within the La Crosse ISFSI where the transfer operations to move the NAC TSC canisters from the NAC VCC to the NAC STC take place and apply to each route.

- Transfer to on-site rail (two lifts):
    - Lift of the NAC STC (loaded with the NAC TSC) in its cradle onto the on-site trailer
    - Lift of the NAC STC from on-site trailer to cask railcar
- Transfer to on-site barge to rail (two to four lifts):
    - Lift of the NAC STC (loaded with the NAC TSC) in its cradle onto the on-site trailer/goldhofer
    - Two options for loading onto barge:
        - Lowering of goldhofer that has been rolled onto barge to allow beams holding transportation cask and cradle to rest on stands and subsequently roll off goldhofer from barge (*Note: this lowering activity may not be necessary if the goldhofer is to be left loaded with the transportation cask and cradle on the barge)*
        - Use a crane to lift the transportation cask from the on-site trailer/goldhofer and place it onto the stands on the barge.
    - Lift of transportation cask and cradle located on beams off stand onto HHT or roll goldhofer off of barge loaded with transportation cask
    - Lift of transportation cask and cradle off of goldhofer/HHT and on to cask railcar.

- Transfer to HHT then to rail (two lifts):
  - Lift of the NAC STC (loaded with the NAC TSC) in its cradle onto the HHT trailer.
  - Lift of transportation cask and cradle from HHT trailer to cask railcar at transload site (*Note: a single lift is assumed at the HHT-to-rail transload site*).

Based on these assessments and the duration of transport on each of the individual routes, the rail routes and the HHT route are essentially equivalent to one another and they are favored over the barge route.

5.3.3.16 Cumulative Population Dose Along Route

The cumulative population dose along each route is expected to be negligible (comparable to background) due to the significant amount of shielding afforded by the transportation casks and their canisters, the age of the SNF, and the minimal duration of exposure during each transport operation. Furthermore, doses to individual members of the public during normal transportation activities are expected to be below background levels. Nevertheless, the relative differences in preferences established for the assessment of this metric are based primarily on the total exposed population established from data provided by START[1] along each route as shown in **Table 5-4**. Those routes with the lowest total exposed populations are favored over the other routes, as they would result in the lowest cumulative dose to the population.

Table 5-4: Route Averaged Population Density Along Each Route

ID	Route Description	Average Population Density (Persons/Square Mile)[1]	Total Exposed Population Estimate[2] (Thousands)
A	Barge Only	365	20
B	HHT Only	256	83
C	Rail Only (BNSF Only)	218	71
D	HHT + Rail at French Island	700	118
E	HHT + Rail at Merrillan	523	284

[1] Data established by START[6] and established by totaling the population located within an 800-m buffer of either side of the route and dividing by the area of the buffer.

[2] Data established by START[6] and established by multiplying the cumulative population density by the route distance and the buffer width on each side of the route (for a total width of 1,600 m).

5.3.3.17 Risks Associated with Number of Lifting Activities

Risks associated with lifting activities are dependent on the number of lifts made of a transportation cask, which have been identified in **Section 5.3.3.15**, and the continuous nature of the operation of those lifts (e.g., do a set of lifts occur sequentially separated by hours, days, or weeks). Based on this assessment, the rail only route is deemed strongly favorable over the barge route due to the number of lifts and over the HHT route due to the discontinuous nature of the lifts that occur as a result of the shipment of a single transportation cask at a time resulting in a day or several days between successive lift activities. These risks are minimized by: the protection afforded the transportation casks by the impact limiters, the design of the lifting equipment (includes multiple safety factors and avoidance of single-failure points), and the robustness of the transportation cask systems. Hence, although this parameter provides some preference to the rail route, the overall risk associated with a lifting device is deemed negligible.

5.3.3.18 Average Accident Frequency on Route

Using data produced from START[11-1], each route could be evaluated for the annual frequency of the average accident rate (accidents per mile per year) for all of the modes of transport used on a route. However, the accident rates for the different modes of transport have different definitions for what constitutes an "accident" and hence, this data can only be used to compare routes which use the same mode of transport from the La Crosse site. So only the two routes that used HHT and rail could be pairwise compared using the data from START[1]. As shown in **Table 5-5**, the HHT + Rail route to and from French Island has an accident rate approximately 6 times lower than the HHT + Rail route to and from Merrillan and hence, the French Island route was deemed mildly favorable over the Merrillan route. For comparisons between the other routes, the rail only route was judged to have the lowest overall accident rate compared to all the routes, followed by the HHT + Rail routes (as these were mostly by rail), the barge only route, and the HHT only route having the highest relative accident rate.

Table 5-5: Average Accident Frequency Over Each Route[1]

Accident Rate* (per mi / yr)	Route				
	Barge Only	HHT Only	Rail Only (BNSF Only)	HHT + Rail at French Island	HHT + Rail at Merrillan
Average Accident Rate	**	**	**	0.0034	0.0197
Factor Increase Over Lowest Rate	N/A	N/A	N/A	1 x	5.8 x

* Note that the values listed in this table were produced by the START program[1] and in the assessment of this metric only the relative comparison values ("Factor Increase Over Lowest Rate") were utilized.

** Values for these routes from the START program[1] are not listed here because these accident rates could not be compared to one another due to different definitions of "accident" between the different modes of transport.

5.3.3.19 Number of Fire Stations & Trained Personnel Nearby Route

Using data produced from START[11-1], each route could be evaluated for the number of fire departments per mile. Based on these results (see **Attachment D**), the number of fire departments ranged from 0.03 to 0.12 per mile. The route with the highest fire departments per mile is the HHT plus rail route via French Island (0.12 per mile) followed closely by the other HHT plus rail route via Merrillan (0.10 per mile), followed by the rail only route (0.09 per mile) and finally the barge and HHT only routes (0.03 per mile).

5.3.3.20 Transit Duration per Conveyance and Consist

The transit duration for each route was roughly estimated during the team meeting and arrived at the following estimates:

1) Barge Only to GCUS
   a) Loading Cask: load NAC TSC canister into NAC STC cask, load NAC STC cask on to on-site trailer/goldhofer, and attach truck/tug to on-site trailer/goldhofer (1 to 3 days per cask)
   b) Transload: transport to barge and either roll-on on-site trailer/goldhofer or lift NAC STC onto stands and then secure and prepare cask for shipment (1 day per cask)
   c) Barge Preparation: pre-barge briefings for procedures, quality, and safety reviews; assemble crew (1 to 2 days for 5 casks)
   d) Barging: transport 501 miles to GCUS (72 hrs per START[11-1] or 3 days for 5 casks)
   e) Unloading Barge: transload operations from barge to rail (2½ days for 5 casks)
   f) Thus, approximately **16 to 25 days** for 5 casks to load onto cask railcar
   g) Total Barge Transit Duration from START[11-1]: 72 hours (accounted for above)
2) Heavy Haul Truck Only to GCUS
   a) Loading Cask: load NAC TSC canister into NAC STC cask, load NAC STC cask on to heavy haul trailer and attach truck to trailer (1 to 3 days per cask)
   b) Trucking: transport 513 miles to GCUS (7 hrs per START[11-1], but will assume 1½ days per cask)
   c) Unloading HHT: prepare and load NAC STC onto cask railcar, secure, and prepare cask for shipment (1 day per cask)
   d) Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).
   e) Thus, approximately **18 to 29 days** for 5 casks to load onto cask railcar
   f) Total HHT Transit Duration from START[11-1]: 7 hours (accounted for above)
3) Rail Only (BNSF Only)
   a) Loading Cask: load NAC TSC canister into NAC STC cask, load NAC STC cask on to on-site trailer/goldhofer, and attach truck/tug to on-site trailer/goldhofer (1 to 3 days per cask)
   b) Transload: prepare and load NAC STC onto cask railcar, secure, and prepare cask for shipment (1 day per cask)

   c) Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day)
   d) Rail: transport 495 miles to GCUS (12 hrs per START[11-1], but will assume 1 day per consist)
   e) Thus, approximately **<u>12 to 22 days</u>** for 5 NAC STC casks to load onto a full consist and move to GCUS
   f) Total Rail Transit Duration from START[11-1]: 12 hours (accounted for above)

4) HHT + Rail at French Island
   a) Loading Cask: load NAC TSC canister into NAC STC cask, load NAC STC cask on to heavy haul trailer and attach truck to trailer (1 to 3 days per cask)
   b) Trucking: transport 21 miles to French Island (assume ½ day per cask)
   c) Unloading HHT: prepare and load NAC STC onto cask railcar, secure, and prepare cask for shipment (1 day per cask)
   d) Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).
   e) Rail: transport 709 miles to GCUS (20 hrs per START[11-1], but will assume 1 day per consist)
   f) Thus, approximately **<u>14 to 25 days</u>** for 5 casks to load onto cask railcar and move to GCUS
   g) Total HHT and Rail Transit Duration from START[11-1]: 20 hours (accounted for above)

5) HHT + Rail at Merrillan
   a) Same as previous rail route: thus, approximately **<u>14 to 25 days</u>** for 5 NAC STC casks to load onto a full consist and move to GCUS
   b) Total HHT and Rail Transit Duration from START [11-1]: 27 hours (accounted for above) to cover the 877 miles to GCUS

As noted in these handling times, there are also the total route transit durations on the HHTs, barges, and rails. START[1] provides these distances and total transit times and **Table 5-6** provides a breakdown by route.

Table 5-6: Route Transit Durations

Distance (miles)	Route				
	Barge Only	HHT Only	Rail Only (BNSF Only)	HHT + Rail at French Island	HHT + Rail at Merrillan
HHT	0	513	0	21	80
Barge	501	0	0	0	0
Rail	0	0	495	709	877
Total Duration (hrs)	72	7	12	20	27

Note: the times provided are based on one, one-way trip and assume travel at posted speed limits, which is not realistic, but expected speeds would still result in HHT transport durations of less than one day since the distances are fairly short. The values shown above do not account for the multiple trips that would be required by HHT to and from the site and do not account for time spent in locks.

Using the data in **Table 5-6** from START[11-1] (note some of these times seem counter intuitive and hence were not solely used to establish the comparisons) and the above handling times, the pairwise comparisons were performed between the various routes.

5.3.3.21 Duration for Infrastructure Improvement

Infrastructure improvements were identified as necessary for the barge and rail only route which require a heavy haul path built to the barge site and the extension of the on-site rail spur combined with a transloading area. In addition, the HHT routes with transload activities were identified to need some improvements to support transloading activities and security. The duration of these infrastructure improvements are not expected to significantly impact de-inventory activities, but could pose a minor burden on the rail, barge, and HHT to rail routes with the rail route posing the largest burden.

5.3.3.22 Ease of Access to Transload Site

For the ease of access to the transload site metric, each rail transload site was evaluated for its current ability to host the transload activity, considering the following characteristics: the ease of access for the HHT/barge/on-site trailer and the rail cars to the site, the presence of the needed infrastructure (e.g., security fencing, crane access to the rail line), and the ability to handle and load a full rail consist). Considering these characteristics, the on-site rail transload site was deemed to be the easiest of the evaluated transload sites to load a rail consist because it is easily accessible by the on-site trailer and from the main rail line, has a security fence, has ample crane and HHT maneuvering (flat) space, has access to a rail line with available transit slots, and although it does not currently have sufficient rail line to load a full consist of 5 casks it is considered to be easily installed. The transload site for on-site transfer to the HHT is deemed to be relatively prepared for shipments as it has a security fence and ample crane maneuvering space; however these routes require off-site transloading on to the rail car and these sites require more infrastructure improvements (e.g., fencing, crane maneuvering space, etc.). The barge route is also deemed to require some infrastructure improvements such as fencing and barge landing improvement, but is deemed to be slightly easier to access than the HHT routes.

5.3.3.23 Security Vulnerability of Route

For the metric on security vulnerability of the route, all routes were capable of being secured; however, some minor advantages of one route over another were identified and these advantages are related to a combination of duration of the shipment, distance traversing urban versus rural regions, number of high threat urban areas on the route, number of transload activities, and the lower vulnerability associated with barge routes over HHT routes. The barge and rail routes direct from the site with no off-site transload activities were judged to be the most favored security routes over the HHT routes that required off-site transload and their cumulative duration created by individual shipments of transportation casks was the highest.

5.3.3.24 Number of Police Stations Nearby Route

Using data produced from START[11-1], each route could be evaluated for the number of police stations per mile along the route. Based on these results (see **Attachment D**), the number of police stations ranged from 0.02 to 0.1 per mile. The route with the highest police stations per mile is the HHT + rail route via French Island (0.1 per mile) followed by the other HHT + rail route via Merrillan (0.08 per mile), followed by the rail only route (0.06 per mile), the barge only route (0.03 per mile), and finally the HHT only route (0.02 per mile).

5.4 Route Recommendations

Using the metric information identified for the routes listed in the previous section, the Orano-led team held conference a call to perform a pairwise comparison of each of the tangible metrics for each of the routes identified in **Section 5.2** (Step 7). This team evaluation, unlike the individual assessments performed for the tangible metrics, ensured SMEs' preferences and knowledge could appropriately influence the results for the SMEs' metrics used to compare the routes, while at the same time allowing those knowledgeable of the routes to provide beneficial inputs and all team members the opportunity to provide feedback to the discussion related to the evaluation of the route and metric.

Figure 5-3 provides an example of the pairwise comparison performed by the de-inventory team for the metric related to the Public Acceptability of route (as denoted on the far-left column). "Column A Routes" (2nd column on left) are subsequently compared against "Column B Routes" (last column on right) for the Public Acceptability of route metric. The favorability scale listed in this figure is the same as identified for the pairwise comparison of the tangible metrics (see **Figure 5-3**). As an example, the second row of the evaluation (excluding the header row) shows that the "C. Rail Only (BNSF Only)" route identified under "Column B Routes" is more favorable when compared to the "A. Barge Only" route identified under "Column A Routes" for the metric related to the Public Acceptability of route, which is reflective of the information provided in **Section 5.3.3.12**.

With 24 tangible metrics and 5 routes to be evaluated, the team performed 240 pairwise evaluations. **Attachment C** shows the entire pairwise evaluation for these metrics.

Using the same weighting scheme as described in **Section 5.3.2** and the relative weighting of the tangible metrics identified in **Table 5-3**, **Figure 5-4** shows the resulting relative weighting of the routes in order of the highest rated (C. rail Only (BNSF Only)) to the least rated (E. HHT + Rail at Merrillan). **Table 5-8** shows the numerical values associated with each of the routes for multiple different weighting schemes:

1) The "Unweighted" results, which are based on each metric having an equal weight.
2) The "Average Weight" results, which are based on the metric weights associated with the "Average Weights" from **Table 5-3**.
3) The "Biased Weight" results, which are based on the metric weights associated with the "Biased Weights" from **Table 5-3.**
4) The "No Safety or Security Metric" results, which are based on zeroing out the weights associated with the safety and security metrics and re-normalizing the "Average Weights" from **Table 5-3**.

5) The "No Public Acceptability Metric" results, which are based on zeroing out the weight for the Public Acceptability of Route metric and re-normalizing the "Average Weights" from **Table 5-3**.

6) The "No Safety, Security, or Public Acceptability Metric" results, which are based on zeroing out the weights for the safety, security, and public acceptability metrics and re-normalizing the "Average Weights" from **Table 5-3**.

Figure 5-3: Example of a Portion of a Pairwise Comparison for Routes Assessment

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Public Acceptability of Route	A. Barge Only			x					B. HHT Only
	A. Barge Only						x		C. Rail Only (BNSF Only)
	A. Barge Only			x					D. HHT + Rail at French Island
	A. Barge Only			x					E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only					x			D. HHT + Rail at French Island
	B. HHT Only					x			E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)		x						D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)		x						E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan

As shown in **Figure 5-4** and **Table 5-7**, the routes with the highest ratings (based on average weighting method) are: Rail Only (BNSF Only) and HHT + Rail at French Island route. The route with the least favored rating (based on average weighting method) is the HHT + Rail at Merrillan route. The top route is favored by over 4% over the other routes, indicating some definitive preference of this route with direct loading of rail on the La Crosse site.

Figure 5-4: Resulting List of Prioritized Routes from the LACBWR ISFSI Site

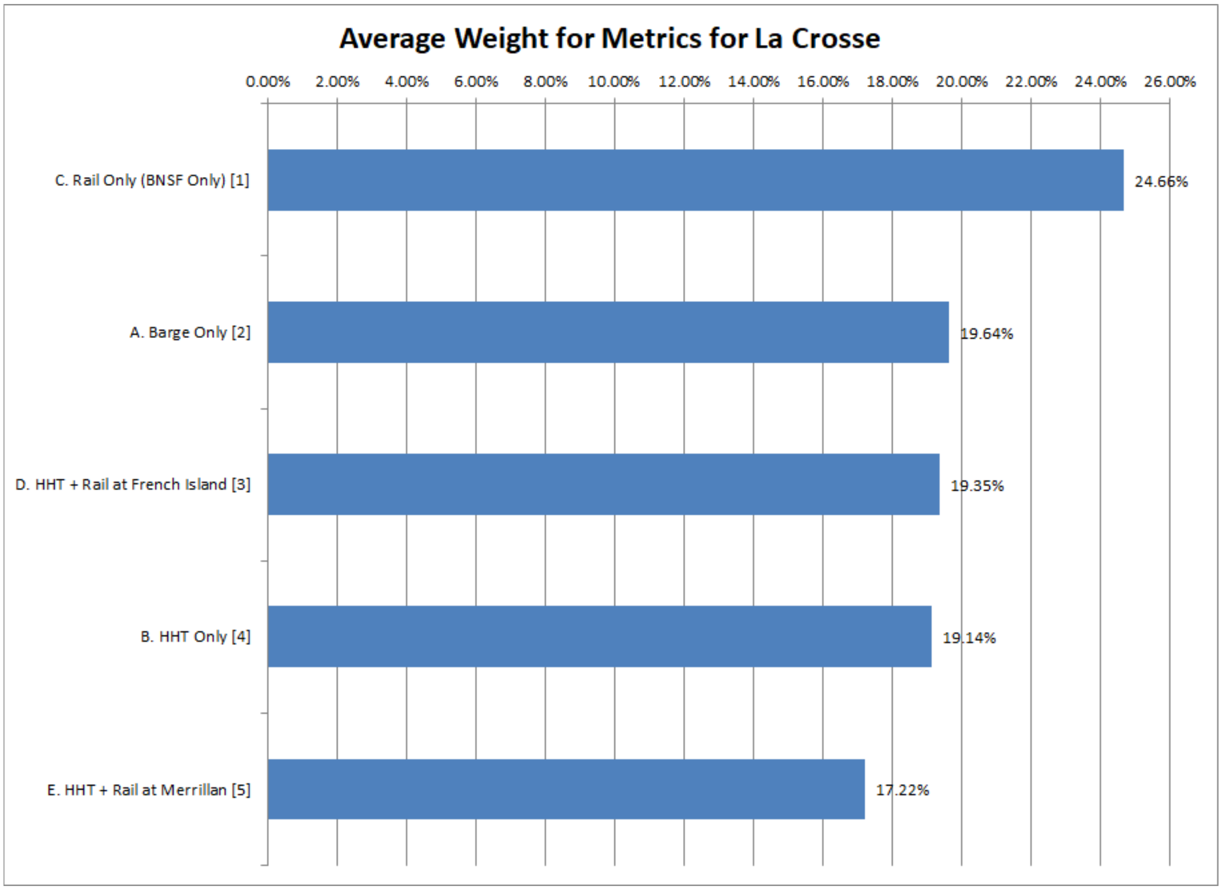


Figure 5-5 shows the impact each tangible metric had on the overall scoring of each route. Due to the number of metrics utilized in this evaluation (24), there clearly is no single dominant metric identified in this figure. However, this figure does show the most favored route (direct rail from the site) received significantly greater contributions from the following tangible metrics: transport to rail class I costs, impact of weather, public acceptability of routes, ease of permit procurement, number of permits, risks associated with number of lifting activities, and ease of access to transload site. Whereas the barge from the site route received significantly greater contributions from the following tangible metrics: cumulative population dose along route, number of non-easily mobilizable populations, and cost of rail transport. The HHT routes received significantly greater contributions from the following tangible metrics: duration for infrastructure improvement (HHT only route) and number of water areas nearby route.

Since the safety and security metrics will be established by regulation to be acceptable, these metrics may not be needed to distinguish routes from one another; hence, an alternative weighting scheme was examined to establish the impact of using no security or safety metrics. As shown in

Table 5-8, the highest-scored route does not change position when the safety and security metrics are removed from the evaluation with and without removal of the public acceptability metric. However, the removal of the safety and security metrics with and without removal of the public acceptability metric does result in changes between the second, third, and fourth ranked routes. Removal of only the public acceptability metric does not result in a change to the original rankings. Additional analyses and sensitivity results were performed on these metrics to examine their impact on the rankings in **Section 5.5**.

Table 5-8 shows the sensitivity of the rankings, in general, to the alternative weighting schemes. To further examine the impact to the ranking/scores of the routes to changes in the weighting of the metrics, a sensitivity analysis was performed using the range of the metrics identified in **Table 5-3** (Step 8).

Table 5-9, **Table 5-10**, **Table 5-11, Table 5-12**, and **Table 5-13** present the results of the sensitivity of the route rankings to the minimization of the weighting of a metric, using the minimum metric weights from **Table 5-3**. For example, under the metric column labeled "Transit Duration per Conveyance" in **Table 5-12**, results are presented using a weight of 3.77% for the "Transit Duration per Conveyance" (instead of the 4.45% in **Table 5-3**) with the other metrics proportionally re-normalized. The results indicate no change occurs to the overall ranking. **Figure 5-6** summarizes the minimum, average, and maximum results presented in **Table 5-9**, **Table 5-10**, **Table 5-11, Table 5-12**, and **Table 5-13** for the minimization of individual metrics. As can be seen from these results, the Rail Only (BNSF Only) route remains robustly ranked as the most favored route for the removal of the SNF from the La Crosse ISFSI (at this time) relative to the other evaluated routes.

Table 5-14, **Table 5-15**, **Table 5-16**, **Table 5-17**, and **Table 5-18** present the results of the sensitivity of the route rankings to the maximization of the weighting of a metric, using the maximum metric weights from **Table 5-3**. For example, under the metric column labeled "Cumulative Worker Exposure" in **Table 5-16**, results are presented using a weight of 6.88% for the "Cumulative Worker Exposure" (instead of the 5.61%), with the other metrics proportionally re-normalized. The results indicate that there is no change in the ranking of the routes. **Figure 5-7** summarizes the minimum, average, and maximum results presented in **Table 5-14**, **Table 5-15**, **Table 5-16**, **Table 5-17**, and **Table 5-18** for the maximization of individual metrics. As can be seen from these results, the top ranked routes remain robustly ranked as the most favored routes for the removal of the SNF from the La Crosse ISFSI relative to the other evaluated routes.

A final assessment of the results was performed by taking the results for each individual from the pairwise comparison on the metrics and using them to establish a route ranking per individual. These results also established, for each individual, the same results in the ranking as seen in the above results (i.e., the rail route with direct shipment from the La Crosse ISFSI was the favorite route) for the removal of the SNF from the La Crosse ISFSI.

As a result of the MUA and its sensitivity analyses, the prioritized list of routes from the La Crosse ISFSI is found in **Table 5-7**.

Table 5-7: Prioritized List of Routes from LACBWR ISFSI

Rank	Prioritized Route
1	C. Rail Only (BNSF Only)
2	A. Barge Only
3	D. HHT + Rail at French Island
4	B. HHT Only
5	E. HHT + Rail at Merrillan

Figure 5-5: Impact of Each Tangible Metric on Each Route's "Score"

Table 5-8: Weighting of Routes

Nominal Results:	Unweighted		Average Weight		Biased Weight		No Safety or Security Metric		No Public Acceptability Metric		No Safety, Security, or Public Acceptability Metric	
Route	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**
A. Barge Only	3	19.42%	2	19.64%	2	19.64%	3	19.40%	2	19.62%	3	19.36%
B. HHT Only	4	19.21%	4	19.14%	4	19.14%	2	19.87%	4	19.34%	2	20.24%
C. Rail Only (BNSF Only)	1	24.46%	1	24.66%	1	24.66%	1	24.31%	1	24.40%	1	23.89%
D. HHT + Rail at French Island	2	19.45%	3	19.35%	3	19.35%	4	18.99%	3	19.44%	4	19.10%
E. HHT + Rail at Merrillan	5	17.46%	5	17.22%	5	17.22%	5	17.42%	5	17.20%	5	17.42%

Table 5-9: Weighting of Routes at Minimum Metric Value (Part 1 of 5)

Metric Minimized:	On-Site Rental Equipment Costs		ISFSI Hardware Procurement Costs		Infrastructure Improvement Costs		Labor and Permitting Costs		Transport to Rail Class I Costs	
Route	Rank	Result	Rank	Result	Rank	Route	Rank	Result	Rank	Result
A. Barge Only	2	19.63%	2	19.63%	2	19.62%	2	19.59%	2	19.74%
B. HHT Only	4	19.13%	4	19.13%	4	19.10%	4	19.14%	4	19.15%
C. Rail Only (BNSF Only)	1	24.71%	1	24.71%	1	24.75%	1	24.63%	1	24.56%
D. HHT + Rail at French Island	3	19.34%	3	19.34%	3	19.34%	3	19.40%	3	19.34%
E. HHT + Rail at Merrillan	5	17.19%	5	17.18%	5	17.19%	5	17.24%	5	17.21%

Table 5-10: Weighting of Routes at Minimum Metric Value (Part 2 of 5)

Metric Minimized:	Cost of Rail Transport		Impact of Weather to Route		Number of Water Areas Nearby Route		Number of Sensitive Environmental Areas Nearby Route		Number of Non-Easily-Mobilizable Populations	
Route	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Route**	**Rank**	**Result**	**Rank**	**Result**
A. Barge Only	2	19.58%	2	19.68%	2	19.92%	2	19.70%	2	19.52%
B. HHT Only	4	19.07%	4	19.17%	4	18.92%	4	19.08%	4	19.08%
C. Rail Only (BNSF Only)	1	24.74%	1	24.60%	1	24.68%	1	24.70%	1	24.66%
D. HHT + Rail at French Island	3	19.38%	3	19.35%	3	19.25%	3	19.36%	3	19.34%
E. HHT + Rail at Merrillan	5	17.23%	5	17.19%	5	17.23%	5	17.16%	5	17.41%

Table 5-11: Weighting of Routes at Minimum Metric Value (Part 3 of 5)

Metric Minimized:	Number of Tribal Lands Crossed		Public Acceptability of Route		Ease of Permit Procurement		Number of Permits		Cumulative Worker Exposure	
Route	Rank	Result	Rank	Result	Rank	Route	Rank	Result	Rank	Result
A. Barge Only	2	19.42%	2	19.63%	2	19.67%	2	19.59%	2	19.63%
B. HHT Only	4	19.33%	4	19.20%	4	19.11%	4	19.21%	4	19.17%
C. Rail Only (BNSF Only)	1	24.76%	1	24.58%	1	24.73%	1	24.59%	1	24.66%
D. HHT + Rail at French Island	3	19.34%	3	19.38%	3	19.30%	3	19.38%	3	19.35%
E. HHT + Rail at Merrillan	5	17.16%	5	17.21%	5	17.19%	5	17.24%	5	17.19%

Table 5-12: Weighting of Routes at Minimum Metric Value (Part 4 of 5)

Metric Minimized:	Cumulative Population Dose along Route		Risks Associated with Number of Lifting Activities		Average Accident Frequency on Route		Number of Fire Stations & Trained Personnel Nearby Route		Transit Duration per Conveyance	
Route	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**
A. Barge Only	2	19.49%	2	19.66%	2	19.67%	2	19.71%	2	19.69%
B. HHT Only	4	19.06%	4	19.16%	4	19.19%	4	19.17%	4	19.14%
C. Rail Only (BNSF Only)	1	24.66%	1	24.59%	1	24.64%	1	24.70%	1	24.65%
D. HHT + Rail at French Island	3	19.34%	3	19.37%	3	19.32%	3	19.30%	3	19.32%
E. HHT + Rail at Merrillan	5	17.46%	5	17.21%	5	17.18%	5	17.11%	5	17.20%

Table 5-13: Weighting of Routes at Minimum Metric Value (Part 5 of 5)

Metric Minimized:	Duration for Infrastructure Improvement		Ease of Access to Transload Site		Security Vulnerability of Route		Number of Police Stations nearby Route	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Barge Only	2	19.64%	2	19.65%	2	19.60%	2	19.70%
B. HHT Only	4	19.09%	4	19.16%	4	19.15%	3	19.25%
C. Rail Only (BNSF Only)	1	24.73%	1	24.63%	1	24.64%	1	24.76%
D. HHT + Rail at French Island	3	19.34%	3	19.37%	3	19.39%	4	19.20%
E. HHT + Rail at Merrillan	5	17.20%	5	17.20%	5	17.22%	5	17.09%

Table 5-14: Weighting of Routes at Maximized Metric Value (Part 1 of 5)

Metric Maximized:	On-Site Rental Equipment Costs		ISFSI Hardware Procurement Costs		Infrastructure Improvement Costs		Labor and Permitting Costs		Transport to Rail Class I Costs	
Route	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**
A. Barge Only	2	19.64%	2	19.64%	2	19.66%	2	19.68%	2	19.43%
B. HHT Only	4	19.14%	4	19.14%	4	19.19%	4	19.13%	4	19.11%
C. Rail Only (BNSF Only)	1	24.62%	1	24.63%	1	24.55%	1	24.69%	1	24.87%
D. HHT + Rail at French Island	3	19.36%	3	19.35%	3	19.36%	3	19.30%	3	19.36%
E. HHT + Rail at Merrillan	5	17.24%	5	17.24%	5	17.25%	5	17.19%	5	17.23%

Table 5-15: Weighting of Routes at Maximized Metric Value (Part 2 of 5)

Metric Maximized:	Cost of Rail Transport		Impact of Weather to Route		Number of Water Areas Nearby Route		Number of Sensitive Environmental Areas Nearby Route		Number of Non-Easily-Mobilizable Populations	
Route	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**
A. Barge Only	2	19.75%	2	19.57%	2	19.50%	2	19.58%	2	19.79%
B. HHT Only	4	19.25%	4	19.08%	4	19.24%	4	19.19%	4	19.21%
C. Rail Only (BNSF Only)	1	24.51%	1	24.75%	1	24.65%	1	24.62%	1	24.67%
D. HHT + Rail at French Island	3	19.30%	3	19.35%	3	19.40%	3	19.34%	3	19.36%
E. HHT + Rail at Merrillan	5	17.19%	5	17.25%	5	17.21%	5	17.27%	5	16.97%

Table 5-16: Weighting of Routes at Maximized Metric Value (Part 3 of 5)

Metric Maximized:	Number of Tribal Lands Crossed		Public Acceptability of Route		Ease of Permit Procurement		Number of Permits		Cumulative Worker Exposure	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Barge Only	2	19.79%	2	19.65%	3	19.44%	2	19.69%	2	19.64%
B. HHT Only	4	19.00%	4	19.05%	4	18.58%	4	19.06%	4	19.10%
C. Rail Only (BNSF Only)	1	24.59%	1	24.78%	1	24.88%	1	24.73%	1	24.67%
D. HHT + Rail at French Island	3	19.36%	3	19.31%	2	19.61%	3	19.32%	3	19.35%
E. HHT + Rail at Merrillan	5	17.26%	5	17.22%	5	17.50%	5	17.19%	5	17.24%

Table 5-17: Weighting of Routes at Maximum Metric Value (Part 4 of 5)

Metric Maximized:	Cumulative Population Dose along Route		Risks Associated with Number of Lifting Activities		Average Accident Frequency on Route		Number of Fire Stations & Trained Personnel Nearby Route		Transit Duration per Conveyance	
Route	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**	**Rank**	**Result**
A. Barge Only	2	19.76%	2	19.60%	2	19.58%	2	19.58%	2	19.51%
B. HHT Only	4	19.20%	4	19.11%	4	19.06%	4	19.11%	4	19.12%
C. Rail Only (BNSF Only)	1	24.67%	1	24.75%	1	24.70%	1	24.63%	1	24.69%
D. HHT + Rail at French Island	3	19.36%	3	19.32%	3	19.39%	3	19.38%	3	19.42%
E. HHT + Rail at Merrillan	5	17.02%	5	17.22%	5	17.27%	5	17.30%	5	17.26%

Table 5-18: Weighting of Routes at Maximized Metric Value (Part 5 of 5)

Metric Maximized:	Duration for Infrastructure Improvement		Ease of Access to Transload Site		Security Vulnerability of Route		Number of Police Stations nearby Route	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Barge Only	2	19.64%	2	19.63%	2	19.70%	2	19.62%
B. HHT Only	4	19.21%	4	19.10%	4	19.12%	4	19.10%
C. Rail Only (BNSF Only)	1	24.54%	1	24.71%	1	24.69%	1	24.63%
D. HHT + Rail at French Island	3	19.36%	3	19.33%	3	19.29%	3	19.40%
E. HHT + Rail at Merrillan	5	17.25%	5	17.24%	5	17.20%	5	17.26%

Figure 5-6: Minimum, Average, and Maximum Results from Sensitivity Analysis for Minimization of Each Metric

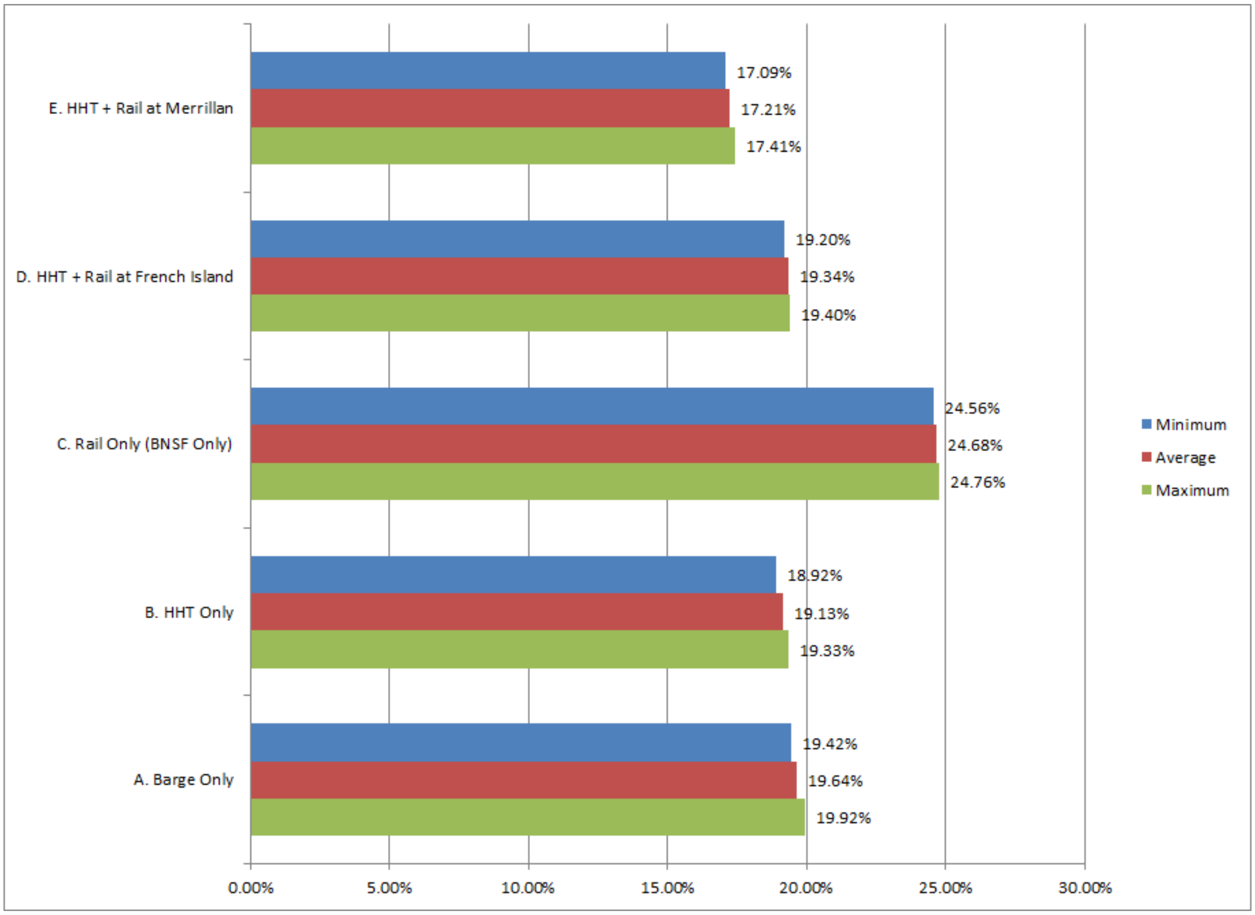
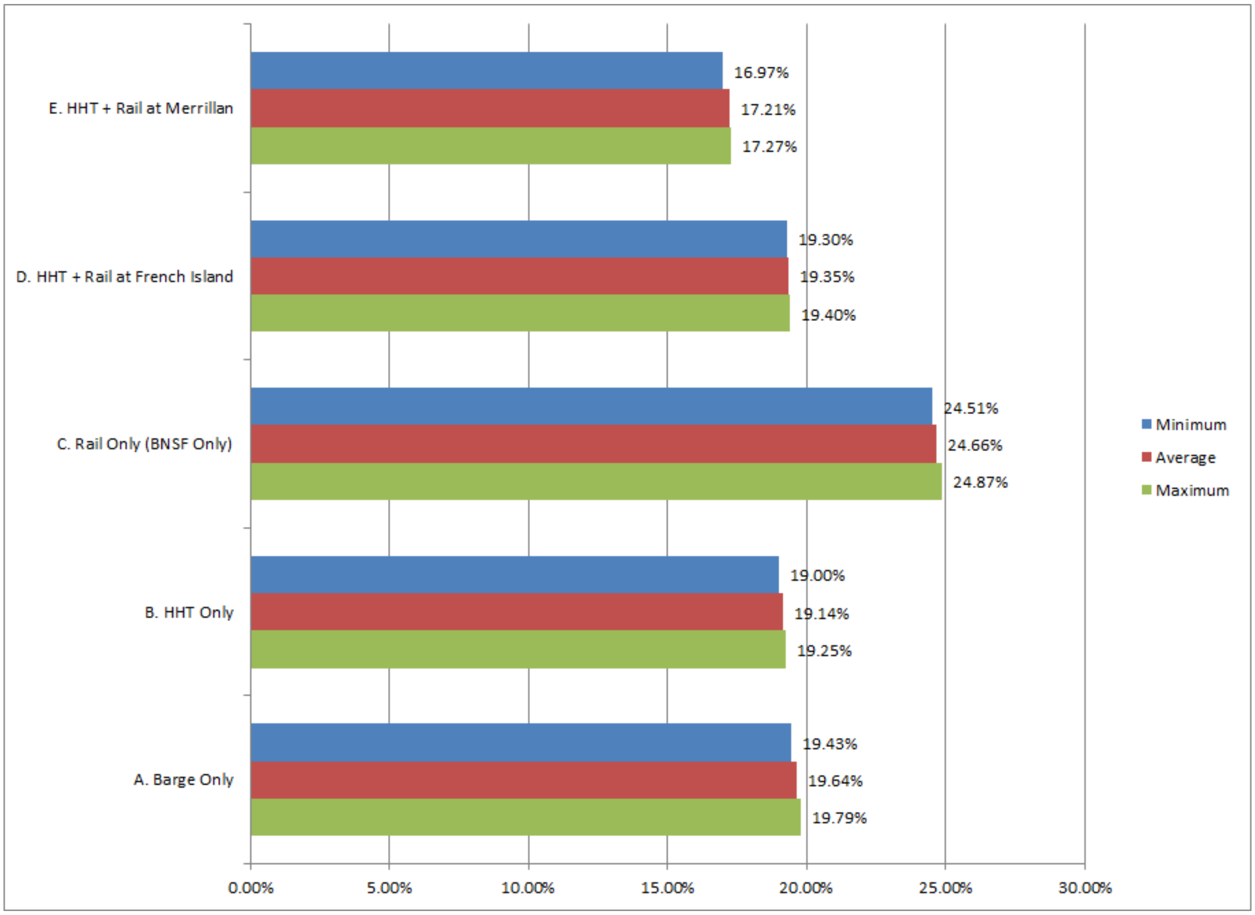


Figure 5-7: Minimum, Average, and Maximum Results from Sensitivity Analysis for Maximization of Each Metric



5.5 Additional Sensitivity Analyses

Additional sensitivity analyses have been performed to examine in more detail the impact of the results of some of the sensitivity analyses performed in **Table 5-8**. The purpose of the MUA is to use objective input, backed by numerical data generated from START[1] and evidence from other sources of information (e.g., pictures), to provide a quantitative ranking of the favorability of route scenarios. Sometimes, however, the subjective opinions of team members can span a larger range than may be necessary to distinguish between routes and may overemphasize the difference between routes. For example, as noted in **Section 5.3.3.16** the dose along the route to individuals is expected to be below background levels (i.e., essentially negligible), but nevertheless cumulative population doses along the routes were still ranked from being neutral to strongly favorable against one another, when in fact they should have at most spanned from neutral to mildly favorable over one another. Additional sensitivity analyses were performed which examined the impact of suppressing the range of assessments for metrics whose material results are acceptable (e.g., through regulatory requirements). Additionally, more detailed analyses of the sensitivity results presented in **Table 5-8** are provided in this section for additional assessment and one final assessment to remove potential redundancy in some of the metrics is examined.

5.5.1 Suppression of Evaluation Span for Select Metrics

As noted in **Section 5.3.3**, there are several metrics used in the MUA that realistically only vary slightly between each route, as the results will always be acceptable for regulatory reasons. The purpose of this sensitivity analyses is to examine the impact to the route rankings as a result of limiting the span select metrics can be evaluated over. These select metrics include:

- Cumulative Worker Exposure
- Cumulative Population Dose along Route
- Risks Associated with Number of Lifting Activities
- Average Accident Frequency on Route
- Number of Fire Stations & Trained Personnel Nearby Route
- Security Vulnerability of Route
- Number of Police Stations Nearby Route

These specific safety and security metrics were selected for evaluation of span suppression as a result of each of them being regulated (e.g., by the NRC) to an acceptable level. Regardless of the route selected, these identified metrics should only vary marginally, so suppressing the span of the pairwise comparison by route from between mildly favorable to mildly unfavorable, as shown in **Figure 5-8**, was examined. Since four of these metrics were ranked, by average, as the top four metrics from the pairwise comparison by individual team members, the suppression of the span of the pairwise comparison could impact the route rankings.

Figure 5-8: Example of Suppression of Span for Cumulative Worker Exposure

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Cumulative Population Dose along Route (α population density)*	A. Barge Only			x					B. HHT Only
	A. Barge Only			x					C. Rail Only (BNSF Only)
	A. Barge Only		x						D. HHT + Rail at French Island
	A. Barge Only	x							E. HHT + Rail at Merrillan
	B. HHT Only					x			C. Rail Only (BNSF Only)
	B. HHT Only			x					D. HHT + Rail at French Island
	B. HHT Only	x							E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)			x					D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)	x							E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island	x							E. HHT + Rail at Merrillan

(Before Suppression)

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Cumulative Population Dose along Route (α population density)*	A. Barge Only				x				B. HHT Only
	A. Barge Only				x				C. Rail Only (BNSF Only)
	A. Barge Only			x					D. HHT + Rail at French Island
	A. Barge Only			x					E. HHT + Rail at Merrillan
	B. HHT Only				x				C. Rail Only (BNSF Only)
	B. HHT Only				x				D. HHT + Rail at French Island
	B. HHT Only			x					E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)				x				D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)			x					E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island			x					E. HHT + Rail at Merrillan

(After Suppression)

In **Figure 5-8**, assessments originally identified as "Strongly Favorable" or "More Favorable" were suppressed to "Mildly Favorable" and those originally identified as "Mildly Favorable" were moved to "Neither Favorable (neutral)" to examine the impact of suppressing the span of the pairwise comparison by route for metrics whose parameters are regulated to acceptable levels.

Figure 5-9 shows the modified rankings with the security and safety metrics evaluation range suppressed. **Figure 5-10** shows the contribution each tangible metric makes to the scoring for each route. **Table 5-19** compares the results from the original assessment and the modified results using the suppressed span. These results show the top route remains unchanged, but routes ranked 2nd, 3rd, and 4th switched positions. Hence the rail route from the La Crosse site remains the highest ranked route, which is consistent with the results identified by the other sensitivity analyses included in this report.

Figure 5-9: Resulting List of Prioritized Routes from the La Crosse ISFSI for the Suppression of Span for Safety and Security Metrics

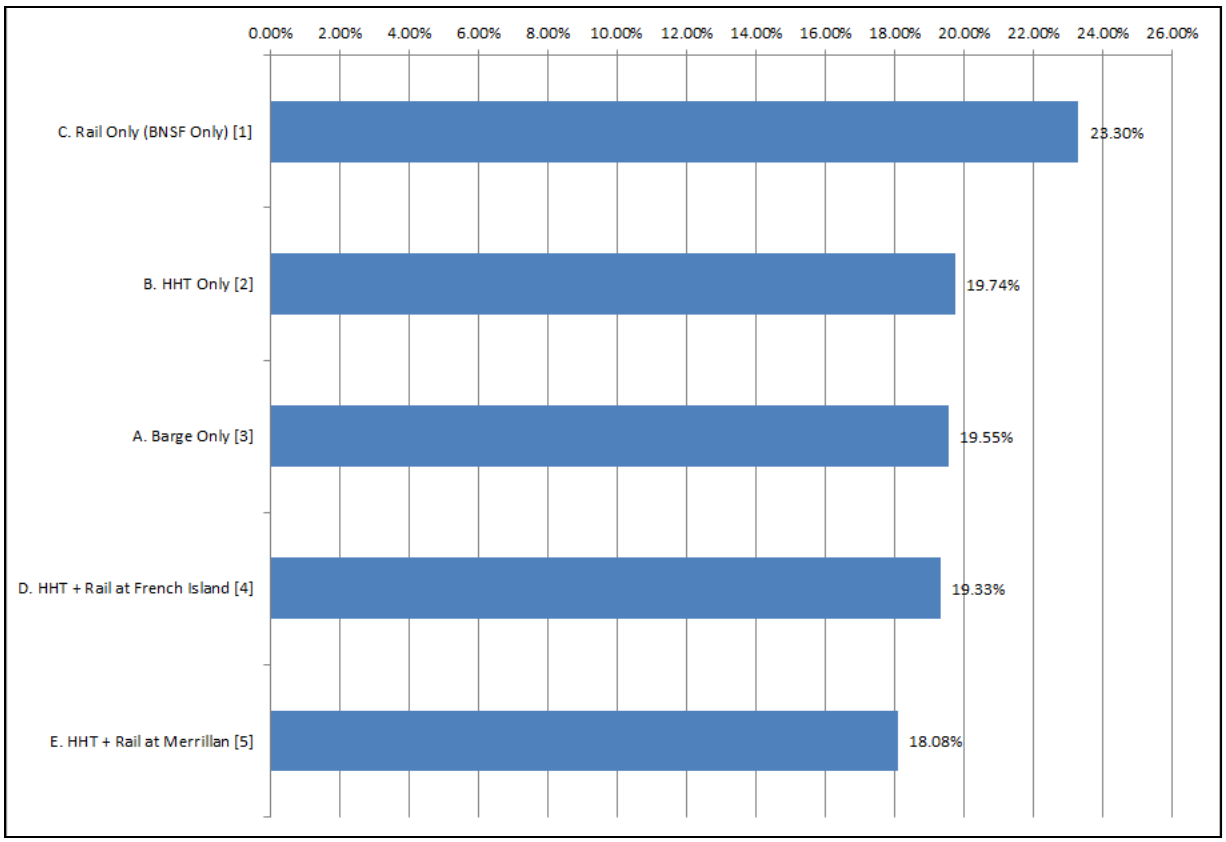


Figure 5-10: Impact of Each Tangible Metric on each Route's Scoring for the Suppression of Span for Safety and Security Metrics

Table 5-19: Comparison of Original MUA Results to the Suppressed Span MUA Results

Suppression Results		Routes	Original Results	
Rank	Avg		Rank	Avg
3	19.55%	A. Barge Only	2	19.64%
2	19.74%	B. HHT Only	4	19.14%
1	23.30%	C. Rail Only (BNSF Only)	1	24.66%
4	19.33%	D. HHT + Rail at French Island	3	19.35%
5	18.08%	E. HHT + Rail at Merrillan	5	17.22%

5.5.2 Details of Select Sensitivity Results

Additional details of some select sensitivity results shown in **Section 5.4** are presented in this section to allow for additional assessment of the results. The specific sensitivity analyses for which additional details are provided include the impact of the removal of:

- The safety metrics including:
  - The cumulative worker exposure metric
  - The cumulative population dose along route metric
  - The risks associated with the number of lifting activities metric
  - The average accident frequency on route metric
  - The number of fire stations & trained personnel nearby route
- The security metrics including:
  - Security Vulnerability of Route
  - Number of Police Stations Nearby Route
- The public acceptability metric
- The public acceptability and security metrics at the same time

Results shown in **Figure 5-11** and **Table 5-20** for the removal of the safety metrics show the top two and bottom ranked routes remain the same as were established from the average weights, with the direct rail route from La Crosse to GCUS remaining the top ranked route, but the HHT only route moving up to the third route in these rankings. Results shown in **Figure 5-12** and **Table 5-21** are for the removal of the security metrics, which shows only the 3rd and 4th ranked routes switching positions relative to the original rankings. Results shown in **Figure 5-13** and **Table 5-22** for the removal of the public acceptability metric which show no change from the original rankings. The final sensitivity analysis performed involved removing both the public acceptability and security metrics at the same time. **Figure 5-14** and **Table 5-23** show the results of this assessment, and the results show changes to the 2nd, 3rd, and 4th ranked routes from the original rankings.

Overall, the direct rail route from La Crosse to GCUS is consistently the highest-ranked route for transloading the transportation casks. However, this site does require additional assessment prior to final selection and some of the particular issues requiring resolution include but are not limited to: extension of the existing rail line at the on-site transload site remaining viable, the building of the associated transload site around this rail extension remaining viable, and the rail routes meeting the required clearances.

Figure 5-11: Impact of Removing the Safety Metrics

Table 5-20: Results from the Deletion of the Safety Metrics

Deletion of Safety Metrics		Routes	Original Results	
Rank	**Avg**		**Rank**	**Avg**
2	19.49%	A. Barge Only	2	19.64%
3	19.46%	B. HHT Only	4	19.14%
1	24.22%	C. Rail Only (BNSF Only)	1	24.66%
4	19.19%	D. HHT + Rail at French Island	3	19.35%
5	17.65%	E. HHT + Rail at Merrillan	5	17.22%

Figure 5-12: Impact of Removing the Security Metrics

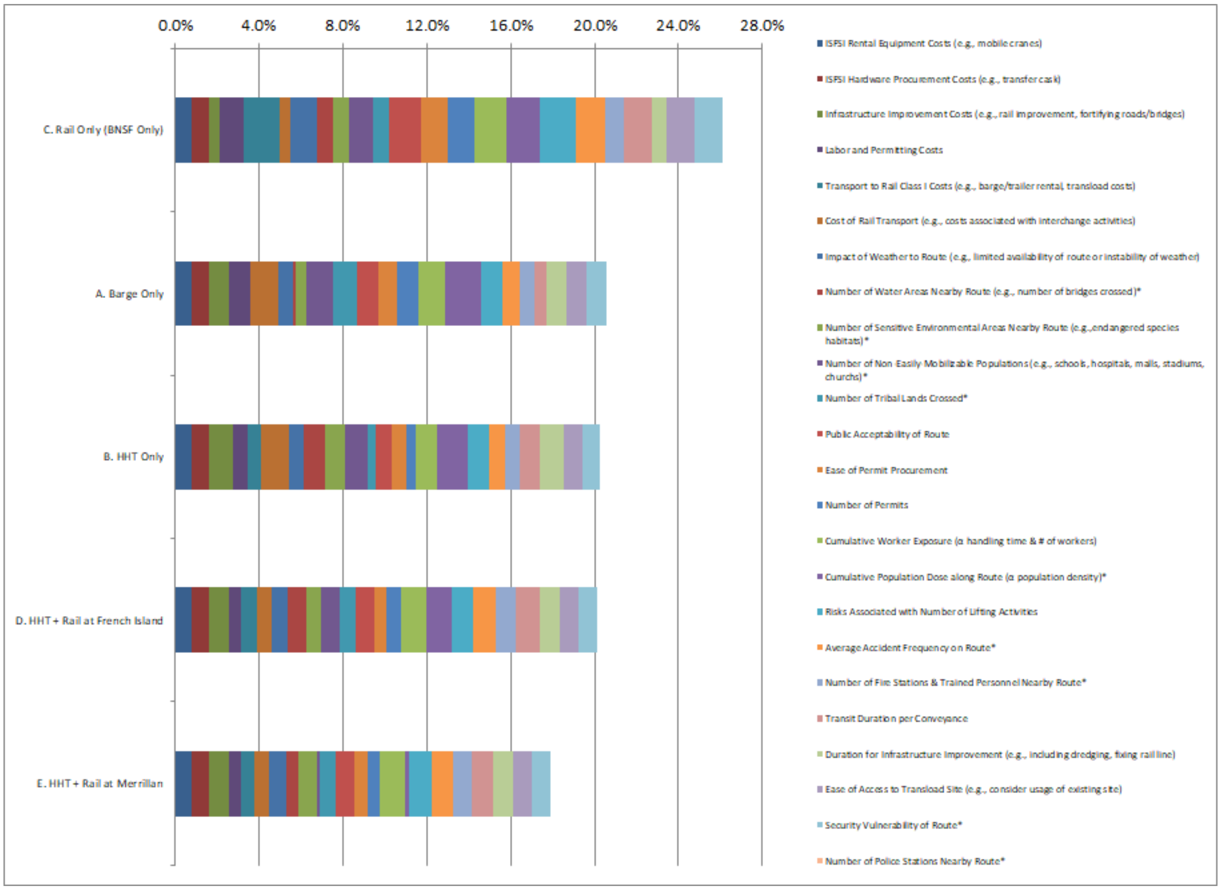


Table 5-21: Results from the Deletion of the Security Metric

Deletion of Security Metric		Routes	Original Results	
Rank	Avg		Rank	Avg
2	19.59%	A. Barge Only	2	19.64%
3	19.40%	B. HHT Only	4	19.14%
1	24.77%	C. Rail Only (BNSF Only)	1	24.66%
4	19.22%	D. HHT + Rail at French Island	3	19.35%
5	17.01%	E. HHT + Rail at Merrillan	5	17.22%

Figure 5-13: Impact of Removing the Public Acceptability Metric

Table 5-22: Results from the Deletion of the Public Acceptability Metric

Deletion of Public Acceptability Metric		Routes	Original Results	
Rank	Avg		Rank	Avg
2	19.62%	A. Barge Only	2	19.64%
4	19.34%	B. HHT Only	4	19.14%
1	24.40%	C. Rail Only (BNSF Only)	1	24.66%
3	19.44%	D. HHT + Rail at French Island	3	19.35%
5	17.20%	E. HHT + Rail at Merrillan	5	17.22%

Figure 5-14: Impact of Removing the Public Acceptability and Security Metrics

Table 5-23: Results from the Deletion of the Public Acceptability and Security Metrics

Deletion of Public Acceptability & Security Metrics		Routes	Original Results	
Rank	Avg		Rank	Avg
3	19.57%	A. Barge Only	2	19.64%
2	19.64%	B. HHT Only	4	19.14%
1	24.49%	C. Rail Only (BNSF Only)	1	24.66%
4	19.31%	D. HHT + Rail at French Island	3	19.35%
5	16.99%	E. HHT + Rail at Merrillan	5	17.22%

5.5.3 Evaluation of Removal of Potential Redundant Metrics

In the assessment of the routes in **Section 5.3.3**, some of the evaluated metrics utilized the same data and hence, potentially results in double-accounting that could unfairly favor a route or routes over another route or routes. In this section, these metrics are identified and re-evaluated to prevent potential double-accounting.

The metrics using, at least partially, the same data for assessment includes:

- *Labor and Permitting Costs*, Ease of Permit Procurement, and Number of Permits
- *Cumulative Population Dose along Route*, Number of Fire Stations & Trained Personnel Nearby Route, and Number of Police Stations Nearby Route

To examine the impact of these potentially double-accounting metrics, the metrics in the above list that are in italics are kept for evaluation while the remaining metrics are first all evaluated as neutral and second having their weights zeroed out. **Figure 5-15** and **Table 5-24** provide the results for the case where all the non-italicized metrics are neutralized and shows changes to the 2nd, 3rd, and 4th ranked routes compared to the original ranking and it does decrease the separation between all the routes indicating the higher ranked routes received a boost from this double-accounting. **Figure 5-16** and **Table 5-25** provide the results for the case where all the non-italicized metrics are removed from the evaluation and again shows changes to the 2nd, 3rd, and 4th ranked routes compared to the original ranking, but otherwise shows no tangible impact to the percentage results.

In conclusion, the potential duplication of data usage in the evaluation of the matrix in this case had little impact to the ranking of the routes. In the end, the direct rail route from the La Crosse ISFSI site is robustly the highest ranked route.

Figure 5-15: Impact of Neutralizing Potentially Redundant Metrics

Table 5-24: Results from the Impact of Neutralizing Potentially Redundant Metrics

Neutralizing Potentially Redundant Metrics		Routes	Original Results	
Rank	Avg		Rank	Avg
3	19.64%	A. Barge Only	2	19.64%
2	19.89%	B. HHT Only	4	19.14%
1	23.74%	C. Rail Only (BNSF Only)	1	24.66%
4	19.36%	D. HHT + Rail at French Island	3	19.35%
5	17.37%	E. HHT + Rail at Merrillan	5	17.22%

Figure 5-16: Impact of Removing Potentially Redundant Metrics

Table 5-25: Results from the Impact of Removing Potentially Redundant Metrics

Neutralizing Potentially Redundant Metrics		Routes	Original Results	
Rank	Avg		Rank	Avg
3	19.58%	A. Barge Only	2	19.64%
2	19.87%	B. HHT Only	4	19.14%
1	24.38%	C. Rail Only (BNSF Only)	1	24.66%
4	19.25%	D. HHT + Rail at French Island	3	19.35%
5	16.92%	E. HHT + Rail at Merrillan	5	17.22%

6.0 CONCEPT OF OPERATIONS FOR RECOMMENDED APPROACH

6.1 Considerations regarding the transportation package selection

The operations associated with the de-inventory of fuel at LACBWR would consist of lease or purchase of required auxiliary equipment and ancillary systems, identification and construction of a TSC Transfer Station pad, mobilization of equipment and systems to the site, operating procedure development and LACBWR approval, equipment set-up and functional testing, development/confirmation of training program materials, training of operating personnel and supervisors, facility operational readiness review, dry run operations, de-inventory activities, transportation operations, and demobilization of equipment from the site.

Due to the complexity of these operations, the sequence of activities are divided into five groups: 1) mobilization operations (procurement/lease and delivery of required equipment to the site, and construction of the TSC Transfer Station pad and Canister Handling Facility [CHF]), construction or improvement to haul roads, installation of additional rail tracks on site to support off-site rail transport; 2) operational readiness (operating procedure and training program development, operator training, dry run(s), and operational readiness review); 3) site operations (performance of TSC transfer operations from MPC-LACBWR VCCs to NAC-STC transport casks for offsite transports); 4) heavy haul road and rail transport operations; and 5) demobilization operations of equipment and personnel from the LACBWR site.

Based on the number of MPC-LACBWR TSCs to be loaded and shipped from the LACBWR ISFSI site (i.e., 5 TSCs with SNF), the plan is to load and ship 5 NAC-STC transportation casks for the single offsite transport campaign (direct rail transport, direct barge, or heavy haul truck (HHT) to off-site rail transload) with a total of 5 NAC-STC transportation cask systems committed to the de-inventory shipping campaign. From the off-site transport review, it appears that direct off-site rail transport would be the preferred transport option with rail car loading on the extended site rail spur.

The following assumptions were used in planning this MPC-LACBWR TSC transfer, loading, and off-site shipment campaign:

1) A total of five complete NAC-STC Transport Systems, including transport cask, impact limiters, YR-MPC and LACBWR cavity spacers, intermodal transport cradles with integral tie-downs and personnel barrier, would be used for the de-inventory campaign located on a single special train system. A total of one five-cask transport for SNF would be required by dedicated train.
2) The LACBWR ISFSI site is adjacent to a main BNSF rail line and there is a current on-site spur; this on-site rail spur would need to be extended. In case barge transport is considered, the site is also adjacent to the Mississippi River and direct off-site transport by barge. Were the heavy haul option to be investigated, an off-site HHT (goldhofer) would transport the NAC-STC packages to a rail intermodal transfer location by single NAC-STC package to the selected rail intermodal transfer location for assembly of the special train or directly to the GCUS.
3) A new TSC Transfer Station pad would be required for off-loading of the TSC from the VCC into the TFR, and subsequent loading of the TSCs into the NAC-STC. The current ISFSI pad does not have sufficient space to set-up all the required equipment and casks to

effectively perform the TSC transfer operation. The location of the TSC Transfer Station pad would be determined based on the mode of off-site transport selected. If direct rail is selected, it is proposed to position the TSC Transfer Station adjacent to the on-site rail siding to limit the number of critical lifts. If barge or HHT modes of transport are selected the TSC Transfer Station would be located closer or adjacent to the current ISFSI pad. The transfer and loading of the TSCs from the VCCs to the NAC-STC transport cask would be performed in a vertical orientation.

4) The TSC Transfer Station is expected to incorporate a TFR restraint system to maintain the stability of the TFR during TSC removal from the VCC, and TSC loading into the NAC-STC. Alternatively, a single failure proof, seismically qualified gantry system incorporating an air or hydraulically operated chain hoist system for TSC lifting and lowering could be provided as discussed later in this section. The TSC Transfer Station pad would need to accommodate the CHF and/or TFR restraint system, and the weight of a loaded MPC-LACBWR VCC, loaded TFR, and NAC-STC. Estimated pad size to support the VCC, the TFR, the NAC-STC, and the required auxiliary equipment, is approximately 30 feet wide x 40 feet. The pad size could be increased as required to provide sufficient space for placement of a mobile crane or gantry crane system mounted on temporary rails, if this transfer equipment option is selected.

5) It is expected that the intermodal transport cradle mounted on the rail car could be used to upright the NAC-STCs using the NAC-STC vertical lift yoke. Alternatively, a horizontal lift beam or lifting sling system would be required to lift the loaded intermodal transport cradles off and on the railcar for positioning on the pad surface for NAC-STC off-loading and down-ending.

6) The NAC-STC packages would be provided with certification of compliance with the US NRC CoC No. 71-9235 maintenance program as specified in **Table 6-2** and Chapter 8.2 of the NAC-STC SAR.

7) New sets of inner and outer metallic O-ring seals would be required to be installed for the inner lid and inner lid vent and drain port coverplates. After replacement and re-installation following TSC loading, the inner lid and vent and drain port coverplates would require helium leakage testing to ANSI N14.5 leak-tight criteria using a helium MSLD. Additional sets of containment seals would be required in case of seal leakage test failure. Additional replacement seals would also be required for the non-containment closures provided by the outer lid, and pressure and interlid port covers. A future NAC-STC CoC amendment may delete the requirement for metallic O-rings for NAC-MPC canister shipments and authorize the use of reusable Viton O-ring containment seals.

8) Depending on the selected mode of off-site transport, all the required transfer and auxiliary equipment detailed in **Section 2.3** would be required to be procured and fabricated, and/or leased to support the loading and shipping campaign.

9) A mobile crane or gantry system would be required to lift the TFR, to remove the TSC from the VCC and load the TSC into the NAC-STC, to lift and load the NAC-STC on the intermodal transport cradle, and to lift and load the intermodal transport cradle to and from the off-site HHT and railcar, if required. Mobile crane, gantry system and/or CHF are required to meet NAC-MPC CoC TS B3.5 requirements.

10) Site operations and contingency procedures would need to be prepared to meet the NAC-MPC system and NAC-STC system CoC and FSAR/SAR requirements.

11) Site operations, health physics, quality assurance (QA) and security personnel would require training in the procedures, FSAR/SAR/CoC requirements, and auxiliary equipment. Training would include on-the-job training (OJT), and hands-on training of the equipment during equipment set-up and functional testing. Following completion of the training program, dry run(s) of the site operations, TSC transfer operations, transport operations, and intermodal transfer operations would be conducted to ensure personnel training is adequate, and that equipment and procedures are appropriate to perform the required operational sequences in a safe and efficient manner. The project activities required to be completed in preparation for the removal of SNF from the LACBWR site are summarized in **Table 6-1**.

6.1.1 Package Permits / Requirements

In order to transport SNF from the LACBWR ISFSI site in the NAC-STC, the package must meet a number of regulatory requirements. Those requirements are described in 10 CFR Part 71. Based on a preliminary review of the MPC-LACBWR TSC loaded contents and the NRC CoC for the NAC-STC (71-9235), the LACBWR site-specific fuel in storage in the 5 MPC-LACBWR TSCs meet the requirements of Paragraph 5(b)(1)(v) for Type and Form of Material, and Paragraph 5(b)(2)(vi) for Maximum Quantity of Material per Package. Prior to transport, a comprehensive review of the fuel in its current storage system and against the NAC-STC CoC and SAR is recommended to be completed to verify the requirements for shipping have been met (refer to **Section 10.0**).

Table 6-1: Activities to Prepare for and Remove SNF from LACBWR ISFSI

	Task	Task Activity Description
Programmatic Activities to Prepare for Transport Operations from a Shutdown Site		
1	Assemble Project Organization	Assemble management teams; identify decommissioned site existing infrastructure, constraints, and transportation resource needs; and develop interface procedures. Identify selected mode of off-site transport to allow requirements and locations for site improvements to be identified.
2	Acquire NAC-STCs, Hardware, Railcars, On-site HHT, Rail Routing, and Transport Services	Develop specifications, solicit bids, issue contracts, and initiate preparations for shipping campaigns; includes procurement of five NAC-STC transport packagings including impact limiters, personnel barriers, and intermodal transport cradles, NAC-STC Lift Yoke and Horizontal Lift Beam; revisions to NAC-STC Part 71 CoC and MPC Storage CoC, as required; procurement of AAR Standard S-2043 railcars; and procurement of offsite rail transportation services.

Task		Task Activity Description
3	Acquire/Lease Required Auxiliary Equipment Including Refurbished TFR, Transfer Adapter(s), Suitable HHT(s) and Prime Mover(s), and Remaining Required Auxiliary Equipment	The LACBWR site does not have any major components except the TFR and TFR lift yoke, auxiliary systems or standard tools available for performance of the required onsite operations necessary to move and unload MPC-LACBWR TSCs from the 5 VCCs and transfer the TSCs to the NAC-STC transport casks. Essentially all equipment would need to be acquired/leased and shipped to site for set-up and checkout prior to start of the training program and performance of the dry run(s). In addition, there is limited staffing at the LACBWR decommissioned site, so outside contractor crews would need to be assembled, trained, and evaluated to perform all transfer operations.
4	Prepare, Design, and Construct Required TSC Transfer Station Base Mat and Equipment in Accordance with the Requirements of the MPC CoC TSs	The final location of the TSC Transfer Station would be based on the mode of transport selected for the program. There is insufficient free space on the LACBWR ISFSI pad space for the placement of the canister handling facility and TFR restraint system and positioning of the required auxiliary equipment. A new TSC Transfer Station pad of sufficient strength and size (approx. 30 x 40 feet) to support the NAC-STC and TFR stack-up and the VCC and TFR stack-up would be required adjacent to the extended on-site rail tracks. In addition, the height of the pad would be required to be similar to the height of the LACBWR ISFSI pad to allow vertical movement of the empty and loaded VCCs using an on-site HHT off of and onto the pad, and onto and from the TSC Transfer Station pad using air pads.
5	Conduct Preliminary Logistics Analysis and Planning	Determine fleet size, transport requirements, and modes of transport for decommissioned site.
6	Coordinate with Stakeholders	Coordinate with carriers and notifications to federal and state regulatory agencies. Obtain route approval from NRC and required state agencies.

Task		Task Activity Description
7	Develop Campaign Plans (e.g., prepare, review, and approve all required site operating procedures for the TSC unloading from the VCCs and transfer/loading into the NAC-STC, preparation and testing of the NAC-STC, and procedures for all the major and auxiliary components and systems)	Develop plans, policies, and procedures for onsite operational interfaces and acceptance, support operations, and in-transit security operations. Initial drafts of the VCC handling, TFR handling, VCC/TFR stack-up, and TSC unloading operations can be prepared from procedures initially prepared during the original loading campaign. Similar procedures would be required for the auxiliary equipment including on-site heavy haul (HHT) operations for vertical movement of the VCC from / to ISFSI pad to TSC Transfer Station, transfer adapter hydraulic system operation, air pad and jack system operations, diesel powered air compressor, etc. New site procedures would be required for the handling of the NAC-STC, TSC Transfer Station operation, on-site HHT operation, proper tie-down and securing of the NAC-STC package to the railcar/intermodal transport cradle, evacuation and backfilling of the NAC-STC cavity with helium, helium leakage testing of the NAC-STC containment boundary seals, etc. All approved procedures would require review and approval by LACBWR Independent Safety Review (ISR).
Operational Activities to Prepare, Accept, and Transport from a Shutdown Site		
8	Conduct Readiness Activities (e.g., In-Processing, Badging, Training, and Dry Run(s) of All Personnel, Procedures, and Equipment and Systems	Assemble and train onsite operations interface team including readiness reviews, tabletop exercises, and dry-run operations. All new de-inventory project personnel including supervisors, riggers/cask technicians, radiation protection (RP), and QA/quality control (QC) personnel would need to be trained and qualified to perform the operating procedures in accordance with LACBWR's Training Programs per TS A 5.2 of the NAC-MPC CoC. Training would require classroom, OJT (operating required equipment), and formal Training Program Evaluation (TPE) effectiveness. All de-inventory project personnel would require training commensurate with their responsibilities and work scope on the project.
9	Load for Off-site Transport	Unload storage systems and transfer MPC-LACBWR TSCs to NAC-STCs, place loaded NAC-STCs onto intermodal transport cradles, installing impact limiters and personnel barrier, and lift onto rail transloading track or direct placement on the on-site railcar spur. Prepare required shipping papers for shipment contents for exclusive use transport.

Task		Task Activity Description
10	Accept Shipment for Off-site Rail Transport	Accept loaded NAC-STC packages on rail for offsite transportation and shipment to the final destination.

6.1.2 Operational Readiness

Prior to the performance of an Operational Readiness Review and Assessment, the assembled de-inventory project team is required to be trained and competence confirmed in all required planned site operations and contingencies. All equipment would have been delivered, assembled, and proper operation verified. Required procedures and project instructions would have been approved and issued. When all preliminary activities have been completed, the Operational Readiness Review and Assessment would be performed. This is a process used to verify facility, equipment, processes, procedures, and other critical activities have been planned and can be executed safely. It also ensures that the project team and procedures are in compliance with the applicable regulations, permits, authorizations, and agreements that are in effect for the shipment to meet regulatory, contract, and stakeholder requirements prior to commencing operations as part of a de-inventory of the LACBWR ISFSI. The following subsection will discuss the operational readiness required to ensure operations at LACBWR are ready to commence and can be performed in a safe and regulatory compliant manner.

A review of the NAC-MPC FSAR and NAC-STC SAR, and the applicable CoCs would need to be performed. This would verify the contents of the MPC-LACBWR TSCs met the required content conditions and quantities listed in the storage CoC No. 1025 Technical Specifications (TSs) and Approved Contents and the CoC. The contents form and quantity of the MPC-LACBWR TSCs would require verification for compliance with the current revision of CoC 71-9235 for the NAC-STC system at the time of shipment.

Operations management would ensure readiness from a quality, safety, and operational perspective. Management assessments of these processes would determine readiness. This assessment would include verification of the roles and responsibilities between the different organizations involved with and performing the work. Communications between the stakeholders, review and approval of procedures, and interfacing with regulators must occur to ensure the processes to execute work have been reviewed and all agree on readiness to start work. Based on the preface for these reports, any DOE shipments would be subject to the same requirements as a commercial shipper of SNF, NRC is assumed to be involved in the initial routing approval and those approved routes would be in place and valid for 5 and 7 years as indicated and described above.[10] Once route approval is granted, advanced notification would be provided prior to the single shipment.

As required by the NAC-MPC TSs, a training program would be required to be implemented for all project personnel with the extent of training required for each individual/project position. The

[10] NRC route approval is not typically required for DOE shipments; however, for purposes of this report, it is assumed that the shipments would be conducted like comparable commercial shipments.

training program would require a qualified trainer to oversee and conduct the training with NAC-MPC operationally qualified personnel to perform the OJT and TPE portions of the training program. The training program would include the following requirements and elements:

Classroom Training:

- Module 1 – NAC-MPC and NAC-STC Systems Overview
- Module 2 – TFR and Transfer Adapter Operations
- Module 3 – MPC-LACBWR VCC Handling and Movement
- Module 4 – On-site HHT Operations (including prime mover, hydraulic jacks, air pad, air compressor, and telescope handler/vehicle operations)
- Module 5 –TSC Unloading Operations from VCC
- Module 6 – NAC-STC Handling and Loading Operations
- Module 7 - NAC-STC Intermodal Transport Cradle Tie-Down and Transloading Operations
- Module 8 – Preparation of NAC-STC for Transport
- Module 9 – NAC-STC Containment O-Ring Helium Leakage Testing
- Module 10 – Use of Measuring and Test Equipment (M&TE)
- Module 11 – Radiological Concerns and ALARA Planning
- Module 12 – Regulatory Requirements
- Module 13 – Supervisor Training
- Module 14 – Contingency Procedures

OJT:

- OJT-1 – Perform Pre-Use Inspections (VCC, TFR, NAC-STC)
- OJT-2 – Perform Periodic Inspections (VCC, TFR, NAC-STC)
- OJT-3 – Prepare a VCC and TFR for Stack-up and TSC Transfer
- OJT-4 – Off-Load Empty NAC-STC from Rail Car / Intermodal Transport Cradle
- OJT-5 – Perform TFR Stack-up and TSC Unloading from VCC
- OJT-6 – Perform NAC-STC and TFR Stack-up for TSC Transfer
- OJT-7 – TSC Loading into NAC-STC
- OJT-8 – Movement of VCC to/from ISFSI/TSC Transfer Station
- OJT-9 – NAC-STC Inner Lid Installation and Torquing, and Cavity Evacuation, Backfill, and Helium Leakage Testing
- OJT-10 – NAC-STC Outer Lid and Pressure/Interlid Port Cover Installation and Leakage Testing

- OJT-10 – Perform Loaded NAC-STC Package Down-ending and Preparation for Transport
- OJT-11 – On-site and Off-site HHT Operations
- OJT-12 – Operate Telescoping Handler and VCC Restraint
- OJT-13 – Operate Diesel Air Compressor, Hydraulic VCC Jacks, and Air Pad Systems
- OJT-14 – Onsite and Off-site Intermodal Transport Cradle Handling Operation

At the completion of the classroom training and OJT elements, operations supervisors would perform TPE for applicable project personnel to confirm the adequacy and effectiveness of the training prior to final training certification.

Operational dry runs with a TSC mock-up to perform the NAC-STC loading operation would be conducted at the LACBWR ISFSI site. Due to a lack of an empty VCC on site, it would be impractical to perform a full dry run of the TSC unloading from a VCC process. However, the actual equipment can be properly positioned and manipulated up to the point of actually withdrawing a TSC to confirm procedures, training and equipment interfaces, fit-up and function.

Communication and interfacing with the applicable stakeholders would be needed to ensure readiness. This would include, but would not be limited to, LACBWR and DOE, and State authorities. In addition, the NRC on-site and Region III inspectors would observe and provide regulatory oversight throughout the entire preparation, construction, and training/dry run program. Some entities would need to be involved in all aspects of the project, i.e., planning, development of concepts, training, readiness approval, and performing oversight on any dry run operations. This would include reviewing procedures and possibly performing audits/assessments to ensure operational readiness. As an additional readiness verification, an independent team of dry cask storage and transport experts would review applicable operational procedures and equipment design/function prior to initiation of the transfer program. As a last step prior to start of operations, a final dry run would be performed as specified in the NAC-MPC CoC TSs and witnessed by DOE, NRC and stakeholders. Additionally, and as applicable, these entities would be involved in event response planning and mitigation, including contingency event training, to ensure that any event is well managed and mitigated prior to the first shipment of the campaign. This would encompass approvals to start work, training, and interaction with state and local authorities. It is assumed that LACBWR, NRC, and DOE would participate as observer/regulator for shipment.

6.1.3 Site Operations

Prior to each MPC-LACBWR TSC transfer sequence encompassing the following major evolutions: loaded VCC retrieval and movement to the TSC Transfer Station; VCC/TFR stack-up and TSC extraction into the TFR; up-righting the NAC-STC from the transport cradle; movement and positioning of the vertical NAC-STC at the TSC Transfer Station; removal of the NAC-STC outer and inner lids and placement/verification of the YR-MPC and MPC-LACBWR transport cavity spacers; placement of the NAC-STC adapter ring and transfer adapter on the NAC-STC; lifting and movement of the loaded TFR from the VCC to the NAC-STC; transfer of the loaded TSC into the NAC-STC; removal of the TFR, transfer adapter and adapter ring from the NAC-STC; installation of the NAC-STC inner lid with new metallic O-ring seals and torquing of the inner lid bolts; evacuation and helium backfill of NAC-STC cavity; installation of vent and drain port covers with new metallic O-ring seals; performance of the inner lid and vent and drain port cover plate containment O-ring helium leakage tests; and movement and down-ending of the loaded NAC-STC on the intermodal transport cradle. Auxiliary equipment associated with the transfer would need to be staged, inspected, and prepared for the transfer operation. Based on review of the ISFSI at LACBWR, **Section 2.0**, Pertinent Site Information, additional room would be required to stage the equipment for the transfer operation and to place the equipment at the TSC Transfer Station.

As noted in **Section 2.1**, it is estimated that a TSC Transfer Station pad of approximately 30 x 40 feet, elevated to approximately 27 inches, would be required to be constructed within the LACBWR site perimeter. The TSC Transfer Station pad could optimally be located adjacent to the extended on-site rail tracks to allow for direct positioning of the NAC-STC casks from the rail cars / transport cradle. At the TSC Transfer Station pad, a CHF or rail-based gantry crane system would be required to meet the criteria specified in Section B 3.5 of the NAC-MPC TSs, and any stationary or mobile crane utilized to lift and handle the loaded TFR and NATC-STC must meet the requirements of TS B 3.5.2.1.3 or B 3.5.2.2, respectively. In addition, if a stationary crane is not single-failure-proof, an impact limiter is required to ensure a TSC drop does not breach the canister (MPC-LACBWR TSC).

An alternative to the location and use of mobile cranes for MPC-LACBWR TSC transfer from the VCC into the TFR and loading into the NAC-STC would be to design and deploy a seismically qualified, single-failure-proof gantry system with lifting slings provided with an integral hydraulic or air-powered chain hoist system. This system would allow the direct movement of the loaded TFR from the top of the VCC to the top of NAC-STC cask for TSC transfer without the need to set down the TFR on the pad surface, with the TSC raised and lowered by the chain hoist with the TFR maintained attached to the lift slings. A similar system is currently being deployed at the Taiwan Power Company's Kuosheng Nuclear Station in Taiwan for the loading of MAGNASTOR BWR VCCs and a Secure Lift System (no gantry) with integral chain hoist was utilized successfully for MAGNASTOR TSC transfer and loading operations at Dominion's Kewaunee Nuclear Station. Such a gantry and integrated chain hoist system would be able to be disassembled and moved to other sites for de-inventory operations. The system would also be adaptable to other storage and transport cask system designs. The use of the gantry and chain hoist system would meet the requirements of the NAC-MPC TS B 3.5 for a CHF.

Prior to the start of any MPC-LACBWR TSC transfer operation or NAC-STC cask handling evolution, a pre-job brief with the operations staff would be conducted to review procedures, verify training of staff, discuss any safety/quality-related concerns and practices, RWP requirements, dose and dose rate expectations, planned RP coverage, ALARA practices, and verify adequate personnel and equipment resources are available to successfully support and complete the planned evolution(s). All work performed would be conducted by procedure, as required by the conduct of operations practices. Stop work authority would be implemented into the working culture to ensure safety and quality of any operation is achieved. Operations management would verify that the NAC-STC has a certification of conformance with all required cask maintenance and testing as specified in **Table 6-2**.

Prior to commencing MPC-LACBWR TSC transfer operations, the primary and auxiliary equipment and services would be configured and positioned as follows:

- Position the HHT adjacent to the VCC to be moved to the TSC Transfer Station with hydraulic jacks extended to raise level of HHT to pad and install aluminum channels under the main HHT beams fore and aft and install wheel chocks. Install bridge plates between pad and HHT deck to facilitate air pad operation. (Note: This step and as follows may be modified if VCC can be moved directly for its storage position to the TSC Transfer Station without the need to leave the ISFS pad. This movement would only require the use of the hydraulic jacking system, air pads and suitable tow/pushing vehicle).

- Position the JCB or similar telescopic boom handler with VCC restraint adjacent to the HHT on the outward side away from the VCC.
- Extend the boom across the bed of the HHT and engage to the VCC.
- Install hydraulic jacks in the four VCC inlet vents ready to raise the VCC off the pad surface.
- Position the four sections of air pads around the VCC for insertion under the VCC when it is raised by the jacks.
- Position the primary mobile crane, if used in lieu of a stationary crane or gantry system (see **Section 10.0**), to be located such that it would be able to reach the overpack down-ending area and the railcar/transport trailer/transport cradle.
- Locate the intermodal transport cradle, with securement straps removed, in the down-ending area either on the off-site HHT (goldhofer) or on the ground.
- Locate the secondary mobile crane intended to be used for lifting the transfer adapter, adapter ring, man-lift, VCC and cask lids adjacent to the transfer pad.
- Position the vacuum pump, leak test system and helium supply on the TSC Transfer Station pad. Also position temporary storage stands for the placement of the VCC lid and NAC-STC outer and inner lids on the pad or directly adjacent to the pad.
- Equipment at the ISFSI pad would include the telescoping hauler and VCC restraint system, VCC jacks, air pads, and diesel air compressor. (*Note: a second air compressor would be required at the Transfer Station if station is not located at the ISFSI extended pad).*
- Once the transfer equipment is staged and ready, the onsite HHT (or air pads alone) would be used to move the first loaded VCC from the ISFSI pad to the TSC Transfer Station. Jacks would be used to lift the VCC off the pad, the air pads would be installed under the VCC baseplate, the VCC lowered onto the pads by the jacks, and the jacks removed. The telescoping hauler would be extended over the HHT and the VCC restraint system attached to the VCC, the air pads activated, and the telescoping hauler then would pull the VCC from the pad onto the HHT. The air pads would be deflated and left in place and VCC restraint removed. The HHT and telescoping hauler would be driven to a position adjacent to the TSC Transfer Station, and the HHT would be prepared for off-loading of the VCC onto the pad. The telescoping hauler would be reattached to the VCC, the air pads re-inflated, and the VCC maneuvered onto the pad. The air pads would then be deflated, and the VCC restraints removed. The work platform(s) would be placed around the VCC, and the VCC lid bolts removed.

Table 6-2: Maintenance Program Schedule

Task	Frequency
Cavity Visual Inspection	Prior to Fuel Loading
Basket Visual Inspection	Prior to Fuel Loading
O-ring Visual Inspection	Prior to Fuel Loading
Outer Lid, Inner Lid and Port Coverplate Bolt Visual Inspection	Prior to installation during each use
Radial Neutron Shield Shell Visual Inspection	Prior to Fuel Loading
Cask Visual and Proper Function Inspections	Prior to each Shipment
Lifting and Rotation Trunnion Visual Inspection Liquid Penetrant Inspection of surfaces and accessible welds	 Prior to each Shipment Annually during use
Maintenance Periodic Leakage Rate Test of Inner Lid and Port Coverplate O-rings	For Viton O-rings, annually or when replaced. For metallic O-rings, prior to each loaded transport.
Preshipment Leakage Rate Test	Prior to loaded transport for casks with Viton O-rings
Transport Impact Limiter Visual Inspection	Prior to each shipment
Quick-disconnect Inspection for Proper Function	 During each Cask Loading/Unloading Operation
Quick-disconnect Replacement	Every two years during transport operations
Metallic O-ring Replacement	Prior to installation for a loaded transport
Viton O-ring Replacement	Annually, or more often, based on inspections during use or leakage test results
Inner and Outer Lid Bolt Replacement	Every 240 bolting cycles (Every 20 years at 12 cycles per year)
PTFE O-ring Replacement	Every two years during transport operations or as required by inspection

Task	Frequency
Periodic Leakage Rate Test	Performed within 12 months prior to each shipment for containment boundary Viton O-rings. No testing needed for out-of-service packaging or for casks provided with containment boundary metallic seals as metallic seals are replaced and maintenance leakage tested during each loading operation.
Post-Fabrication Thermal Test	Performed after a cask experiences an adverse event such as fire, drops or impacts that result in obvious damage to the neutron shield. The cask will need to pass the pre-fabrication thermal test prior to being used in a subsequent fuel transport.

The next operational sequence would be to off-load an empty NAC-STC from the off-site HHT (goldhofer), if not planned for later in the operational sequence. First, the empty cask would be visually inspected for any transport or handling damage and then surveyed to determine if there is any radiation/contamination. The personnel barrier would be removed and stored using the secondary mobile crane. Next, the front and rear impact limiters would be unbolted, removed, and stored in a protected area to prevent any damage to the stainless-steel shells. The cask front tie-downs would be removed and stored. A visual inspection of the primary lifting trunnions would be performed to inspect for any damage or galling. Any road dirt and previous labels would be removed from the cask's surfaces. The primary mobile crane would then be connected to the NAC-STC lift yoke and the lift yoke engaged to the two primary NAC-STC lifting trunnions. The crane and lift yoke would then upend the NAC-STC by lifting from the front to rear while maintaining the center of gravity of the cask under the crane lift point while rotating the cask on its rear trunnions.

Alternatively, at the discretion of site operations management and handling equipment available, the horizontal lift beam would be used to off-load the NAC-STC on the intermodal transport cradle with the impact limiters and tie-downs still installed. Once positioned on the ground, the detailed up-righting operations described above would be performed to prepare and upright the NAC-STC in preparation for movement to the Transfer Station pad. Once in a vertical orientation, the NAC-STC would be lifted from the intermodal transport cradle and placed in position at the Transfer Station adjacent to the loaded VCC.

Once the NAC-STC is in position on the TSC Transfer Station pad, a complete visual inspection of the cask surfaces and components would be performed to verify the correct assembly of the cask. Using the man-lift and/or work platforms, personnel would access the top of the cask to inspect the outer lid, outer lid bolts, pressure and interlid port covers, bolting, and leak test port plugs. The outer lid bolts are then removed, inspected for thread damage, and stored, and the outer lid alignment pins installed. The four-point lifting sling is then installed to the outer lid lifting threaded holes and the outer lid is lifted and removed. The outer lid is stored to protect the O-ring which is inspected for damage, and the outer lid alignment pins removed. This non-containment O-ring is replaced if required.

The vent port coverplate bolts (captured) and coverplate would be removed to access the cask cavity and a pressure and gas sampling system connected to measure cask cavity pressure and cavity gas radioactivity levels (as determined by site). The cask cavity would then be vented to atmosphere through a HEPA filter set (also used during evacuation of the cask cavity following TSC loading connected to the exhaust of the vacuum pump). The vent port coverplate and bolts would be inspected for damage, corrective actions taken as required, and then they would be stored to prevent loss or damage. Prior to re-installation, new metallic O-rings would be installed in the vent port coverplate. The inner lid bolts would then be de-torqued in the numbered sequence of the bolts as stamped on the cask lid, and the two inner lid alignment pins installed in the bolt holes identified as guides. The inner lid bolts would be inspected for any damage and damaged bolts replaced with authorized spares and stored to prevent loss or damage. The inner lid lifting rig set would then be attached to the four lift designated holes using swivel hoist rings connected to the secondary mobile crane. The inner lid is lifted, removed, and stored in a location to protect the O-ring grooves. Prior to inner lid re-installation, the two inner lid metallic O-ring seals would be replaced. Following the inner lid removal, an inspection of the inner lid containment boundary seating surface is performed. Finally, prior to insertion of a MPC-LACBWR TSC, the installation of the YR-MPC and LACBWR lower cavity spacers would be performed. Two lower spacers and one upper cavity spacer would be required for all MPC-LACBWR TSC loading operations. Prior to the empty return shipment, the YR-MPC and MPC-LACBWR cavity spacers would be removed during off-loading of the TSC and returned to the NAC-STC owner/operator in an IP-1 package for use in future applicable transports. After the spacer installation, the cask adapter ring is lifted, installed in the inner lid seating surface, and bolted in place. The adapter is provided to interface with the TFR transfer adapter plate and to provide additional shielding during the loading of the TSC into the NAC-STC.

The secondary mobile crane would be placed into position for removal of the VCC lid. The secondary mobile crane would then be used to lift and place the transfer adapter on the top of the VCC. Once the VCC Lid is removed, the radiation dose from the TSC and the VCC/TSC annulus would increase significantly. After this point in the operation and through the extraction of the TSC from the VCC, radiation streaming is to be expected and may be significant. As Low As Reasonably Achievable (ALARA) considerations would need to be accounted for during these operations, and radiation levels monitored and controlled. The TSC lift rigging sets would be installed in the six lifting threaded holes on the TSC structural lid (or the TSC Lift Adapter Plate bolted to the TSC structural lid to connect to the Secure Lift Yoke Chain Hoist System). If installed, threaded hole plugs would be removed. The primary mobile crane or CHF crane with a TFR Lift Yoke (or seismically qualified Gantry System Secure Lift Yoke and Integral Chain Hoist System) would then be used to lift and place the empty TFR with retaining ring installed in position on the transfer adapter positioned on the top of the VCC. Prior to removal of the lift yoke from the TFR trunnions, the TFR restraint system would be installed or attached depending on the restraint system design, if required. (Note: A TFR restraint system and a CHF or primary crane would not be required if a seismic gantry/secure lift yoke/chain hoist system is not utilized. In addition, the lift yoke/slings would not be required to be disconnected from the TFR trunnions).

The system would now be ready for removal of the shield door lock pins, opening of the shield doors using the auxiliary hydraulic unit for the retrieval of the TSC redundant lifting sling sets and connection to the crane hook using long reach tools and tag lines with personnel access provided to the top of the TFR by use of the man-lift.

The next operational sequence is the lifting of the MPC-LACBWR TSC from the VCC using the crane system into the TFR until the top of the MPC-LACBWR TSC is lifted to just below (< 1 inch) the retaining ring. The retaining ring is designed to prevent the unauthorized extraction of a loaded TSC from the TFR and the retaining ring is structurally designed to take the entire weight of the loaded MPC-LACBWR TSC and TFR without failure. However, caution should be used to ensure that the top of the TSC does not engage the retaining ring. Once the MPC-LACBWR TSC is in the TFR, the auxiliary hydraulic system is used to close the shield doors and the MPC-LACBWR TSC is lowered to rest on the doors. During the TSC transfer operation, radiation dose rates are expected to be high at the TFR to adapter plate interface and through gaps in the shield door to TFR openings. Also, once the MPC-LACBWR TSC is in the TFR dose rates on the TFR surface would be higher than the dose rates from a loaded VCC. It should be noted that there may be residual removable contamination on the exterior surfaces of the MPC-LACBWR TSC as allowed by NAC-MPC TS Limiting Condition of Operation (LCO) A.3.2.1, which allows up to 10,000 dpm/100 cm^2 from beta and gamma sources, and 100 dpm/100 cm^2 from alpha sources. The residual removable contamination is a result of use of filtered SFP water in the annulus flush water during in-pool SNF loading operations. Although the TS establishes maximum limits, a significant majority of the MPC-LACBWR TSCs had less than 2,500 dpm/100 cm^2 beta/gamma contamination in surveys performed during TSC closure and transfer to VCC for storage. Few if any had contamination exceeding 5,000 dpm/100 cm^2. It is expected that weathering will have significantly reduced the residual contamination prior to the de-inventory project. However, contamination control practices would be required to be observed during MPC-LACBWR TSC handling and transfer operations to the NAC-STC transport cask. It is expected that interior surfaces of the NAC-STC and TFR may potentially pick up minimal contamination during the MPC-LACBWR TSC transfer and loading operations. The potential contamination of the interior of the NAC-STC cavity would not exceed the allowable contamination limits specified for an empty radioactive return shipment per 49 CFR 173.428.

Once the shield doors are closed and the door lock pins installed, the lifting slings would be detached from the crane hook and lowered to rest on top of the MPC-LACBWR TSC. The crane would then be used to retrieve the TFR lift yoke, which would then be engaged to the TFR lifting trunnions to lift and remove the TFR from the top of the VCC and be placed in a temporary storage area after removing the TFR restraint system. The secondary crane would then be used to remove the transfer adapter. It is recommended that a second transfer adapter be utilized to allow the immediate movement of the loaded TFR from the top of the VCC to the NAC-STC without the need to set the TFR down on the pad. At an appropriate point in the operations evolution, the empty VCC movement to the designated ISFSI position or designated storage area would be performed using the air pads and/or HHT, and telescoping handler to return the empty for future decommissioning. Due to limited area of the ISFSI pad for retrieval of loaded VCCs, it may be appropriate to consider moving the empty to a separate temporary pad for temporary storage prior to decommissioning. This pad may be located outside of the security fence as the VCC would now be empty and not under the security conditions of 10 CFR Part 72.

As an operational alternative sequence, with the use of a seismically qualified gantry system, the VCC and NAC-STC could both be positioned adjacent to each other with access to raise or lower the MPC-LACBWR TSC provided by the gantry system incorporating a chain hoist system. In this operating scenario, two transfer adapters are required so that the TFR containing the TSC can be moved directly from the top of the VCC to the top of the NAC-STC without the need to place the loaded TFR on the pad surface. A single hydraulic operating system with separate sets of hoses connecting to the two-transfer adapter operating cylinders would be used to operate the TFR shield doors. The seismically designed gantry system would also eliminate the need to provide a separate CHF TFR restraint system, as the TFR and MPC-LACBWR TSC would always be under the control of the gantry. A separate air-operated or hydraulic100-ton chain hoist suspended from the gantry would be used to lift and lower the MPC-LACBWR TSC from the VCC and to the NAC-STC, respectively.

In preparation for the MPC-LACBWR TSC loading into the NAC-STC, the primary mobile or CHF crane or gantry system is then used to lift and install the loaded TFR on top of the NAC-STC/transfer adapter ensuring the adapter's female connectors engage with the male connectors of the shield door. The auxiliary hydraulic system would then be connected to the adapter hydraulic cylinders. Prior to disengaging the TFR lift yoke, the CHF TFR restraint system would be installed and/or positioned to restrain the TFR under seismic events. The primary mobile crane is then connected to the TSC redundant lifting sling sets by manually retrieving the sling set from the top of the TSC and installing the master link to the crane hook with access to the top of the TFR using a man-lift. The sling set is then used to raise the MPC-LACBWR TSC approximately 1 inch off of the shield doors. The shield door lock pins are removed and the shield doors opened. The primary mobile, CHF crane, or gantry system is then used to slowly lower the MPC-LACBWR TSC into the NAC-STC cask cavity. During the MPC-LACBWR TSC transfer operation, radiation dose rates are expected to be high at the TFR to adapter plate interface and through gaps in the shield door to TFR openings. Once the TSC is fully down in the NAC-STC cavity resting on the YR and LACBWR transport spacers, the sling set would be removed from the crane hook and lowered through the TFR annulus to rest on top of the MPC-LACBWR TSC. The TFR shield doors are then closed, and the door locks installed, and the crane and TFR lift yoke would be engaged to the TFR trunnions for the lifting and removal of the TFR from the NAC-STC. The TFR is then lifted off the NAC-STC and set down and staged for the next MPC-LACBWR TSC unloading sequence from the next loaded VCC.

Operators would then access the top of the NAC-STC to remove the TSC lifting slings and hoist rings from the six lifting threaded holes (or the TSC Lift Adapter and bolting) and the four bolts attaching the transfer adapter to the cask adapter ring. Then, using the transfer adapter sling set and the secondary crane, they would remove the transfer adapter and TSC sling set and place them in storage for the next VCC unloading sequence. Ensure that the MPC-LACBWR TSC structural lid plugs are not re-installed in the six holes, as their installation in the TSC structural lid are not authorized for transport. To complete the MPC-LACBWR loading for transport, the two upper cavity spacers are installed on top of the TSC's structural lid.

Next, the cask adapter ring is unbolted and attached to slings and removed using the secondary crane. A visual inspection of the cask seal seating surface is performed and any dirt or debris is removed using a soft cloth. The inner lid alignment pins are installed in the designated holes and the cask inner lid provided with new metallic O-ring seals is lifted using the secondary crane and inner lid sling set and installed in the lid recess using the alignment pins to appropriately align the lid to the lid bolt holes. Once the lid is fully seated, remove the alignment pins and install the 42 lid bolts lubricated with Never-Seez or equivalent, and using the bolt torquing device, torque the lid bolts in the indicated numbered sequence stamped on the lid in complete three passes to a final torque of 2,540 ± 200 ft-lbs (e.g., 825 ft-lbs, 1,650 ft-lbs, 2,540 ft-lbs).

After the inner lid is secured, a vacuum pumping and helium backfill system would be connected to the vent port and the cask cavity evacuated to a vacuum pressure of ≤ 3 torr. Without breaking the connection to the vent port, the cask cavity is then backfilled with high-purity helium (≥ 99.9%) to 1 atm (absolute) pressure. The vacuum pumping and helium backfill system is then disconnected from the vent port quick disconnect fitting. The vent port sealing surface is then inspected and cleaned, as necessary, and the vent port coverplate installed with new metallic O-ring seals. The four coverplate bolts lubricated with Never-Seez or equivalent are then torqued to a final torque of 300 ± 20 in-lb. If the current test and O-ring status of the drain port coverplate is unknown, it is recommended in the latest NRC guidance on ANSI N14.5 practices[27] that the port coverplate be removed, the O-ring grooves and mating seating surfaces inspected and cleaned, and the port coverplate re-installed and torqued to a final torque of 300 ± 20 in-lb.

Final helium leakage testing of the three inner lid cask containment boundaries (e.g., inner lid seals, and vent and drain port coverplate seals) would then be performed using a helium MSLD system to confirm that each containment boundary closure is leak-tight in accordance with ANSI N14.5-1997 to a leakage rate of ≤ 2 x 10^{-7} cm^3/s, helium with a minimum sensitivity of 1 x 10^{-7} cm^3/s, helium. Following successful leakage testing, the MSLD would be removed from each component and the leak test port plug would be re-installed with a new O-ring seal and tightened to the designated torque (e.g., inner lid test port plug to 30 ± 3 ft-lbs; port coverplate test port plug to 70 ± 5 in-lbs.).

The next operational sequence to prepare the NAC-STC cask is to install the outer lid alignment pins and install the outer lid with a new metallic O-ring seal to the cask's upper forging. Remove the two alignment pins and install the 36 outer lid bolts lubricated with Never-Seez or equivalent and torqued to a final torque of 550 ± 50 ft-lbs. Attach a supply of air, nitrogen, or helium to the interlid port quick-disconnect and backfill the interlid volume to 15 (+2, -0) psig air, nitrogen, or helium and hold for 10 minutes. No loss of pressure is permitted during the 10-minute test period. Disconnect air, nitrogen, or helium supply. Detach pressure drop test equipment and reinstall the interlid port cover and torque the bolts to 140 ± 10 in-lbs. Remove the interlid port cover test plug and pressurize the interlid port cover O-rings to 15 (+2, -0) psig air, nitrogen, or helium and hold for 10 minutes. No loss of pressure is permitted during the 10-minute test period. Remove the pressure drop test equipment, vent off the test gas, re-install test plug, and tighten the port plug to 70 ± 0.5 in-lbs.

The NAC-STC containment boundary provided by the inner lid closures and secondary boundary provided by the outer lid and port covers is now verified as properly closed and leakage tested.

Following final leakage testing, decontamination of the cask external surfaces would be performed. A visual inspection of the primary trunnion and rotation trunnion recess bushings for general condition and lubrication would be performed, with corrective actions as required. Using the primary mobile crane connected to the NAC-STC Lift Yoke, the NAC-STC primary trunnions would be engaged and the loaded cask removed from the CHF. The cask would need to be moved over to the off-site goldhofer HHT provided with an intermodal transport cradle (or the intermodal transport cradle positioned on the ground) and the NAC-STC lowered until the rear trunnion recesses are seated into the cradle's rear rotation trunnions and fully engaged. Taking precaution to maintain the cask's center of gravity over the centerline of the cranes load path, the NAC-STC would be slowly lowered and rotated into a horizontal position on the intermodal transport cradle. (Note that the rear trunnion recesses are off-set from the cask centerline to assist in correct down-ending). If the cask is loaded on the intermodal transport cradle located on the ground or at the Transfer Station pad, a specially designed horizontal lift beam can be used to horizontally lift the loaded NAC-STC/intermodal transport cradle and place it on the off-site HHT or rail car. The

NAC-STC lift yoke would be disengaged and placed in a protected storage area in preparation for the next NAC-STC handling sequence.

Once the cask is in the horizontal position, final removable contamination surveys can be taken for areas to be covered by the front and rear impact limiters. The cask tie-down assembly is installed between the top neutron shield plate and the trunnions and engaged to restrain the cask in a vertical orientation. Using the secondary mobile crane and the impact limiter sling set, the front/upper impact limiter is lifted and installed to the lid end of the cask. While maintaining the impact limiter weight on the crane, the 16 impact limiter retaining rods are installed and torqued to 75 ± 5 ft-lb. The 16 impact limiter nuts are installed and torqued to 35 ± 2 ft-lb followed by the impact limiter jam nuts torqued to 75 ± 5 ft-lb. The crane and sling set are then disengaged from the front impact limiter and the impact limiter installation operation would then be repeated for the rear/lower impact limiter. To provide evidence of tampering during transport, security seal wire and tamper indicating devices can be installed between the front impact limiter and the primary trunnion or intermodal transport cradle. If required, the intermodal transport cradle horizontal lift beam is used to lift and place the loaded intermodal transport cradle containing the assembled NAC-STC package on the final transport conveyance.

Final radiation surveys are then performed with dose rates taken at the cask surface, 1 meter from the cask surface and 2 meters from the vertical plane of the transport conveyance. The maximum dose rate at 1 meter from the cask is defined as the transport index. All dose rates and contamination surveys must comply with applicable DOT regulations. The appropriate Criticality Safety Index assigned to the package contents should be determined in accordance with the CoC and indicated on the Fissile Material labels applied to the package. The personnel barrier is then installed and bolted to the transport cradle and the barrier access port is padlocked closed. Appropriate placards are applied to the transport vehicle in accordance with DOT regulations. The final shipping documentation is then completed by the transport specialist including instructions to the carrier regarding the required Exclusive Use Shipment.

6.1.4 Transport Operations

6.1.4.1 Special Permit Requirements

There are no required permits for transporting the loaded transportation casks from the LACBWR ISFSI to the recommended, on-site rail transload location. In order to move the loaded train from the site, the shipper would be required to obtain the following:

- A formal clearance submission would be made to the originating Class I rail carrier. For the purposes of this project, the goal is to deliver the overpacks from the LACBWR ISFSI to the Class I rail carrier, BNSF, which would clear the entire route with all participating railroads.
- For the purposes of this report, it is assumed that DOE would be the shipper and that the shipments would be conducted by commercial carriers like comparable commercial shipments. Although typically not required for DOE shipments, for purposes of this report, it is assumed that DOE would file an application with the NRC for an approved rail route from La Crosse to the identified destination. DOE Order 460.2B[50] provides information on the management of DOE materials transportation and packaging.

Note: a formal clearance submission is required for all dimensional shipments on all railroads involved in the full route. With loading at the recommended track location within the LACBWR, the clearance will be submitted to BNSF for the rail movement and it will clear the entire route to the final destination, in this case to the GCUS.

Each Class I rail carrier has a formal procedure for clearance submissions, and all are electronically filed. Some require a fee to accompany clearance submissions and some do not. At this time, BNSF does not require a fee for conducting the clearance evaluation. The following components must be present in each clearance submission:

1) Identification of the origin, the destination, the standard transportation commodity code, the shipper, receiver, and associated serving carriers, and the route (including interchange locations for the requested route).
2) Identification of the specific railcar to be used for the shipment.
3) All dimensions of the loaded unit on the railcar, which depict a profile of the loaded unit and car together. These should also include:
    a) A diagram of offsets, ballasts, or any other loading configuration specifics important to the railcar.
    b) Center of gravity measurements and total weight of the unit plus the railcar.
4) A diagram of the unit with actual placement on the selected railcar.

The more specific the information provided in the clearance submission, the better the chance of clearance acceptance. The above submission requirements are considered a minimum. Some railroads require additional information for clearance acceptance. The AAR Open Top Loading Rules delineate what must be submitted for acceptance at interchange between carriers.

Note: requirements may be relaxed if movement is restricted to only one railroad and is not subject to interchange with another carrier. This also applies to loading and securement configurations. However, with HAZMAT, the relaxation of these requirements is not expected nor anticipated principally for safety reasons.

Furthermore, it is recommended that more than 6 months are allotted for the railroad clearance submission process in the event the intended routes have not been approved for previous shipments and the approval process takes longer than anticipated. This recommendation is based on extensive experience in obtaining super-load permits for movements of similar weight and dimensions and HAZMAT (Class 7) shipments. Once the railroad cleared route is approved by NRC, it would be valid and effective for 7 years for rail routes. The NRC would approve routes for a period of 5 years for combination routes (truck-to-rail siding, transloading, and rail to destination). The minimum amount of time to submit cleared routes to the NRC for approval is 90 days; however, it would prefer 6 months.

Once the rail route is cleared by all involved railroads, the clearance is valid for 6 months for railroad purposes and should the campaign take longer than 6 months, the clearance must be resubmitted. The clearance ensures that the loaded dimensions and weights of the transportation cask and railcar (in this case the train) would traverse the railroad route without any impediment. It would need to be resubmitted after 6 months to ensure no changes have taken place on the rail route that would affect the ability for the dimensional load to pass the route safely without striking anything (tunnels, bridges, trestles, signals, silos, or any structure that may be close to the track), including taking into consideration other dimensional traffic moving in the same lane. For practical purposes, an extension could be granted until the shipping campaign is completed if the six months expires before the campaign has concluded.

Any time a route condition changes or needs to be altered on an approved route, the shipper must notify the NRC and submit an amendment.

Road permits would be required for movement of the cranes and other equipment to LACBWR to be used for lifting or transloading the transportation casks onto the rail cars. The permits would also dictate the requirement for private escorts (not the security team) and State Police escorts for both the mobilization and demobilization efforts of the equipment to be used in the on-site operations. These escorts are separate than those required by the regulations for LLEA for safety and security purposes.

In addition to the equipment moving to LACBWR for the on-site transload, any oversized equipment like cranes, would require road permits from the leasing location to travel over the road for use in the rail transload facility and ISFSI. Depending on the size of the crane, private escorts and State Police escorts likely would be required in accordance with the road permits for the States and jurisdictions that the trucks would travel through to reach the site.

6.1.4.2 Coordination with Mode of Transport

This section provides a description of activities necessary to coordinate with the site owners in preparation for the transport activities. The actions necessary to prepare for and remove the SNF from LACBWR are listed as tasks in **Table 6-3**. These identified actions are based on the assumption that DOE, or another management and disposal organization would be responsible for shipping to and operating the consolidated interim storage facility or repository. Based on these tasks, the characteristics of the site's inventories of SNF, the onsite conditions, the near-site transportation infrastructure and experience, time sequences of activities, and time durations were developed to prepare for and remove the loaded transportation casks.

Table 6-3: Transport Related Activities to Prepare and Remove SNF from LACBWR ISFSI

Task		Task Activity Description
Programmatic Activities to Prepare for Transport Operations from a Shutdown Site		
1	Assemble Project Organization	Assemble management teams, identify shutdown site existing infrastructure, constraints, and transportation resource needs and develop interface procedures.
2	Acquire Casks, Railcars, Ancillary Equipment and Transport Services	Develop specifications, solicit bids, issue contracts, and initiate preparations for shipping campaigns. Includes procurement of transportation casks and revisions to CoC as may be needed, procurement of AAR Standard S-2043

Task		Task Activity Description
		railcars, and procurement of off-site transportation services.
3	Conduct Preliminary Logistics Analysis and Planning	Determine fleet size, transport requirements, and modes of transport for shutdown site.
4	Coordinate with Stakeholders	Assess and select routes and modes of transport and support training of transportation emergency response personnel.
5	Develop Campaign Plans	Develop plans, policies, and procedures for at-site operational interfaces and acceptance, support operations, and in-transit security operations.
Operational Activities to Prepare, Accept, and Transport from a Shutdown Site		
6	Conduct Readiness Activities	Assemble and train on-site operations interface team and shutdown site workers. Includes readiness reviews, tabletop exercises and dry run operations.
7	Load for Transport from ISFSI to on-site transload track for Loading Rail Cars	Load and prepare casks and place on rail cars for the off-site train transportation
8	Transmit TSC load reports and transportation related documents	Assemble TSC load reports and the applicable transportation documents and transmit to the rail transload facility.
9	Accept for Onsite Transport	Accept loaded casks on rail cars for off-site transportation by railroad to CGUS.
10	Transport	Ship shutdown site casks.

6.1.4.3 Description of activities necessary to coordinate with BNSF:

- All diagrams, including dimensions, center of gravity and weights must be collected, preferably in CAD format.
- Determination of serving carriers at origin and destination, as well as all carriers involved in the desired route – will be used in the clearance submission
- Any transport diagrams should be collected.
- Securement information, including weights of the components in transport configuration plus the weights of the rail cars, would be used to determine and verify railroad acceptability and for use in preparation of clearance diagrams.
- The Transportation Plan must include: DOT inspections, securements, routing issues (obstructions, bridge reinforcement, etc.), document checks, notifications, and briefings.

6.1.4.4 Description of Activities Necessary to Coordinate with Railroad:

The private rail siding located on the La Crosse property is served by the BNSF Railroad. Meeting with the railroad six months prior to beginning the loading operation would allow for coordinating and planning with the railroad to set expectations for service level requirements and crew staffing. Special considerations and possibly budget concerns would need to be addressed by the railroad to ensure it has the available crews to run a dedicated train and is willing to do so. Knowing how many trains will be handled and with what frequency will be important to the railroad. Other items to discuss would be security requirements for the crew entering the site, describing the intended operations, planning for the placement, inspection of the loaded train, and all other operations including establishing the mechanics for pulling the released train from the site and obtaining the transit schedule for delivery to the GCUS.

Specifically for this site, since there is no scheduled service for the plant and since numerous HAZMAT unit trains move by the site daily, there would need to be coordination between the site and the BNSF to ensure a proper time period is available for the railroad to enter the site and pull the train without significant interruption of the HAZMAT unit trains moving along the corridor.

Other requirements include:

- Develop the Security Plan for the rail transload site (on-site) and notify the serving carrier, BNSF, of the existence of the plan and provide a contact name and number for the site. Provide proper notification that the transload site would be designated as a "Rail Secure Area".
- The recommended transload site is located within the La Crosse site. If it has not already been designated as a rail secure area with the railroad, this must be established.
- Although not required, plan to institute the same precautions and planning as is used in Toxic Inhalation Hazards (TIH)/Poisonous Inhalation Hazards (PIH) handling and reporting for added measure of security at the rail transload site. This provides notice to the railroad of the level of preparation and operations planning for the campaign.
- Determine if railroad police are available and would be present during the manned interchange and any other stops along the rail route on the way to the final destination.

They can provide extra observation in rail yards to deter rail fans, which typically "chase" dimensional shipments along the rail route and, other trespassers in the yards.

- Hold initial meetings with the Class I carrier to explain the movement, provide estimated number of trains to ship, discuss the dedicated train requirement, and begin rate negotiations for the trains.
- Mention current safety and security measures for the site to ensure the railroad is aware of special considerations and operating procedures in case they have no familiarity with these requirements
- Note and discuss safety features that are in place or would be added to the site: fence, lights, defined perimeter, etc.
- Discuss requirements of crew entry into the site (Transportation Worker Identification Credential (TWIC) cards, training, etc.).
- Discuss manned interchanges with the railroad and record keeping requirements.
- Discuss normal times of operation for the established plant and any extensions in hours the plant has granted to the shipper for conducting the transload campaign, coordinating operations hours and access to the plant. This is important for planning release of the loaded train and consideration of the current rail operations on the operating division in conjunction with normal operating parameters at the plant.
- Initiate communications with all rail carriers in the route to ensure a smooth transition at all interchange points. In this case, with the recommended route, only one Class I railroad is involved in the route to the GCUS.
- Hold initial meetings with the railroad's local trainmaster and safety manager to discuss intended operations and parameters for operations, even though the transload is taking place on a private and secure site.
- Communicate to the railroads that all requirements have been exceeded for the intended site and operations. All diagrams, including dimensions, center of gravity and weights must be collected, preferably in CAD format.

6.1.4.5 Description of Activities Necessary to Coordinate with Crane Company and Rigging Providers:

- All diagrams including dimensions, center of gravity, and weights must be collected (preferably in CAD format) to be provided to the crane company for use in planning the proper lift plan. This includes crane selection for the job based on the conditions of the site and rigging plans and configurations.
- Any manufacturing lift and transport diagrams, especially regarding restrictions on pick points or special rigging required for lifts, should be collected and distributed to the crane company. This information will be used for plan development, including crane selection.
- Crane company/riggers would physically survey the items to be lifted, ground conditions, and other requirements (e.g., turn radius for crane and ancillary equipment) in addition to any specialized rigging provided by the site specific to the transportation casks being lifted.

This is a joint effort between the crane company experts/engineers and transload operator/licensee/shipper. Coordination among the parties would ensure all aspects of the lift and securement plan are considered and planned.

- A timeline would be established for mobilization of all required equipment including all standard rigging tools, forklifts, etc., to make sure all equipment is in place and tested prior to the start of the operation and test lift.

6.1.4.6 Transportation-related Operational Readiness Items

Equipment readiness is determined through review of the following:

- Insurance requirements of the contract are in place before the start of the campaign.
- Transportation equipment certifications are current and would be for the duration of the transportation cycle.
- All vehicles have required registrations (as applicable).
- All vehicles have current inspections.
- Radiological packaging meets all current requirements.
- Packages are correctly identified; all required markings and placards are properly displayed and are available at the site prior to beginning the operation.
- Inspections for equipment to be utilized to handle and transport the loaded transportation casks to the on-site rail siding have been conducted and copies provided.

6.1.4.7 Transportation Personnel Readiness:

- Identify key personnel and their qualifications.
- Ensure required background checks are current and requirements of coverage of drug and alcohol programs are met.
- Provide copies of the training materials and ensure required trainings are current for all employees involved.
- Provide copies and ensure that all personnel are in possession of and working from the correct procedures and RWP.
- Ensure all private security personnel have required weapons certifications to cover the transportation cycle.
- Ensure the transportation personnel would be monitored for radiological exposure, if required.
- Ensure proper equipment and personnel are available to monitor workers for contamination, if required.

6.1.4.8 Transportation Readiness Notifications:

- Provide copies and ensure proper notifications have been made to the Tribes, NRC, State and local governments, DOT, USCG, and DOE as applicable. The USCG would need to be notified because the transload site is located immediately on a navigable waterway and it should be aware of the transportation activities taking place on site.

- In compliance with the regulations, the security team or site-provided security must be in place for VCC movements and once the transportation casks begin to move from the LACBWR site.
- Provide copies of and ensure all required permits to transport SNF are prepared and/or in place.
- Ensure proper notification requirements are met for the disposal/storage facility.
- Identify scheduled meetings and briefings that would be conducted for all phases of the shipments.

Once the train is loaded and proper notification has been given to the railroad and the Bill of Lading issued for the movement and confirmation received from the serving rail crew of the switch time, the chocks would be removed and the locomotive would attach to the loaded train and pull it from the facility once the Rail Transload Supervisor unlocks the gate to allow the train to exit the transload facility property with the Rail Transload Security Team (armed security escorts) in the escort car.

The railroad and Transload Facility Manager would document the manned interchange in writing.

The BNSF train would leave the facility with the loaded train and proceed to CGUS. The Class I carrier would provide advance notification to the GCUS location to coordinate the arrival and manned delivery to the GCUS. It would proceed to the GCUS with only stops for refueling and crew changes at which time railroad police would guard the train during these minimal stops. An estimated transit schedule would be provided to the shipper for the entire train movement. The ability to monitor and trace the train would be limited to need-to-know personnel.

Upon arrival at the GCUS, the BNSF train crew would document the manned interchange, deliver the loaded train to the designated track and then disengage its locomotive.

6.1.5 Demobilization

Once the TSC de-inventory project operations have been completed, demobilization would commence. This is the process of removing all the equipment and materials used during the operation at the LACBWR ISFSI site and returning it to its proper owner in accordance with rental of lease agreements. This includes returning any leased property to the proper owner in the agreed upon condition in accordance with the lease, which may include leaving added pads, fences, and lighting in place.

As the TSC exterior surfaces are potentially contaminated as discussed earlier, large components, such as the TFR, transfer adapter, lift yokes, etcetera would be decontaminated, approved for free release, and returned to the owner(s) for storage. Specialized equipment (e.g., the VDS, leak test systems, air pads, jacking systems, etc.) would be decontaminated, returned to the owner, and placed into storage.

Railcars would be shipped directly from the disposal or storage site at the completion of the project in accordance with the release criteria established by DOE. The train would be returned to its storage track until it is needed for the next shipment. The transport packaging, transport cradles, lift yokes, and the like would be decontaminated, placed in an assembled condition, and returned to DOE for storage and maintenance.

The CHF would be disassembled, decontaminated, and crated for storage for next use on another site.

Demobilization of ancillary equipment from LACBWR site would be accomplished in the same manner as it was mobilized. Trailers used to transport the VCCs would be surveyed for contamination, broken down, and loaded onto flatbed trailers when required for return to its owner. Forklifts, man lifts, and any large pieces of equipment would be surveyed and loaded onto flat beds and drop deck trailers for transport back to origin. It is customary for the leasing company to pick up the equipment once it is formally released by the contractor. Rigging, tools, and smaller articles would be surveyed and loaded into containers and flatbed trailers for transport back to the owner. Security-associated equipment, such as fences and lighting, would be broken down, surveyed, and returned to the suppliers, as appropriate. If personnel trailers, porta-johns, and storage trailers are utilized, utilities would be disconnected, and the units returned to the leasing companies. Cranes would need to be broken down and transported, as required, by the road permits to reach their next destination or be returned to the owner's storage yard. Any standard rigging rented with the crane would also be inspected for condition, documented, properly packaged to prevent damage, and returned to the owner or leaser.

The empty VCCs would remain on site for disposition by LACBWR as potentially contaminated and activated materials. In addition, the ISFSI site would be decommissioned in accordance with NRC and site regulatory requirements.

In the event any of this equipment is purchased, it would be surveyed and loaded onto trailers or containers for movement by HHT to its storage facility. Generally speaking, this process takes approximately two weeks to complete including demobilization of the CHF. The train would be returned intact to its storage location and would likely move in regular train service, which may take a few weeks depending on the distance and route dictated for the movement.

6.1.6 Resource Requirements / Staffing

Personnel required at the LACBWR site:

- Operations Manager (OM)
- Cask Operations Shift Supervisor (COSS)
- Training Specialist
- Procedure Writers
- RP Specialist– in charge of the radiation monitoring and surveys.
- Transport and Waste Management Coordinator (TC) - provides supervision of the waste management aspects of the program and of the transport. The TC is in charge of the preparation of the shipping papers, verification of the proper labeling and placarding of the transport, and tracking and response coordination. Position may be seconded by a Transport Analyst.
- Crane Operators (CO)

- Riggers
- Rail Loading Supervisor
- Rail Loading Security Team
- Cask Operations Technicians/Mechanics
- Tractor / JCB Driver and Equipment Operators
- QA/QC Specialist
- Security Personnel

6.2 List of Ancillary Equipment

Additional ancillary equipment that would be needed through-out the de-inventory process are given in **Table 6-4**, **Table 6-5**, and **Table 6-6**.

Table 6-4: Additional Equipment for LACBWR Site Transfer

Additional Equipment for LACBWR Site Transfer	
Primary Mobile Crane	Required for vertical lifting and movement of the TFR, the vertical lifting and movement of the NAC-STC, the upending and down-ending of the NAC-STC from and to the intermodal transport cradle/frame located on the railcar, or on the ground and subsequently lifted horizontally and loaded onto the railcar.
Secondary Mobile Crane	Required for lifting ancillary items, such as the VCC lid, transfer adapter, NAC-STC inner and outer lids, transport impact limiters, and personnel barrier
Man basket/ lift	Capable of accessing the top of the TFR when in stack-up position on the VCC or NAC-STC would be required for retrieval of the TSC lifting slings
Lifting Rigs	See **Section 2.3** for details
Standard rigging and supplies	See **Section 2.3** for details
Lifting Jacks / Air Pad Rig Set / Diesel-Powered Air Compressor	See **Section 2.3** for details

Additional Equipment for LACBWR Site Transfer	
Standard tools	These include personal protective equipment (PPE), communications equipment, wrenches, etc.
Telescoping Hauler / Forklift	Used to assist handling of VCC with air pad system

Note: the listing and description of all equipment and systems required to safely transfer the MPC-LACBWR TSCs from onsite storage VCCs to NAC-STCs are provided in ***Section 2.3*** *of this report.*

Table 6-5: On-Site TT Transport

ON-SITE HHT Transport	
1 TT Designed for Vertical Movement of VCC	Type to be similar to TT used in LACBWR MPC loading operations
1 Truck Cab- Prime Mover	To provide motive force to on-site TT
JCB Extended Boom / Pusher	Required to pull / push VCC on and off of the ISFSI pad and TSC Transfer Station with VCC riding on air pads.
Standard tools	These include PPE, communications equipment, wrenches, etc.

Table 6-6: Rail Equipment (per Consist)

Rail Equipment (per consist)	
Locomotive(s)	Dedicated for the train movement and at least two required per AAR S-2043.
Buffer cars	Used to provide buffer between loaded overpack cars and all other cars.

Rail Equipment (per consist)	
Overpack cars	Heavy duty flat cars.
Escort car	Houses the armed security team and we would meet the portion of AAR S-2043 applicable to escort cars.
Redundant radio equipment	Used for communication between the security team and the monitoring control center, LLEA, and other required parties. This communication system is in addition to the normal radio communication of the railroad crew with dispatch.
GPS/impact recorder units	One per loaded overpack car. While GPS (telemetric devices) are required for SNF movements, combination units are commonly used by shippers on sensitive and high-value dimensional shipments to indicate both locations of the cars/train and to document all forces exerted on the load car while moving. These are not required by regulation or the railroad but are an additional means of ensuring safety and security in the handling of the units during transportation.

6.3 Sequence of Operations / Schedule

The operations would be sequenced as described in **Section 6.1**.

For the onsite loading sequence, it is estimated that 3 x 10-hour days per TSC would be required to move the VCC, off-load the NAC-STC transport cask, retrieve the TSC from the VCC into the TFR, load the TSC into the NAC-STC, close and prepare the NAC-STC for transport (e.g., evacuation, helium backfill, leakage testing), placement of the loaded NAC-STC on the transport vehicle/horizontal transport cradle and release for transport, and move the empty VCC back to the ISFSI pad. Therefore, for a 5-cask train, approximately 15 days would be required per shipment.

Prior to the start of site operations, new site procedures or current site procedures would be required to be prepared or revised and approved by LACBWR ISR as follows:

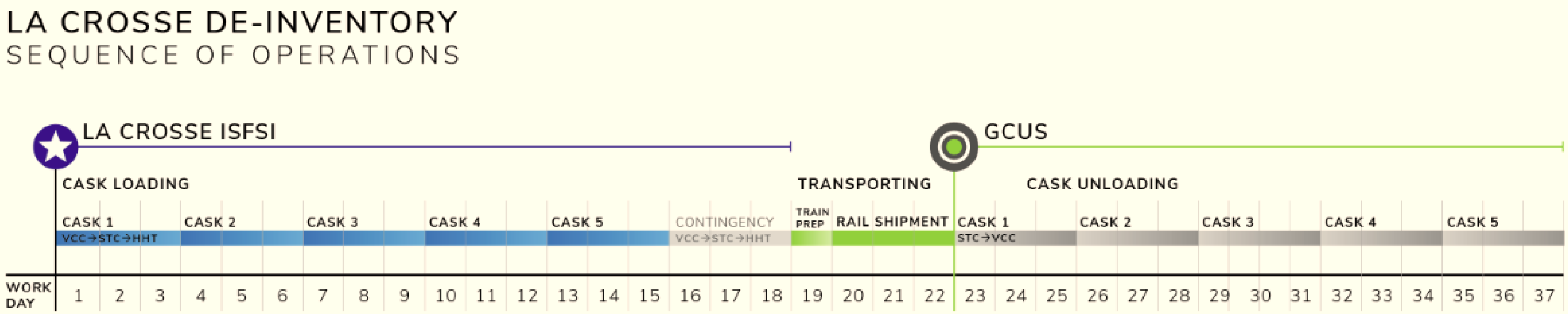
- Pre-Use and Periodic Inspection Instructions for TFR, VCC, NAC-STC, TFR Lift Yoke, NAC-STC Lift Yoke, and Horizontal Lift Beam
- De-inventory Project Conduct of Operations Procedure
- VCC Movement Operations
- TSC Unloading Operations from VCC

- TSC Loading Operations into NAC-STC
- NAC-STC Leakage Testing Operations
- NAC-STC Lifting, Handling, and Preparation for Transport Operations
- TSC Transfer Station Operations
- TSC, VCC, TFR, and NAC-STC Dose and Removable Contamination Survey Procedure
- Contingency Procedures
- Training Course Description for LACBWR De-inventory Project
- TSC Transfer and Loading Job and Task List
- NAC-MPC / NAC-STC General Cleaning Procedure
- Control and Calibration of M&TE
- FME Procedure
- Document Control and Records Retention Procedure
- OJT and Evaluation Procedure
- Site Materials Control Procedure

The sequence of operation timeline, **Figure 6-1**, outlines the operations associated with the facility at the LACBWR site, the short on-site heavy-haul transportation operations, and off-site rail transportation services. Note that some operations could be done concurrently (equipment staging and some inspections) to reduce time, but this was not considered in the development of this timeline. Transfer operations at the LACBWR site would include the overpack handling operations to transfer the overpacks and preparation for shipment. The transit times listed in **Figure 6-1** are provisional and may change as route details and operations are better defined. The transfer of the TSC from the VCC to the NAC-STC is estimated to take approximately three 10-hour days per NAC-STC. Transport of the NAC-STC packages from the LACBWR site to the on-site rail siding, conducting the transload from the HHT to the rail cars (if applicable), and securing the NAC-STC package/intermodal transport cradles to the railcars and preparation of the train would take approximately 15 days total. The total evolution from the initial transfer of a TSC from a VCC to a NAC-STC to the completion of the unloading of the NAC-STCs takes approximately 37 days.

For the resources estimate, the timeline of the operations can be broken down into one shipment of 5 packages over a period of approximately eight weeks per complete turnaround as shown in **Figure 6-1** and staffing requirements per **Table 6-7**. An additional 8 weeks of planning and preparation is added before the start of the first campaign.

Figure 6-1: Sequence of Operations



ASSUMPTIONS:

1. A set of 5 NAC-STC used for the campaign
2. One set of goldhofer and tugger mobilized on site
3. One crew to support onsite transfers and off site transloading operations

Table 6-7: Operations Timeline with Required Resources

	Major steps for a 5 TSC campaign	Resources required [in full-time equivalent]*											Estimated Duration (in weeks)
		OM	COSS	TS	PW	RP	TC	CO	RM	EO	QS	SP	
1	Detail planning of the operations, preparation of the campaign, mobilization of the equipment, procedure preparation and approval, training program, and pre-loading review(s) and dry run(s)	1	2	1	2	2	1	2	6	2	1	3	2 months (8-9 weeks) prior to start 1st campaign
2	Onsite transfer of the SNF canisters and preparation of the 5 packages	1	2	1	1	2	1	2	6	2	1	3	15 days per 5 cask campaign
3	Shipment to destination	0.5			1		2						1 week per 5 cask campaign
4	Unloading	0.5	1		1	1	2						2 weeks per 5 cask campaign
5	Return transport of empty casks to DOE	0.5			1		2						1 week per 5 cask campaign

***Key:**

OM: Operations Manager	**TC**: Transport and Waste Management Coordinator
COSS: Cask Operations Shift Supervisor	**RM**: Rigger/Cask Operations Technician/ Mechanic
TS: Training Specialist	**EO**: Tractor/JCB Driver and Equipment Operator
PW: Procedure Writer	**QS**: QA/QC Specialist
RP: Radiation Protection	**SP**: Security Personnel
CO: Crane Operator	

6.4 As Low As Reasonably Achievable (ALARA) Planning

Specific requirements are provided in 10 CFR 72.126, “Criteria for radiological protection,” that address radiological control measures for work with dry cask storage of SNF. Infrastructure requirements that would be required for transitioning from essentially a static, monitoring condition of the storage of SNF to an active work-site that involves handling and loading operations would be considerable. Stranded sites that are no longer staffed with trained and qualified health physics personnel would be dependent upon either loaned labor from the utility, if those resources are still available, and/or contract health physics staff. In addition, portable survey instruments, portable continuous air monitors, and area radiation monitors must be provided along with the means to maintain them, calibrate, and response check for usage. Infrastructure must also be provided to facilitate safe operations at the site. Temporary offices, electric power for lights, equipment and instrumentation, potable water, and limited decontamination facilities must be in place prior to start of operations at the ISFSI. Considerations must be made to provide for the following:

- Effluent monitoring and control
- Airborne and direct radiation monitoring capabilities
- Personnel and equipment access control
- Radioactive material control
- Decontamination capabilities for personnel and equipment
- ALARA equipment such as temporary shielding for low exposure waiting areas, video surveillance equipment, and other remote or robotic equipment may be appropriate.

In accordance with the requirements stated in 10 CFR Part 20 and 10 CFR Part 72, sufficient controls must be in place to protect the workers and the public from radiation. Therefore, at a minimum, the following requirements must be satisfied prior to commencement of radiological work activities at the site:

- Approved radiological control procedures in place
- A sufficient number of trained and qualified Radiological Control Technicians (RCTs) are mobilized and ready to support operations at the pad (estimated at one supervisor and two RCTs per shift)
- Sufficient quantity of radiation control equipment and consumable supplies on hand to support the planned work activities (PPE, signage for posting, radwaste controls, etc.)
- Qualified RP/ALARA supervision assigned for oversight of radiological work activities
- Personnel dosimetry for monitoring worker doses including thermoluminescent dosimeters and electronic dosimeters available for issue
- A bioassay program in place for worker monitoring (in vivo and in vitro as necessary)
- Health Physics instrumentation calibrated and suited for the types of surveys and measurements required in place

- Detailed work plans developed that would be used for RWP preparation and ALARA evaluation
- In addition to the RCTs, workers that are supporting operation have been trained and qualified to the applicable Rad Worker Program requirements.

6.5 Quality Assurance Requirements

All quality-affecting activities associated with cask handling operations including transportation would be controlled under an NRC-approved Quality Assurance Program (QAP) meeting the requirements of 10 CFR Part 50, Appendix B (within owner-controlled area); 10 CFR Part 71, Subpart H (as related to transportation); and 10 CFR Part 72 Subpart G (within the ISFSI site), as applicable to the scope of work.

Fabrication of important safety components and support equipment for the NAC-MPC would be controlled under the licensee's QAP or by a qualified supplier's QAP that has been approved for this scope of work. Component classification guidance is taken from Regulatory Guide 7.10[44] and NUREG/CR-6407[45] to establish a graded approach to QA. These QAPs are used to establish the quality category of components, subassemblies, and piece parts according to each item's relative importance to safety.

7.0 BUDGET AND SPENDING PLAN

The total estimated budget for the whole LACBWR campaign organized over 16 calendar weeks is $5.6 M. This amount is based on the assumptions and estimates listed below. The estimates provided here are centerline estimates based on the current knowledge of the sites and of the operations needed. They are based on operations being performed at the date the data was gathered for this report (2021). This section provides a breakdown of the estimated campaign costs for the de-inventory of the LACBWR site, by activity, and to the extent cost information is currently available. This report does not specify the party or parties responsible for the costs estimated herein.

The following assumptions were made to assess the costs in this report:

1) One set of 5 NAC-STC transport casks, 5 pairs of impact limiters, 5 personnel barriers, 5 transport cradles are provided by the cask vendor. Ancillary equipment to prepare the transport cask for transportation (tooling, lifting yoke, spreader bar, leak test equipment, VDS, etc.) would be supplied by the cask vendor. No estimate is provided here.
2) The cask railcars, escort car, buffer cars, locomotives, etc. are provided by DOE. No estimate is provided here.
3) The site-specific physical road survey and the complete de-inventory study which includes communication with the site and official stakeholders are not included here.
4) It is assumed that no covered building would be used at the designed transload location. No cost for a new building construction is considered here.
5) Train delivery to the final destination and return shipment of the empties by train are not included. For scheduling purposes, the destination is considered to be GCUS.
6) Assumptions are made based on the current status of the origin site and current understanding of the operation. Some pieces of equipment are not designed yet, and no reasonable assumption can be made at this point.
7) Additional on-site security fencing at loading site is included to the scope.
8) One iteration of eight weeks would be necessary to complete the de-inventory. In addition, another iteration of eight weeks is added and would happen before the first shipment for campaign readiness, procedure writing, dry run, testing and training purpose.
9) Pre-loading canisters inspection activities are not included in the cost estimates
10) Does not account for potential impact of additional specific local regulatory requirements, if applicable, and assumed labor performed by vendor-approved specialists.
11) The TFR to be mobilized for this effort already exists and is assumed to be in operable condition at the time of the operations and does not need to be refurbished or repaired to support the transfer operations. It is also considered that the TFR is available at the site and does not need to be transported from a different site.

7.1 Fees and Permits

No truck permit is expected to be necessary for these moves other than the one that may be required for the mobilization of the transfer equipment (that are already included in the mobilization cost) as there is no highway transport of the casks.

No physical road survey would be expected.

An estimated amount of $50,000 for the NRC route approval processing, preparation of the Security Plan, route survey and the clearance are to be expected. In addition to these costs, States may require the payment of fees for the transport of SNF or HLW through the States. These costs are currently unknown.

7.2 Campaign Operation Management

The Campaign Operation Management would require a crew to be dedicated to the preparation, planning, and supervision of the operation, as described in **Section 6.0**. The Operation Management Team would be composed of a Project Manager, Plant Manager/Coordinator supported by a Scheduler and some engineering staff.

The estimated cost for the Management crew for the 16-week campaign is $0.4 million. In addition to the physical road survey, the management crew would also oversee the planning phase leading to a complete de-inventory study including communication with the site and official stakeholders. This is not captured here.

7.3 Equipment for the Loading Operations

The estimated costs for the mobilization of the equipment on site, the lease of one 375-ton crane, a 150-ton crane and operators for 16 weeks at the shipper site one large forklift, two-man baskets, three welding machines, miscellaneous supplies, air pads and compressor, a telescopic handler and the mobilization/demobilization of the equipment would be approximately $0.9 million for the duration of the LACBWR campaign.

Additional equipment is also necessary for the transfer of the TFR. No lease cost is included here as it is assumed here that this equipment would be borrowed from another site. The cost for mobilization and demobilization of this equipment is estimated to be $0.9M.

No cost for a new building is considered here.

7.4 Site modifications

Extension of the security fencing is likely to be needed to allow the transfer of the TSC from the ISFSI to the railcar loading area and/or the transfer station. In addition, the design and construction of a new TSC transfer pad and station to support the operation, as described in **Section 6.0**, is estimated to be $1.1M.

7.5 In-Transit Security

The security at both the shipping and receiving sites would be ensured by the crew already in place at the site and is therefore not included in this estimate.

The in-transit security crew is estimated to be $0.5 million for the rail movement on the Class I railroad for the campaign. These costs will be the total for the overall security costs for the entire movement to the final destination as it is reasonable to assume the same security crew will be responsible for the security over the entire shipment.

7.6 Cask Transportation Services at Transshipment Site

The Cask Transportation Services team would consist of a Transport coordinator located on site who would coordinate the transport operations with truck drivers, support the shipper in the preparation of shipping documentation, and marking, labeling, and placarding. The Transport Coordinator will also notify the required regulatory body in accordance with the applicable regulation. The Transport Coordinator will be supported by a Transport Analyst. They will consolidate the communication between the shipper site, consignee site, truck drivers, and different stakeholders involved during the transportation phases. The team will also oversee the coordination for the return of the empty casks (detailed in **Section 6.0**).

No transportation costs are included the rail transport of the casks loaded on railcars from the origin site to the location where the short line meets the class I railroad as the site is connected to the Class 1 railroad.

The estimated costs for the cask transportation services are $0.4 million for the entire campaign.

7.7 Onsite Operations

The shipping site operations would be composed of the crew listed in **Section 6.4**. The estimate for the whole crew for the onsite operation is $1.4 million for the entire campaign.

7.8 Breakdown of the Costs by Activity

This section provides a breakdown of the estimated $5.6 million cost of de-inventorying the LACBWR site, by activity, and to the extent cost information is currently available.

- Management and onsite operations (labor): $1.8 million
- Equipment (e.g., transportation casks, railcars, cranes, movers, etc.): >$1.8 million (cost of casks and railcars is currently unknown)
- Site Modifications: $1.1 million
- Transportation services and security: $0.9 million.

7.9 Additional Cost Estimates to Support De-Inventory Activities

Additional costs estimated in this section that are associated with some of the activities involving the shipment of the casks from the transload site to GCUS and include: consist transportation services (loaded and unloaded) costs; emergency response center operation costs; railcar maintenance services costs; and transportation cask maintenance and compliance costs. Estimates for these costs are provided in the following sub-sections; however, these costs have several significant conditions associated with them including:

- The shipment of the consist occurs in the current quarter of the calendar year (2nd quarter of 2021), as rates are temporal.

- The transportation casks meet the 10 CFR Part 71 regulatory limits (e.g., thermal, structural, and radiological) at the time of shipment.
- The maintenance and compliance activities assumed in the cost estimate for the transportation casks are representative of the yet to be built casks systems utilized in this report (i.e., the NAC STC) and are similar to one another.
- The maintenance activities projected for the railcars are representative of DOE's in-progress railcar design of the ATLAS cask car and will be built to ship the transportation casks identified in this report.
- The transportation cask systems and railcars are assumed to be leased to DOE and maintained at vendor operated facilities.
- The emergency response center is assumed to have been designed for the handling of multiple near-simultaneous rail shipments of SNF and estimated costs are for personal assigned full time to the monitoring of shipments only from the LACBWR ISFSI and the portion of the facility and communication equipment needed to support the shipments from the LACBWR ISFSI.

Due to the potential significant impact of these stated conditions on the following identified costs, the values are presented in ranges that provide a rough order of magnitude for the associated costs. Development of more precise values requires resolution to the above conditions, consideration of economies of scale and synergies associated with the de-inventory of multiple sites at the same or nearly same time, understanding of ownership of equipment (e.g., railcars and casks), and a comprehensive breakdown of activities.

7.9.1 Estimate of Transportation Costs

For the BNSF movement of a single rail consist from the on-site transload track at La Crosse to the GCUS site, which is a point-to-point distance of approximately 455 railroad miles, the costs would be comparable to the current market rates for radioactive materials rail shipments and would be broken down into the following categories:

- Freight Costs per Consist
- Special Train Movement Costs (Empty casks return shipment done on merchandise train)
- Current Fuel Surcharge Costs (this surcharge adjusts on a monthly basis)

7.9.2 Estimate of Emergency Response Center Operation Costs

The operating costs for an Emergency Response Center are based on the following additional assumptions:

- A team of 5 transport analysts to ensure a 24/7 on-duty presence and to allow an individual to attend the required periodic trainings.
- One manager with the dual role of resource manager and technical expert on emergency response.

- The crew will support the emergency response and will provide the resources to support the day-to-day transport operations with the support of a transport coordinator located on site.
- The crew will be in charge of the coordination and necessary notifications. They will coordinate with the transport vendors (railroads, trucking companies, etc.), the DOE, and the shipping and receiving sites. They will also act as the interface with the first responders and their contact information will be indicated on the shipping documentations.
- The entire crew will be trained to the DOT, NRC, DOE, and shipper's requirements. The crew will have the necessary DOE clearances, access to the safeguards information, and appropriate training. Additional emergency training such as Federal Emergency Management Agency training would also be useful.

The costs for an Emergency Response Center should be considered independent of the number of shipments and includes the costs for an office and associated communication equipment.

7.9.3 Estimate of Railcar Maintenance Services Costs

To develop an estimate for railcar maintenance services costs, a combination of experience from an existing fleet of railcars used to ship low level waste in the U.S. and activities involving the design and potential building of AAR S-2043 compliant cask and buffer railcars for SNF shipment was utilized. For the purpose of estimating these costs, they are assumed for a single consist, made up of the aforementioned two buffer cars, five cask cars, and one escort car and dedicated to the de-inventory of the LACBWR ISFSI, as opposed to costs associated with maintaining a fleet of rail cars for the de-inventory of multiple sites. No maintenance costs associated with locomotives are included in this assessment. In addition:

- Routine railcar maintenance is assumed provided by the handling railroads and, depending on the costs, will be invoiced to the car owner (major and emergency maintenance) or covered by the shipping rate (minor/regular maintenance).
- Buffer car (4-axles) maintenance costs.
- Cask car (12-axles) maintenance costs.
- Escort car (4-axles) maintenance costs.
- Costs associated with administering a fleet maintenance program.

The above costs associated with the maintenance of a fleet of rail cars encompass activities associated with the physical inspection, periodic regular servicing, and minor routine maintenance and repair activities. In addition, administrative costs for maintaining the program and covering taxes and insurance included in the above costs. However, these costs are estimated to only cover the cars in use for the de-inventory of the LACBWR ISFSI, rather than the costs associated with establishing and maintaining a facility and fleet for the larger inventory of rail cars needed for a national campaign. A separate assessment would need to be performed to establish if it is more prudent to lease the needed support services from an existing qualified supplier rather than establishing a dedicated facility to service, maintain, and store this fleet of rail cars considering:

- Administrative costs for such a support facility.

- Taxes can vary significantly by site for such a support facility, which could be placed in a large number of jurisdictions due to the number of potential de-inventory sites.
- Similarly, construction and maintenance costs for such a facility can vary widely depending on the suitable site selected.
- Staffing costs for such a facility would also vary by site selected.

As noted above, routine maintenance activities for railcars are generally provided by the railroad and a portion is covered in freight rates.

7.9.4 Estimate of Transportation Cask Maintenance and Compliance Costs

To estimate the costs associated with the maintenance of a transportation cask, the following additional assumptions were made:

- One single shop is assumed to be used to perform the maintenance for all the transport casks (including those from different cask vendors if applicable).
- Costs associated with the transport to or from this shop are not included, as its location has not yet been established (although an economic argument could be made to locate this facility near the receiver site to minimize the transport costs).
- The shop where maintenance activities are to take place must have approval from the State to perform radiological work and dispose of the radioactive wastes potentially generated by the maintenance activities, noting the shop will need to open potentially contaminated transportation casks that may result in the release of some contamination.
- The shop must provide facilities for the storage of transportation casks, potentially for long periods of time.
- The shop must also allow for the training of personnel on cask maintenance operations.
- The shop must provide a covered building to allow maintenance operations to occur under any weather conditions and at any time of the year.
- The shop must be able to receive and store railcars (preferred) and/or HHT and ideally be connected by a rail spur to a major railroad.
- The shop must be equipped with a crane capable of lifting a transportation cask and the associated cradle/skid from a railcar or HHT.
    - Conservatively, the lifting capacity of this crane would need to be approximately 375 tons, although the transportation casks brought to this facility will be empty (i.e., will not include a canister with SNF).
    - From a nuclear safety standpoint, no critical load lift is necessary and hence, the crane does not need to be designed as single failure-proof.
    - The crane hook and height of the crane must be compatible with the lifting of yokes and associated rigging supplied by cask vendors.
- Some details of the transportation cask maintenance program will be different between cask vendors; however, the bulk of the maintenance costs are assumed to involve the following larger scale common activities:

  - External decontamination of the casks
  - Internal decontamination of the casks
  - Replacement of sealing gaskets
  - Periodic maintenance and leak testing of the containment boundary
  - Load tests
  - Maintenance of spare parts
  - Maintenance of the leak testing tools
  - Maintenance of cask leak testing equipment
  - Maintenance of the vacuum drying systems
  - Maintenance of lifting and support equipment (yokes, trunnions, skids, etc.)
- Leak testing will be performed according to American National Standards Institute (ANSI) N14.5-2014, unless specified otherwise in a Safety Analysis Report, by an American Society for Nondestructive Testing (ASNT) Level II cask operator.
- The maintenance program will be approved by an ASNT Level III reviewer and performed in accordance with the specifications identified in each transportation cask's Safety Analysis Report.
- The single shop will require a radiation protection plan that will be implemented and maintained.
- The size of the facility and the staff are assumed to limit maintenance to only one cask at a time.
- The staff at this single shop will be composed of 2 trained operators, some engineering support, a half-time ASNT Level II cask operator, and a part time ASNT level III procedure writer/reviewer.

8.0 SECURITY PLAN AND PROCEDURES

A Security Plan would encompass strategies and procedures in compliance with 49 CFR Part 172 to ensure the safety and the security of the material, employees, and the public during loading, transloading activities, and movement associated with the transportation of the SNF from the La Crosse ISFSI to the final destination.

The transportation activities covered by the plan would include all aspects of the shipment from loading the transportation casks at the La Crosse ISFSI, preparing them for movement on the transport trailer to the on-site rail transload track, to the train movement to the hypothetical destination of the GCUS.

Multiple entities have jurisdiction over commercial shipments of SNF in the U.S. including the NRC, USCG, and the DOT. The DOT's PHMSA issues the Hazardous Materials Regulations in 49 CFR Parts 171-180 and represents the DOT in international organizations. The relevant regulations addressing the security of SNF during transportation include 49 CFR Parts 172-177; 10 CFR 73.20, 73.37 and 73.72 (advanced notification); and 49 CFR Part 172, Subpart I.

The basic statute regulating HAZMAT transportation in commerce in the U.S. is 49 U.S. Code 5101 et seq., which identifies "hazardous materials" by commodity, or a group of commodities. It identifies regulations for the safe movement of HAZMAT, including safety and security for movements within the U.S. Several agencies have jurisdiction over different aspects of commercial transportation of HAZMAT depending on the mode of transport and other circumstances of the shipment. These agencies include the PHMSA, Federal Motor Carrier Safety Administration, FRA, Federal Aviation Administration, and USCG. Together these entities cover all aspects of commercial transportation of HAZMAT, which includes the movement of SNF, by road, rail, air, or water with an emphasis on safely moving this material.

Given the geographic proximity of both the ISFSI and transload site to navigable waters, the MTSA is assumed to govern the La Crosse water-served site, even though the recommended mode of transportation is direct rail. Any site, whether private or public, that is on or adjacent to water and handling or storing HAZMAT will be governed by the USCG regulations, and it is assumed that MTSA provisions apply to both the ISFSI and transload site. As such, additional security precautions should be implemented, including development, in consultation with the USCG, of an MTSA security plan, if one does not already exist for the site. Likewise, when movement of SNF is occurring on-site, the USCG should be notified to monitor and patrol the navigable waters adjacent to the facility to provide a secure maritime area and limit access to the site by water. The COTP has the authority to establish the area as either a Safety Zone or Security Zone during loading operations.

In addition to the maritime security measures for the rail-served transload site, the railroad will be notified the site is being declared a "rail secure area" (due to the transload operation), as required by regulation. This means all provisions of the Security Plan will be adhered to and enforced and effectively, a layered security approach will be established to govern the site for ISFSI transload operation, the HHT-to-rail movement, and the rail transload operations.

While maintaining security protocols relevant to the control of sensitive information regarding the movement of the SNF and its associated procedures, all relevant parties to the transportation activity will receive a copy of the Security Plan, and complete applicable training. All personnel will be required to return a signed copy of the Security Plan review signature sheet to the designated site administrator as part of documentation control

8.1 Security Plan Requirements

Security plans for the transportation of hazardous materials in commerce are addressed in 49 CFR Part 172, Subpart I, which mandates a security plan must be in writing and contain an assessment of security risks for transportation of hazardous materials identified in 49 CFR 172.800, which includes highway route-controlled quantities (HRCQ) of radioactive materials. The plan must address the identified risks including security, while the material is en route. The Security Plan must also provide protection of the ISFSI facility and transload activities incidental to the transportation, including loading and unloading operations. This document assumes the provisions of the MTSA of 2002 are applicable. No formal determination has yet been made by the USCG or the NRC as to its applicability.

As delineated in 49 CFR 172.802, a Security Plan must also include the following elements addressing:

- Personnel security: Measures to confirm information provided by job applicants hired for positions that involve access to, and handling of, the HAZMAT covered by the Security Plan;
- Unauthorized access: Measures to address the assessed risk that unauthorized persons may gain access to the HAZMAT or transport conveyances being prepared for transportation of the HAZMAT;
- En-route security: Measures to address the assessed security risks of shipments of HAZMAT covered by the Security Plan en route from origin to destination, including shipments stored incidental to movement;
- Security Plan Owner: Identification, by job title, of the senior management official responsible for overall development and implementation of the Security Plan;
- Security duties: Duties and responsibilities for each position or department tasked with implementing any portion of the plan and the process of notifying employees when specific elements must be implemented;
- Training: Description of the training required by HAZMAT employees in accordance with 49 CFR 172.704 (a)(4) and (a)(5); and
- Risk Assessment: As assessment of the following:
    - Transportation security risks for shipments of the specific HAZMAT listed in 49 CFR 172.800 (includes radioactive materials).
    - Site-specific or location-specific risks associated with facilities at which the HAZMAT is prepared for transportation, stored, or unloaded incidental to movement (e.g., rail transload facility).
    - Appropriate measures to address the assessed risks.

The Security Plan, including the transportation security risk assessment, must be in writing and retained for as long as it remains in effect. It must be reviewed, at a minimum, on an annual basis and updated as necessary to reflect changing circumstances. Each person required to develop or implement a portion of the Security Plan must maintain a copy of the plan (written or electronic) that is accessible at their principal place of business and must make the plan available upon request, at a reasonable time and location, to an authorized official of the DOT or the Department of Homeland Security (DHS). The most recent version of the Security Plan, or portions thereof, must be available to the employees who are responsible for implementing it, consistent with personnel security clearance, or background investigation restrictions and a demonstrated need to know. When the Security Plan is updated or revised, all employees responsible for implementing it must be notified and all copies of the plan must be maintained as of the date of the most recent revision.

8.2 Scope

Key transportation, security, and Federal and State agency officials involved in the transport will need to be identified. The truck and rail transfer sites where the SNF will be loaded or unloaded will also need to be identified. Security professionals will conduct the security and risk analysis from point of origin (La Crosse) to the final destination. In addition, a physical route analysis will be conducted to determine any potential logistical issues that may exist or that could pose a risk to security during all phases of the operation. Security professionals involved will identify requirements for compliance as part of the action plan and define and establish procedures for the operation, including contingency plans.

8.3 Identifying and Selecting the Principal Parties (Administrative Team)

The following should be considered for the identification and selection of the principal parties involved in the development of the Security Plan:

- The Security Contractor would chair the Administrative Team for the entire process or until an alternate is determined.
- Once the requirements of each transload site and the destination of the SNF is determined, contact should be made with all parties involved in the operation, including the rail and truck operators that will be involved with the transfer.
- Per 10 CFR 73.37 (b)(1)(viii), the initial contact with logistical partners should be made at a high level of the organizations in order to ensure the protection of Safeguards Information.
- Initial meetings should bring together the licensee, security, and risk assessment contractor or designee, high level logistical partners in truck, rail, and other vendors (e.g., crane and rigging companies and monitoring partners), DHS, DOT, USCG, NRC, and other Federal and State officials, as needed.
- The meeting should address the concerns of each representative group, identify any groups that may not be present or need to be included, and come away with a framework for managing the project and how communications will be handled at all phases of the operation.
- The purpose of this meeting is to establish the Administrative Team as a partnership dedicated to working together to ensure the safety and security of the SNF in transportation and identify any areas of concern.

8.4 Select the Rail/Truck Transload Site to be Used

The following should be considered when selecting and/or using a secure, existing transload site:

- If an existing transload site is identified, it is preferred that it be a fully enclosed and secure commercial installation or that it can be easily secured. If the site must be established, these measures must be considered to enclose the site in an effort to create a secure perimeter around the loading location. This will include fencing and lighting around the perimeter of the property, installing security cameras and limiting egress and ingress to secure gates with locks at both the rail and truck entrances;
- Establish direct contacts at the site(s) for logistics and security; and
- Ensure that all persons on site with direct knowledge or access to the transfer location have background checks. Security clearances may also be considered but are not required.
- Assuming MTSA jurisdiction over the site and transload locations, TWIC identification cards would be mandatory for workers. TWIC cards are issued by TSA and involve background and fingerprint checks.

8.5 Identifying and Selecting the Risk and Security Assessment Team

Identification and selection of the Risk and Security Assessment Team (RSAT) should consider the following:

- Once the routes are proposed and agreed to by the Administrative Team, a RSAT shall be formed to conduct a security risk assessment of the routes and transfer sites.
- The RSAT will be selected and approved by the Administrative Team.
- The RSAT will be comprised of security and risk professionals from licensee, security contractor, and any Federal and State agency that wishes to participate.

The RSAT will perform the security risk assessment of the surrounding transportation infrastructure. This includes, but is not limited to, bridges, tunnels, overpasses, proximity to population centers or landmarks, direct route access to the installation, identification of potential bottlenecks, narrow roads, interstate highways, proximity to hospitals, schools, civic centers, shipping channels, and highly populated areas. The assessment should include a 10-mile area on either side of the center of the proposed transportation route. Contingency routes should be identified and assessed throughout the transportation route.

Each step in the proposed route should be geographically divided and the results submitted to the Administrative Team for evaluation. If the RSAT uncovers any major concerns during the Security Risk Assessment, the next portion of the route geographically should be placed on hold until the issue is resolved in the event the transportation route must be changed. If no major concerns are uncovered, the RSAT can continue with the next geographical portion of the trip. During the assessment, agreements need to be made with all state agencies in the state(s) that is included in the assessment before finalizing the assessment.

8.6 Evaluating the Security and Risk Assessment

Upon completion of each geographical portion of the risk assessment, the assessment will be submitted to the Administrative Team for review, evaluation, and approval. All identified risks will be evaluated and resolved, or a contingency developed prior to approval of that portion of the transportation route.

8.7 Developing a Hazardous Materials Security Plan

The following should be considered while developing a HAZMAT Security Plan:

- Existing Security Plans for the site, railroads, trucking companies and transload sites, should be incorporated into the overall plan, especially to develop a concise hand-off of security responsibilities at each transfer.
- The Security Plan hand-off of responsibility at each site will be reviewed by the RSAT and evaluated and approved by the Administrative Team, DHS, DOT, USCG, the licensee, and each individual state authority for each state that will be crossed.
- Strict chain-of-custody protocols will be established, and all physical transfers will be "manned" and documented[47].
- Any additional Security Plan that will be needed at the rail/truck transfer sites will be developed using the "Risk Management Framework for Hazardous Materials Transportation"[48] and the "Enhancing Security of Hazardous Materials Shipments Against Acts of Terrorism or Sabotage"[47].

8.8 Develop Security and Communication Protocols

Security and communication protocols will be developed as follows by the Administrative Team:

- All personnel identified above will have background checks completed prior to being included in any communications.
- The level of security required for operations personnel such as railroad personnel, truck drivers, riggers, flag men, security personnel, and others once the project is operational must be identified and classified.
- What type of communications can and cannot be used during the entire project.
- What level of distribution will be allowed and how that will be administered and monitored.
- Develop and approve all distribution lists and approved contacts.

8.9 Development of Security Plan and Protocols for Marine Facilities

The following will be considered in the development of a Security Plan and associated protocols for a marine facility site (LACBWR and on-site transload track).

When a site handling hazardous materials, including SNF, is located near or on the water, additional maritime security precautions should be considered. While no determination has been made on its applicability, the MTSA describes prudent security measures for maritime facilities.

A Facility Security Plan (FSP) should be developed that identifies procedures and processes for transportation activities on site. The FSP is implemented by a Facility Security Officer (FSO) and submitted to the COTP for the Sector in which the site is located. The RSAT will conduct a security assessment up to the entrance of the marine facility. A review of the FSP in effect inside the marine facility will be conducted with the permission of the USCG COTP.

An Area Maritime Security Plan should be developed that identifies procedures for handling the maritime domain surrounding the facility during a transportation activity. Included in the Area Maritime Security Plan would be buffer zones where commercial or pleasures vessels would not be permitted during a transportation activity at the site. If vessels are to be used to transport SNF, the vessels would need a Vessel Security Plan (VSP). The VSP outlines vessel security and identifies the Vessel Security Officer, who would be delegated the responsibility of implementing the VSP and coordinating with the USCG and the FSO during a transportation activity. This plan should be created in coordination with the COTP.

8.10 Railroad Security Requirements

The following are railroad security-related requirements:

- The TSA published rules regarding the rail transportation of certain HAZMAT, which became effective on December 26, 2008[49] and are still in effect. The materials subject to these rules include explosive, TIH, PIH, and HRCQ. TSA refers to these commodities collectively as Rail Security-Sensitive Materials (RSSM). As a result of these rules, the carrier will only be able to accept or deliver RSSM from Rail Secure Areas.
- There are additional requirements for delivery/acceptance of RSSM in designated High Threat Urban Areas HTUA, but none of the geographical locations involved in this assessment fall into designated HTUA.
- Shipments of RSSM will be subject to chain-of-custody requirements which apply:
    - To all shippers of these materials
    - To receivers only located in High Threat Urban Areas (HTUA)
- Personnel must be physically present for attended hand-offs of the railcars to document the transfer by recording the following information:
    - Each railcar's initial and number
    - The individual attending the transfer
    - The location of the transfer
    - The date and time of the transfer
- Additionally, for any location in a HTUA that receives RSSM by rail, security personnel must be present 24 hours a day, 7 days per week. For any location that has notified the railroad that an RSSM railcar is available for shipment (released).
- Security personnel must be present 24 hours a day, 7 days per week from the time notification was provided to the railroad until the transfer has been completed and appropriately documented by both the shipper and railroad.
- A facility that is directly served by a railroad will be required to provide the following information to the carrier:
    - Acknowledgement that the facility has an appropriately designated Rail Secure Area,

  - The facility has designed and implemented procedures to ensure compliance with TSA chain-of-custody requirements effective as of February 15, 2009[48] (the requirements remain the same for rail-served sites handling HAZMAT),
  - If the facility has not established a Rail Secure Area or put chain-of-custody procedures in place, declare when it expects to complete these requirements and what interim measures are in place to ensure compliance in the meantime,
  - Without compliance with these measures, the railroad may refuse to perform switching services at the facility until the requirements are met, and
  - Proper and current contact information must be supplied, including company name, street address, phone number, and primary point of contact.
- There is no requirement to submit the Security Plan to the railroad for review or approval, but the shipper must inform the serving railroad that the plan exists.
- All of the above will apply to the SNF rail transload facility.

8.11 Provisions for Protection of In-Transit Road Shipments

Specific provisions for protection of in-transit road shipments of SNF are found in 10 CFR 73.37(c):

- Transportation vehicles must be accompanied by at least two individuals
  - One serving as an armed escort
  - A second armed member of the LLEA in a mobile unit or
  - Led by a separate vehicle occupied by at least one armed escort and trailed by a third vehicle occupied by at least one armed escort.
- All armed escort are equipped with a minimum of two weapons (as permitted by law); however, this requirement does not apply to LLEA personnel who are performing escort duties.
- Transport and escort vehicles are equipped with redundant communication abilities that provide 2-way communications between the transport vehicle, the escort vehicle(s), the MCC, LLEA, and one another. To ensure that 2-way communication is possible at all times, alternate communications should not be subject to the same failure modes as the primary communication.
  - Escorts must have the ability to call for assistance when necessary
  - Escorts must be provided with a way to quickly develop new LLEA contacts and obtain new route information when unexpected detours become necessary
  - Escorts must be provided a way to coordinate the movement of transport and escort vehicles when more than one transport vehicle is used in the shipment
  - Escorts must be able to reach the emergency phone number provided on the approved route
- The transport vehicle must be equipped with NRC-approved features that permit immobilization of the cab or cargo-carrying portion of the vehicle with the purpose being

to render the vehicle inoperable or incapable of movement under its own power. It must take at least 30 minutes to reverse the immobility once engaged.

- The transport vehicle driver must be trained with, and capable of implementing, the transport vehicle immobilization, communications, and other security procedures.

Shipments must be continuously and actively monitored by a telemetric position monitoring system or an alternate tracking system reporting to a MCC. The MCC shall:

- Provide positive confirmation of the location, status, and control over the shipment, and
- Implement preplanned procedures in response to deviations from the authorized routes.
- Or notification of actual, attempted, or suspicious activities related to the theft loss or diversion of a shipment.

These procedures must include contact information for the appropriate LLEA along the shipment route.

8.12 Provisions for Protection of In-Transit Rail Shipments

The following provisions are required for protection of in-transit rail shipments in accordance with 10 CFR 73.37(d):

- Loaded cars must be accompanied by two armed escorts.
- At least one escort is stationed on the train, permitting observation of the shipment car while in motion (generally, in an escort or security car).
- Each armed escort shall be equipped with a minimum of two weapons (as permitted by law, but does not apply to LLEA personnel performing guard duties)..
- The train operator(s) and each escort are equipped with redundant communication capabilities that provide 2-way communications between the transport, the escort vehicle(s), the MCC, local law enforcement agencies, and one another.
- To ensure that 2-way communication is possible at all times, alternate communications should not be subject to the same failure modes as the primary communication device.
- Rail shipments must be monitored by a telemetric position monitoring system or an alternate tracking system reporting to the licensee, third-party, or railroad MCC.
- The MCC shall provide positive confirmation of the location of the shipment and its status.
- The MCC shall implement preplanned procedures in response to deviations from the authorized route or to a notification of actual, attempted, or suspicious activities related to the theft, diversion, or radiological sabotage of a shipment.
- These procedures shall include, but not be limited to, the identification of and contact information for the appropriate LLEA along the shipment route.

8.13 Provisions for Protection of In-Transit Barge Shipments

Specific provisions for protection of in-transit barge shipments are found in 10 CFR 73.37(e) and include:

- A shipment vessel while docked at a U.S. port is protected by:
  - Two armed escorts stationed on board the shipment vessel, or stationed on the dock at a location that will permit observation of the shipment vessel; or
  - A member of a LLEA, equipped with normal local law enforcement agency radio communications, who is stationed on board the shipment vessel, or on the dock at a location that will permit observation of the shipment vessel.
- As permitted by law, all armed escorts are equipped with a minimum of two weapons. This requirement does not apply to LLEA personnel who are performing escort duties.
- A shipment vessel, while within U.S. territorial waters, shall be accompanied by an individual, who may be an officer of the shipment vessel's crew, who will assure that the shipment is unloaded only as authorized by the licensee.
- Each armed escort is equipped with redundant communication abilities that provide 2-way communications between the vessel, the movement control center, local law enforcement agencies, and one another. To ensure that 2-way communication is possible at all times, alternate communications should not be subject to the same failure modes as the primary communication.

Because the on-site loading facility from the LACBWR ISFSI to HHT is located adjacent to the waters of the U.S. waterway, the following will apply, even though no transportation on the waterways is expected to occur:

- U.S. waters extend to 3 nautical miles from the U.S. land territory, except for small offshore islands.
- Security between 3 and 12 nautical miles from the coast falls under the responsibility of the USCG.
- If a U.S. port is used for transport, the licensee shall coordinate with both the USCG and local port authorities during a transport (or transload) operation to ensure that all parties are appropriately informed and to ensure the physical protection thereof[52].
- If an established port facility is used, protocols of that MTSA plan will be enforced to protect the shipment from any threat presented from the rail transfer site being located on water or adjacent to the water and provide protection against theft, diversion, or radiologic sabotage while located adjacent or next to the water.

Items requiring action for protection of transload sites (HHT to rail) near navigable waterways include:

- MTSA plan to be developed and implemented on the rail transfer site or amended to include the transfer if already in place.
- Property to be fenced.
- Property to be lighted.
- Perimeter and fence line to be surveilled by a closed-circuit camera system.
- All personnel on a water-served site must obtain a TWIC.

- All personnel who are on duty will have the capability to delay or impede such acts as listed for the Security Plan and can request assistance promptly from LLEA responses forces and USCG.
- All provisions applicable to U.S. ports may apply to a private water-served site, including coordinating with USCG and local port authorities.

9.0 EMERGENCY RESPONSE PLAN AND PREPAREDNESS

The purpose of the Emergency Response Plan (ERP) is to establish notification protocols and provide response guidance in the event of a reportable incident involving an HHT, rail, or barge shipment transporting HAZMAT. The ERP includes all pertinent contact and contingency information including specific contact names and phone numbers, as well as procedures in the event of an incident. These procedures encompass the requirements for providing and maintaining emergency information during transportation and at facilities where HAZMAT is loaded, stored, or otherwise handled during every phase of transportation.[53]

Emergency response information is required to be immediately available for use at all times when HAZMAT is present. It is also required to be immediately available to any Federal, State, or local government agency representative who responds to an incident or is investigating an incident (per 49 CFR 172.600(c)(1)&(2)).[61]

9.1 General Guidance for an Emergency Response Plan

As required by 49 CFR 172.602, emergency response information must be provided that can be used in the mitigation of an incident involving hazardous materials and, as a minimum, must contain the following information:

- The basic description and technical name of the hazardous material;
- Immediate hazards to health;
- Risks of fire or explosion;
- Immediate precautions to be taken in the event of an accident or incident;
- Immediate methods for handling fires;
- Initial methods for handling spills or leaks in the absence of fire; and
- Preliminary first aid measures.

This information must be written in English and available for use away from the package and provided in an approved format such as shipping papers or a document containing all the relevant information that will be found in shipping papers[53].

This emergency response information is usually incorporated into an ERP. The ERP will include the emergency contact telephone number (per 49 CFR 172.604) and this number:

- Must be monitored at all times the HAZMAT is in transportation, including storage incidental to transportation;
- Must be monitored by a “person who is either knowledgeable of the hazardous material being shipped and has comprehensive emergency response and incident mitigation information for that material or has immediate access to a person who possesses such knowledge and information.”
- Must be entered on the shipping paper(s) immediately following the description of the hazardous material;

- Must be entered on the shipping paper(s) in a prominent, readily identifiable, and clearly visible manner; and
- Must be the number of the person offering the hazardous material for transportation when that person is also the emergency response information provider, or the number of an agency or organization capable of, and accepting responsibility for, providing the detailed information.

All HAZMAT rail shippers are registered with CHEMTREC, or a similar company, to provide the above requirements. Shipper must make sure to provide CHEMTREC with current information on the material before it is offered for transportation.

As stated above, the purpose of the ERP is to establish notification and response guidance in the event of a reportable transportation incident involving a HHT or rail shipment that is transporting hazardous material. The plan would include information in compliance with 49 CFR 172.600 to 172.606 (i.e., Subpart G) and other federal, state, and local requirements and regulations and is intended to provide direction by identifying immediate measures to contain the situation and ensure safety and security until the LLEA and emergency response professionals arrive on the scene.

The emergency response procedures apply to persons who offer, accept, transfer, or otherwise handle HAZMAT during transportation. In this case, the procedures will apply to site operations at LACBWR, on-site HHT transport beginning with all transfer operations conducted at LACBWR to transfer the overpacks from the ISFSI to the transfer trailer for the on-site transport to the on-site rail siding (loop track). This includes all transload operations to place the overpacks onto the railcars, movement of the dedicated train from the rail transload facility along the entire route from LACBWR to the final destination.

The security personnel accompanying the train will remain with the train for the entire train movement.

Each entity involved in each facet of the transportation operation will develop its own emergency response information and procedures commonly included in an ERP. The plan will be disseminated to the appropriate employees and the information will become part of the overall Security Plan for the licensee. Each entity on the project will have separate and individual procedures respective to its role, but they will be coordinated for the project to delineate hand-off procedures (interfaces) to clearly define responsibilities for each phase and participant. Note that the limitations of information dissemination as identified by 10 CFR 71.11 must be considered before sharing information concerning safety, security, and emergency response.

An example of the index for such a plan and the information to be included is listed below. This example index comes from a proprietary ERP (containing safeguards information) from a trucking company that is actively transporting HAZMAT. It is only intended to be an example of the potential contents of an ERP.

Section 1: Purpose & Scope

Section 2: Commitments, Company procedures, Title 49 CFR related material

Section 3: References – 49 CFR Part 172 (subpart G), Hazardous Material Regulations, First Notifications, Emergency Response Guidebook (latest edition issued by DOT), Condition Reports, Assistance with Radioactive Material Transportation Incidents, Conference of Radiation Control Program Directors, Inc. (CRCPD) "CRCPD Notes," current edition

Section 4: General - Definitions of relevant terms: Emergency, Hazardous Material, Minor and Major Incident, Reportable Quantity, Responsibilities identified for the following employees: Manager of Compliance, Director of Radiation Safety, Transload Facility Drivers, Driver Incident packet with checklists, schematics, etc.

Section 5: Notifications - Notification of Transportation Incidents, Minor and Reportable Incident Notification - definitions, Emergency Contact Phone Numbers for all Company (transload, etc.) employees including 24/7 contact numbers, Emergency Response Agencies for the jurisdictions in which the SNF is traveling, with requirements for notification and frequency, Emergency Contact Responsibilities

Section 6: Attachments - Incident Log, Checklist of notifications with internal and external notification contacts and contact numbers, Notifications and conditions for contacting the National Response Center and State Agencies, Blank incident logs indicating identifying incidents and resultant injuries, with room for documenting any damage, mode contact information is listed along with vehicle details and road location (for road), and any resulting drug tests.

9.2 LACBWR Site-Specific Considerations for the Emergency Response Plan

The MUA identified the highest ranked route for transporting the SNF from LACBWR to be a direct rail route, where the transportation casks would be directly loaded onto railcars. Since LACBWR is located on or adjacent to a U.S. waterway (The Mississippi River), it is assumed that MTSA requirements apply, in addition to the Rail Secure Area designation. These two sources of provisions would present a layered security approach for the operations involved in the loading campaign. As a result, some additional fencing would be required to enclose the rail transload area (the portion of the track where the train would be loaded).

The USCG is responsible for reviewing and approving the MTSA plan for operations conducted on any water-served site, including activities at the ISFSI and rail transload site, as it pertains to safety and security of the sites from the coastline. The respective COTPs from the Ninth USCG District would be involved in the assessment of the plan. This may include a request from the site for the USCG to establish a barrier or security zone around the site while the on-site truck transport and rail transloading operations are conducted. The required notification would be given in writing to the serving railroad, BNSF, stating that the area meets the requirements of a "rail secure area" and contact information will be supplied to the railroad. There is no requirement, as stated earlier, for the railroad to approve the Security Plan.

At this time, no formal determination has been made as to the applicability/jurisdiction of MTSA on the LACBWR site. Compliance with MTSA is recommended as a conservative approach to implementing a multi-tiered security plan.

The site Security Plan for LACBWR, as required by 10 CFR Part 73, is comprehensive and encompasses various protection measures for the vital areas of the site, including the ISFSI. This plan will include compliance with 10 CFR 73.55(e)(ii), which requires the licensee to identify areas from which a waterborne vehicle must be restricted and in coordination with local, State, and federal agencies having jurisdiction over waterway approaches, provide periodic surveillance and observation of waterway approaches and adjacent areas. Hence, any MTSA requirements for the site is presumed to become part of the overall Security Plan for the site.

Additional considerations should include natural disaster planning and contingency plans for flooding. There are several resources available through the USACE for assistance with emergency planning including the Flood Handbook. NOAA provides forecasting data to help determine if and when a flood may be predicted for a particular area, for example "Mississippi River at La Crosse (LACW3)". Some of the flood related data available includes flow and stage exceedance, historic and recent crests, as well as historical information and predictive information including "chances of exceeding river flow at specific mileposts." Other useful resources for monitoring and predicting weather related events and natural disasters are listed on the last page of the report Natural Hazards Assessment for Vernon County, WI which was prepared by NOAA. Additional state specific information is available in the State of Wisconsin Emergency Response Plan, 2021-2023.[64]

The Great Flood of 1993 resulted in catastrophic damages throughout much of the Upper Mississippi River basin[39]. The area has continued to flood in subsequent years including: 2001, 2008, 2010, 2011, 2013 & 2015. Genoa, WI has a slightly higher than national average monthly wind speed nine months of the year[40] and the state averages 23 tornadoes per year[41][42] and 40 thunderstorm days per year. [42] Both river flooding and flash flooding can occur, along with urban-related flood problems. The terrain can lead to mud slides and generally increases the flash flood threat.[42] The area has multiple locations where the weather is monitored, including Mississippi River Lock & Dam #8 at Genoa which is approximately ½ mile from the LACBWR site.[42]

Another promising initiative to combat the flooding issues in the area is The Upper Mississippi River Watershed Project/Assessment which is awaiting funding. The project will develop a systemic flood risk management plan just like the one in place on the Lower Mississippi River. "Lack of a systemic flood risk management plan for the UMR results in levee districts, communities and others, taking actions in an uncoordinated manner in response to flood concerns. This uncoordinated flood response ultimately transfers risk to other areas, often without their knowledge."[43]

10.0 RECOMMENDED NEXT STEPS

Based on the results of this study, the following recommendations are provided to support implementation of a future de-inventory program. These recommendations are listed in approximate order of when to be addressed (earliest to latest):

1. Conduct an engineering survey of the onsite path from the ISFSI to the loading area and evaluate the need for improvements to ensure acceptable conditions of transport exist. Consider the extent of the concrete roadway needed to be added/upgraded at the site to handle anticipated transportation activities, as well as any grade improvements needed on steep paths. A formal inspection of the existing onsite rail spur and engineering plan will be required to complete the addition of the track extension.
2. With the coal plant having ceased operations, conduct an evaluation of the coal dock to identify the maximum weight it can hold to ensure barge roll-on operations could safely be executed there, as an option. The structure and tolerance of the weight-bearing ability of the dock is paramount in determining if the pier is a viable option for loading a barge closer to the ISFSI (and its inclusion in the MUA for evaluation).
3. Prepare a listing of all miscellaneous equipment and services required to safely and efficiently perform the MPC-LACBWR TSC transfers into the NAC-STC transport cask and prepare the casks for off-site transport. Such equipment would include required measuring and test equipment (MT&E) and calibration services, radiological instrumentation and services, radioactive material control supplies, additional lighting to support operations, standard tooling, hydraulic torquing equipment, etc. The listing should also include identification of responsible party for procurement and maintenance of identified equipment and materials.
4. Evaluate the need to procure on-site HHT to accommodate vertical movement of MPC and UMS VCCs at YR, CY, MY and LACBWR in accordance with original NAC Design and Procurement Specification requirements.
5. The MPC-LACBWR TSCs and NAC-STCs will need to be evaluated prior to transport to ensure 10 CFR Part 71 requirements are met. At a minimum, this will need to involve a comparison of the fabrication records against the CoC requirements and verification that the canister integrity has been maintained. It is recommended to allocate 2-3 years for this activity, which could involve a need to revise the CoC. In general, a complete transportability study consisting of a comparison of each transport cask and its contents in a transport configuration to the 10 CFR Part 71 CoC at the time the transport will be performed by the NRC licensee with the support of the transport cask CoC holder prior to transportation of each canister to be offered for transport.
6. Establish planned shipment date from the ISFSI and verify:
    a. The CoC for the NAC-STC package is still valid. NAC has confirmed that it fully intends to submit a timely renewal application for the NAC-STC 10 CFR Part 71 Certificate of Compliance, as required.
    b. The contents, as loaded in the MPC-LACBWR TSCs are compliant to the applicable CoC requirements (e.g., dose and thermal transport limits are satisfied).

   c. Ability for permitting the transportation activities along the selected route(s).

7. Establish equipment needs for transportation:

   a. Procurement of the appropriate number of NAC-STCs, associated impact limiters, cavity spacers, transport cradles, personnel barriers, and TFR and NAC-STC vertical lifting yokes, and horizontal lift beam.

   b. Regarding the procurement of the five required NAC-STCs, and associated impact limiters, cavity spacers, transport cradles, personnel barriers, and vertical lifting yoke and horizontal lift beam, the following delivery times are estimated based on imposition of the 'Buy American' clause:

      i. If all NAC-STCs casks are purchased from one US fabricator at one time (and have not been previously procured for other de-inventory projects):

         1. First two casks, 24 months after receipt of order.
         2. Next two casks, 32 months after receipt of order.
         3. Final one cask, 36 months after receipt of order.

      Theses cask dates bound the supply dates for impact limiters, lifting equipment, auxiliary equipment, etc.

      ii. If foreign fabricators were allowed to be considered, dates would be shortened by at least 2 months for each delivery.

   c. Design, procure and construct additional equipment and auxiliaries including Transfer Station pad, Canister Handling Facility, and Gantry Crane and Chain Hoist System (if used), TFR lift yoke, vacuum, leak test and helium backfill system, pressure drop test system, etc. Limiting schedule delivery date would be for the design and construction of the gantry crane and chain hoist system at 24 months, with CHT at 18 months, and Transfer Station pad design and construction at 12 months.

8. Establish LACBWR ISFSI site operations related details, including electrical power requirements for performing operations and verify availability at LACBWR ISFSI.

9. Determine the maximum height a NAC-STC package can be lifted without impact limiters. Lifts of the loaded package are proposed to allow downloading on the intermodal transport cradle. If NAC-STC and TFR are lifted and handled utilizing single-failure-proof lifting and handling equipment in accordance with ANSI N14.6 and NUREG-0612, then there should not be an issue regarding TFR or NAC-STC lifting heights without requiring a drop analysis.

10. Establish if the TSC Transfer Station pad can be placed adjacent to the planned extended on-site rail spur to allow MPC-LACBWR TSC transfers to occur immediately adjacent to the rail spur.

11. Establish the most efficient location for the upending and down-ending of the NAC-STC packaging (e.g., on the trailer or on the ground) as the lift height will be lower with the cradle on the ground.

12. Examine potential for optimizing (time, exposure, cost. etc.) the design of the transfer activities through the use of a gantry crane and chain hoist system.
13. Consult with appropriate regulatory authorities on the applicability of the MTSA and its requirements for LACBWR ISFSI.
14. Provide clarification of the identified conditions and assumptions presented in Chapter 7.0 to understand:
    - Considerations of economies of scale for campaigns
    - Synergies associated with the de-inventory of multiple sites at the same time or in succession
    - Understanding equipment (rail cars and casks) ownership impact
    - The need for a comprehensive breakdown of activities involved in these costs including:
        - Cask consist
        - Transportation service costs
        - ERP/MCC operations costs
        - Rail car maintenance costs
        - Freight costs
        - Repositioning costs
        - Transportation cask maintenance & compliance costs
15. Due to the potential significant impacts of the conditions and assumptions used to determine the estimated costs associated with activities involving the rail shipment of transportation casks from the transload site to the GCUS site (i.e., cask consist transportation services costs, emergency response center operation costs, railcar maintenance services freight costs, and transportation cask maintenance and compliance costs), the development of more precise costs requires resolution to, or clarification of, the identified conditions and assumptions given in **Chapter 7.0**, as well as consideration of economies of scale and synergies associated with the de-inventory of multiple sites at the same or nearly same time, understanding of equipment (e.g., railcars and casks) ownership impact, and the need for a comprehensive breakdown of activities involved in these costs.

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Attachment A: Full Pairwise Comparison for the Tangible Metrics

Place a single "X" per line where you believe the importance of the metric in column A falls against the metric in column B.

Column A Metrics	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (Neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Metrics
ISFSI Rental Equipment Costs (e.g., mobile cranes)								ISFSI Hardware Procurement Costs (e.g., transfer cask)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Labor and Permitting Costs
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Cost of Rail Transport (e.g., costs associated with interchange activities)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Number of Water Areas Nearby Route (e.g., number of bridges crossed)*
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Number of Tribal Lands Crossed*
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Public Acceptability of Route
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Ease of Permit Procurement
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Number of Permits
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Cumulative Worker Exposure (α handling time & # of workers)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Cumulative Population Dose along Route (α population density)*
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Risks Associated with Number of Lifting Activities
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Average Accident Frequency on Route*
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Number of Fire Stations & Trained Personnel Nearby Route*
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Transit Duration per Conveyance
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Ease of Access to Transload Site (e.g., consider usage of existing site)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Security Vulnerability of Route*
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Number of Police Stations Nearby Route*
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Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Security Vulnerability of Route*
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)								Number of Police Stations Nearby Route*

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Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Water Areas Nearby Route (e.g., number of bridges crossed)*
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Tribal Lands Crossed*
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Public Acceptability of Route
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Ease of Permit Procurement
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Permits
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Cumulative Worker Exposure (α handling time & # of workers)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Cumulative Population Dose along Route (α population density)*
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Risks Associated with Number of Lifting Activities
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Average Accident Frequency on Route*
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Fire Stations & Trained Personnel Nearby Route*
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Transit Duration per Conveyance
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Ease of Access to Transload Site (e.g., consider usage of existing site)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Security Vulnerability of Route*
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Number of Police Stations Nearby Route*
Cost of Rail Transport (e.g., costs associated with interchange activities)								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Water Areas Nearby Route (e.g., number of bridges crossed)*
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Tribal Lands Crossed*
Cost of Rail Transport (e.g., costs associated with interchange activities)								Public Acceptability of Route
Cost of Rail Transport (e.g., costs associated with interchange activities)								Ease of Permit Procurement
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Permits
Cost of Rail Transport (e.g., costs associated with interchange activities)								Cumulative Worker Exposure (α handling time & # of workers)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Cumulative Population Dose along Route (α population density)*
Cost of Rail Transport (e.g., costs associated with interchange activities)								Risks Associated with Number of Lifting Activities
Cost of Rail Transport (e.g., costs associated with interchange activities)								Average Accident Frequency on Route*
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Fire Stations & Trained Personnel Nearby Route*
Cost of Rail Transport (e.g., costs associated with interchange activities)								Transit Duration per Conveyance
Cost of Rail Transport (e.g., costs associated with interchange activities)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Ease of Access to Transload Site (e.g., consider usage of existing site)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Security Vulnerability of Route*
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Police Stations Nearby Route*

Place a single "X" per line where you believe the importance of the metric in column A falls against the metric in column B.

Column A Metrics	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (Neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Metrics
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Water Areas Nearby Route (e.g., number of bridges crossed)*
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Tribal Lands Crossed*
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Public Acceptability of Route
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Ease of Permit Procurement
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Permits
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Cumulative Worker Exposure (α handling time & # of workers)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Cumulative Population Dose along Route (α population density)*
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Risks Associated with Number of Lifting Activities
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Average Accident Frequency on Route*
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Fire Stations & Trained Personnel Nearby Route*
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Transit Duration per Conveyance
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Ease of Access to Transload Site (e.g., consider usage of existing site)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Security Vulnerability of Route*
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Number of Police Stations Nearby Route*
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Number of Tribal Lands Crossed*
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Public Acceptability of Route
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Ease of Permit Procurement
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Number of Permits
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Cumulative Worker Exposure (α handling time & # of workers)
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Cumulative Population Dose along Route (α population density)*
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Risks Associated with Number of Lifting Activities
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Average Accident Frequency on Route*
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Number of Fire Stations & Trained Personnel Nearby Route*
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Transit Duration per Conveyance
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Security Vulnerability of Route*
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Number of Police Stations Nearby Route*
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Number of Tribal Lands Crossed*
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Public Acceptability of Route
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Ease of Permit Procurement
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Number of Permits
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Cumulative Worker Exposure (α handling time & # of workers)
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Cumulative Population Dose along Route (α population density)*
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Risks Associated with Number of Lifting Activities
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Average Accident Frequency on Route*
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Number of Fire Stations & Trained Personnel Nearby Route*
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Transit Duration per Conveyance
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Security Vulnerability of Route*
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Number of Police Stations Nearby Route*
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Number of Tribal Lands Crossed*
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Public Acceptability of Route
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Ease of Permit Procurement
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Number of Permits
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Cumulative Worker Exposure (α handling time & # of workers)
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Cumulative Population Dose along Route (α population density)*
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Risks Associated with Number of Lifting Activities
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Average Accident Frequency on Route*
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Number of Fire Stations & Trained Personnel Nearby Route*
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Transit Duration per Conveyance
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Security Vulnerability of Route*
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Number of Police Stations Nearby Route*

Place a single "X" per line where you believe the importance of the metric in column A falls against the metric in column B.								
Column A Metrics	**Column A Strongly Favorable**	**Column A More Favorable**	**Column A Mildly Favorable**	**Neither Favorable (Neutral)**	**Column B Mildly Favorable**	**Column B More Favorable**	**Column B Strongly Favorable**	**Column B Metrics**
Number of Tribal Lands Crossed*								Public Acceptability of Route
Number of Tribal Lands Crossed*								Ease of Permit Procurement
Number of Tribal Lands Crossed*								Number of Permits
Number of Tribal Lands Crossed*								Cumulative Worker Exposure (α handling time & # of workers)
Number of Tribal Lands Crossed*								Cumulative Population Dose along Route (α population density)*
Number of Tribal Lands Crossed*								Risks Associated with Number of Lifting Activities
Number of Tribal Lands Crossed*								Average Accident Frequency on Route*
Number of Tribal Lands Crossed*								Number of Fire Stations & Trained Personnel Nearby Route*
Number of Tribal Lands Crossed*								Transit Duration per Conveyance
Number of Tribal Lands Crossed*								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Number of Tribal Lands Crossed*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Number of Tribal Lands Crossed*								Security Vulnerability of Route*
Number of Tribal Lands Crossed*								Number of Police Stations Nearby Route*
Public Acceptability of Route								Ease of Permit Procurement
Public Acceptability of Route								Number of Permits
Public Acceptability of Route								Cumulative Worker Exposure (α handling time & # of workers)
Public Acceptability of Route								Cumulative Population Dose along Route (α population density)*
Public Acceptability of Route								Risks Associated with Number of Lifting Activities
Public Acceptability of Route								Average Accident Frequency on Route*
Public Acceptability of Route								Number of Fire Stations & Trained Personnel Nearby Route*
Public Acceptability of Route								Transit Duration per Conveyance
Public Acceptability of Route								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Public Acceptability of Route								Ease of Access to Transload Site (e.g., consider usage of existing site)
Public Acceptability of Route								Security Vulnerability of Route*
Public Acceptability of Route								Number of Police Stations Nearby Route*
Ease of Permit Procurement								Number of Permits
Ease of Permit Procurement								Cumulative Worker Exposure (α handling time & # of workers)
Ease of Permit Procurement								Cumulative Population Dose along Route (α population density)*
Ease of Permit Procurement								Risks Associated with Number of Lifting Activities
Ease of Permit Procurement								Average Accident Frequency on Route*
Ease of Permit Procurement								Number of Fire Stations & Trained Personnel Nearby Route*
Ease of Permit Procurement								Transit Duration per Conveyance
Ease of Permit Procurement								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Ease of Permit Procurement								Ease of Access to Transload Site (e.g., consider usage of existing site)
Ease of Permit Procurement								Security Vulnerability of Route*
Ease of Permit Procurement								Number of Police Stations Nearby Route*
Number of Permits								Cumulative Worker Exposure (α handling time & # of workers)
Number of Permits								Cumulative Population Dose along Route (α population density)*
Number of Permits								Risks Associated with Number of Lifting Activities
Number of Permits								Average Accident Frequency on Route*
Number of Permits								Number of Fire Stations & Trained Personnel Nearby Route*
Number of Permits								Transit Duration per Conveyance
Number of Permits								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Number of Permits								Ease of Access to Transload Site (e.g., consider usage of existing site)
Number of Permits								Security Vulnerability of Route*
Number of Permits								Number of Police Stations Nearby Route*
Cumulative Worker Exposure (α handling time & # of workers)								Cumulative Population Dose along Route (α population density)*
Cumulative Worker Exposure (α handling time & # of workers)								Risks Associated with Number of Lifting Activities
Cumulative Worker Exposure (α handling time & # of workers)								Average Accident Frequency on Route*
Cumulative Worker Exposure (α handling time & # of workers)								Number of Fire Stations & Trained Personnel Nearby Route*
Cumulative Worker Exposure (α handling time & # of workers)								Transit Duration per Conveyance
Cumulative Worker Exposure (α handling time & # of workers)								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Cumulative Worker Exposure (α handling time & # of workers)								Ease of Access to Transload Site (e.g., consider usage of existing site)
Cumulative Worker Exposure (α handling time & # of workers)								Security Vulnerability of Route*
Cumulative Worker Exposure (α handling time & # of workers)								Number of Police Stations Nearby Route*
Cumulative Population Dose along Route (α population density)*								Risks Associated with Number of Lifting Activities
Cumulative Population Dose along Route (α population density)*								Average Accident Frequency on Route*
Cumulative Population Dose along Route (α population density)*								Number of Fire Stations & Trained Personnel Nearby Route*
Cumulative Population Dose along Route (α population density)*								Transit Duration per Conveyance
Cumulative Population Dose along Route (α population density)*								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Cumulative Population Dose along Route (α population density)*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Cumulative Population Dose along Route (α population density)*								Security Vulnerability of Route*
Cumulative Population Dose along Route (α population density)*								Number of Police Stations Nearby Route*

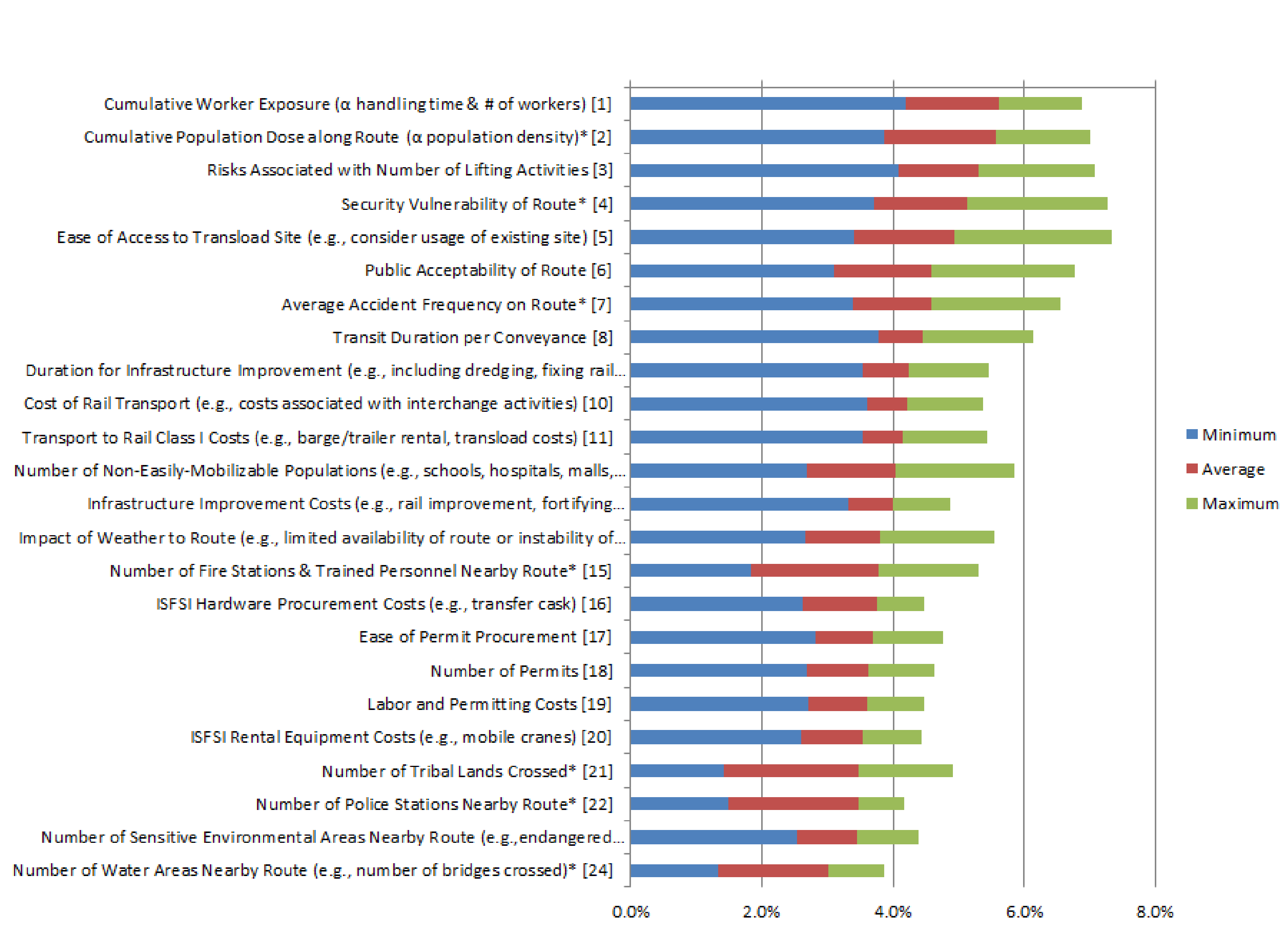
Place a single "X" per line where you believe the importance of the metric in column A falls against the metric in column B.

Column A Metrics	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (Neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Metrics
Risks Associated with Number of Lifting Activities								Average Accident Frequency on Route*
Risks Associated with Number of Lifting Activities								Number of Fire Stations & Trained Personnel Nearby Route*
Risks Associated with Number of Lifting Activities								Transit Duration per Conveyance
Risks Associated with Number of Lifting Activities								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Risks Associated with Number of Lifting Activities								Ease of Access to Transload Site (e.g., consider usage of existing site)
Risks Associated with Number of Lifting Activities								Security Vulnerability of Route*
Risks Associated with Number of Lifting Activities								Number of Police Stations Nearby Route*
Average Accident Frequency on Route*								Number of Fire Stations & Trained Personnel Nearby Route*
Average Accident Frequency on Route*								Transit Duration per Conveyance
Average Accident Frequency on Route*								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Average Accident Frequency on Route*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Average Accident Frequency on Route*								Security Vulnerability of Route*
Average Accident Frequency on Route*								Number of Police Stations Nearby Route*
Number of Fire Stations & Trained Personnel Nearby Route*								Transit Duration per Conveyance
Number of Fire Stations & Trained Personnel Nearby Route*								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Number of Fire Stations & Trained Personnel Nearby Route*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Number of Fire Stations & Trained Personnel Nearby Route*								Security Vulnerability of Route*
Number of Fire Stations & Trained Personnel Nearby Route*								Number of Police Stations Nearby Route*
Transit Duration per Conveyance								Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)
Transit Duration per Conveyance								Ease of Access to Transload Site (e.g., consider usage of existing site)
Transit Duration per Conveyance								Security Vulnerability of Route*
Transit Duration per Conveyance								Number of Police Stations Nearby Route*
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)								Ease of Access to Transload Site (e.g., consider usage of existing site)
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)								Security Vulnerability of Route*
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)								Number of Police Stations Nearby Route*
Ease of Access to Transload Site (e.g., consider usage of existing site)								Security Vulnerability of Route*
Ease of Access to Transload Site (e.g., consider usage of existing site)								Number of Police Stations Nearby Route*
Security Vulnerability of Route*								Number of Police Stations Nearby Route*

Attachment B: Results from the Twelve Individual's Pairwise Comparison for the Tangible Metrics

Metric	Rater																										
	1		2		3		4		5		6		7		8		9		10		11		12		Average		
	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	Average
ISFSI Rental Equipment Costs (e.g., mobile cranes)	3.86%	15	3.23%	23	2.60%	24	4.08%	13	3.47%	18	2.69%	24	3.68%	17	3.89%	15	3.59%	16	3.47%	20	3.44%	19	4.44%	6	3.5%	20	17.5
ISFSI Hardware Procurement Costs (e.g., transfer cask)	4.20%	11	3.32%	21	2.63%	23	3.77%	16	3.96%	14	4.17%	7	3.65%	19	3.56%	24	3.53%	17	3.93%	14	3.86%	16	4.47%	3	3.8%	16	15.4
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)	3.96%	14	3.56%	20	3.65%	11	4.86%	8	4.08%	13	3.32%	20	3.74%	15	3.86%	16	4.44%	12	3.93%	14	4.05%	14	4.44%	6	4.0%	13	13.6
Labor and Permitting Costs	3.23%	17	3.59%	15	2.72%	20	4.35%	11	2.99%	21	2.75%	23	3.50%	21	3.86%	16	4.32%	13	3.23%	22	4.23%	10	4.47%	3	3.6%	19	16.0
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	4.05%	12	3.65%	14	3.80%	9	4.80%	9	4.38%	11	3.53%	16	3.83%	13	3.65%	23	5.43%	5	4.23%	8	4.05%	14	4.44%	6	4.2%	11	11.7
Cost of Rail Transport (e.g., costs associated with interchange activities)	3.99%	13	3.59%	15	4.29%	7	5.07%	7	4.26%	12	3.80%	15	3.74%	15	3.83%	20	5.37%	6	4.23%	8	4.11%	13	4.41%	9	4.2%	10	11.7
Impact of Weather to Route (e.g., limited availability of route or instability of weather)	3.05%	19	4.02%	9	2.69%	21	2.66%	21	4.50%	10	4.02%	11	4.26%	8	3.86%	16	5.56%	4	4.02%	13	3.38%	20	3.71%	24	3.8%	14	14.7
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*	2.99%	20	3.59%	15	2.69%	21	1.33%	24	2.69%	23	3.26%	22	3.86%	12	3.77%	21	2.57%	21	2.51%	24	3.23%	24	3.77%	10	3.0%	24	19.8
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*	3.71%	16	3.83%	10	2.90%	19	3.47%	18	2.54%	24	3.32%	20	4.11%	11	4.38%	7	2.75%	19	3.35%	21	3.26%	23	3.77%	10	3.4%	23	16.5
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*	5.25%	6	5.86%	3	3.77%	10	2.99%	20	4.86%	7	3.44%	18	4.38%	6	3.77%	21	2.69%	20	3.89%	17	3.80%	17	3.77%	10	4.0%	12	12.9
Number of Tribal Lands Crossed*	3.14%	18	3.71%	12	4.92%	6	1.42%	23	2.84%	22	3.50%	17	4.59%	5	3.86%	16	2.45%	22	4.08%	12	3.32%	21	3.77%	10	3.5%	21	15.3
Public Acceptability of Route	5.59%	5	5.01%	5	6.76%	5	3.62%	17	5.50%	3	3.41%	19	3.41%	22	5.95%	1	3.11%	18	4.17%	10	4.74%	6	3.77%	10	4.6%	6	10.1
Ease of Permit Procurement	2.81%	22	3.32%	21	3.41%	16	4.05%	14	3.29%	19	4.14%	9	3.35%	23	4.77%	2	4.47%	11	3.11%	23	3.68%	18	3.77%	10	3.7%	17	15.7
Number of Permits	2.69%	23	3.11%	24	3.47%	15	3.38%	19	3.14%	20	4.62%	5	3.35%	23	4.05%	13	4.02%	14	4.56%	5	3.32%	21	3.77%	10	3.6%	18	16.0
Cumulative Worker Exposure (α handling time & # of workers)	5.65%	4	6.28%	1	6.88%	4	6.16%	2	5.65%	2	4.20%	6	5.74%	2	4.56%	4	4.80%	9	6.07%	1	5.16%	3	6.16%	1	5.6%	1	3.3
Cumulative Population Dose along Route (α population density)*	6.40%	1	6.28%	1	7.00%	3	3.86%	15	5.80%	1	3.86%	13	5.80%	1	4.74%	3	6.13%	2	5.83%	2	4.83%	4	6.16%	1	5.6%	2	3.9
Risks Associated with Number of Lifting Activities	5.10%	7	4.98%	6	7.07%	1	5.34%	4	5.04%	6	6.16%	3	5.59%	4	4.08%	10	5.04%	8	5.22%	4	5.50%	1	4.47%	3	5.3%	3	4.8
Average Accident Frequency on Route*	4.50%	8	4.56%	7	3.38%	18	4.77%	10	5.19%	5	3.86%	13	5.65%	3	4.41%	6	6.55%	1	3.86%	18	4.50%	8	3.77%	10	4.6%	7	8.9
Number of Fire Stations & Trained Personnel Nearby Route*	2.60%	24	4.08%	8	3.59%	12	5.31%	5	3.59%	17	4.05%	10	3.68%	17	4.08%	10	1.84%	23	4.56%	5	4.20%	11	3.77%	10	3.8%	15	12.7
Transit Duration per Conveyance	4.23%	10	3.83%	10	4.26%	8	4.23%	12	4.74%	8	5.40%	4	4.32%	7	4.29%	8	6.13%	2	3.93%	14	4.32%	9	3.77%	10	4.5%	8	8.5
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)	4.38%	9	3.59%	15	3.53%	13	5.46%	3	3.83%	15	3.93%	12	4.20%	9	4.20%	9	4.80%	9	4.53%	7	4.68%	7	3.77%	10	4.2%	9	9.8
Ease of Access to Transload Site (e.g., consider usage of existing site)	5.68%	3	3.71%	12	3.41%	16	7.34%	1	4.62%	9	7.13%	2	4.17%	10	4.08%	10	5.22%	7	5.37%	3	4.80%	5	3.77%	10	4.9%	5	7.3
Security Vulnerability of Route*	6.04%	2	5.68%	4	7.04%	2	5.22%	6	5.34%	4	7.28%	1	3.77%	14	4.47%	5	3.71%	15	3.80%	19	5.37%	2	3.77%	10	5.1%	4	7.0
Number of Police Stations Nearby Route*	2.93%	21	3.59%	15	3.53%	13	2.45%	22	3.71%	16	4.17%	7	3.62%	20	4.02%	14	1.48%	24	4.14%	11	4.17%	12	3.77%	10	3.5%	22	15.4

Purple	Lowest Ranked
Red	Highest Ranked


Cumulative Worker Exposure (α handling time & # of workers) [1]
Cumulative Population Dose along Route (α population density)* [2]
Risks Associated with Number of Lifting Activities [3]
Security Vulnerability of Route* [4]
Ease of Access to Transload Site (e.g., consider usage of existing site) [5]
Public Acceptability of Route [6]
Average Accident Frequency on Route* [7]
Transit Duration per Conveyance [8]
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail...
Cost of Rail Transport (e.g., costs associated with interchange activities) [10]
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs) [11]
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls,...
Infrastructure Improvement Costs (e.g., rail improvement, fortifying...
Impact of Weather to Route (e.g., limited availability of route or instability of...
Number of Fire Stations & Trained Personnel Nearby Route* [15]
ISFSI Hardware Procurement Costs (e.g., transfer cask) [16]
Ease of Permit Procurement [17]
Number of Permits [18]
Labor and Permitting Costs [19]
ISFSI Rental Equipment Costs (e.g., mobile cranes) [20]
Number of Tribal Lands Crossed* [21]
Number of Police Stations Nearby Route* [22]
Number of Sensitive Environmental Areas Nearby Route (e.g., endangered...
Number of Water Areas Nearby Route (e.g., number of bridges crossed)* [24]
0.0%
2.0%
4.0%
6.0%
8.0%
Minimum
Average
Maximum

Attachment C: Full Pairwise Comparison for the Routes

Place a single "X" per line where you believe the importance of the metric for the route in column A falls against the same metric for the route in column B.

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
ISFSI Rental Equipment Costs (e.g., mobile cranes)	A. Barge Only				x				B. HHT Only
	A. Barge Only				x				C. Rail Only (BNSF Only)
	A. Barge Only				x				D. HHT + Rail at French Island
	A. Barge Only				x				E. HHT + Rail at Merrillan
	B. HHT Only				x				C. Rail Only (BNSF Only)
	B. HHT Only				x				D. HHT + Rail at French Island
	B. HHT Only				x				E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)				x				D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)				x				E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
ISFSI Hardware Procurement Costs (e.g., transfer cask)	A. Barge Only				x				B. HHT Only
	A. Barge Only				x				C. Rail Only (BNSF Only)
	A. Barge Only				x				D. HHT + Rail at French Island
	A. Barge Only				x				E. HHT + Rail at Merrillan
	B. HHT Only				x				C. Rail Only (BNSF Only)
	B. HHT Only				x				D. HHT + Rail at French Island
	B. HHT Only				x				E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)				x				D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)				x				E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)	A. Barge Only					x			B. HHT Only
	A. Barge Only			x					C. Rail Only (BNSF Only)
	A. Barge Only			x					D. HHT + Rail at French Island
	A. Barge Only			x					E. HHT + Rail at Merrillan
	B. HHT Only		x						C. Rail Only (BNSF Only)
	B. HHT Only			x					D. HHT + Rail at French Island
	B. HHT Only			x					E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)						x		D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)						x		E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Labor and Permitting Costs	A. Barge Only			x					B. HHT Only
	A. Barge Only					x			C. Rail Only (BNSF Only)
	A. Barge Only		x						D. HHT + Rail at French Island
	A. Barge Only		x						E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only			x					D. HHT + Rail at French Island
	B. HHT Only			x					E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)		x						D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)		x						E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	A. Barge Only			x					B. HHT Only
	A. Barge Only							x	C. Rail Only (BNSF Only)
	A. Barge Only			x					D. HHT + Rail at French Island
	A. Barge Only			x					E. HHT + Rail at Merrillan
	B. HHT Only							x	C. Rail Only (BNSF Only)
	B. HHT Only					x			D. HHT + Rail at French Island
	B. HHT Only					x			E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)	x							D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)	x							E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island			x					E. HHT + Rail at Merrillan
Cost of Rail Transport (e.g., costs associated with interchange activities)	A. Barge Only				x				B. HHT Only
	A. Barge Only	x							C. Rail Only (BNSF Only)
	A. Barge Only		x						D. HHT + Rail at French Island
	A. Barge Only		x						E. HHT + Rail at Merrillan
	B. HHT Only	x							C. Rail Only (BNSF Only)
	B. HHT Only		x						D. HHT + Rail at French Island
	B. HHT Only		x						E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)				x				D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)				x				E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Impact of Weather to Route (e.g., limited availability of route or instability of weather)	A. Barge Only				x				B. HHT Only
	A. Barge Only						x		C. Rail Only (BNSF Only)
	A. Barge Only					x			D. HHT + Rail at French Island
	A. Barge Only					x			E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only					x			D. HHT + Rail at French Island
	B. HHT Only					x			E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)		x						D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)		x						E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*	A. Barge Only							x	B. HHT Only
	A. Barge Only							x	C. Rail Only (BNSF Only)
	A. Barge Only							x	D. HHT + Rail at French Island
	A. Barge Only							x	E. HHT + Rail at Merrillan
	B. HHT Only		x						C. Rail Only (BNSF Only)
	B. HHT Only		x						D. HHT + Rail at French Island
	B. HHT Only		x						E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)					x			D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)		x						E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island		x						E. HHT + Rail at Merrillan

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*	A. Barge Only						x		B. HHT Only
	A. Barge Only					x			C. Rail Only (BNSF Only)
	A. Barge Only					x			D. HHT + Rail at French Island
	A. Barge Only						x		E. HHT + Rail at Merrillan
	B. HHT Only			x					C. Rail Only (BNSF Only)
	B. HHT Only			x					D. HHT + Rail at French Island
	B. HHT Only			x					E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)			x					D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)					x			E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island					x			E. HHT + Rail at Merrillan
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*	A. Barge Only			x					B. HHT Only
	A. Barge Only			x					C. Rail Only (BNSF Only)
	A. Barge Only		x						D. HHT + Rail at French Island
	A. Barge Only	x							E. HHT + Rail at Merrillan
	B. HHT Only					x			C. Rail Only (BNSF Only)
	B. HHT Only			x					D. HHT + Rail at French Island
	B. HHT Only	x							E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)			x					D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)	x							E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island	x							E. HHT + Rail at Merrillan
Number of Tribal Lands Crossed*	A. Barge Only		x						B. HHT Only
	A. Barge Only		x						C. Rail Only (BNSF Only)
	A. Barge Only		x						D. HHT + Rail at French Island
	A. Barge Only		x						E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only						x		D. HHT + Rail at French Island
	B. HHT Only						x		E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)				x				D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)				x				E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Public Acceptability of Route	A. Barge Only			x					B. HHT Only
	A. Barge Only						x		C. Rail Only (BNSF Only)
	A. Barge Only			x					D. HHT + Rail at French Island
	A. Barge Only			x					E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only					x			D. HHT + Rail at French Island
	B. HHT Only					x			E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)		x						D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)		x						E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Ease of Permit Procurement	A. Barge Only			x					B. HHT Only
	A. Barge Only				x				C. Rail Only (BNSF Only)
	A. Barge Only			x					D. HHT + Rail at French Island
	A. Barge Only			x					E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only				x				D. HHT + Rail at French Island
	B. HHT Only				x				E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)	x							D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)	x							E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Number of Permits	A. Barge Only			x					B. HHT Only
	A. Barge Only					x			C. Rail Only (BNSF Only)
	A. Barge Only		x						D. HHT + Rail at French Island
	A. Barge Only		x						E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only						x		D. HHT + Rail at French Island
	B. HHT Only						x		E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)	x							D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)	x							E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island			x					E. HHT + Rail at Merrillan
Cumulative Worker Exposure (α handling time & # of workers)	A. Barge Only			x					B. HHT Only
	A. Barge Only					x			C. Rail Only (BNSF Only)
	A. Barge Only				x				D. HHT + Rail at French Island
	A. Barge Only				x				E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only				x				D. HHT + Rail at French Island
	B. HHT Only				x				E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)			x					D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)			x					E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Cumulative Population Dose along Route (α population density)*	A. Barge Only			x					B. HHT Only
	A. Barge Only			x					C. Rail Only (BNSF Only)
	A. Barge Only		x						D. HHT + Rail at French Island
	A. Barge Only	x							E. HHT + Rail at Merrillan
	B. HHT Only					x			C. Rail Only (BNSF Only)
	B. HHT Only			x					D. HHT + Rail at French Island
	B. HHT Only	x							E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)			x					D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)	x							E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island	x							E. HHT + Rail at Merrillan

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Risks Associated with Number of Lifting Activities	A. Barge Only				x				B. HHT Only
	A. Barge Only						x		C. Rail Only (BNSF Only)
	A. Barge Only				x				D. HHT + Rail at French Island
	A. Barge Only				x				E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only				x				D. HHT + Rail at French Island
	B. HHT Only				x				E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)		x						D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)		x						E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Average Accident Frequency on Route*	A. Barge Only			x					B. HHT Only
	A. Barge Only						x		C. Rail Only (BNSF Only)
	A. Barge Only					x			D. HHT + Rail at French Island
	A. Barge Only					x			E. HHT + Rail at Merrillan
	B. HHT Only						x		C. Rail Only (BNSF Only)
	B. HHT Only					x			D. HHT + Rail at French Island
	B. HHT Only					x			E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)			x					D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)			x					E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island			x					E. HHT + Rail at Merrillan
Number of Fire Stations & Trained Personnel Nearby Route*	A. Barge Only				x				B. HHT Only
	A. Barge Only					x			C. Rail Only (BNSF Only)
	A. Barge Only						x		D. HHT + Rail at French Island
	A. Barge Only					x			E. HHT + Rail at Merrillan
	B. HHT Only					x			C. Rail Only (BNSF Only)
	B. HHT Only						x		D. HHT + Rail at French Island
	B. HHT Only			x					E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)			x					D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)				x				E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island						x		E. HHT + Rail at Merrillan
Transit Duration per Conveyance	A. Barge Only					x			B. HHT Only
	A. Barge Only						x		C. Rail Only (BNSF Only)
	A. Barge Only						x		D. HHT + Rail at French Island
	A. Barge Only						x		E. HHT + Rail at Merrillan
	B. HHT Only					x			C. Rail Only (BNSF Only)
	B. HHT Only					x			D. HHT + Rail at French Island
	B. HHT Only					x			E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)			x					D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)		x						E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island			x					E. HHT + Rail at Merrillan

Metric	Column A Routes	Column A Strongly Favorable	Column A More Favorable	Column A Mildly Favorable	Neither Favorable (neutral)	Column B Mildly Favorable	Column B More Favorable	Column B Strongly Favorable	Column B Routes
Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)	A. Barge Only					x			B. HHT Only
	A. Barge Only			x					C. Rail Only (BNSF Only)
	A. Barge Only				x				D. HHT + Rail at French Island
	A. Barge Only				x				E. HHT + Rail at Merrillan
	B. HHT Only		x						C. Rail Only (BNSF Only)
	B. HHT Only			x					D. HHT + Rail at French Island
	B. HHT Only			x					E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)					x			D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)					x			E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Ease of Access to Transload Site (e.g., consider usage of existing site)	A. Barge Only				x				B. HHT Only
	A. Barge Only					x			C. Rail Only (BNSF Only)
	A. Barge Only				x				D. HHT + Rail at French Island
	A. Barge Only				x				E. HHT + Rail at Merrillan
	B. HHT Only					x			C. Rail Only (BNSF Only)
	B. HHT Only					x			D. HHT + Rail at French Island
	B. HHT Only					x			E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)		x						D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)		x						E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Security Vulnerability of Route*	A. Barge Only			x					B. HHT Only
	A. Barge Only				x				C. Rail Only (BNSF Only)
	A. Barge Only			x					D. HHT + Rail at French Island
	A. Barge Only			x					E. HHT + Rail at Merrillan
	B. HHT Only					x			C. Rail Only (BNSF Only)
	B. HHT Only				x				D. HHT + Rail at French Island
	B. HHT Only				x				E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)		x						D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)		x						E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island				x				E. HHT + Rail at Merrillan
Number of Police Stations Nearby Route*	A. Barge Only			x					B. HHT Only
	A. Barge Only					x			C. Rail Only (BNSF Only)
	A. Barge Only						x		D. HHT + Rail at French Island
	A. Barge Only					x			E. HHT + Rail at Merrillan
	B. HHT Only					x			C. Rail Only (BNSF Only)
	B. HHT Only						x		D. HHT + Rail at French Island
	B. HHT Only						x		E. HHT + Rail at Merrillan
	C. Rail Only (BNSF Only)					x			D. HHT + Rail at French Island
	C. Rail Only (BNSF Only)					x			E. HHT + Rail at Merrillan
	D. HHT + Rail at French Island			x					E. HHT + Rail at Merrillan

Attachment D: Route Information from START for La Crosse

Route	HHT Distance (mi.)	Barge Distance (mi.)	Rail Distance (mi.)
A. Barge Only	0	501	0
B. HHT Only	513	0	0
C. Rail (BNSF Only)	0	0	495
D. HHT/Rail Transload at French Island, WI	21	0	709
E. HHT/Rail Transload at Merrillan, WI	80	0	877

Parameter	**Route > Metric** \/	A. Barge Only	B. HHT Only	C. Rail (BNSF Only)	D. HHT/Rail Transload at French Island, WI	D. HHT/Rail Transload at Merrillan, WI
Total Dist. (mi)		500.65	513.16	494.71	730.7	957.4
Travel Time (hours)	Duration	72	7	12	20	27
Accident Likelihood (per mile/year)	Accidents	0.1594	0.2997	0	0.0034	0.0197
Water Crossings	Acceptability	0	39	52	51	101
Average Track Class		N/A	N/A	3.7	3.7	3.5
Average Rail Traffic Density		N/A	N/A	5.1	5	3.7
Average Pop Density (/ mi^2)		364.7	255.7	217.7	700.4	523.3
Total Population	Pop Dose	20,360	83,140	70,796	117,598	283,910

Parameter	**Route > Metric \/**	A. Barge Only	B. HHT Only	C. Rail (BNSF Only)	D. HHT/Rail Transload at French Island, WI	D. HHT/Rail Transload at Merrillan, WI
Mass Gathering Places	Pop Dose	47	61	101	176	240
Tribal Lands (per mi^2)	Acceptability	0	0.14	0.07	0.07	0.08
Sensitive Environ. Area (/ mi^2)	Acceptability	92.41	13.32	43.8	50.65	22.24
Locks		17	N/A	N/A	N/A	N/A
Tunnels		0	0	0	3	1
Emergency Response Capability (/ mi^2)		0.06	0.05	0.15	0.2329	0.1791
Fire Departments (per mi^2)		0.03	0.03	0.09	0.1205	0.0991
Police (per mi^2)		0.03	0.02	0.06	0.1011	0.0808
Hospitals (per mi^2)		0	0	0	0.0014	0.0091

Parameter	**Route > Metric** \/	A. Barge Only	B. HHT Only	C. Rail (BNSF Only)	D. HHT/Rail Transload at French Island, WI	D. HHT/Rail Transload at Merrillan, WI
Educational Institutions (total)		15	45	38	68	218
Grammar Schools		14	40	36	66	210
Higher Education		1	5	2	2	8
Special Age Groups (total)		10	47	41	70	182
Day Care		10	29	27	45	113
Nursing Homes		0	18	14	25	69

Parameter	**Route > Metric** \/	A. Barge Only	B. HHT Only	C. Rail (BNSF Only)	D. HHT/Rail Transload at French Island, WI	D. HHT/Rail Transload at Merrillan, WI
Railroad Crossings (total at grade)		0	19	616	638	1275
Signs		0	0	107	104	283
Signals		0	1	158	147	81
No signs or signals		0	0	0	0	0
Both signs / signals		0	0	0	0	0
Unknown signs/signal		0	18	351	387	911