INITIAL SITE-SPECIFIC DE-INVENTORY REPORT FOR SAN ONOFRE

DECEMBER 2024

U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY | SPENT FUEL & HIGH-LEVEL WASTE DISPOSITION

PNNL-37106

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Initial Site-Specific De-Inventory Report for San Onofre Nuclear Generating Station (SONGS)

RPT-3018876-000

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REVISION LOG

Rev.	Date	Affected Pages	Revision Description
000	11/22/24	N/A	Initial Issue

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LIST OF ACRONYMS

AAR	Association of American Railroads
AEA	Atomic Energy Act
AHSM	Advanced Horizontal Storage Module
ALARA	As Low As Reasonably Achievable
AMP	Aging Management Program
ANSI	American National Standards Institute
ASNT	American Society for Nondestructive Testing
AZ	Arizona
BNSF	Burlington Northern Santa Fe Railway
BOL	Bill of Lading
CA	California
CAD	Computer Aided Drawing
CBR	Cask Bottom Region
CEC	Cavity Enclosure Container
CFR	Code of Federal Regulations
CLS	Closure Lid System
CO	Crane Operator or Colorado
CoC	Certificate of Compliance
COSS	Cask Operations Shift Supervisor
COTP	Captain of the Port
CRCPD	Conference of Radiation Control Program Directors, Inc.
CTR	Cask Top Region
DHS	Department of Homeland Security
DOE	Department of Energy
DOT	Department of Transportation
DSC	Dry Storage/Shielded Canister
EO	Tractor/JCB Driver and Equipment Operator
ERP	Emergency Response Plan
EV	Enclosure Vessel
FEMA	Federal Emergency Management Agency
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FSAR	Final Safety Analysis Report
FSO	Facility Security Officer
FSP	Facility Security Plan
ft	feet
GCS	Gamma Capture Space
GCUS	Geographical Center of the 48 Contiguous United States
GPS	Global Positioning System
GTCC	Greater Than Class C
GWd	GigaWatt-day
HAZMAT	Hazardous Material
HBF	High Burnup Fuel
HHT	Heavy Haul Truck/Transport
HI-STAR	Holtec International Storage, Transport, And Repository

HLW	High-Level Radioactive Waste
HRCQ	Highway Route Controlled Quantity
HSM	Horizontal Storage Module
HSR	High-Speed Rail
HTUA	High Threat Urban Areas
IA	Iowa
ID	Idaho
IFBA	Integral Fuel Burnable Absorber
IL	Illinois
IMO	International Maritime Organization
in	inch
ISFSI	Independent Spent Fuel Storage Installation
ISR	Independent Safety Review
KS	Kansas
kW	Kilowatt
lbs	Pounds
LLC	Limited Liability Corporation
LLEA	Local Law Enforcement Agency
LLW	Low-Level Radioactive Waste
M&TE	Measuring and Test Equipment
MCC	Movement Control Center
MHDP	Multi-Hazards Demonstration Project
MO	Missouri
MOTCO	Military Ocean Terminal Concord
MPC	Multi-Purpose Canister
mph	miles per hour
MTHM	Metric Tons Heavy Metal
MTSA	Maritime Transportation Security Act
MUA	Multi-Attribute Utility Analysis
MWe	MegaWatt electric
NE	Nebraska
NCS	neutron capture space
NFAH	Non-Fuel Assembly Hardware
NOAA	National Oceanic and Atmospheric Administration
NRC	U.S. Nuclear Regulatory Commission
NRHM	Non-Radioactive Hazardous Materials
NV	Nevada
NWPA	Nuclear Waste Policy Act
O&M	Operations and Maintenance
OJT	On the Job Training
OK	Oklahoma
OM	Operations Manager
OSG	Old Steam Generator
OSHA	Occupational Safety and Health Administration
OTR	Over-the-Road
Perkins STC	Perkins Specialized Transportation Company
PHMSA	Pipeline and Hazardous Materials Safety Administration

PIH	Poisonous Inhalation Hazard
POS	Point of Switch
PPE	Personal Protective Equipment
PSDAR	Post-Shutdown Decommissioning Activities Report
PSRR	Pacific Sun Railroad
PW	Procedure Writer
PWR	Pressurized Water Reactor
QA	Quality Assurance
QAP	Quality Assurance Program
QC	Quality Control
QS	QA/QC Specialist
RAM	Radioactive Materials
RCT	Radiation Control Technician
RM	Rigger/Cask Operations Technician/Mechanic
RP	Radiation Protection
RPV	Reactor Pressure Vessel
RSAT	Risk and Security Assessment Team
RSSM	Rail Security Sensitive Materials
RVI	Reactor Vessel Internal
RWC	Radioactive Waste Container
RWP	Radiation Work Permit
SAR	Safety Analysis Report
SCE	Southern California Edison Company
SFP	Spent Fuel Pool
SME	Subject Matter Expert
SNF	Spent Nuclear Fuel
SONGS	San Onofre Nuclear Generating Station
SP	Security Personnel
SPMT	Self-Propelled Modular Transporter
START	Stakeholder Tool for Assessing Radioactive Transportation
TC	Transport and Waste Management Coordinator
TEU	Twenty-Foot Equivalent Unit
TIH	Toxic Inhalation Hazards
TPE	Training Program Evaluation
TS	Training Specialist
TSA	U.S. Transportation Security Administration
TWIC	Transportation Worker Identification Credential
TX	Texas
UMAX	Underground Maximum
UP	Union Pacific
U.S.	United States
USACE	U.S. Army Core of Engineers
USCG	U.S. Coast Guard
UT	Utah
VCT	Vertical Cask Transporter
VSP	Vessel Security Plan

VVM	Vertical Ventilated Module
VW	Variable Weight
WY	Wyoming

EXECUTIVE SUMMARY

The purpose of this report is to assist the United States (U.S.) Department of Energy's (DOE) preparations for transporting spent nuclear fuel (SNF) and applicable Greater Than Class C (GTCC) low-level radioactive waste (LLW) to a future federal consolidated interim storage facility. This report addresses the tasks, equipment, and interfaces necessary for the complete de-inventory of the San Onofre Nuclear Generating Station (SONGS) independent spent fuel storage installation (ISFSI) site. It is located near the town of San Clemente, CA, approximately 70 miles southeast of Los Angeles, CA and 60 miles northwest of San Diego, CA. As such, this report is intended to provide information useful for planning options within an integrated nuclear waste management system.

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

The MUA results identified a ranking of six possible routes from the SONGS site, listed here in order of decreasing favorability as analyzed by the MUA:

1) An all-rail route with the railcars loaded on the on-site SONGS rail spur and then travel about 2,200 miles to GCUS via one rail carrier;
2) An all-rail route with the railcars loaded on the on-site SONGS rail spur and then travel about 2,350 miles to GCUS via two rail carriers;
3) A short HHT route of approximately 2 miles northwest of the SONGS site, across from the San Onofre State Park to existing rail track where a transload occurs from the HHT to railcars and then travel by rail for about 2,200 miles via one rail carrier to GCUS;
4) A HHT route of about 19 miles south to Camp Pendleton in Del Mar, CA to a barge landing where a transload occurs from the HHT to a barge and then travel by barge about 550 miles to Military Ocean Terminal Concord (MOTCO) where a transload occurs from barge to railcars and then travel by rail about 2,220 miles via one rail carrier to GCUS;
5) A HHT route of about 61 miles south to Port of San Diego, CA where a transload occurs from the HHT to a vessel and then travel by vessel about 5,200 miles via the Panama Canal to Port of Houston, TX where a transload occurs from vessel to railcars and then travel by rail about 850 miles via one rail carrier to GCUS; and
6) A HHT route of about 61 miles north to Los Angeles Port, CA where a transload occurs from the HHT to a vessel and then travel by vessel about 5,250 miles via the Panama Canal to Port of Houston, TX where a transload occurs from vessel to railcars and then travel by rail about 850 miles via one rail carrier to GCUS.

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 consistent rankings: the highest ranked route (Direct Rail to GCUS via one rail carrier) always remained the same and no changes occurred between the ranking of the remaining routes either with the Direct Rail to GCUS via two rail carriers ranked second, the heavy haul truck to rail ranking third, the heavy haul truck to barge to rail ranking fourth, and the heavy haul truck to vessel to rail routes ranking fifth and sixth.

Using the primary MUA result, a concept of operations and a recommended budget and spending plan are detailed for the removal of SNF and GTCC LLW from the SONGS site using the most attractive shipment route: direct rail from the site on BNSF (Burlington Northern Santa Fe Railway) to the GCUS. The total estimated budget for the entire SONGS campaign organized over 120 weeks (based on specific assumptions and estimates identified in the report) is $34M (2024). Also documented in this assessment are aspects of a Security Plan and associated procedures and an Emergency Response Plan and associated preparedness for the prospective shipments. Finally, a set of actions to be taken before initiating the removal of the SNF and GTCC LLW from the SONGS site are proposed.

1.0 INTRODUCTION

This report provides an assessment of the tasks, equipment, and interfaces that would be necessary to remove the spent nuclear fuel (SNF) and Greater Than Class C (GTCC) low-level waste (LLW) from the San Onofre Nuclear Generating Station (SONGS) Independent Spent Fuel Storage Installation (ISFSI) located near the town of San Clemente, CA, approximately 70 miles southeast of Los Angeles, CA and 60 miles northwest of San Diego, CA. The objective of this removal activity would be to transport the SNF and GTCC LLW to a Class I railroad, where it could then be transported to a future federal consolidated interim storage facility or geological repository. A railroad hub in the central U.S. with connections to all other major rail carriers (aka the geographical center of the 48 contiguous United States, GCUS) 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 does not imply that this location is being considered for a future federal 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.

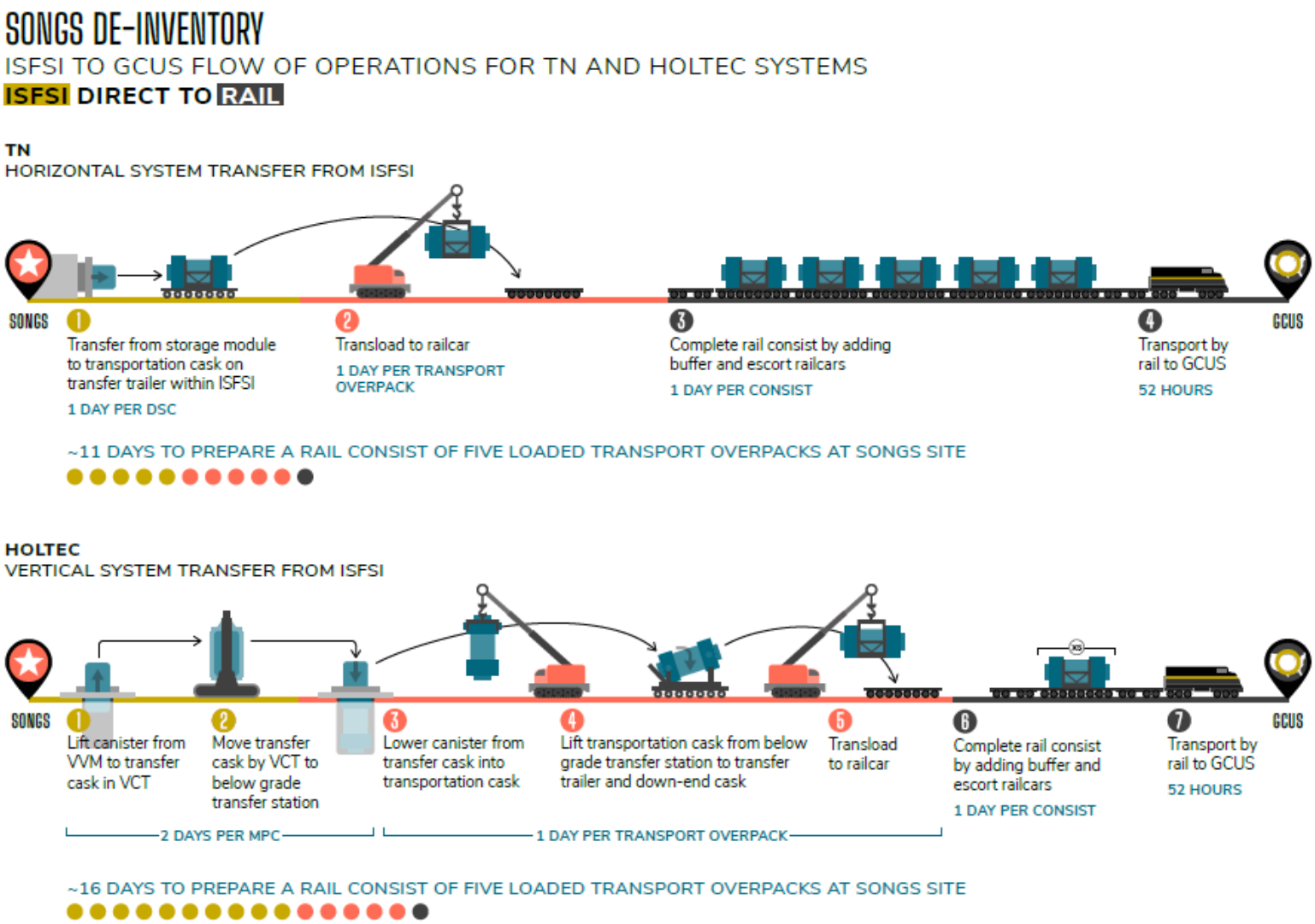
In performing this assessment, the results are expected to support preparations for transporting SNF and applicable GTCC low-level radioactive waste to a future federal consolidated interim storage facility for the U.S. Department of Energy (DOE). This assessment specifically examines the removal of the SNF and GTCC LLW contained within the SONGS ISFSI using the Orano team's 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 Department of Transportation (DOT) using U.S. Nuclear Regulatory Commission (NRC) certified packages and approved routes like comparable commercial shipments.

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 SNF and the GTCC LLW to be shipped from the site; and a description of the TN Advanced NUHOMS and the Holtec UMAX systems used to store this material on-site and the associated transportation packaging systems, the TN MP197HB cask and the Holtec HI-STAR 190 cask (Holtec International Storage, Transport, And Repository). The site information is vital to establishing if sufficient space exists to perform transfer activities and 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 transportation casks from the SONGS 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. Ultimately a formal inspection would be necessary to verify assumed site criteria. The characteristics of the SNF and GTCC LLW at the SONGS ISFSI were reviewed against the requirements found in the NRC Certificate of Compliance (CoC) for these transportation packaging systems. Similarly, the information for the canisters to be shipped were also reviewed against the associated requirements in their respective CoCs. Finally, the information about the storage systems in use were reviewed along with the characteristics of their respective transportation packaging systems to identify any challenges to the ability to transfer the canisters into the transportation packaging systems. If any

potential issues were identified during these reviews, the problems were documented along with any needed or recommended corrective actions, including the possible need to revise the CoC or request an exemption from the regulator.

After the pertinent site information was assessed and a transportation route analysis was performed, as described in **Section 3.0**, transportation routes from the SONGS ISFSI to a Class I railroad were identified, which could be used for subsequent shipment to a federal repository or interim storage facility. Multiple modes of transport of the SNF and GTCC LLW were considered (i.e., heavy haul truck [HHT], rail, and barge). From the SONGS ISFSI site itself, all three modes were evaluated to be viable options for shipment of the SNF and GTCC LLW, however no viable barge landings were identified for direct barge routes from the site, instead barge routes were identified that first required HHT transport to a transload site to a barge. **Figure 1-1** through **Figure 1-4** depict the major steps of the potential transfer scenarios considered for the evaluated routes. As shown in these figures, the direct to rail scenario is the least complicated approach, with the minimum number of times a cask and canister need to be handled, whereas the HHT and barge/vessel scenarios are more complicated, with additional handling activities. The assessment of the transportation routes resulted in a listing of multiple viable routes with both positive and negative attributes that require evaluation to identify the optimal and/or favored route to transport the SNF and GTCC LLW from the SONGS site.

Figure 1-1: Potential Flow of Operations per Mode of Transport from the SONGS ISFSI: ISFSI Direct to Rail



(Note: VVM is the Vertical Ventilated Module and VCT is the vertical cask transporter)

Figure 1-2: Potential Flow of Operations per Mode of Transport from the SONGS ISFSI: ISFSI to HHT to Rail

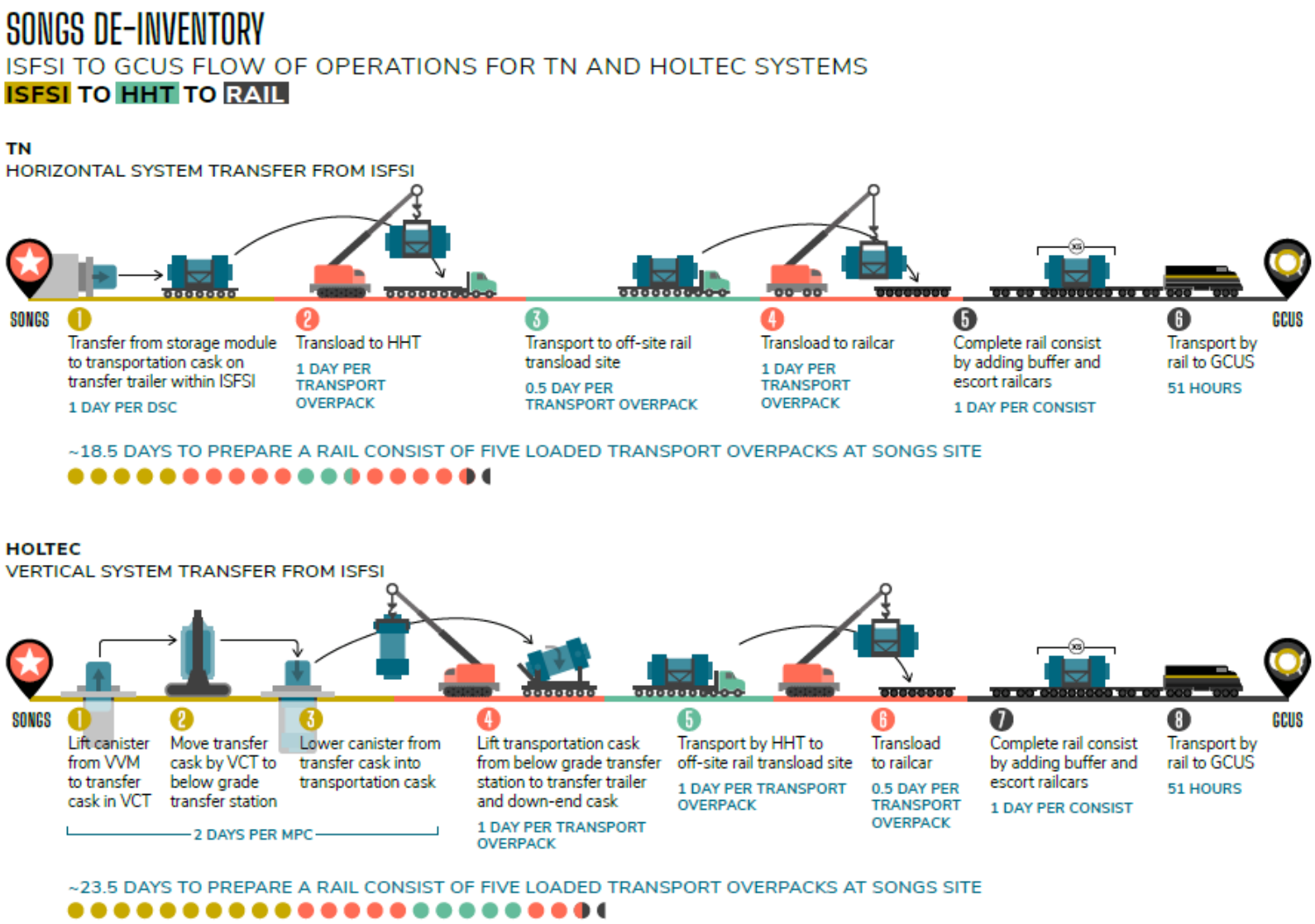


Figure 1-3: Potential Flow of Operations per Mode of Transport from the SONGS ISFSI: ISFSI to HHT to Vessel to Rail

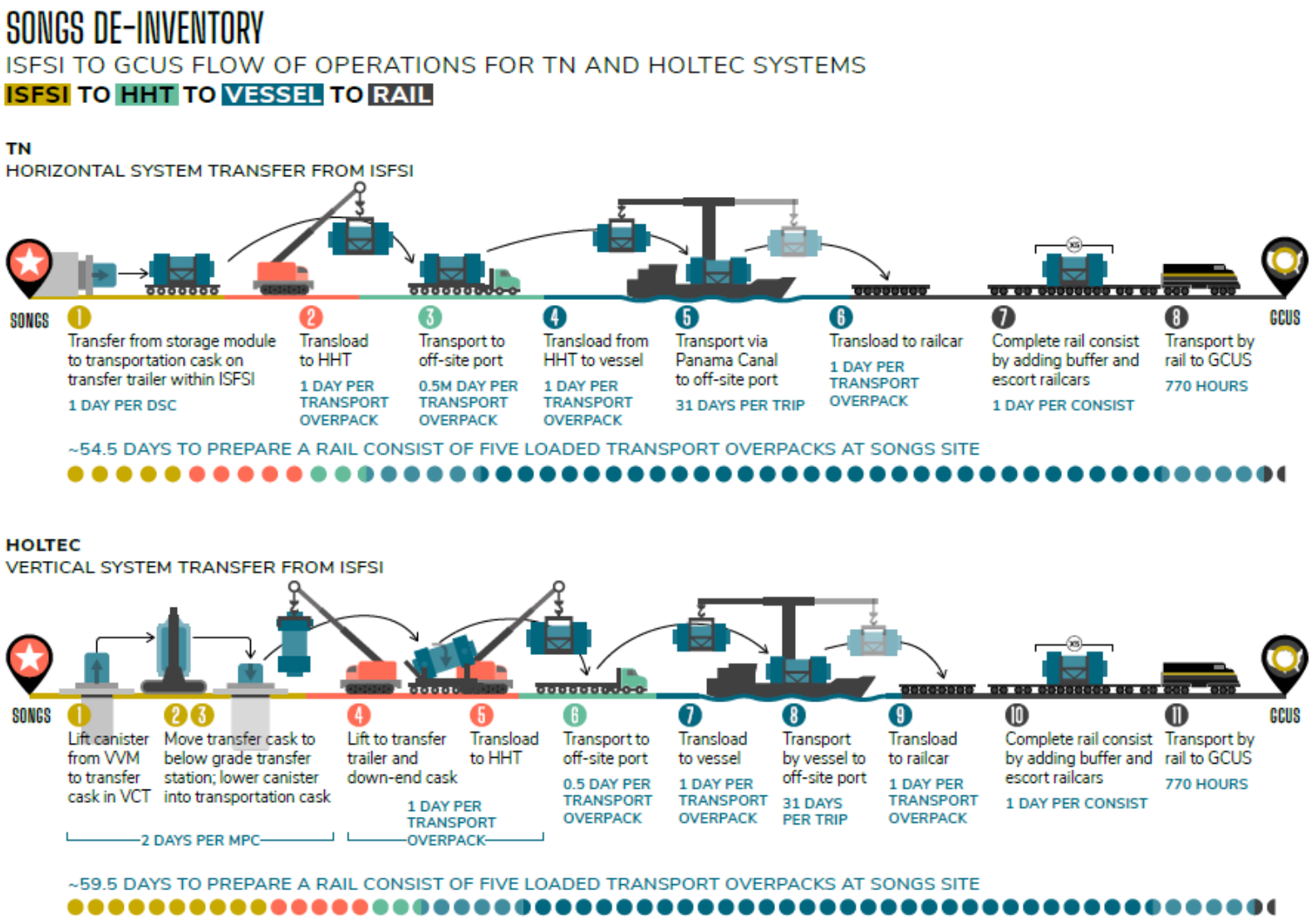
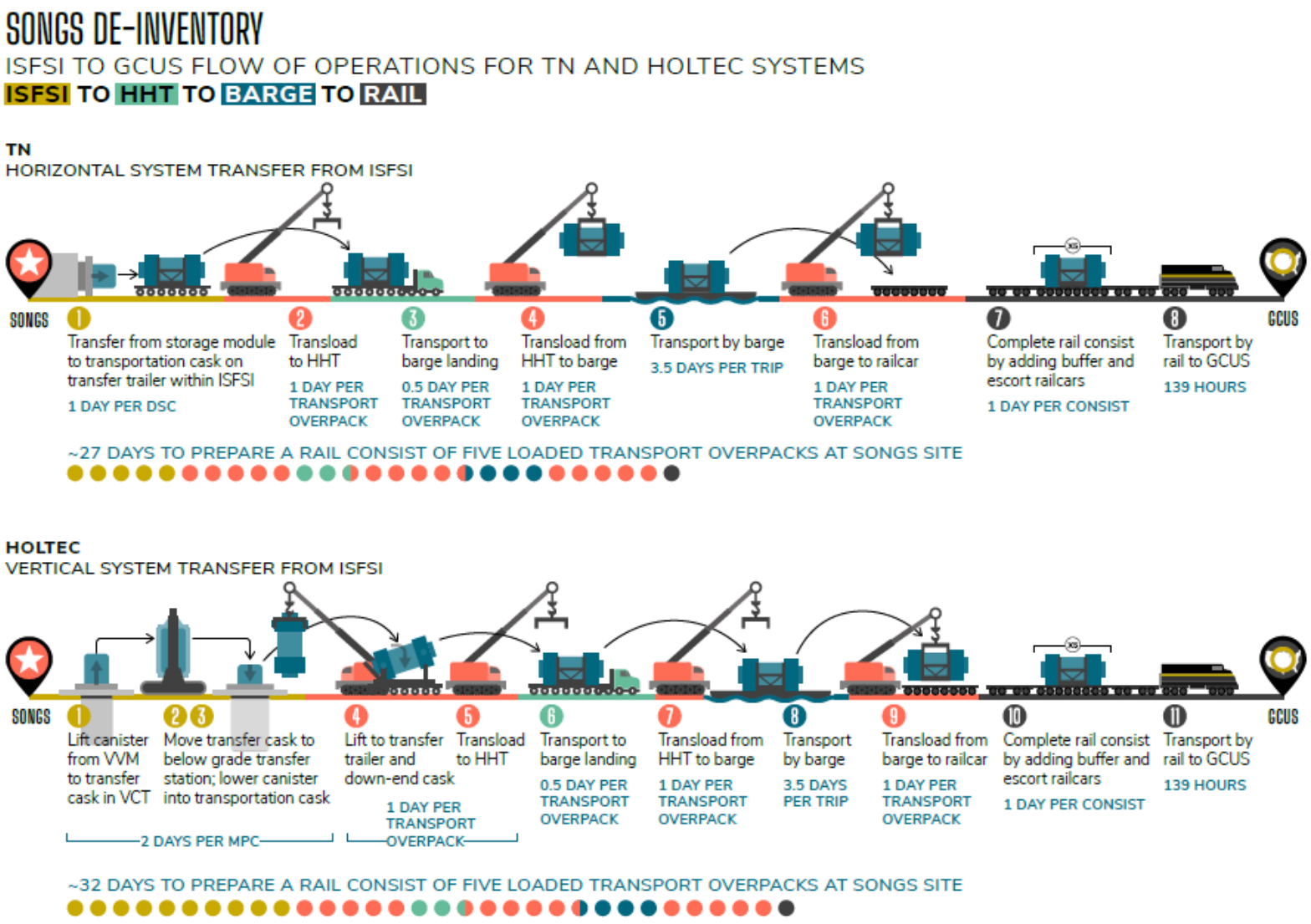


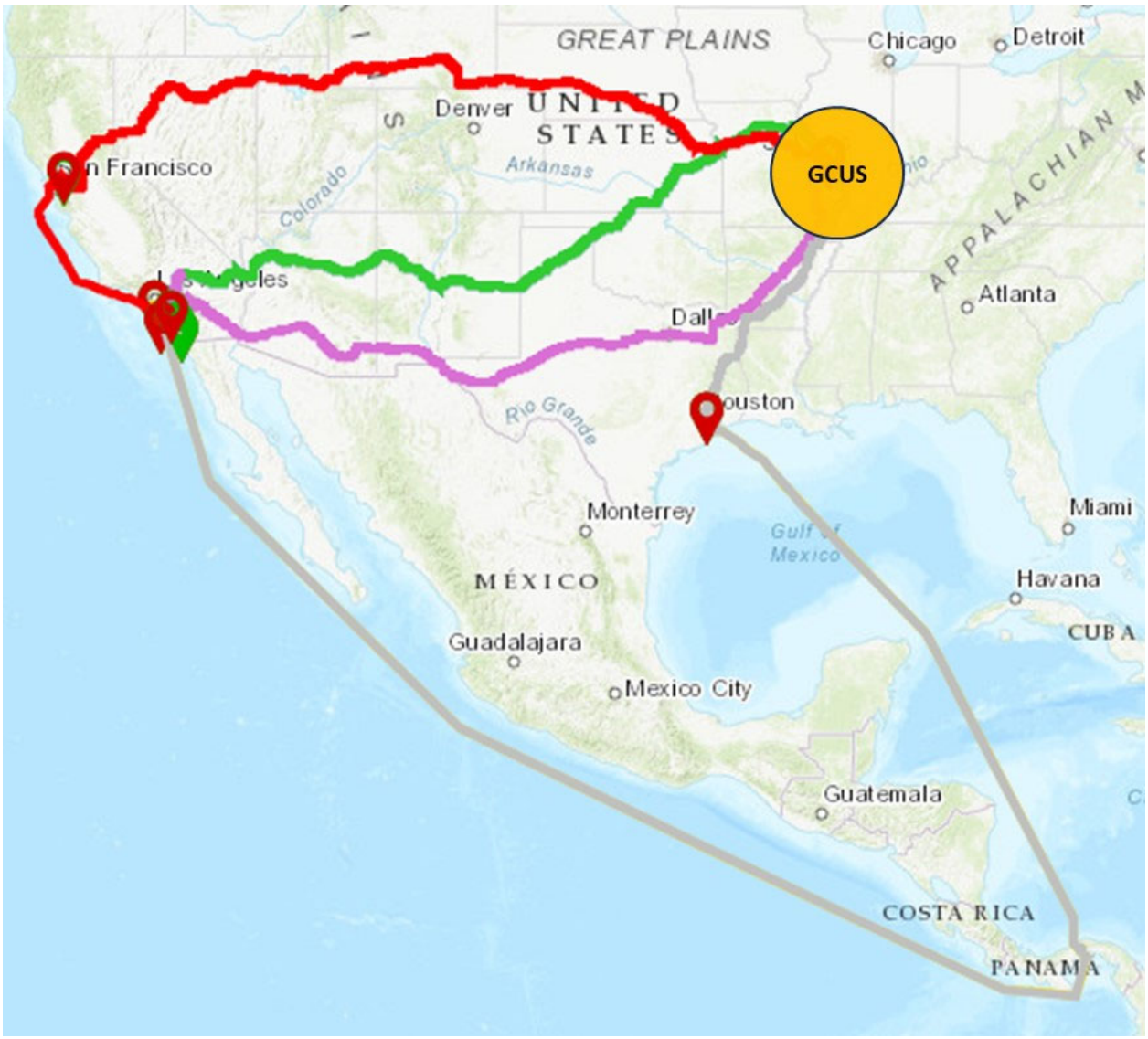
Figure 1-4: Potential Flow of Operations per Mode of Transport from the SONGS ISFSI: ISFSI to HHT to Barge to Rail



A Multi-Attribute Utility Analysis (MUA) was selected as the means to assess and rank the various routes and modes. 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 3.0** to reduce the number of identified routes from greater than 20 to a more manageable six. After the participating entities were identified in **Section 4.0**, these six routes were evaluated using the MUA to rank the routes for shipping the SNF and GTCC LLW from SONGS to the hypothetical destination of GCUS by Class I rail in **Section 5.0**. **Figure 1-5** identifies the routes evaluated in the MUA.

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 **Sections 6.0** and **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 SNF and GTCC LLW from SONGS.

Figure 1-5: Possible Routes Evaluated by the MUA for Shipment of SNF and GTCC LLW from SONGS ISFSI



The routes are described in further detail in **Section 3.0**. These figures were produced using results from DOE's Stakeholder Tool for Assessing Radioactive Transportation (START) software [1]. The colored lines indicate the routes analyzed by the MUA as explained in **Section 5.0**.

2.0 PERTINENT SITE INFORMATION

2.1 Description of Site/Characteristics

2.1.1 Overview

The San Onofre Nuclear Generating Station (SONGS) site, owned by Southern California Edison (SCE) Company, is located on California's Pacific coast, near the town of San Clemente. SONGS is approximately 70 miles southeast of Los Angeles and 60 miles northwest of San Diego. **Figure 2-1** and **Figure 2-2** show the locations of SONGS, relative to major and minor landmarks [2].

The site is bordered on the southwest by the Pacific Ocean and on the northeast by Old Pacific Highway, which is adjacent to Interstate Route 5 (I-5). The site is between two public access parks, San Onofre State Beach and San Onofre Bluffs Campground, to the northwest and southeast along the coastline, respectively. The site elevation is near or below 100-ft [3]. The grades between SONGS and I-5 are minimal. The coast nearby SONGS is steep, with grades above 60%. Nearby topology is shown in **Figure 2-3**.

The SONGS site was built on an 84-acre site, leased from the US Marine Corps' Camp Pendleton [4]. The site boundaries, including the disconnected Mesa Complex, are shown in **Figure 2-4**. In general, this report does not address the Mesa Complex, which was returned to the Department of Navy on June 1, 2023. When discussing the site, only the section that captures the reactor buildings (Units 1, 2, and 3), shown in **Figure 2-5**, is relevant, unless noted otherwise. Within the site there is a closed area boundary, shown in **Figure 2-6**, that only contains the ISFSI and nearby components. This reduced controlled area boundary was approved for exemption on January 5th, 2023 [4].

SONGS consists of three reactor units labeled throughout as Unit 1, Unit 2, and Unit 3. Unit 1, a Westinghouse 3-loop pressurized water reactor (PWR) that generated 456 Mwe gross, began operation in 1968 and shut down permanently in 1992 [4]. Units 2 and 3, two Combustion Engineering 2-loop PWRs that each generated 1,127 Mwe gross, began operation in 1983 and 1984, respectively, and both shutdown in 2012. By August of 2020, all fuel had been moved out of the spent fuel pool and loaded into casks at the ISFSI [7].[1]

In June 2013, SCE announced plans to permanently retire Units 2 and 3 at SONGS. On June 12, the licensee submitted a Certification of Permanent Cessation of Power Operations to the NRC, certifying that SCE has permanently ceased power operations at SONGS Units 2 and 3. With this announcement, the NRC staff established an inspection and oversight program that is appropriate for the licensee's proposed decommissioning activities. In September 2014, SCE submitted to the NRC the SONGS Post-Shutdown Decommissioning Activities Report (PSDAR) [8].

The nearest railroad line runs north and south along Old Pacific Highway and is a Class I railroad, BNSF. The rail line is operationally shared between the single freight line and multiple commuter rail carriers.

[1] The SONGS ISFSI is a single ISFSI but with two storage systems located separate from one another. There is one ISFSI manager for the site and one fence line for the ISFSI around both storage systems.

Figure 2-1: SONGS Location in Relation to Nearby Major Metropolitan Areas [2]

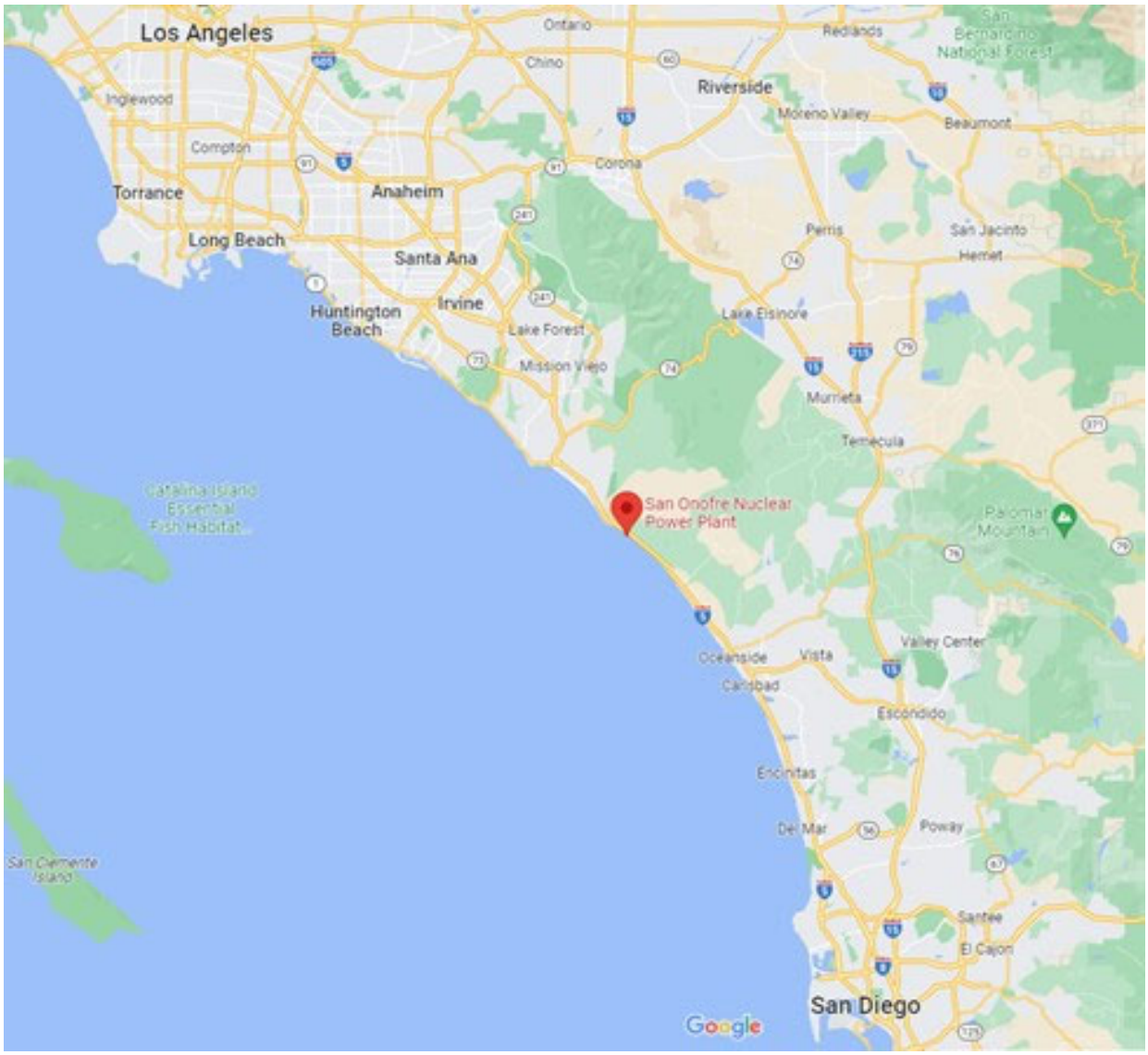


Figure 2-2: SONGS Location in Relation to Local Parks and Communities [2]

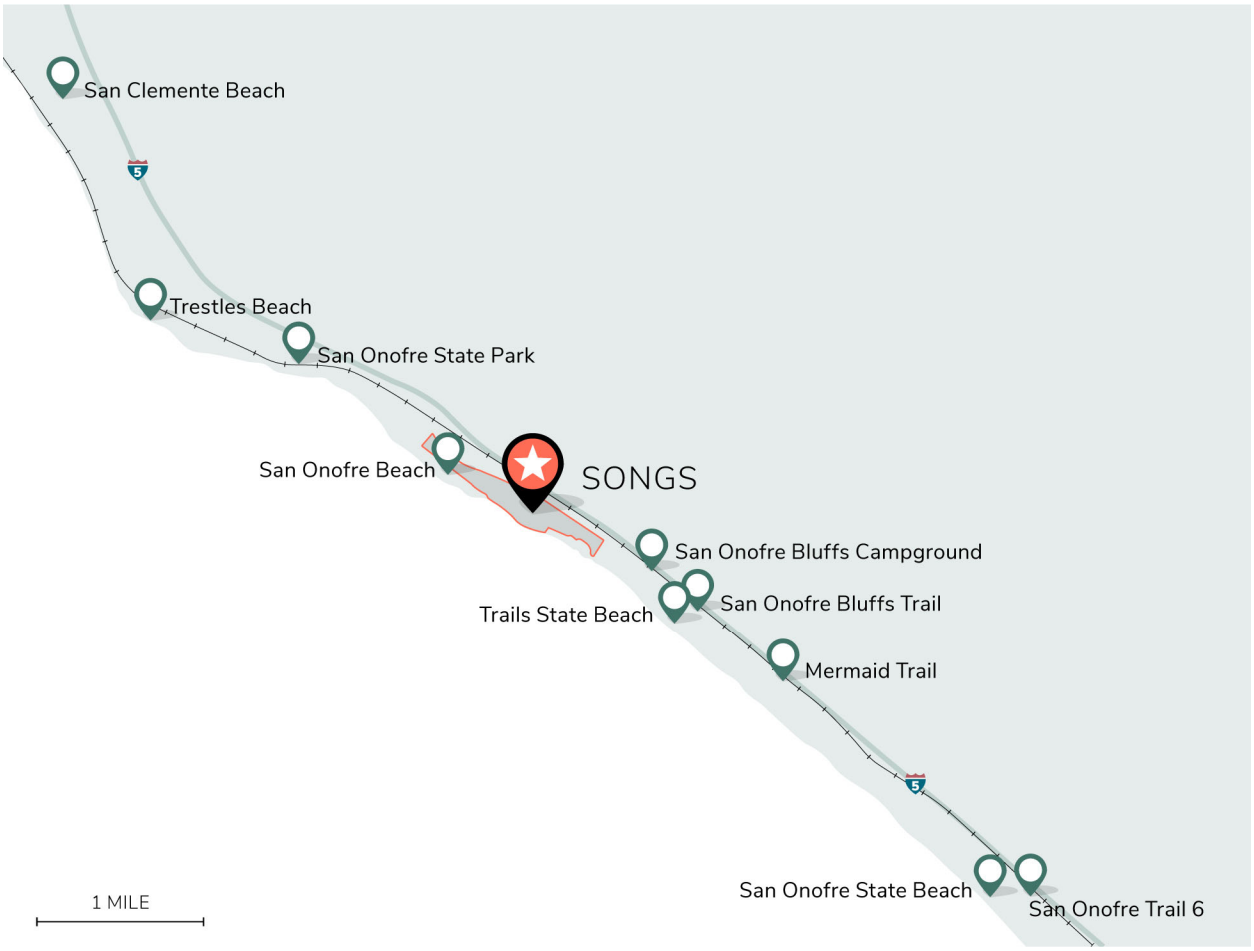


Figure 2-3: SONGS Site and Near-Site Topography Map [3]

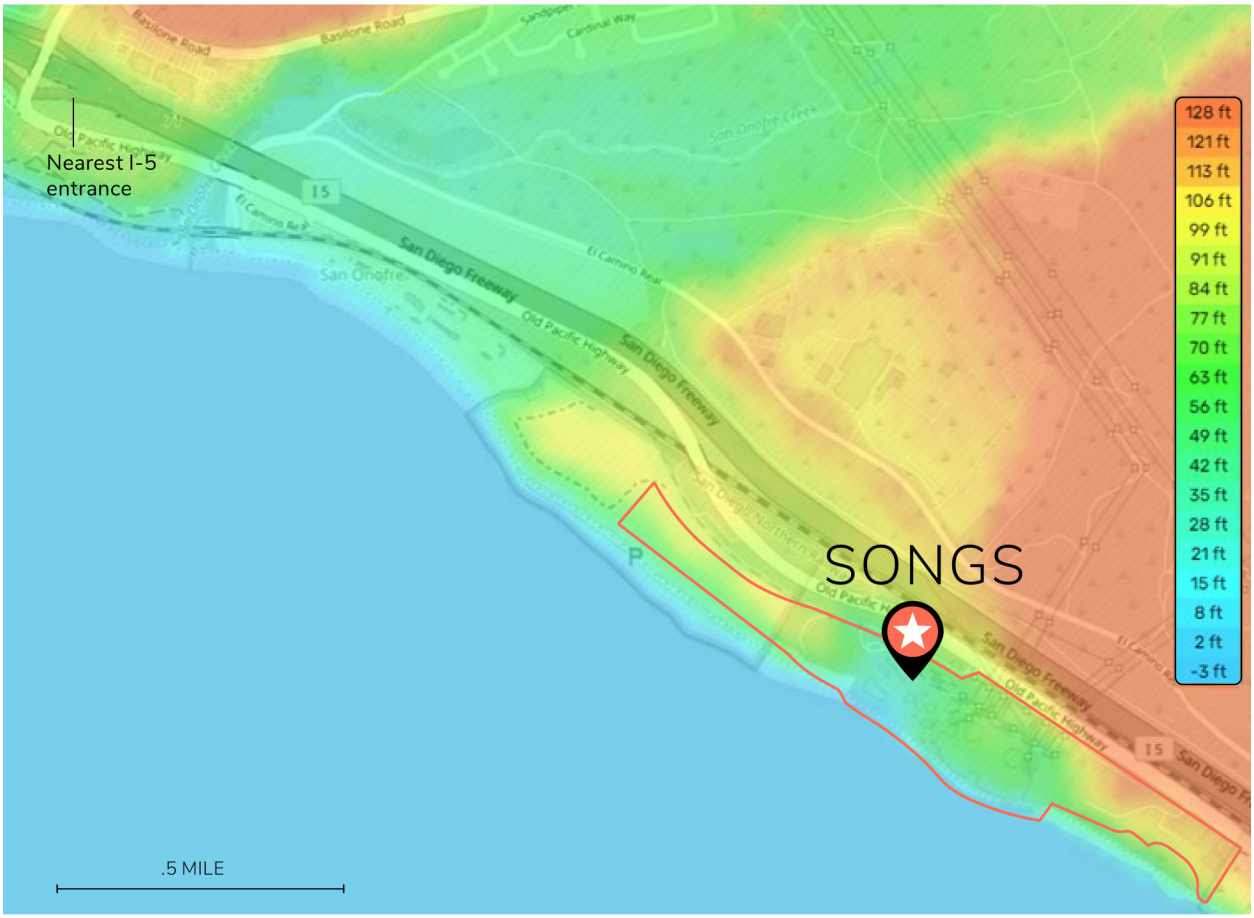
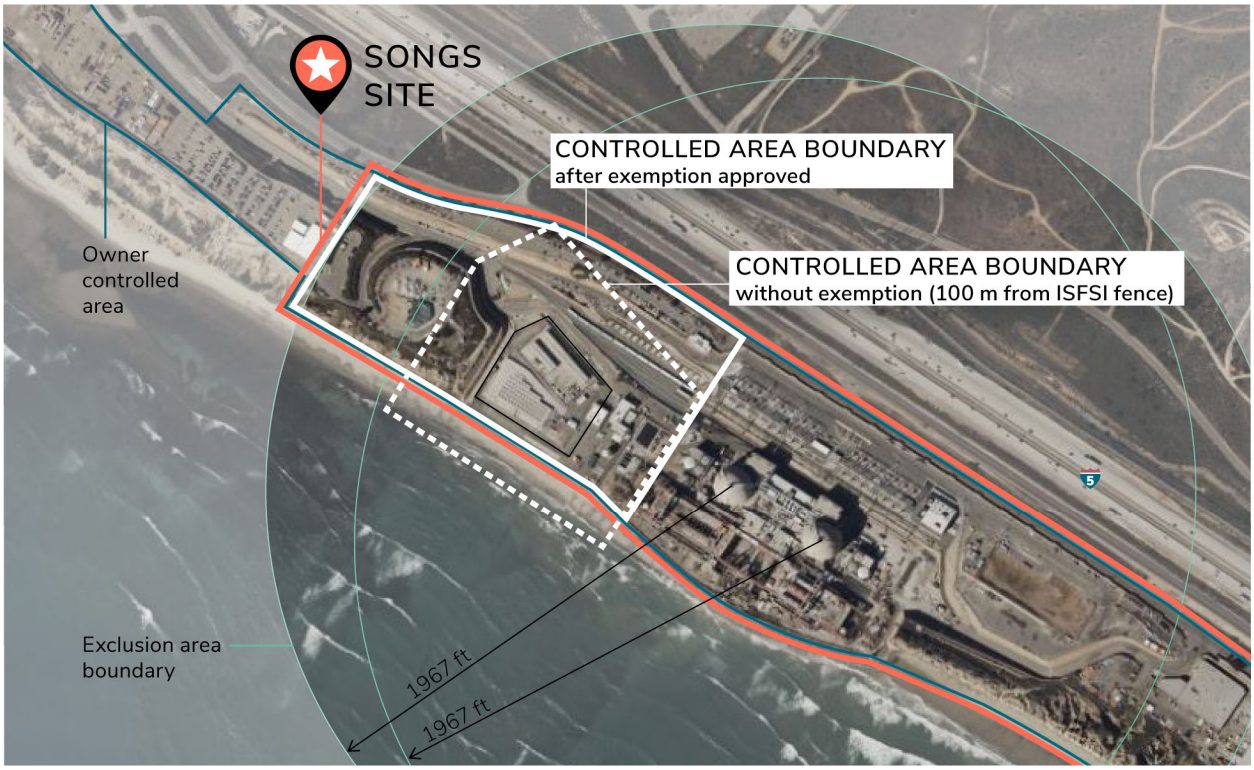


Figure 2-4: SONGS Site Boundaries

Figure 2-5: SONGS Site Layout, Unit Locations

Figure 2-6: Approximate SONGS Boundaries [5]



2.1.2 Site Infrastructure

SONGS is directly rail-served by Class I railroad, BNSF. BNSF sold the rail line, which includes the on-site rail and the rail traveling by the site, to The North County Transit District, which runs multiple commuter trains over the line. BNSF is the only freight carrier that operates over this line. BNSF has controlling rights to the spur leading into the SONGS site up to the point of switch (POS) where Beach Club Road crosses over the spur.

Prior to the commencement of decommissioning activities, the plant was served by a Class III short line called Pacific Sun Railroad (PSRR). It conducted the day-to-day switching for the plant and BNSF only served the site to handle unit train shipments.

The main rail line near SONGS runs parallel to I-5. The on-site rail spur has been upgraded and the configuration of the track has been altered from the original footprint. Six new tracks were installed where the SONGS administrative, warehouse, and shop building had been located (see **Figure 2-7**). Two long tracks run parallel to one another and extend 1,670 feet from the POS to the first gate for the property and 529 feet farther to the demolished building where the new tracks are installed.

The rail line outside SONGS is also heavily used for various commuter trains, which impacts the timeslots available for serving the plant and for movement of freight trains through this area. This factor will need to be considered for timing outbound SNF movements.

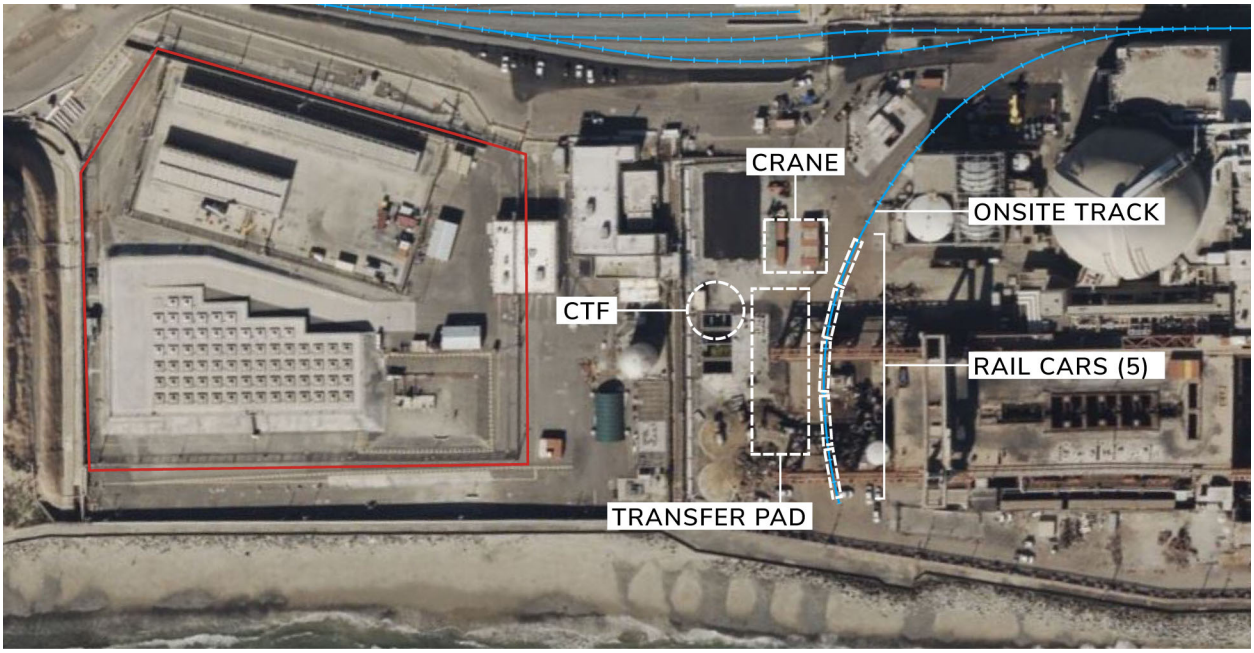
The HHT roads on site appear to be in good condition as they have been used for outbound truck shipments during decommissioning. Some of the grades within the site are steep, at 6 degrees, and

may affect the ability of heavy or larger items to be loaded properly as level areas are required to safely load specialized HHT trailers within the site. This was true for the outbound steam generators that had to be loaded onto a specialized trailer parked on Old Pacific Highway outside the main gate.

There is no on-site barge facility at SONGS.

There are two separate ISFSI storage facilities within SONGS as is described in **Section 2.2** with good access for loading outbound trains on a rail siding located 355 feet to the east of the ISFSIs.

Figure 2-7: On-Site Rail Spur Layout



(Note: The location of the CTF and Transfer Pad are suggestions in this figure and alternative locations for these facilities may be selected.)

2.1.3 Near-Site Transportation Infrastructure

2.1.3.1 Rail

As identified in the previous section, SONGS is directly rail-served by BNSF who sold the line to North County Transit District. BNSF continues to operate the freight service over the line. Prior to decommissioning, PSRR served the plant for day-to-day operations and BNSF only entered the site to pull unit trains. BNSF is now the only rail carrier to serve the site.

Several commuter train companies operate using the same mainline railroad track that is used to serve the plant, **Figure 2-8**. Some of the various companies operating passenger services along this line include: (1) Amtrak Pacific Surfliner and Metrolink commuter rail service (see **Figure 2-9**) which operate between Orange County and Oceanside, CA and (2) the North County Transit District which provides the Coaster and Sprinter commuter rail service between Oceanside and

San Diego and Oceanside and Escondido, CA [9]. As a result of the frequency of the commuter and passenger trains operating on this track, there are limited windows for the freight rail carrier to service SONGS.

Currently, the site is served twice per week on Tuesday and Thursday evenings. BNSF must get approval from the commuter lines to occupy the track to reach the plant. A service window is provided for the freight rail carrier to enter, switch, and exit the plant. BNSF normally switches the plant from midnight to approximately 4:00 am.

As of February 2022, there are 7 tracks inside the plant equaling a total of 6,125 feet of track providing the ability for the plant to hold 65 gondola railcars at once, **Figure 2-10**. The track configuration was upgraded in 2019 to add tracks where the old administrative, warehouse, and shop building was located. In addition, the existing switch (from the West) leading to the ISFSIs was replaced with a single track off the parallel tracks to the east. These tracks were added to expand track capacity to support removing debris from the site during decommissioning, **Figure 2-11**. Two of the tracks extend further into the site, parallel to one another, which can be seen in blue in **Figure 2-10**. The closest track to the ISFSI is approximately 355 feet east of the ISFSIs as shown in **Figure 2-10**.

There are no plans to further increase the track at the site. In fact the decommissioning contractor currently plans to remove the added tracks at the end of the decommissioning activities.

There is a significant grade (6%) from the point of switch to the plant tracks. Even though the track has a steep grade, the plant is routinely switched using one locomotive. **Figure 2-12** is representative of the grade along the tracks.

An additional storage track is located just outside the plant, across from San Onofre Beach Camp Pendleton, which is separated from the track by a wall that borders the campground. BNSF uses this track to temporarily store cars being placed or pulled from the plant. The track is 1,767 feet long and runs parallel to the mainline. The storage track is located ½ rail mile from the POS leading into the plant.

The rail yard that serves the site is located at Stuart Mesa, CA 11.7 rail miles south of the plant. Outbound loaded gondola cars are pulled by BNSF and move to BNSF's rail yard in Barstow, CA. Further movement is determined by the ultimate destination for the cars. Most of the outbound loaded railcars for decommissioning are being shipped to Clive, UT to the Energy*Solutions*' disposal site. Those cars move from Barstow, CA to West Colton, CA to interchange with Union Pacific (UP) for the balance of the move to the Clive disposal site.

The SONGS rail system is actively used with approximately 30 gondola railcars being shipped weekly.

Figure 2-8: Mainline Tracks Passing Near SONGS [2]

Figure 2-9: Metrolink Lines Passing Near SONGS [10]

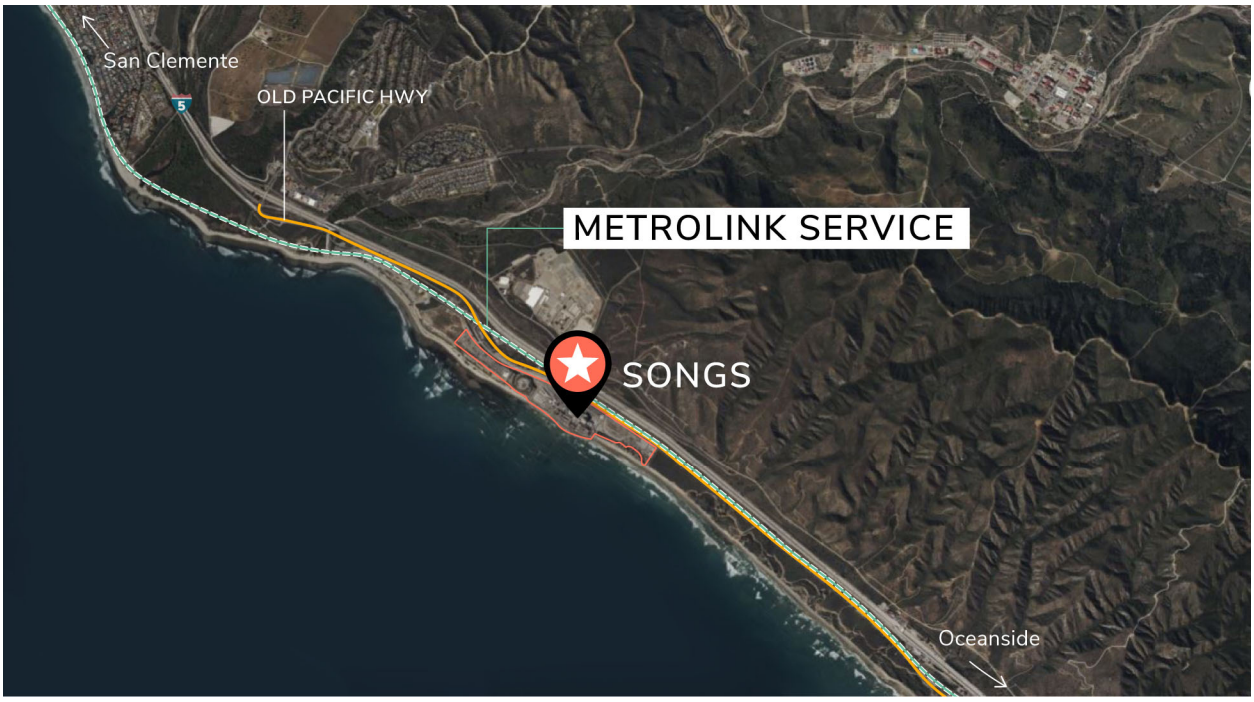


Figure 2-10: Rail Layout at SONGS

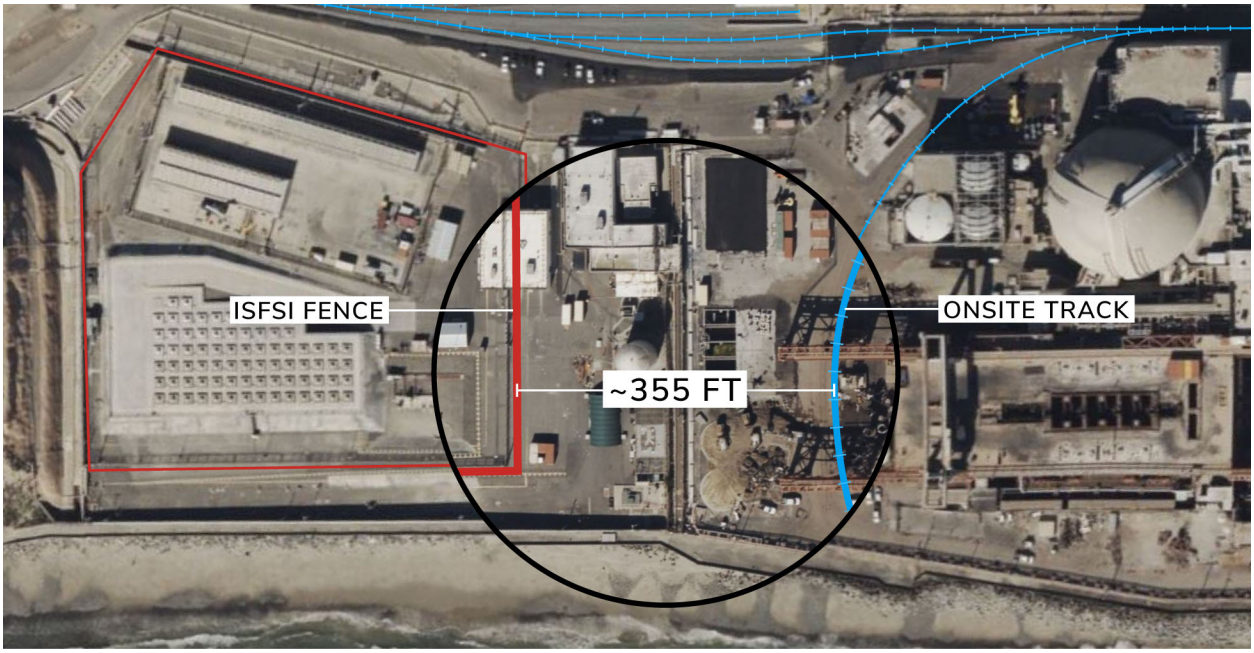


Figure 2-11: Newly Constructed Tracks at SONGS [11]

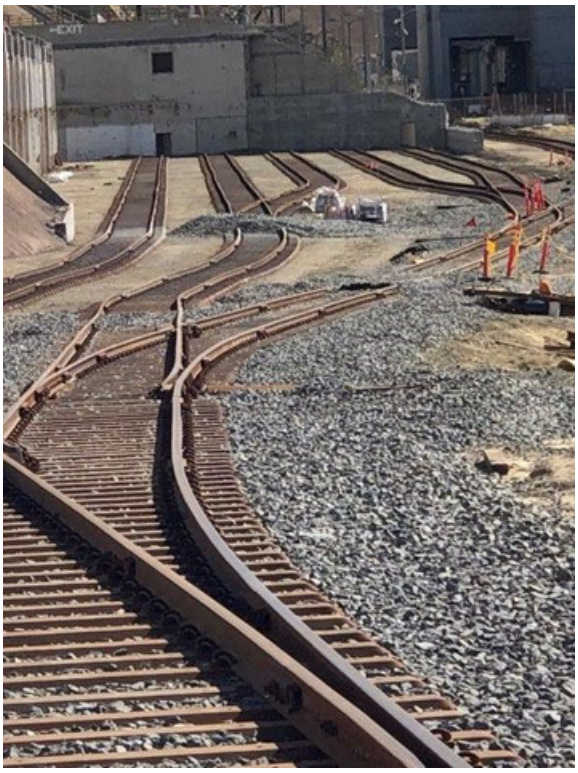


Figure 2-12: SONGS Access Road On-Site Grade [11]

2.1.3.2 Heavy-Haul Transport (HHT)

SONGS is situated just off Old Pacific Highway, very near I-5. I-5 North and I-5 South are each four lanes leading to Los Angeles and San Diego, respectively. Exiting the site can be accomplished using the existing on-site roads, which connect to a site access road. Access to Old Pacific Highway can be accomplished either by the northwest or southeast entrances, shown in **Figure 2-13**. The closest access to both I-5 North and I-5 South near SONGS is via a highway entrance approximately 3 miles northwest along Old Pacific Highway from the SONGS northwest entrance. However, depending on the length of the trailers being used and the weight of the loads in combination with the grades on site, negotiation of the turns required to reach I-5 may be challenging or may require a circuitous versus direct route to the highway. For example, some very unique solutions were required when the four generators were trucked from the site in 2015. The very long specialized trailer had to be loaded outside the main gate directly on Old Pacific Highway, instead of inside the plant [18].

Due to the changes in track configuration inside the plant, a short haul transport of 355 feet, shown in **Figure 2-10** from the ISFSIs to the on-site rail loading track, will be required.

Figure 2-13: SONGS Near-Site HHT Access Points

2.1.3.3 Barge

The site has no barge access, despite its location adjacent to the Pacific Ocean. At the time the plant was built, there was an attempt to construct a barge slip [9], but it was unsuccessful due to tidal (wave and current) activity, and the site remains without direct barge access today.

In the past, inbound shipments of replacement generators, imported from Kobe, Japan in 2008 and 2010 to the Port of Los Angeles and Port of Long Beach, were transloaded onto ABS barges and barged south of the plant to the Del Mar Boat Basin dock at Camp Pendleton for delivery to the site by tracked vehicles using a combination of private and public roads to reach the site. More details of these movements are described in **Section 3.0**.

2.1.4 Standardized Advanced NUHOMS System Details

The Advanced NUHOMS System provides for the horizontal storage of PWR SNF in a dry shielded canister (DSC) that is placed in an Advanced Horizontal Storage Module (AHSM), **Figure 2-14**. 1,187 SNF assemblies, out of the 3,855 total, are stored in 50 NUHOMS Dry Storage Canisters [12]. There are two NUHOMS system configurations present at SONGS, 17 are NUHOMS 24PT1-AHSM with 24PT1-DSC payload and the remaining 33 are NUHOMS 24PT4-AHSM with 24PT4-DSCs.

The Advanced NUHOMS System accommodates up to 24 PWR fuel assemblies with stainless steel or zircaloy cladding, uranium dioxide or U-Pu mixed oxide fuel pellets, Integral Fuel Burnable Absorber (IFBA) assemblies, and Non-Fuel Assembly Hardware (NFAH). Up to four assemblies may be stainless steel-clad damaged fuel assemblies in lieu of an equal number of

undamaged fuel assemblies or one failed mixed oxide assembly with no other failed assemblies in the 24PT1-DSC [13].

The DSC (24PT1-DSC and 24PT4-DSC) provides confinement, an inert environment, structural support, and criticality control for its contents. The 24PT1-DSC shell is a welded stainless steel pressure vessel that includes thick shield plugs at either end. The 24PT1-DSC basket consists of spacer discs, support rods, and poisoned guide-sleeves. The DSCs are longitudinally restrained to prevent movement [13].

Structural support for the SNF and basket guide-sleeves is provided by circular spacer disc plates. Axial support for the basket assembly is provided by four support rods. The support rods extend over the full length of the cavity with allowance provided for thermal growth of the support rods in the axial direction. Stainless-steel screened confinement cans can also be placed inside the 24PT1-DSC guide-sleeves for storage of damaged fuel assemblies.

The ASHM provides SNF decay heat removal, physical protection, and radiological protection for the 24PT1-DSC. The AHSM consists primarily of thick concrete walls, a steel support structure for the 24PT1-DSC, and a thick concrete door. Each AHSM includes thermal monitoring instrumentation. The AHSM provides the bulk of the radiation shielding for the 24PT1-DSC. Thick concrete supplemental shield walls are used at either end of an AHSM array and along the back wall of single-row arrays to minimize radiation dose rates both on-site and off-site. The AHSMs are “tied” to adjacent AHSMs but are not tied to the basemat.

In addition to these storage system components, the Advanced NUHOMS System utilizes transfer equipment to move the 24PT1-DSCs from loading operations to AHSMs. This transfer system consists of a transfer cask, a lifting yoke, a hydraulic ram system, a prime mover for towing, a transfer trailer, a cask support skid, and a skid positioning system. Auxiliary equipment such as a cask/canister annulus seal, a vacuum drying system, and an automated welding system are also used to facilitate canister loading, draining, drying, inerting, and sealing operations.

There are several differences between the 24PT1-DSC discussed above and the 24PT4-DSC, shown in **Figure 2-15** and **Figure 2-16**, respectively, that may affect removal of SNF from SONGS. The largest difference is that, compared to the 24PT1-DSC, the 24PT4-DSC is 10-inches longer, to accommodate larger fuels, as a result the former will require an additional sleeve and spacers, which are included in the licensed design and will be fabricated as needed, to be transported in MP197HB casks. Due to the additional length, AHSMs that hold 24PT4-DSCs do not have a spacer installed. Aside from lengths, minimal differences, such as individual component materials and number of internal support rods, exist but will have a negligible effect on the transfer and transport operations. There is no change to the loading, unloading, or transport operations when moving from 24PT1-DSC to 24PT4-DSC.

The 24PT1-DSC is not currently certified to ship in MP197HB (as seen in **Figure 2-33**), but rather the MP187 transport cask. While there is one MP187 cask that exists, MP187 impact limiters have not been fabricated, the fabrication of these is expected to be prohibitively expensive. As such, it is recommended that the canisters currently licensed for transport in the MP187 are licensed and transported in the MP197HB. As mentioned previously, axial spacers will be used as needed to account for the 10-inch height difference between 24PT1- and 24PT4-DSC, the radial gaps are managed by a sleeve inside of the MP197HB.

An alternate transportation cask, the TN Eagle SC, may be used instead as it was recently licensed under docket 71-9382 [65] and includes the 24PT1 and 24PT4 canisters. The RWCs however are

not included at this time and would need to be added during a licensing action. For this report, the MP197HB will be evaluated as the transportation cask for use. There are no differences between the MP197HB and TN Eagle SC transportation casks that would significantly impact the results of this report.

The system includes the following items:

The NUHOMS OS197 transfer cask (as seen in **Figure 2-31**) is used in the Advanced NUHOMS System, during DSC loading and closure operations and transfers to the AHSM.

The transfer trailer for the Advanced NUHOMS System consists of a heavy industrial trailer used to transfer the empty cask, support skid and the loaded transfer cask between the plant's fuel/reactor building and the ISFSI. The trailer is designed to ride as low to the ground as possible to minimize the overall AHSM height and the transfer cask height during DSC transfer operations. The trailer is equipped with four hydraulic leveling jacks to provide vertical alignment of the cask with the AHSM. The trailer is towed by a conventional heavy haul truck tractor or other suitable prime mover.

The cask support skid is mounted on a surface with sliding support bearings and hydraulic positioners to provide alignment of the cask with the AHSM. Brackets with locking bolts are provided to prevent movement during trailer towing. The hydraulic ram may be mounted on the skid or, as an option, the ram can be set-up using a frame structure bolted to the cask bottom and a rear support tripod. The cask support skid is mounted on a low-profile heavy haul industrial trailer.

The hydraulic ram system consists of a hydraulic cylinder with a capacity and a reach sufficient for DSC insertion into and retrieval from the AHSM. The design of the ram support system provides a direct load path for the hydraulic ram reaction force. The system uses a rear ram support for alignment of the ram to the DSC, and trunnions as the front support. The design provides positive alignment of the major components during DSC insertion and retrieval.

Figure 2-14: Advanced NUHOMS System Horizontal Storage Model (AHSM) Drawing [13]

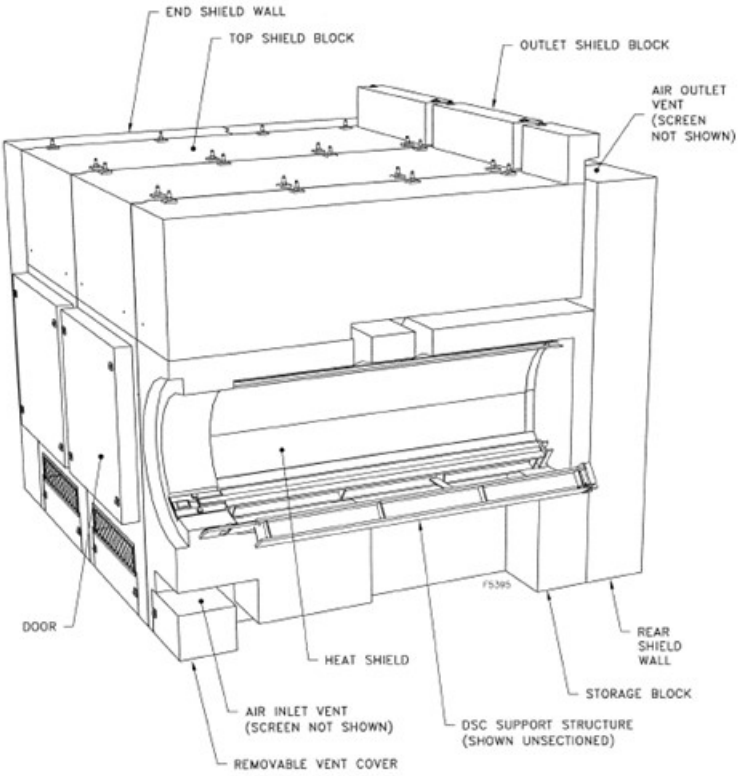


Figure 2-15: Advanced NUHOMS System 24PT1-Dry Storage Canister (DSC) [13]

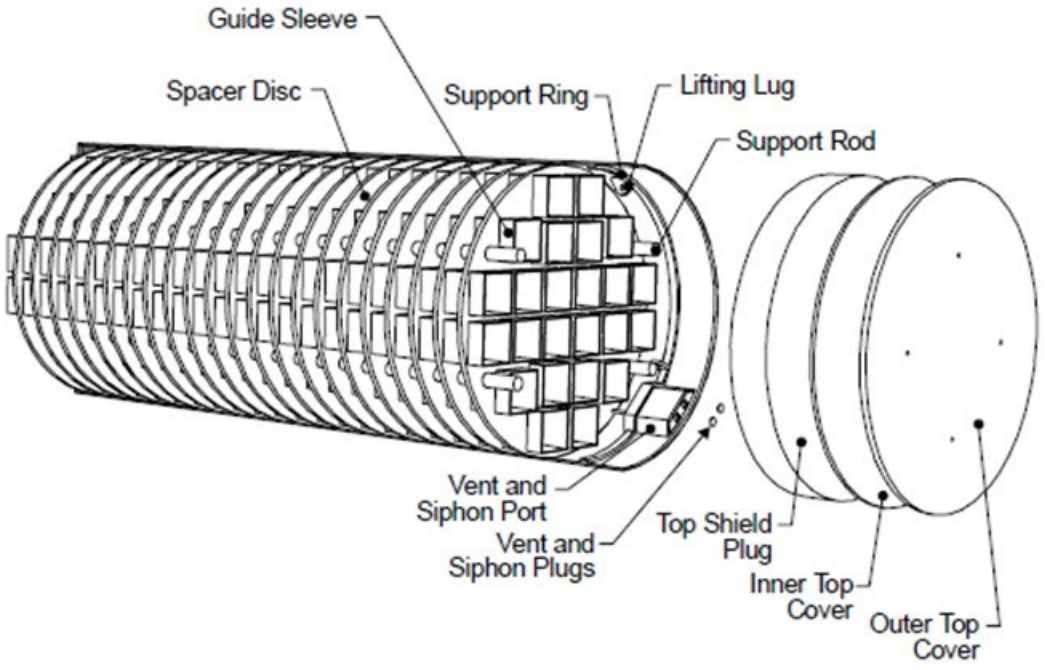


Figure 2-16: Advanced NUHOMS System 24PT4-DSC [13]

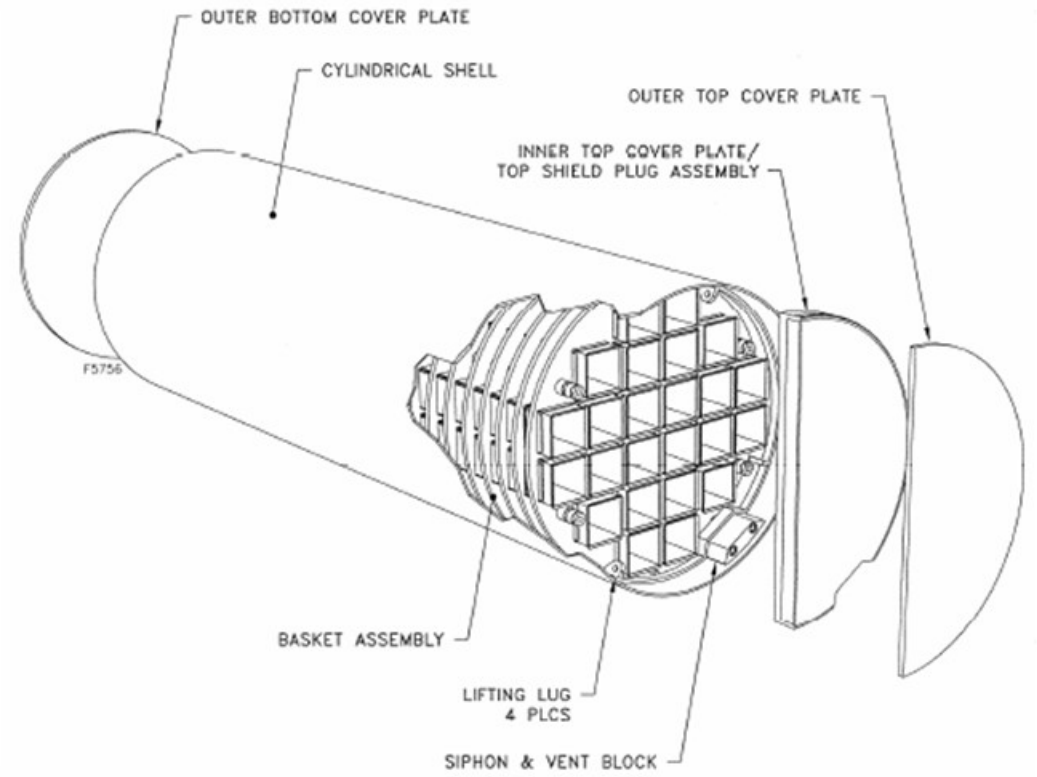


Figure 2-17: Holtec HI-STAR 190 Cask on Railcar [66]

2.1.5 Holtec HI-STORM UMAX Storage System Details

2,668 spent fuel assemblies out of 3,855 total are stored within Holtec HI-STORM multi-purpose canisters (MPCs). The HI-STORM UMAX stores a hermetically sealed canister containing spent nuclear fuel in an in-ground Vertical Ventilated Module (VVM). The annex identifier UMAX is an acronym of Underground Maximum capacity. HI-STORM UMAX is designed to provide long-term underground (i.e., stored within a monolithic block, some of which is below grade) storage of loaded MPCs.

HI-STORM UMAX is intended for dry storage of spent nuclear fuel at a HI-STORM UMAX ISFSI, illustrated in **Figure 2-18**, and may contain any number of VVMs. The VVM storage cavity dimensions and the air ventilation system have been designed to enable it to also store all MPCs certified for storage in the HI-STORM 100 overpack. However, the HI-STORM UMAX Certificate-of-Compliance is currently limited to only MPC-37 and MPC-89. MPCs are denoted by the capacity in number of fuel assemblies.

The MPC, shown in **Figure 2-19**, is an integrally welded pressure vessel which defines the confinement boundary for the stored spent nuclear fuel assemblies. Regardless of the storage cell count, the construction of the MPC is fundamentally the same, the basket is a honeycomb structure comprised of cellular elements. This is positioned within a circumscribing cylindrical canister shell.

The HI-TRAC variable weight (VW) transfer cask (HI-TRAC), illustrated in **Figure 2-20 and Figure 2-21**, is required for shielding and protection of the SNF during loading and closure of the MPC and during movement of the loaded MPC from the cask loading area of a nuclear plant spent fuel pool to the storage overpack. The MPC is placed inside the HI-TRAC transfer cask and moved by the vertical cask transporter (VCT) into the cask loading area for fuel loading and unloading.

The HI-STORM UMAX VVM, shown in **Figure 2-22**, provides for storage of the MPCs, in a vertical configuration, inside a subterranean cylindrical cavity. The chief distinguishing features of the VVM are its low profile and in-ground configuration. The MPC is below the ISFSI Pad for its entire height allowing the earth, ISFSI pad, and closure lid to provide shielding of the stored fuel. The key constituents of a HI-STORM UMAX VVM and ISFSI structures are described below.

The cavity enclosure container (CEC) consists of a thick-walled shell welded to a bottom plate. The top of the container shell is stiffened by a ring-shaped flange. The constituent parts of the CEC are made of low carbon steel plate, with stainless steel as an optional material for some components. In its installed configuration, the CEC is interfaced with the surrounding sub-grade for most of its height except for the top region where it is girdled by the ISFSI pad. With the closure lid removed, the CEC is a closed bottom, open top, thick-walled cylindrical vessel that has no penetrations or openings. The top surfaces of the MPC support system are made of stainless steel. The divider shell is a vertical cylindrical shell concentrically situated in the CEC that divides the CEC into an inlet flow downcomer and an outlet flow passage. The bottom end of the divider shell has cutouts to direct airflow for cooling. The divider shell is not attached to the CEC, which allows its convenient removal for decommissioning. The lower and upper ends of the MPC are restrained by radial guides at the MPC's baseplate for the lower end and attached to the divider shell for the upper end. The radial guides serve as an aid during transfer operations.

The closure lid is a steel structure filled with plain concrete. Both the inlet and outlet vents are located at grade. There are no lateral streaming paths in the VVM body, and the outlet air passage is located in the closure lid thus, there is no lateral radiation leakage paths during the MPC lowering or raising operation that eliminates the need for shield blocks. To minimize the radiation emitted from the storage cavity, a portion of the closure lid extends into the cylindrical space above the MPC. This cylindrical below-surface extension of the closure lid is also made of steel filled with shielding concrete.

The ISFSI pad is a monolithic reinforced concrete structure that provides the load bearing surface for the cask transporter. The portion of the ISFSI pad adjacent to the VVM is slightly sloped and thicker than the rest of the ISFSI pad. There also exists a support foundation pad, which is the underground pad which supports the HI-STORM UMAX ISFSI.

The subgrade is the lateral space between each CEC, the support foundation pad, and the ISFSI pad. The subgrade is filled with a controlled low-strength material or lean concrete, together characterized as self-hardening engineered subgrade.

The enclosure wall is an optional structure which may be utilized to mitigate groundwater intrusion at sites with a high-water table. This is not applicable to SONGS.

The HI-TRAC VW transfer cask, shown in **Figure 2-21**, is engineered to be used to perform all short-term loading and unloading operations of the MPC. **Figure 2-23** illustrates the lowering or raising of the MPC into/from the HI-TRAC from/into the VVM using the VCT. The use of the suffix VW in the HI-TRAC's designation is intended to convey this Variable Weight feature incorporated by changing the HI-TRAC height and lead thickness to best accord with the MPC height and plant's architecture. There are three versions of the HI-TRAC VW. SONGS currently has the "standard" version transfer cask on-site and therefore; no other versions will be discussed. The "standard" version employs a water jacket to provide neutron shielding.

HI-TRAC is principally made of carbon steel and lead. The cask consists of two major parts, a multi-shell cylindrical cask body and a quick connect/disconnect bottom lid. The cylindrical cask body is made of three concentric shells joined to a solid annular top flange and a solid annular bottom flange. The innermost and the middle shells are connected in place by longitudinal ribs. The space between these two shells is occupied by lead. Between the middle shell and the outermost shell is the weldment that is referred to as the "water jacket." The water jacket is filled with water and may contain some ethylene glycol, if warranted by the environmental conditions at the time of use. The water jacket is outfitted with pressure relief devices to prevent over-pressurization.

The standard version HI-TRAC is lifted using a pair of lift blocks that are anchored into the top forging of the transfer cask using a set of high strength bolts. The bottom of the transfer cask is equipped with a thick lid. It is provided with a gasket seal against the machined face of the bottom flange creating a watertight (open top) container. The bottom lid can be fastened and released from the cask body by accessing its bolts from above the transfer cask bottom flange, which is an essential design feature to permit MPC transfer operations.

The MPC for all HI-STORM/HI-STAR systems consists of two principal components, namely the enclosure vessel (EV) and the fuel basket. The MPC-37 multipurpose canister holds 37 pressurized water reactor SNF assemblies and was originally certified as part of the HI-STORM 100 System.

Due to the differing storage contents of each MPC, the maximum loaded weight differs among MPCs. However, the maximum weight of a loaded MPC is approximately 49 tons.

All MPCs have identical external diameters. The outer diameter of the MPC is 76-inches and the maximum overall length is approximately 201½-inches. The MPC fuel basket is assembled from a rectilinear gridwork of plates so that there are no bends or radii at the cell corners. The MPC fuel basket is positioned and supported within the MPC shell by a set of basket supports welded to the inside of the MPC shell. The MPC fuel basket may also be positioned and supported by basket shims welded directly to the MPC fuel basket or by extruded aluminum shims that are installed in the annular space between the MPC fuel basket and the enclosure vessel.

The MPC cavity is dried using either a vacuum drying system or a forced helium dehydration system (see **Figure 2-24**). The MPC is backfilled with 99.995% pure helium in accordance with the limits identified in the HI-STORM FSAR [14] during canister sealing operations. The top of the MPC lid is equipped with four threaded holes that allow lifting of the loaded MPC (thread size varies by design and will be available on the utility canister drawings). These holes allow the loaded MPC to be raised/lowered from the HI-TRAC/HI-STORM system.

Lifting lugs attached to the inside surface of the MPC canister shell serve to permit placement of the empty MPC into the HI-TRAC transfer cask. The lifting lugs also serve to axially locate the MPC lid prior to welding. These internal lifting lugs are not used to handle a loaded MPC. Since the MPC lid is installed prior to any handling of a loaded MPC, there is no access to the lifting lugs once the MPC is loaded.

The MPC lid is a circular plate edge-welded to the MPC outer shell. The lid is equipped with vent and drain ports (with welded cover plates that are under the closure rings) utilized to remove moisture and air from the MPC and backfill the MPC with a specified amount of inert gas (helium). The closure ring is a split circular ring edge-welded to the MPC shell and lid. The MPC lid provides sufficient rigidity to allow the entire MPC loaded with SNF to be lifted by threaded holes in the MPC lid.

In alloy X baskets, such as those found in the MPC-37, the Metamic or Boral neutron absorber panels are completely enclosed in stainless steel sheathing that is stitch welded to the MPC basket cell walls along their entire periphery. The edges of the sheathing are bent toward the cell wall to make the edge weld.

Moving the MPC-37 canisters from ISFSI storage to the transportation cask involves significant equipment and maneuvering because the canisters are stored vertically and transported vertically on-site and horizontally off-site. The MPC-37 design requires the canister to be lifted and lowered from the top, using temporary MPC lifting attachments. Further, the HI-STAR 190 transportation cask bottom closure is not removable. Thus, the canister needs to be lifted out of the HI-STORM UMAX module into the HI-TRAC VW transfer cask and subsequently lowered from the transfer cask into the transportation cask from the top, this stack-up configuration is shown in **Figure 2-25**. A mating device is situated between the UMAX module and the transfer cask. The mating device facilitates removal and re-installation of the transfer cask bottom lid.

Once the MPC-37 canister is inside the transfer cask, it is suspended until the transfer cask bottom lid is re-installed via the mating device. After the transfer cask bottom lid is re-installed, the canister is lowered to rest on the bottom lid and the canister lift slings may be detached from the canister. The transfer cask (with the canister inside) is then lifted off of the mating device and readied to transfer the canister to the HI-STAR 190 transportation cask.

The VCT shown in **Figure 2-23** and **Figure 2-26** is utilized to transfer the loaded or unloaded HI-TRAC transfer cask to or from any VVM and eventually to transfer an MPC from a VVM into a transportation overpack using the HI-TRAC transfer cask. The VCT is designed with a hoist system designed to lower or raise an MPC from or into a HI-TRAC transfer cask.

The HI-STAR 190 transport cask has been identified as the most likely candidate for transporting loaded MPCs due to its compatibility with the HI-TRAC transfer cask, which is required for removing MPCs from the HI-STORM UMAX VVM [6]. HI-STAR 190 is the model name of a transport package engineered to serve as a type B(U)F-96 package for transporting radioactive material including SNF, reactor related non-fuel waste, and high level waste. The HI-STAR 190 is designed as the transportation cask for the MPCs certified for storage in the HI-STORM UMAX.

The HI-STAR 190 cask is shown in **Figure 2-17** is divided into six constituent parts, each with distinct roles and features. The containment shell is the inner-most cylindrical member of the cask containment system. The cask bottom and top regions each consists of a thick nickel steel forging with a Holtite insert. The cask top region includes the collapsible trunnions which are the cask's interfacing lift points. The closure lid system consists of a specially shaped closure lid, with two machined concentric grooves to provide containment protection. The gamma capture space, which refers to the annular space around the containment shell, is enclosed by the intermediate shell strengthened by radial gussets and filled with lead. Similarly, the neutron capture space (NCS), the outer-most annular space, is enclosed by an alloy shell buttressed by radial gussets and filled with Holtite-B.

During transport, the HI-STAR 190 cask lies in a horizontal orientation with two AL-STAR 190 impact limiters installed at the two extremities and a personnel barrier. The impact limiters feature extremely rigid cylindrical barrels that engage the top and bottom of the cask with a snug fit. Each cylindrical barrel is enveloped by crushable material, which in turn is enclosed by a stainless-steel skin. The personnel barrier is placed over the cask to provide a physical barrier to prevent manual access to the cask.

Lifting trunnions are attached via the trunnion support structure to the neutron shield ribs. Two lifting trunnions are located 180° apart in the sides of the top flange. Two additional trunnions are attached near the bottom extremity of the cask and located 180° apart.

Figure 2-18: Illustration of HI-STORM UMAX ISFSI Layout [6]

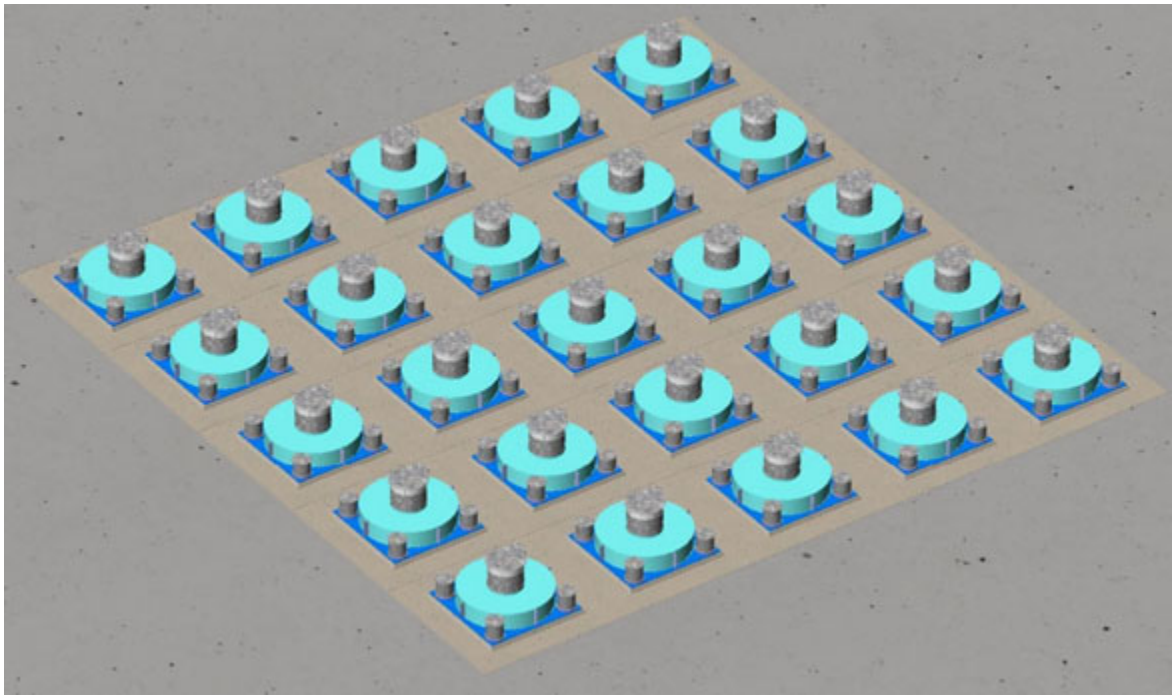


Figure 2-19: MPC-37 Cross-Section Illustration [6]

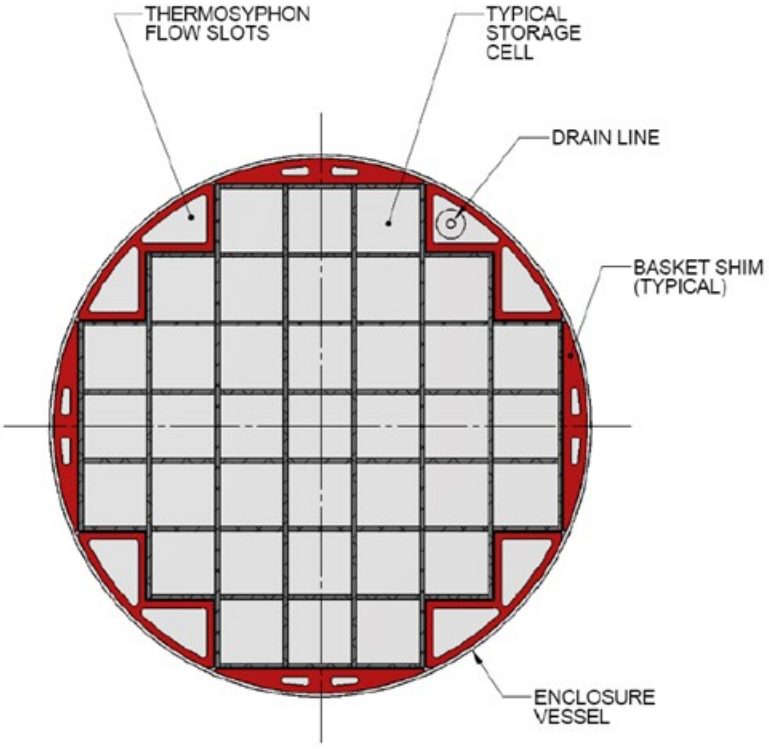


Figure 2-20: HI-TRAC Transfer Cask [6]

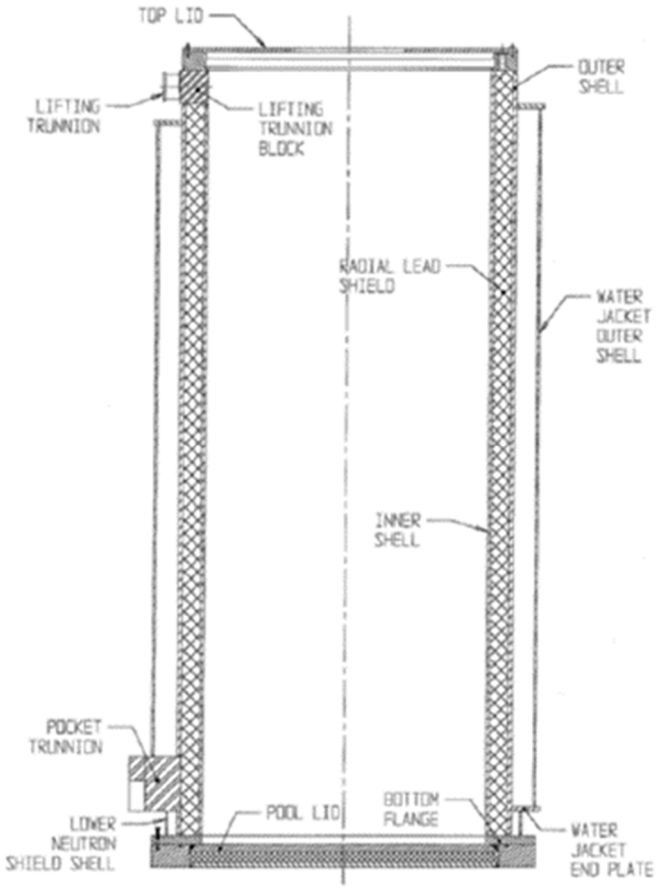


Figure 2-21: HI-TRAC VW Transfer Cask Isometric Cutaway [6]

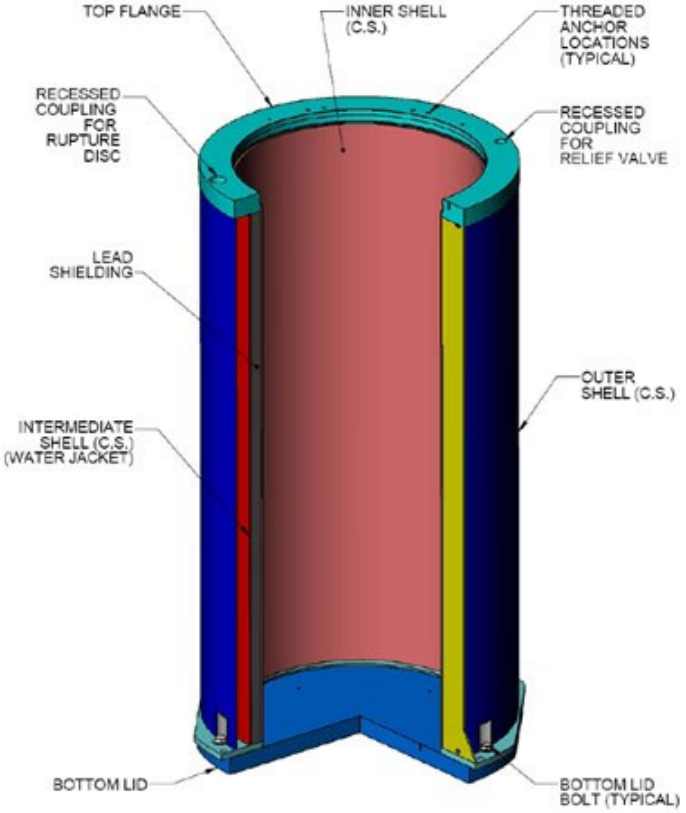


Figure 2-22: HI-STORM UMAX VVM [50]

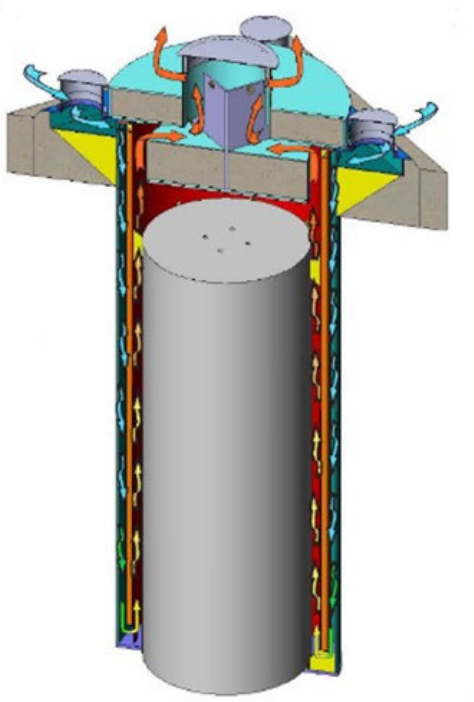


Figure 2-23: MPC Transfer at the ISFSI [6]

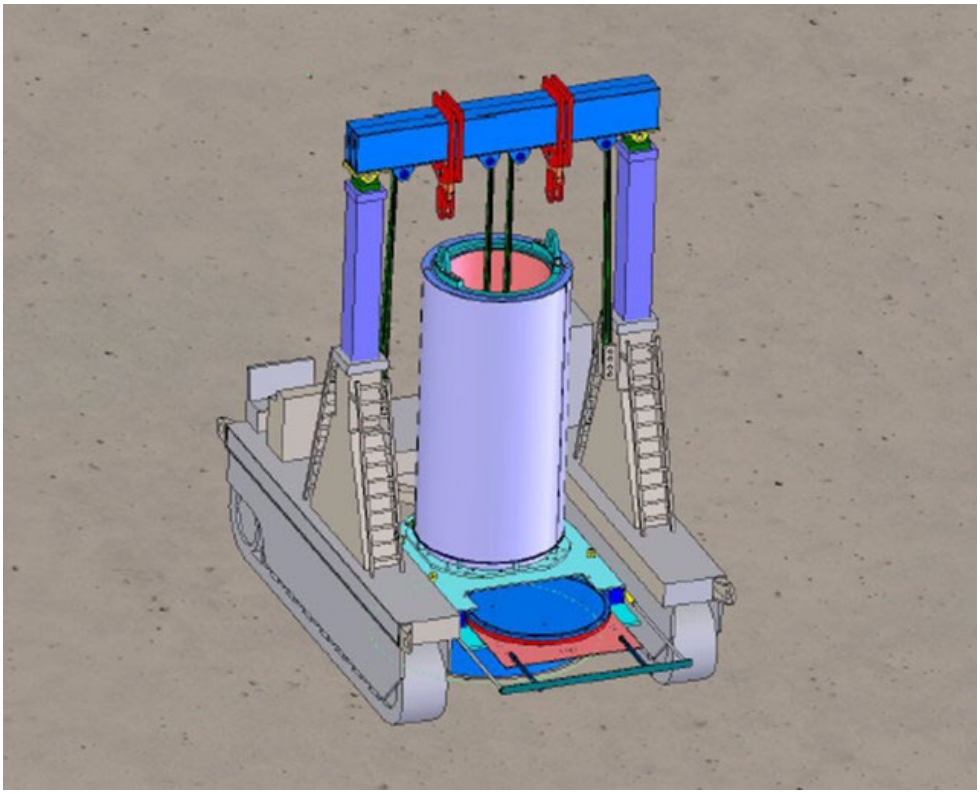


Figure 2-24: Holtec Forced Helium Dehydration System [51]

Figure 2-25: Stack-Up Operation of Holtec HI-TRAC VW to Ventilated Storage Cask (similar to HI-STAR 190 Stack-Up Operation) [50]

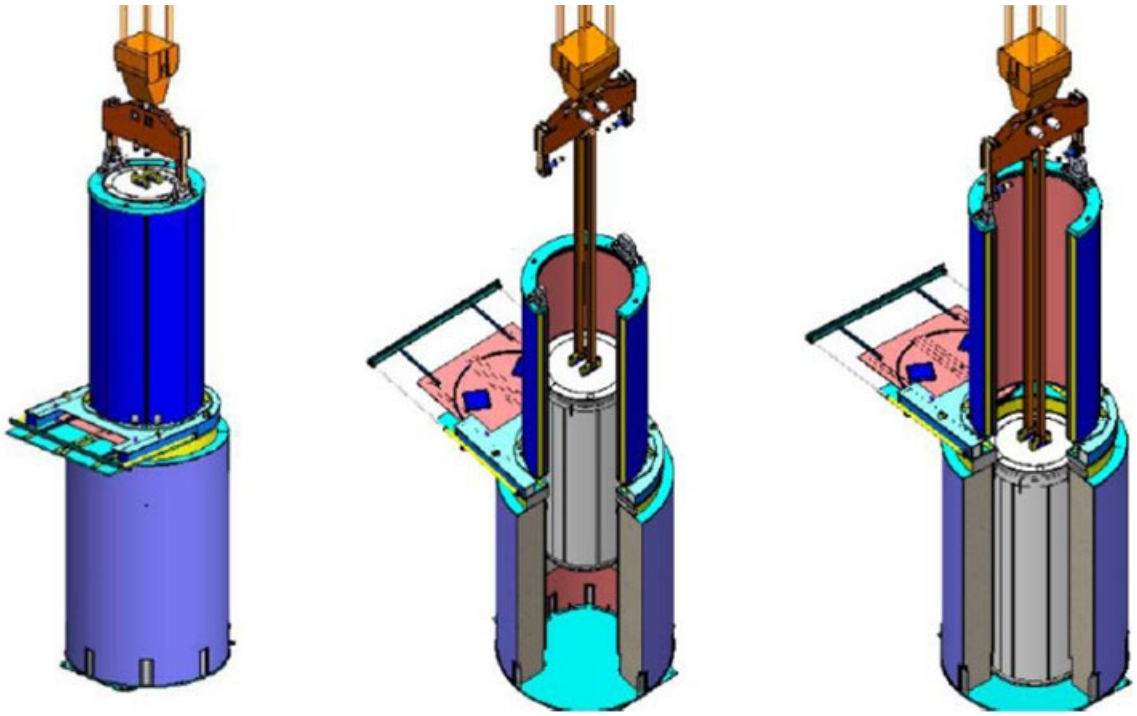


Figure 2-26: VCT In-Use at SONGS, First Fuel Move, January 2018 [11]

2.2 Characteristics of SNF and GTCC LLW to be Shipped

The SONGS ISFSI consists of a TN NUHOMS system, on two separate pads, and a Holtec UMAX system monolith as seen in **Figure 2-27** and **Figure 2-28**. The site's Special Nuclear Material Inventory Report [12] contains the inventory date for each DSC and MPC, prior to being welded closed. The maximum decay heat generation rate for payloads at SONGS is less than 30 kW per MPC [12].

A total of 3,855 fuel assemblies are stored in the SONGS ISFSI. 1,187 assemblies are stored in 50 NUHOMS DSCs and 2,668 fuel assemblies are stored within 73 Holtec MPCs. The 3,855 fuel assemblies are composed of 395 Unit 1 fuel assemblies, 1,726 Unit 2 fuel assemblies, and 1,734 Unit 3 fuel assemblies. The Radioactive Waste Container (RWC) stored in AHSM-15 contains GTCC waste from Unit 1. RWCs stored in AHSM-62 and -63 are repurposed 24PT4 DSCs and contain GTCC legacy waste from the Units 2 and 3 spent fuel pools (SFPs), respectively. RWCs stored in AHSMs-52 and -54 contain Unit 2 reactor vessel internal (RVI) segmentation GTCC waste; RWCs stored in AHSM-53, -55, -59 and -61 contain Unit 3 RVI segmentation GTCC waste. Two trashcans contain vacuum filters that are likely contaminated with fuel pellet material and are stored within MPC-089 in VVM002 and MPC-063 in VVM004.

The 395 SNF assemblies stored at the San Onofre site from Unit 1 include 391 stainless steel-clad and four zirconium alloy clad assemblies. **Figure 2-29** illustrates the number of spent nuclear fuel assemblies from Unit 1, stored at the San Onofre site, based on their burnup. The oldest fuel was discharged in 1971 and the last fuel was discharged in 1992. The median discharge year of the fuel

is 1988. The lowest burnup is 6.8 GWd/MTHM and the highest burnup is 39.3 GWd/MTHM. The median burnup is 30.0 GWd/MTHM. No high burnup spent nuclear fuel (burnup greater than 45 GWd/MTHM) from Unit 1 is stored at the San Onofre site.

There is a total of 3,460 spent nuclear fuel assemblies from Units 2 and 3 stored at the San Onofre site. The fuel rods in these fuel assemblies are zirconium alloy clad. There is also two rod storage baskets containing rods from reconstituted fuel assemblies in Unit 2 and 3 (one per unit).

There are 94 damaged spent nuclear fuel assemblies from San Onofre-1, -2, and -3 stored in DSCs. There are 27 assemblies from San Onofre-1 stored in 9 canisters, 46 assemblies from San Onofre-2 stored in 4 canisters, and 21 assemblies from San Onofre-3 stored in 2 canisters. These assemblies are packaged in damaged fuel canisters. There are also 34 damaged assemblies from San Onofre-2 and 29 damaged assemblies from San Onofre-3 stored in MPCs. These assemblies are also stored in damaged fuel canisters. There are two rod storage baskets and two fuel debris containers, one each from San Onofre-2 and San Onofre-3, stored in damaged fuel canisters in MPCs. Two additional fuel assemblies are stored in damaged fuel canisters due to the presence of foreign material. There are a total of 69 damaged fuel canisters stored in 28 MPCs. .

Figure 2-30 illustrates the number of spent nuclear fuel assemblies from SONGS Units 2 and 3 based on their burnup. For SONGS Units 2 and 3 combined, the oldest fuel was discharged in 1984 and the last fuel was discharged in 2012. The median discharge year of the fuel is 1999. The lowest burnup is 9.3 GWd/MTHM and the highest burnup is 55.1 GWd/MTHM. The median burnup is 40.7 GWd/MTHM. There are 1,123 spent nuclear fuel assemblies from San Onofre-2 and -3 that have burnups greater than 45 GWd/MTHM. These 1,123 fuel assemblies are classified by the NRC as high burnup spent nuclear fuel.

Figure 2-27: ISFSI Pads at SONGS

(Photo Provided Courtesy of the SONGS Site)

Figure 2-28: Holtec UMAX ISFSI Pad at SONGS [11]

Figure 2-29: Mass and Number of Each Cladding Type of SNF Assemblies by Discharge Year at SONGS

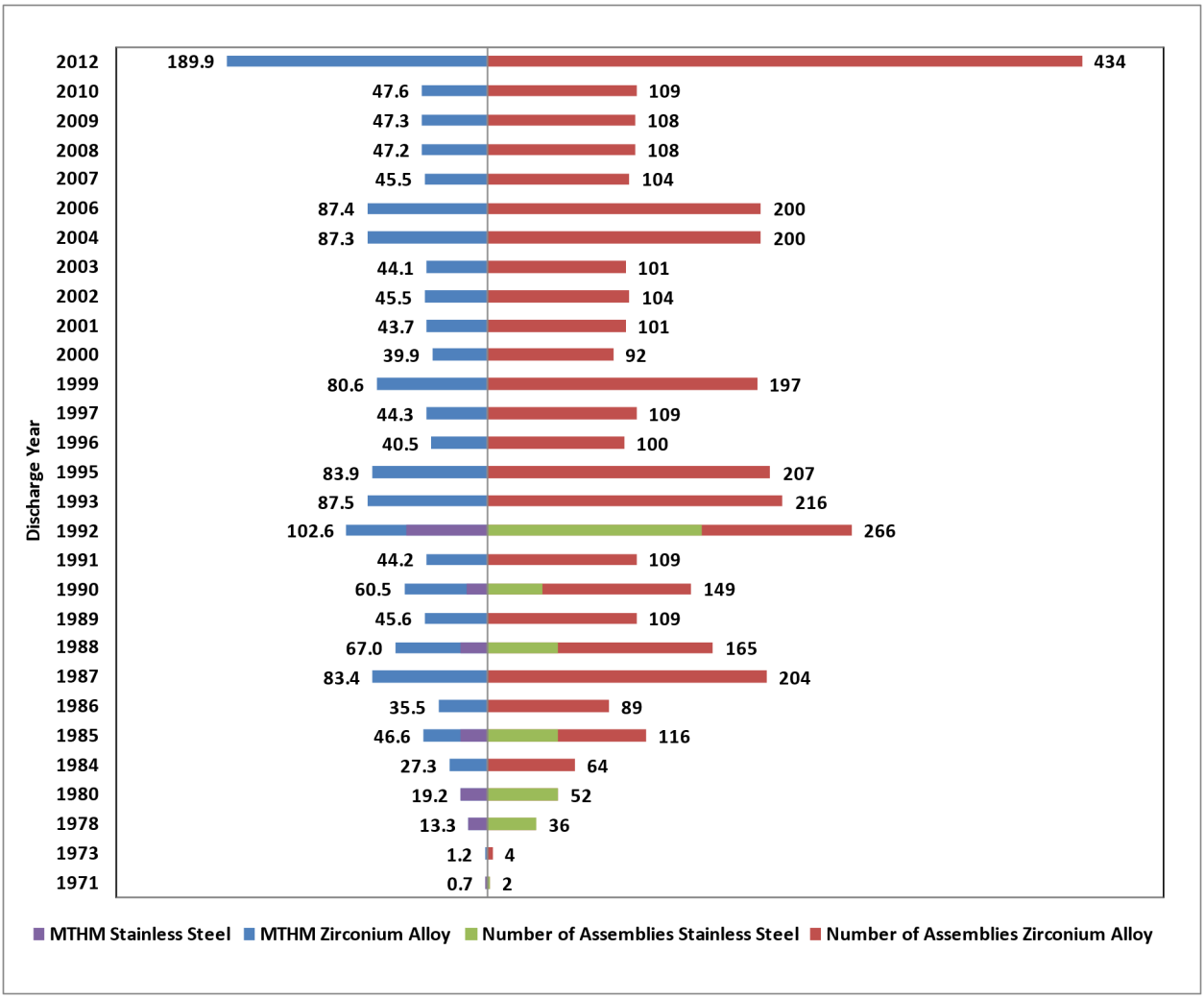
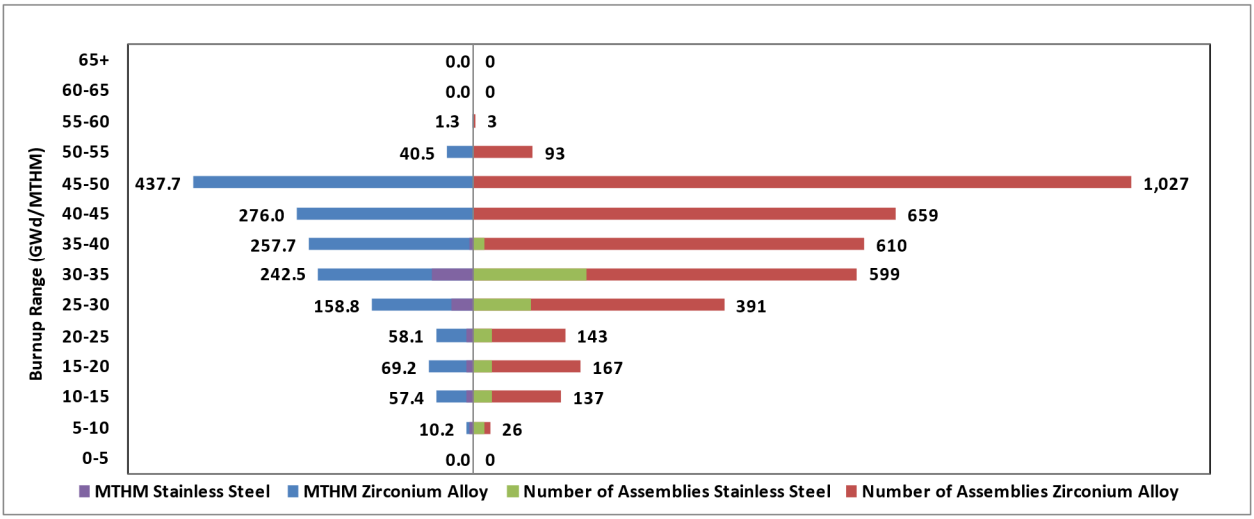


Figure 2-30: Mass and Number of Each Cladding Type of SNF Assemblies by Burnup Range at SONGS



2.3 Description of Canisters/Overpacks to be Shipped

The procedure for moving storage canisters from ISFSI storage modules/systems to transportation casks is significantly different between the TN canisters, which are stored horizontally, and the Holtec canisters, which are stored vertically. Separate logistical arrangements for these two types of transfers will be made.

2.3.1 TN NUHOMS Transportation System Details

The NUHOMS DSCs can be moved directly from storage modules into transportation casks. The TN MP197HB transportation cask is designed to mate with the Advanced NUHOMS storage modules. This allows the canisters to be pulled horizontally, via hydraulic ram, directly from the Advanced NUHOMS module into the transportation cask without using a transfer cask. The transfer operation configuration is shown in **Figure 2-31** and **Figure 2-32**. The weight and dimensions of various elements of the MP197HB transportation cask are identified in **Table 2-1**.

The MP197HB transportation casks, shown in **Figure 2-33** and **Figure 2-34**, could be used for 24PT1-DSCs with spacers and 24PT4-DSCs without spacers, respectively, due to the difference in heights between the two DSCs. The MP197HB cask is authorized to transport a variety of NUHOMS DSCs, which vary in size. For shorter DSCs, spacers can be added at either end of the cask cavity as required to reduce axial gaps between the canister and the cask [16]. Alternatively, as noted above the TN Eagle SC transportation cask could be used to ship these DSCs.

During transportation, the containment boundary of the MP197HB cask (including the inner shell, the cask lid, the bottom ram access closure plate, the vent and drain ports, and the associated seals) is pressurized with helium to preclude air in-leakage and assist in heat removal. The cask lid and the bottom ram access closure plate include dual seals and a test port to perform leak testing between the seals. Leak testing of the vent and drain port seals involve the use of a special test port tool to verify the integrity of those seals [16].

The AHSM door is removed and the MP197HB is moved into position at the circular module opening. A hydraulically driven grapple mechanism is used to retrieve the canister. An opening in the bottom of the transportation cask provides access for the grapple mechanism to be extended through the empty cask to engage the grapple ring attached to the bottom of the DSC. Once engaged, the DSC is pulled out of the AHSM into the MP197HB transportation cask using the hydraulic drive system.

Once the DSC is seated inside the MP197HB, the transfer trailer is backed a short distance away from the module, allowing the MP197HB lid to be installed. The cask is then moved to a suitable location to be prepared for shipment. Once cask preparation is complete, the cask is moved to the transport position (either HHT trailer or railcar) where impact limiters and a personnel barrier are installed. At this point, the package is ready to ship.

A customized TN transfer trailer and hydraulic ram must be used to facilitate DSC withdrawal from the AHSM. Cask cranes and appropriate lifting and rigging equipment will be needed to lift and handle smaller components and to move the transportation cask between the transfer trailer and the transport position. Details of the loading sequence will vary somewhat based on the transport mode and cradle designs being used. There is no difference in operations between the SNF canisters and the GTCC canisters.

The transfer of a DSC from an HSM to an NUHOMS MP197HB, and subsequent preparations for transport, will include the following high-level activities (detailed operations are described in **Section 6.0**):

- Verify the integrity of the DSC and that the contents are authorized for the MP197HB (see **Section 10.0**).
- Transfer the empty cask and transport skid from the HHT or railcar to the transfer trailer.
- Remove the personnel barrier and impact limiters.
- Remove the front trunnion covers from the cask and install the front trunnions.
- Remove the cask lid and then, if present, remove the canister sleeve spacer ring or if not present, install the canister sleeve inside the cask.
- Install the unloading flange into the cask opening.
- Install the DSC spacer into the bottom of the cask.
- Remove the ram access closure plate.
- Position the cask in close proximity to the HSM.
- Remove the HSM door and the DSC seismic restraint assembly.
- Align and dock the cask to the HSM.
- Install the cask/HSM restraints.
- Install the ram, extend through the cask bottom port, and engage the DSC grapple ring.
- Retract the ram, pulling the DSC into the cask.
- Remove the ram cylinder and install the ram access closure plate.
- Remove the cask/HSM restraints and reposition the loaded cask away from the HSM.

- Remove the unloading flange and install the canister sleeve spacer ring into the cask.
- Install the cask lid.
- Remove the cask front trunnions and install the associated trunnion covers.
- Perform the containment boundary leak tests.
- Install the impact limiters and then install the personnel barrier.
- Transfer the loaded cask and the transport skid from the transfer trailer to the HHT or railcar.

To perform the above activities, the below ancillary devices would be required [16]. Unless specifically addressed, these components are not considered to be safety-related or important to safety.

Leak Test System: prior to transport of the MP197HB casks, the containment boundary seals need to be leak tested. This is done after the cask cavity has been evacuated with a vacuum system and then backfilled with helium. In addition to the vacuum system, helium mass spectrometer along with a test port tool will be required. It is recommended that this equipment be obtained from the cask vendor when the cask is supplied.

Replacement seals for cask lid and for the vent, drain, and test port plugs: prior to performing the final containment boundary seal leak tests, new seals need to be installed. This will need to occur each time the cask is used for a new transport activity, so several seal sets will be required. It is recommended that multiple sets of the seals be obtained from the cask vendor when the cask is supplied. These seals are considered important to safety as they are used to maintain the containment boundary during transport.

DSC Spacer: due to the shorter length of the 24PT1 DSC, a 10-inch-long spacer needs to be installed between the bottom of the cask and the DSC. It is recommended that this equipment is obtained from the cask vendor when the cask is supplied. This spacer is considered important to safety as it is used to prevent movement of the DSC during transport.

Transportation cradle/skid: a cradle (also referred to as a skid) for the MP197HB will need to be designed and fabricated. It is assumed that this cradle will be used during the DSC transfer operations as well as for the subsequent transportation (truck, rail, and/or barge) from the site. A conceptual design of this cradle/skid, depicted in **Figure 2-34**, includes straps that go over the cask body to secure the cask to the cradle/skid. A shear key is included in the cradle, which interfaces with the shear key pocket in the cask body to resist axial transportation loads. Lifting points on the cradle allow for lifting the cradle with the loaded cask attached and configured for transport (with impact limiters and personnel barrier). The final design and fabrication of this cradle will likely need to be performed by the cask vendor.

Transport Cask Lift Beam: the horizontal intermodal transport cradle lift beam would be used to lift and move an empty or loaded transportation cradle containing an empty or loaded MP197HB cask with impact limiters and personnel barrier installed at the loading site, transloading (intermodal transfer) site, and/or at the cask receiving and unloading location. This device will need to be fabricated and should be provided by the vendor supplying the transportation cradle.

Transfer Trailer: an on-site transfer trailer, as seen in **Figure 2-31** and **Figure 2-32**, would be used to position the horizontally oriented MP197HB cask at the HSM. This trailer is designed to handle the OS197 Transfer Cask (on site at SONGS) and has a payload capacity of 125 tons, which will likely need to be modified for transferring the DSCs from the HSMs to the MP197HB due to the weight and dimensions of the MP197HB cask being greater than the transfer cask. The cask vendor maintains the design of this equipment and can provide the necessary design and fabrication services.

Prime Mover: a HHT, or other similar prime mover, will be needed to move the transfer trailer. The cask vendor, who will address any needed trailer modifications, will be able to provide the specifications for this equipment.

Skid Positioning System: a series of hydraulic cylinders and low-friction contact pads are used between the transfer trailer and cask cradle (skid) to allow final alignment of the cask to the HSM. This system was designed to handle the OS197 Transfer Cask and will likely need to be modified for transferring the DSCs from the HSMs to the MP197HB due to the weight and dimensions of the MP197HB cask being greater than the transfer cask. The cask vendor maintains the design of this equipment and can provide the necessary design and fabrication services.

Hydraulic Ram and Grapple: a hydraulic ram, with a capacity of 80,000 pounds and a minimum stroke of 20 feet, will be required for retracting the DSC from the HSM into the cask. A grapple is located at the end of the ram for attaching to the DSC grapple ring. A ram securement system will be needed to mount the ram directly to the bottom of the MP197HB cask, rather than to the transfer skid used previously during HSM loading operations. The cask vendor maintains the design of this equipment and can provide the necessary design and fabrication services.

Hydraulic Power Unit: a hydraulic system, consisting of a pump, control valves, and a control system, is used to power the hydraulic cylinders on the transfer trailer, skid positioning system, and the hydraulic ram.

Cask/HSM Restraints: a set of adjustable restraints are needed to secure the front trunnions of the MP197HB cask to mounting points embedded in the front face of the HSM. These are used to prevent movement of the cask during DSC transfer operations between the HSM and the cask. A set of cask/HSM restraints will be needed for cask loading operations. The cask vendor maintains the design of this equipment and can provide the necessary design and fabrication services.

Cask Lid Handling Device: a below-the-hook lifting device will be required to handle the lid of the MP197HB cask, while the cask is oriented horizontally. This device will attach to threaded holes in the lid and will be designed such that the lid will hang vertically when it is being removed or installed. It is recommended that this equipment is obtained from the cask vendor when the cask is supplied.

HSM Door-Handling Device: a second below the hook-lifting device will be required to handle the door of the HSM. It is recommended that the same equipment be used for unloading the HSMs as was used during the cask loading operations.

Cranes: it is envisioned that two mobile cranes, one rated for at least 375 tons, would be required for the transfer and loading operations. The primary crane would be used to lift

the transportation cask and the secondary crane would handle all the ancillary equipment. Assuming the impact limiters are installed onto the loaded MP197HB transportation cask prior to lifting, commercially available mobile cranes will be sufficient.

Impact Limiters: the transportation cask will arrive with two impact limiters according to the requirements of the Safety Analysis Report (SAR). The impact limiters would be fabricated as part of the transport cask procurement and fabrication. These impact limiters are considered important to safety as they are used to protect the cask during a design basis accident.

Personnel Barrier: as required by the SAR, a personnel barrier would be placed around the loaded cask. The barrier, which attaches to the cradle, spans the distance between the impact limiters and matches the outer diameter of the impact limiters. This device does not currently exist, so it would need to be designed and fabricated. There are no unique requirements that would present expected complications with the lead time and cost of obtaining personnel barriers.

Table 2-1: NUHOMS MP197HB Weights and Dimensions [16]

Attribute	Value	Comments
Empty Overpack Weight	157,500 lbs	Without impact limiters
Cask Lid Weight	6,000 lbs	
Impact Limiter Weight	25,000 lbs	Combined total of 2 impact limiters
Loaded Cask Weight	303,600 lbs	With impact limiters
Maximum Transport Load	335,000 lbs	
Overall Length	271.25 inches	With impact limiters
Overpack Length	210.25 inches	Without impact limiters
Overpack Diameter	97.75 inches	Without impact limiters
Impact Limiter Diameter	126 inches	

Figure 2-31: AHSM DSC Removal via Hydraulic Grapple System [13]

Figure 2-32: AHSM DSC Transfer Configuration Drawing [13]

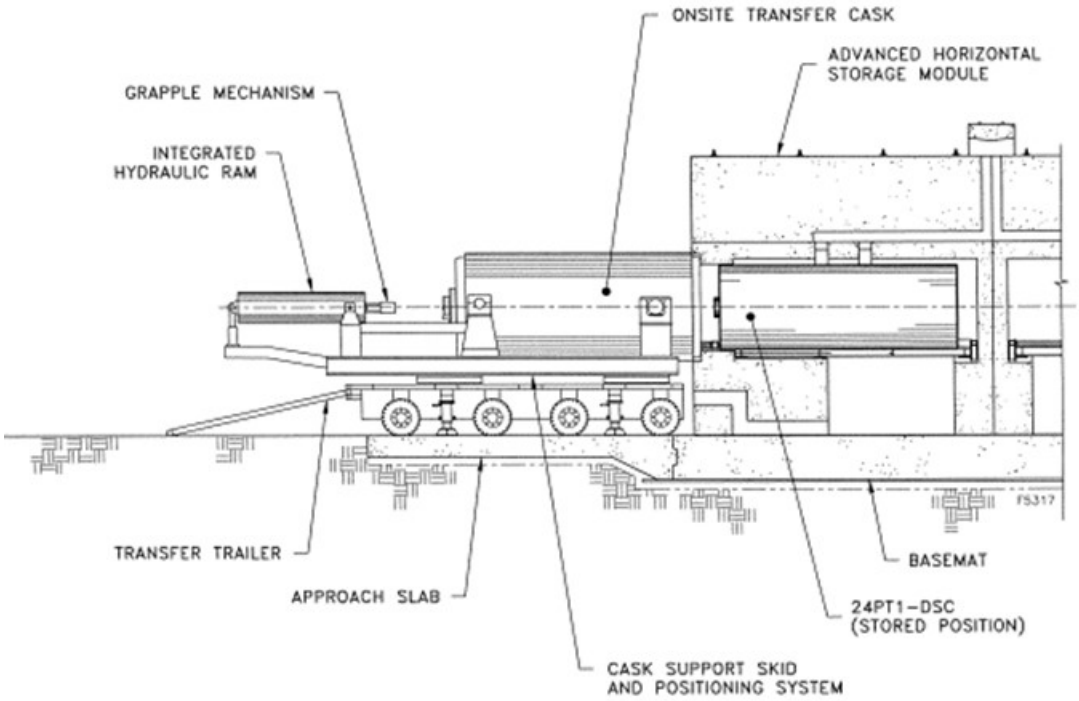


Figure 2-33: NUHOMS MP197HB Transportation Cask [16]

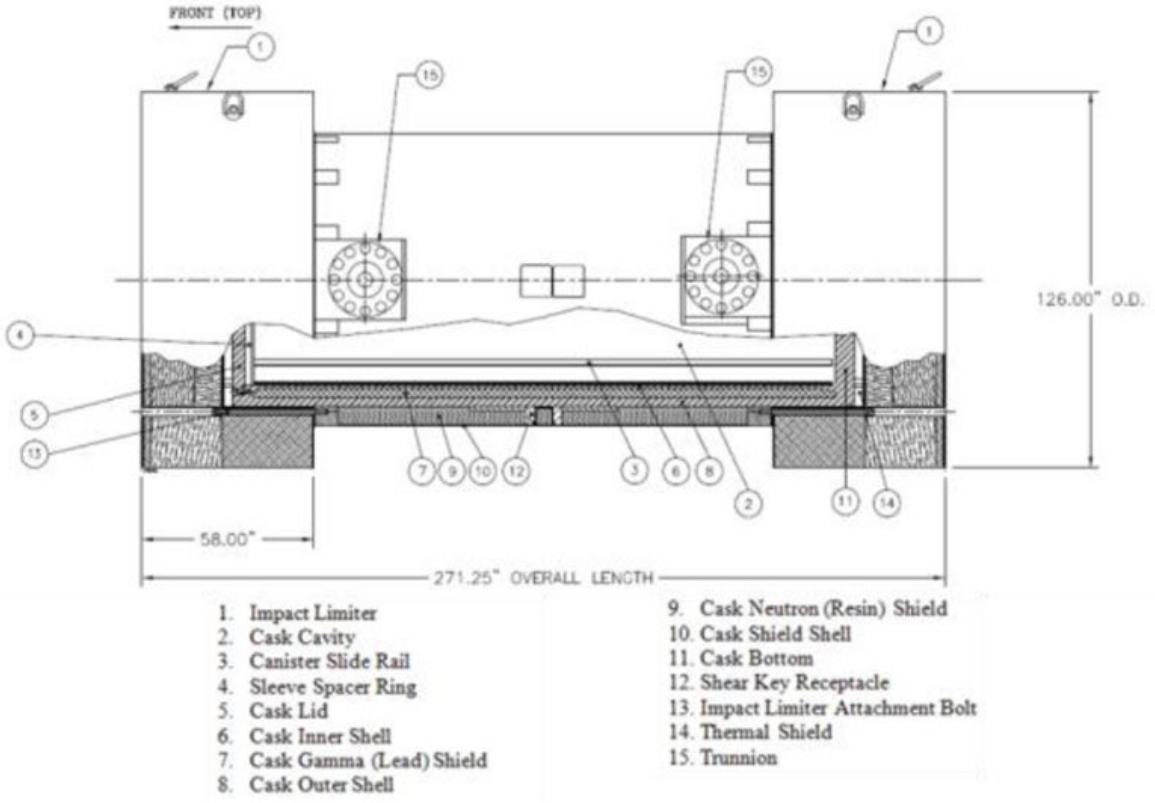
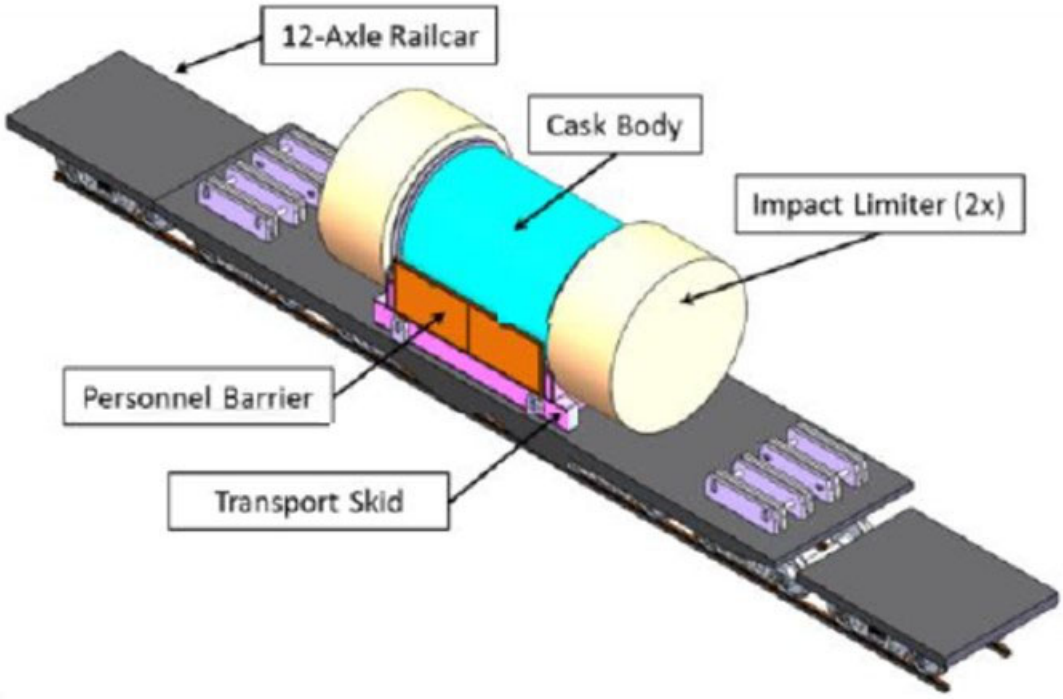


Figure 2-34: MP197HB on Railcar [49]



2.3.2 Holtec HI-STAR 190 Transportation System Details

Moving the Holtec MPC-37 canisters from ISFSI storage to the HI-STAR 190 transportation cask involves more equipment and maneuvering than the TN DSCs because the canisters are stored vertically and transported horizontally. The MPC-37 design requires the canister to be lifted and lowered from the top, using temporary MPC lifting attachments. Further, the HI-STAR 190 transportation cask bottom closure is not removable and hence, the MPC needs to be lifted out of the HI-STORM UMAX module into a transfer cask and subsequently lowered from the transfer cask into the transportation cask from the top. A mating device is situated between the UMAX module and the transfer cask as shown in **Figure 2-35**. The mating device facilitates removal and re-installation of the transfer cask bottom lid.

The process to load the MPC into a HI-STAR 190 transportation cask consists of the following major steps:

1. Lift the MPC into the HI-TRAC transfer cask with the aid of the Mating Device, following HI-STORM UMAX FSAR procedure.
2. Stack the transfer cask atop the HI-STAR 190 with the 190 Mating Device interposed between them. Then lower the MPC into HI-STAR 190.
3. Remove the transfer cask and the Mating Device.
4. Install the Cask Closure Lid.
5. If high-burnup fuel is transported, perform the MPC pre-shipment leakage rate test to confirm the integrity of the MPC containment boundary and perform a shell surface defect inspection.
6. Evacuate the cask cavity and fill the cask cavity space with helium.
7. Close the cask closure lid port plug and install closure lid cover plate.
8. Perform the necessary leakage tests on the cask containment seals.
9. Secure the cask on the transport vehicle with impact limiters attached, attach security seal, and install the personnel barrier.
10. The HI-STAR 190 package is then ready for transport.

It is expected, and recommended, that a below-grade cask transfer of the MPC to the HI-STAR 190 transportation cask will be performed. A below-grade cask transfer, depicted in **Figure 2-35**, involves placing the empty HI-STAR 190 in a below-grade opening, attaching the mating device using a VCT, shown in **Figure 2-36**, and then performing the transfer as described above. This contrasts with a "stack-up" operation at an above ground cask transfer facility, which involves lifting the transfer cask on top of the transport cask and introduces different issues (e.g., the need for a transfer pit, the potential scraping of the outside of the transportation cask, etc.).

A below-grade cask transfer would require excavation of an approximately 9-foot-diameter opening to a depth of approximately 15 to 18 feet, placement of a foundation, and erection of the peripheral structure around the opening. A potential location is shown in **Figure 2-7**. At the surface, the transfer facility would also require a reinforced concrete pad around the opening to provide the access and structural support needed for the loaded VCT to perform canister uploading

and downloading. Once the MPC is lowered into the HI-STAR 190 transportation cask, the mating device and HI-TRAC VW transfer cask can be removed. The VCT is then used to install the transportation cask lid, lift the cask out of the below-grade transfer facility, and move the cask to the preparation area to be readied for shipment, which includes down-ending the cask, placement onto a shipping cradle, adding impact limiters and personnel barrier.

Figure 2-35: Cut-Away of Below-Grade Transfer Operation from HI-TRAC Transfer Cask to HI-STAR 190 [50]

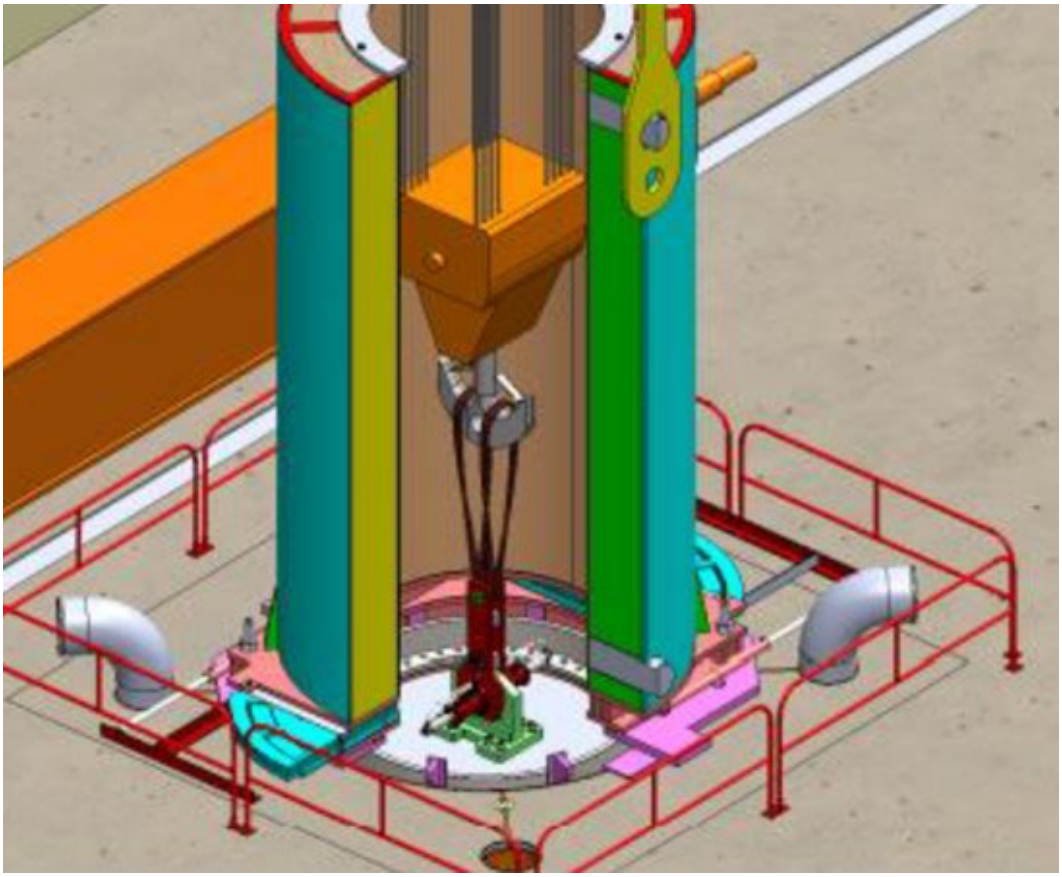


Figure 2-36: Vertical Cask Transporter, Fully Extended [9]

2.3.3 Site Equipment Inventory

In Table 2-2 is a complete inventory of the equipment currently on site at SONGS for use in decommissioning.

Table 2-2: SONGS Site Equipment Inventory

Subsystem	Descriptor	Quantity
Holtec Equipment at SONGS		
HI-TRAC	Cask with lift lugs and bolts.	1
	Lift yoke, stand, and air controller box and hose.	1
	Mating device with adaptor, hydraulic pump and hose set	1
MPC	Lift cleats, bolts, and shield device (dog cone).	1
	Neutron shield device.	1
Lifting	Downloader slings.	2
	140,000-lbf intermediate slings.	2

Subsystem	Descriptor	Quantity
	150,000-lbf downloader shackles.	2
	216,000-lbf downloader Crosby master links.	2
Other	Load cell shackle system and laptops.	2
Orano TN Equipment at SONGS		
OS-197-1	Cask.	1
	Yokes with stands.	2
	Cask restraints	2
	Greiner transfer trailer, skid, and ram.	1
	Hydraulic power unit for ram.	1
	Operating platform.	2
OS-200	Cask.	1
	Yoke with stand.	1
	Skid positioning system lateral module.	1
	Skid positioning system center guide module.	1
	Restraint system.	1
	Ram assembly grapple extension.	1
	Skid pin assemblies.	4
	Lubrite box assemblies.	4
	Shield plug restraint.	4
	Skid and ram tower assembly.	1
AHSM	Door lift beam.	1
	Door vertical storage pallet.	1
	DSC alignment tool.	1
	HSM Concrete modules with DSC support structures and erection hardware.	6

Subsystem	Descriptor	Quantity
	HSM Base lifting assembly.	1
	HSM Door lift beam.	1
Other	Vacuum drying system.	1
	FMC B600 aircraft tow tractor.	1
	Automated Weld System	1

3.0 TRANSPORTATION ROUTE ANALYSIS

This section describes the available routes investigated to transport the loaded transportation casks from SONGS for delivery to the closest Class I railroad and the subsequent movement to GCUS. Although there is ample rail infrastructure at the site to conduct on-site transloading of the casks 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 3.4**, the options available were down-selected using specified criteria, resulting in a total of six scenarios to consider further using the MUA process, as covered in detail in **Section 5.0**, including 2 direct rail, 1 HHT-to-rail, 2 HHT-to-vessel-to-rail, and 1 HHT-to-barge-to-rail options.[2]

3.1 Heavy-Haul Trucking Routes

SONGS is located just south of San Clemente, CA and north of Oceanside, CA, and abuts Camp Pendleton. It is located along Old Pacific Highway, approximately 70 miles southeast of Los Angeles and 60 miles northwest of San Diego directly on the Pacific Coast. SONGS is located on military property, owned by Camp Pendleton. Its entrance is on Old Pacific Highway just off of I-5.

Both interstate highways and county routes are close to the site. From the exit gate at SONGS to Old Pacific Highway it is 58.2 feet, 2.5 miles from SONGS to the access ramp for I-5 north, and 2.9 miles from SONGS to the access ramp for I-5 south.

California has state designated truck routes for heavy haul, restricted/prohibited areas, Hazardous Materials (HAZMAT), Highway Route Controlled Quantity (HRCQ) of Class 7 radioactive materials (RAM) preferred routes, and non-radioactive hazardous materials (NRHM) routes. There are 29 preferred routes in California for HRCQ/RAM, 14 restricted routes where HAZMAT is prohibited, and 265 NRHM routes. The six HRCQ/RAM preferred routes near SONGS are listed in **Table 3-1**.

Table 3-1: HRCQ Restricted (P) Routes Close to SONGS [19]

Restriction	Designation	Location
HRCQ	Preferred	Interstate 805 from Interstate 5 [north of the City of San Diego] to State Route 905.
HRCQ	Preferred	Interstate 5 from State 78 [MP 51—Carlsbad] to Interstate 8.
HRCQ	Preferred	Interstate 5 from Interstate 405 [MP 93—Irvine] to State 78 [MP 51—Carlsbad].

[2] Note that routes through the Panama Canal will be by a sea-going vessel (i.e., a ship), whereas routes using U.S. waters could utilize a barge (i.e., flat-bottomed boat) over a vessel.

Restriction	Designation	Location
HRCQ	Preferred	Interstate 15 from State 60 [Mira Loma] to State 163 [San Diego].
HRCQ	Preferred	Interstate 5 from Interstate 605 [MP 123—Santa Fe Springs] to Interstate 405 [MP 93—Irvine].
HRCQ	Preferred	Interstate 15 from Nevada border to State 60 [Mira Loma]

California also has permitting rules for dimensional and HAZMAT shipments on California roads that govern the type of equipment that must be used for oversized/overweight shipments. The rules specify the number of axles and weight distribution, private escorts, police escorts, lighting, placards, and signals required for the movement. The permits are contingent upon compliance with these specifications. It is not unusual that these rules are conflicting with neighboring states, which is a challenge in assigning proper specialized trailers for heavy haul shipments. There are restricted and preferred routes in neighboring states and along the route from SONGS to GCUS, particularly in the following states: Utah, New Mexico, Colorado, Texas, but Nevada has no routes listed in the registry.

The private paved roads on the SONGS site appear to be in good condition. There is good access to and from the ISFSIs to the site exit and to the on-site rail transload area. HHT ingress and egress to the site is via Old Pacific Highway, which can be accessed from I-5 or local roads with special permission/permits from both directions, north and south, of the plant. There are steep grades on-site, which will affect the ability to safely load HHT equipment on these grades.

HHT has been used in the past to remove LLW from SONGS, including dimensional used equipment and debris. These items were transported to Clive, UT for disposal at the Energy*Solutions* facility. One of the best examples of this is the four old steam generators that were hauled by Perkins Specialized Transportation Company (Perkins STC) in 2015. Several aspects of these four shipments were unusual and required atypical operations and conditions in order to comply with the permits and to physically prepare the loads for shipment. The trailer used to transport the steam generators was specifically designed to transport the steam generators from the plant. The trailer was designed and built by Perkins STC and the equipment is known as “the road train” (see **Figure 3-1** and **Figure 3-2**).

Loading the four (4) Old Steam Generators (OSGs) onto the specialized trailer, was a challenge. Each OSG moved alone, so it took four separate shipments to remove all four OSGs. The trailer had to be assembled and loaded outside the plant. The trailer was positioned on Old Pacific Highway outside the main entrance to the plant. Prior to departure, the driver was required to back up the transporter approximately 1.5 miles to the encroachment area onto I-5. Special improvements were made to allow for I-5 access with fourteen (14) loaded travel legs required to complete each trip. Route development, permitting, and third-party organizations were both time consuming and challenging due to the size and weight of the loads, but ultimately proved successful.

Although the intended destination, Clive, UT is directly rail served, the OSGs moved by HHT because they were too wide at 15ft 6in to obtain clearance to move by rail to Clive, UT. These transports proved the difficult movements could be executed successfully.

Figure 3-1: Perkins STC Steam Generator Shipment Using "The Road Train" [18]

Figure 3-2: Over-the-Road Movement of "The Road Train" with Pushers included for Navigation over Steep Terrain [18]

Although not practical or economical for the number of casks to move in this shipping campaign, HHT direct routes from SONGS to GCUS were investigated but were screened due to the length

and duration of the transits and, direct HHT movement is inconsistent with the parameters of this study of moving the casks from the ISFSIs to a Class I railroad.

START [1] identified three direct HHT routes from SONGS to GCUS, ranging from 3,980 miles to 1,809 miles with transit times varying from 556 hours to 103 hours. Due to the speed and permit restrictions and based on practical experience moving dimensional cargo over-the-road (OTR), it is unlikely that this cargo would be able to move these distances within the START identified time frames, since multiple states must be traversed, and coordination of State Police escorts and inspections would be required when trucks enter each state along the route. The direct HHT routes would encompass travel through at least seven states and multiple Tribes.

The direct HHT routes to GCUS from SONGS are as follows:

1- Minimum population route:
    a. 3,980 miles, 556 hours (33,352 minutes)
    b. Mostly follows state roads with occasional short spans on interstates. It travels through CA, NV, UT, ID, WY, CO, KS, NE, IA, MO, IL.

2- Minimum distance route:
    a. 1,809 miles, 146 hours (8,778 minutes)
    b. Mostly follows state highways, local roads, and short travel on interstates through CA, AZ, NM, TX, OK, KS, MO, IL.

3- Minimum transit time route:
    a. 1,927 miles, 103 hours (6,145 minutes)
    b. Mostly follows through: CA, AZ, NM, TX, OK, MO, IL.

Another drawback for moving the casks by HHT is the fact the trucks can only haul one cask at a time. HHT is also subject to frost laws in Nevada which will impact the transit time of the movement as speed and weight restrictions are imposed twice a year during spring thawing and winter inclement weather. The frost laws are instituted as needed, which means they are subject to change with little notice based on current road conditions.

There is no existing on-site HHT road which leads to the waterfront portion of the site because there is no barge slip or area for grounding the barge, even though the site is located directly on the Pacific Ocean. The roads leading to the ISFSIs are in place and appear to be in good condition.

Two private rail tracks were identified as the best choices of the identified nearby tracks for possible use as off-site transload areas for loading the train consist[3]. These two tracks are options, in the event there were unforeseen problems with the existing rail track, which is not anticipated at this time as it has recently been refurbished and is currently being used for outbound shipments from the site. To investigate all modes available for shipment, the closest rail tracks to the SONGS site with the ability to load trains were identified and are reflected in **Table 3-2**.

[3] The "train consist" is considered made up in this report of a locomotive, two buffer cars, one to five cask cars, and a rail escort vehicle.

Table 3-2: Closest Rail Tracks Outside of SONGS

Track Location	Siding Length (ft)	Approx. HHT Mileage to Track	Site Description	Challenges/Considerations
Rail track outside plant across from San Onofre State Park (near beach parking lot)	1,493	5 miles	SONGS owned storage/staging track	Served by BNSF, active rail used for staging cars outside the plant. Sufficient land/room available for crane and equipment, would need to be fenced and lighted for loading trains. There may be challenges reaching it on direct truck route due to radius of turns and public encroachment on plant.
Camp Pendleton Commissary Track	4,098	21 miles	Active loading track for military flat cars	Potential clearance issue with tunnel in curve to exit site to mainline.
Ace Welding & Fabrication Building 1325 S. Coast Hwy Oceanside, CA 92054	968	22.5 miles	Commercial facility	Track located against building, not conducive to loading dimensional cargo.
Braun Medical 2525 McGaw Avenue Irvine, CA	690.4	32.8 miles	Commercial facility – active shipper	Active shipper/receiver of covered hoppers, limited track
Impression Vanity 17353 Derian Avenue Irvine, CA 92614	697.3	32.9 miles	Commercial facility – cars parked on track	Track is on a curve, needs maintenance, switch in place, cars parked on the track.
Undetermined Shipper 1491 Santa Fe Dr Tustin, CA 92780	2,134	34.3 miles	Commercial facility	Track between buildings, multiple switches, no room to conduct a dimensional loading.
Superpacc 1432 Santa Fe Dr Tustin, CA 92780	2,822 (2 tracks)	34.4 miles	Commercial facility – unloading racks for covered hopper cars	Track in between buildings, unloading racks for covered hoppers, parallel track, tight quarters. Active track in between buildings enclosed, no room to operate a transload.

Track Location	Siding Length (ft)	Approx. HHT Mileage to Track	Site Description	Challenges/Considerations
Weber Plywood & Lumber 15501 Mosher Avenue Tustin, CA 92780	227.5	34.7 miles	Commercial facility	Gated track against building.
Camp Pendleton South	6,103 (4 tracks)	35 miles	Military Facility: Railroad yard-active	Extensive rail infrastructure with several tracks that are long enough to load the entire train consist, within military base, already fenced and secured.
Naval Construction Battalion Port Hueneme Track 4363 Missile Way Port Hueneme, CA 93403	5,124 (4 tracks)	35.1 miles	Military Facility – active port	Very busy port location, interference with existing business, require permission, farther away from site.
Shinoda Design Center 601 W. Dyer Ave. Santa Ana, CA 92707	2,377	36 miles	Commercial facility	3 tracks along building, behind gate, paved “road” on other side, wide enough for crane although narrow and skinny maybe a culvert next to the road. Fenced and elevated area next to the track.
Behr Paint 3400 West Garry Avenue Santa Ana, CA 92704	479.5	36.5 miles	Commercial facility – active shipper	Two curved parallel tracks inside the gate, car spots below loading rack (overhead obstruction), not enough room to load trains here, active shipper.
Plastics Express 3200 E. Frontera Avenue Anaheim, CA 92806	Multiple tracks	52 miles	Commercial facility – active shipper	Very active plastics transload yard, covered hoppers
Ventura Transfer Co. 2418 E. 223rd St. Carson, CA 90810	3,169	64 miles	Commercial facility – active receiver	Liquid transfer terminal, too congested with rail traffic, active receiver

Track Location	Siding Length (ft)	Approx. HHT Mileage to Track	Site Description	Challenges/Considerations
Caravan Global – Warehouse and Fulfillment 2839 E. El Presidio Street Carson, CA 90810	1,299.3	66 miles	Commercial facility	Curved track, limited area for staging and loading while existing business is operating, trailers parked on the track. Potential track condition concerns.
Titan Terminal & Transport 4570 Ardine Street South Gate, CA 90280	3,524.4 (not cont-iguous)	67.3 miles	Commercial facility	Liquid terminal, 2 curved tracks, unloading racks, congested plus 4 straight tracks.
801 E. Anaheim St. Wilmington, CA 90744	1,202.8	71.2 miles	Empty lot	Empty lot with track, condition questionable, fenced, at opposite end of the BNSF yard, track likely needs work, laydown yard.
PQ Corp. 4452 Ardine Street South Gate, CA 90280	3,000 (in ladders)	78.2 miles	Commercial facility – active shippers	3 liquid terminals, busy, active shippers, impossible to conduct dimensional transload here
Weber Logistics 1366 30th Street San Diego, CA 92154	1,316.6 (2 tracks)	78.3 miles	Commercial facility – active shippers	3 active shippers on these tracks, not enough room to load trains, and one-set of tracks against building

START [1] was utilized to create truck routes to the first two rail served sites in **Table 3-2** that are identified within close proximity to the SONGS site and already have the required infrastructure to load trains for the outbound shipping campaign. Both locations are considered viable options for establishing an off-site transload location in the event there were issues with the track inside SONGS; although the preference is to load on existing track within the site, close to the ISFSIs. The existing track near the ISFSIs is within a protected area with a short 355ft self-propelled modular transporter (SPMT)/HHT move to the new rail track for loading. See the recommended loading location shown in **Figure 2-7**.

Routes were configured to utilize interstate highways wherever available to avoid using two-lane country or local roads and potentially alleviate road congestion during tourist seasons since the site is surrounded by beaches. An alternate combination route which was not examined was using I-5 and the beach to move casks from the site via specialized tracked vehicles along the beach to Camp Pendleton as was previously used for some inbound heavy components from Japan, in 2008 and 2010.

The best potential transload track just outside the plant is located across from San Onofre State Park with direct access from Old Pacific Highway and/or El Camino Real. In addition to having plenty of track to load the train, there is sufficient room to stage and place the required equipment for an efficient train loading campaign. The area would require fencing, lighting, and monitoring equipment to provide a secure area for loading. The site and nearby public beach are segregated by a wall, although a security evaluation would be required to determine if additional measures should be taken to further secure the site from the public for safety and security purposes.

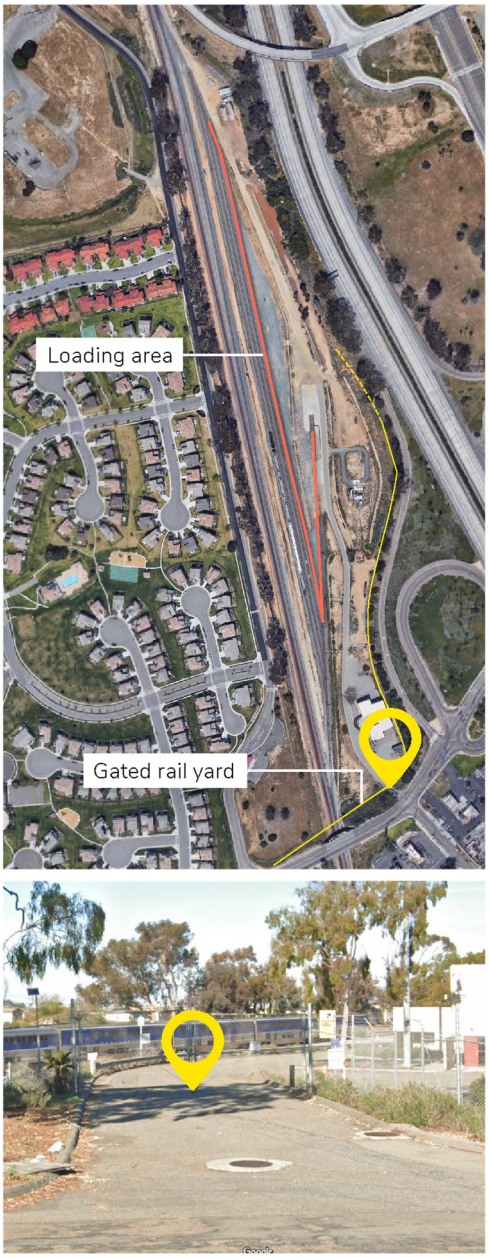
This track is leased to SONGS according to a lease agreement provided by the site. The track is parallel to the mainline track which leads to the site's rail siding. The point of switch is located 3,249ft from the transload track point of switch (see **Figure 3-3**).

Figure 3-3: SONGS Mainline Track from Point of Switch

The second selected site is a private rail yard on the military base, Camp Pendleton South. It is fenced and secured within the military base. It is served by BNSF. This is an actively maintained track used for loading equipment in preparation for the movement of military equipment being positioned for exercises. This track is located south of the site. The advantage of this site is that it is an existing rail yard and there appears to be plenty of track to conduct transloads and build trains without interfering with existing train operations (see **Figure 3-4**). Some trackwork may be required before use. Using this site would require obtaining permission from the military and any operations at this site would have to be coordinated around any planned existing military shipments, which would have priority.

The other potential transload (to rail) sites identified in Table 3-2 were evaluated for the potential to perform transload activities without modification (i.e., in the as-is state) and, as noted in the final column of this table, were identified to have some challenges/considerations that might not make these routes appear as attractive as the first two entries into the table. For completeness, all the investigated potential transload sites are included in the table.

Figure 3-4: Camp Pendleton South Rail Yard



Although these sites may provide good alternate options for establishing off-site locations for a transload, the fact remains that SONGS has sufficient useable rail in place at this time on the site to allow for conducting an efficient shipping campaign entirely on the SONGS property. This would eliminate the need for HHT road surveys and permits, additional transit time, and costs for additional critical lifts. It would also save the costs of using another shipper's private rail infrastructure to load the trains (which may be complicated by having to schedule shipments to avoid interference with the owner's transport campaigns), cost for upgrades to the transload infrastructure (if any are required at the time), and costs to enhance or establish acceptable security for SNF/HAZMAT at the sites.

Some additional sites initially considered for outbound barge/vessel include the locations listed in Table 3-3. These transload sites involve moving the loaded transportation overpack from SONGS by the HHT trailer to a vessel or a barge. The barge in general is intended to move loaded overpacks to a nearby domestic port with access to rail, which can subsequently be shipped by rail to GCUS. The vessel in general is intended to move loaded overpacks by ocean via the Panama Canal to the Port of Houston where it is transloaded to rail and shipped to GCUS.

Table 3-3: Additional Locations Considered for Transload from HHT to Vessel/Barge

Port Location	Terminal Operator	Approx. HHT Mileage to Port	Site Description	Challenges/Considerations
Camp Pendleton South, CA Barge ramp	Military	22 miles	Military Barge Ramp	Private barge ramp used by the Amphibious Vehicle Test Team, Boat Basin Road, US Marine Corps.
Port of San Diego, CA Tenth Street Terminal	Pasha Automotive	57 miles	Breakbulk pier inside the Port of San Diego	It is a very busy automobile and banana import location and is ranked #3 in the United States for intermodal container handling.
Port of Long Beach, CA Pier F Berth 206	SSA	62 miles	Breakbulk pier inside the Port of Long Beach	Project cargo and large machinery is handled at this pier. It is a secure location. Very busy container port, ranked #2 in U.S. “Hazard Pay” quoted extra.
Port of Los Angeles, CA Berth 154 Breakbulk Terminals	SSA/Pasha	65.2 miles	Breakbulk pier inside the Port of Los Angeles	The port is ranked as the #1 Container Port in the United States and is very congested. It is a secure location requiring a purpose and TWIC or escort to enter the port. There are four project cargo berths here.
Port Hueneme, CA Pacific RoRo Terminal 333 Ponoma St. Port Hueneme, CA	Oxnard Harbor District	135 miles	Breakbulk pier inside the Port of Hueneme	Not as busy terminal as others in this table but HHT route is longer and potentially through heavily populated areas.

Port of Los Angeles (**Figure 3-5)** and Port of Long Beach (**Figure 3-6**) are located right next to one another and are marketed together. Both are very busy container ports, being consistently ranked 1 and 2 in the United States for the volume of intermodal containers moved through these ports. HHT routes to the ports are listed above in the table and involve passing several rail sidings before reaching the ports. The HHT route from SONGS to these ports travels through congested areas.

Figure 3-5: Port of Los Angeles HHT-to-Vessel Transload Site

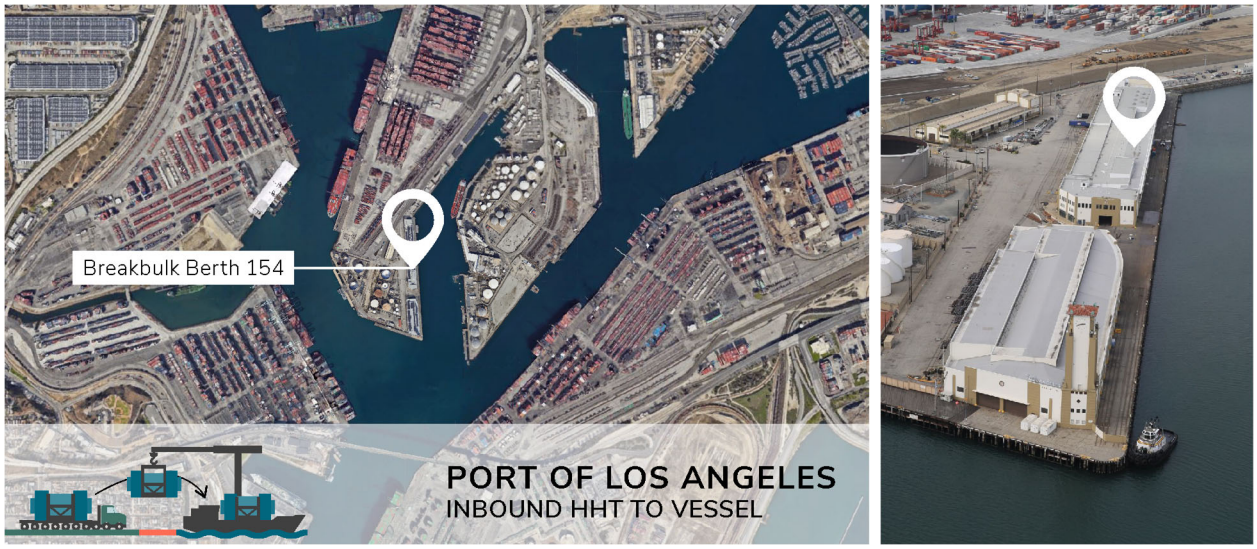
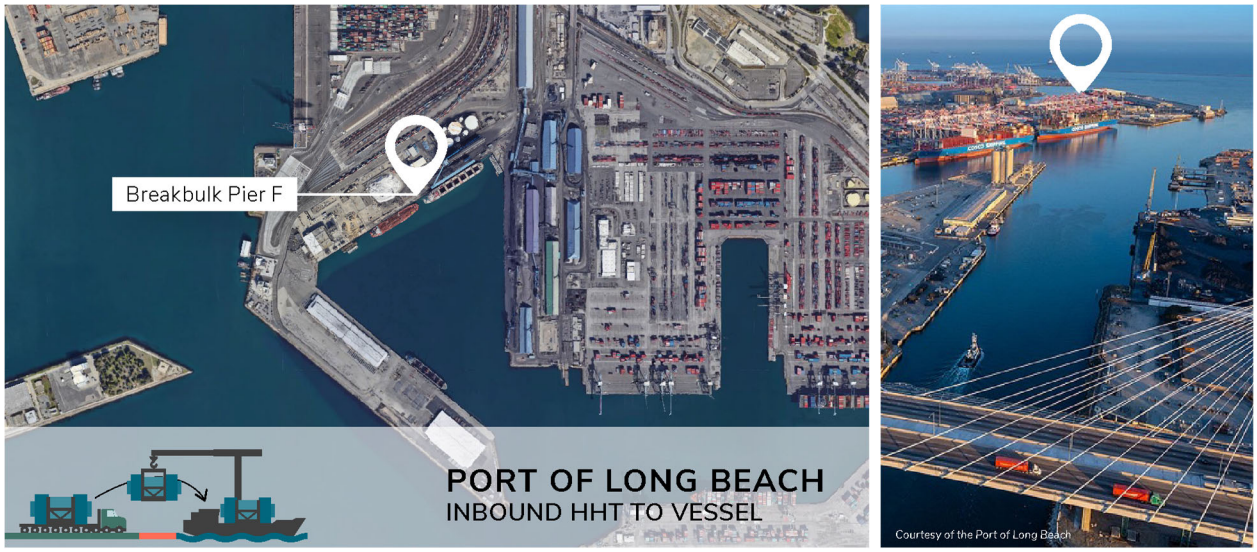


Figure 3-6: Port of Long Beach HHT-to-Vessel Transload Site



Port of San Diego (**Figure 3-7**) is also a busy port, automobiles and fruit are the major commodities moving through this port followed by containers. It is the primary port of entry for Honda, Fiat, Audi, Mazda, Acura, Isuzu, Volkswagen, Nissan, Mitsubishi Fuso, and Hino Motors into America.

The Port holds a 24½-year lease with Dole Food Company bringing in much of the country's banana crop. It is also the third-busiest cruise ship port in California. It is closer to SONGS than the ports of Los Angeles and Long Beach and involves a less congested route. Truck routes for regular inbound truck traffic to the port are depicted in **Figure 3-8** published by the port.

Figure 3-7: Port of San Diego HHT-to-Vessel Transload Site

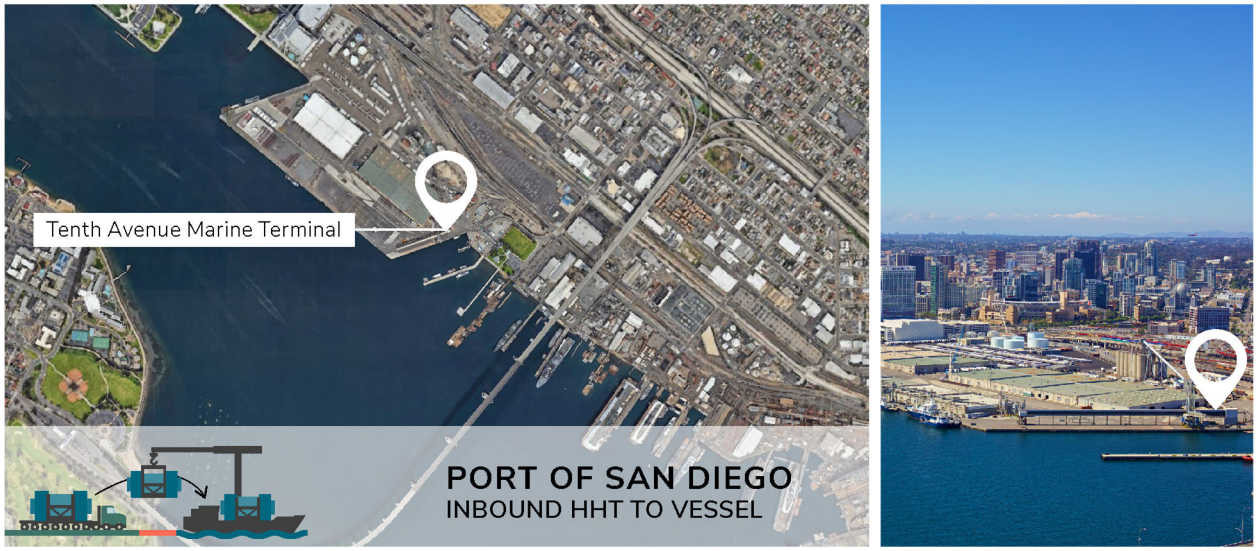
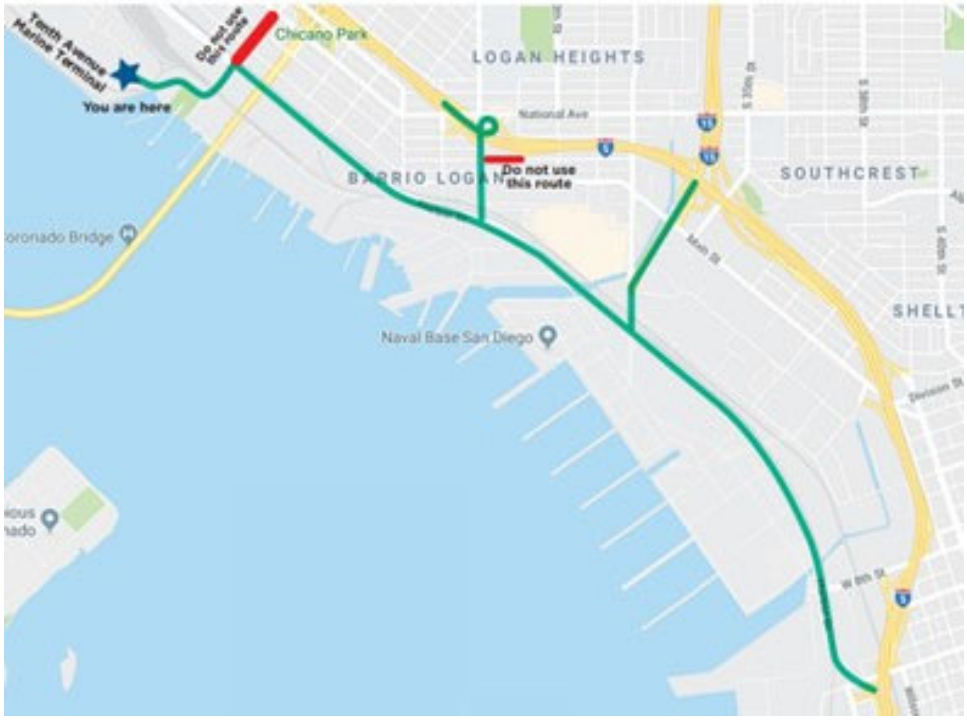


Figure 3-8: Port of San Diego Truck Routes



3.2 Rail Routes

As described in **Section 2.0**, the SONGS site is directly rail served by the BNSF rail carrier, which is a Class I railroad. It is the only rail carrier which has access to the site. There are no other freight rail carriers located in the immediate vicinity.

Previously, from October 2008 to September 30, 2020, Pacific Sun Railroad, owned by WATCO, served the SONGS site under contract with BNSF. The contract expired and BNSF resumed freight operations along this line on October 1, 2020 [20]. On August 17, 2020, PSRR filed a petition seeking discontinuance of service over 21.5 miles of BNSF owned track including trackage rights. The territory affected " . . . consists of the Escondido Subdivision, (from milepost 0.0 at Oceanside, CA to milepost 21.2 at Escondido, CA), and the Miramar Spur, which extends approximately 0.3 miles eastward from milepost 252.9 at Miramar, CA (on BNSF's San Diego Subdivision); and, discontinue[ance] of local trackage rights over approximately 45.49 miles of BNSF rail line on its San Diego Subdivision (the Trackage Rights Line), extending from milepost 252.9 at Miramar to milepost 207.41 at the border of Orange County, CA, and San Diego County, CA." [21]

The mainline switch is still in place and is actively being used by SONGS*Solutions* for outbound rail shipments during the decommissioning process. There is a long lead from the BNSF mainline POS into the site (2,199 ft). Currently, there are 7 tracks in the plant and the original switch and track leading to the ISFSIs was replaced from a western to eastern access. The new track comes off the southernmost parallel track, from the east. This new single line track is located approximately 355ft east of the two ISFSIs and will hold 5 heavy-duty flat cars. **Figure 2-10** shows the ISFSIs and track configuration.

When the track was refurbished at the site, the footprint changed at least twice since decommissioning commenced. The 7 tracks now in place have the capacity to store 65 gondola cars and allow for room to load and stage cars as needed.

In preparation for decommissioning, the tracks at SONGS were upgraded to allow for loading different types of railcars, providing room for staging empty railcars awaiting loading, and for loaded railcars awaiting pick up from BNSF (see **Figure 2-7**). Once the Administrative, Warehouse, and Shop building was demolished, additional parallel tracks were added in this space providing more capacity.

The maximum number of outbound loaded railcars shipped at one time is generally 12 to 15 per switch. This limitation is due to the grade of the track in the facility. Only one locomotive is used to switch the plant and pull the loaded cars.

Figure 3-9: New Rail Lines to SONGS [52]

There are several passenger and commuter trains that operate along the mainline track from San Luis Obispo, CA to San Diego, CA. Multiple trains were identified that operate on this line on a daily basis, some of which run multiple times/day. **Figure 3-10** identifies the trains operating closest to the site.

As a result of the steady commuter train traffic outside the plant and in the immediate geographical area of the site, there are limited windows for the freight rail carrier to switch the site. BNSF serves the plant twice a week from midnight to 4 AM on Tuesdays and Wednesdays, as needed, when switches are requested. The serving crew operates out of Stuart Mesa railyard which is located 11.7 rail miles south of the site. The BNSF crew originates at this yard but drops loaded cars at the BNSF Barstow railyard in Barstow, CA.

The site is currently switched twice per week, but service would revert to an “as needed” basis once decommissioning is completed and there are no more regular shipments from the site. The BNSF would only come into the site to place an empty train or pull a loaded one and this transload track would be switched in the same manner, on an as-needed basis but not as frequently as twice/week.

Amtrak runs several passenger lines into, through, and out of California. **Figure 3-11** shows the Amtrak trains currently operating close to the SONGS site.

Figure 3-10: Map of Area Operating Rail Carriers

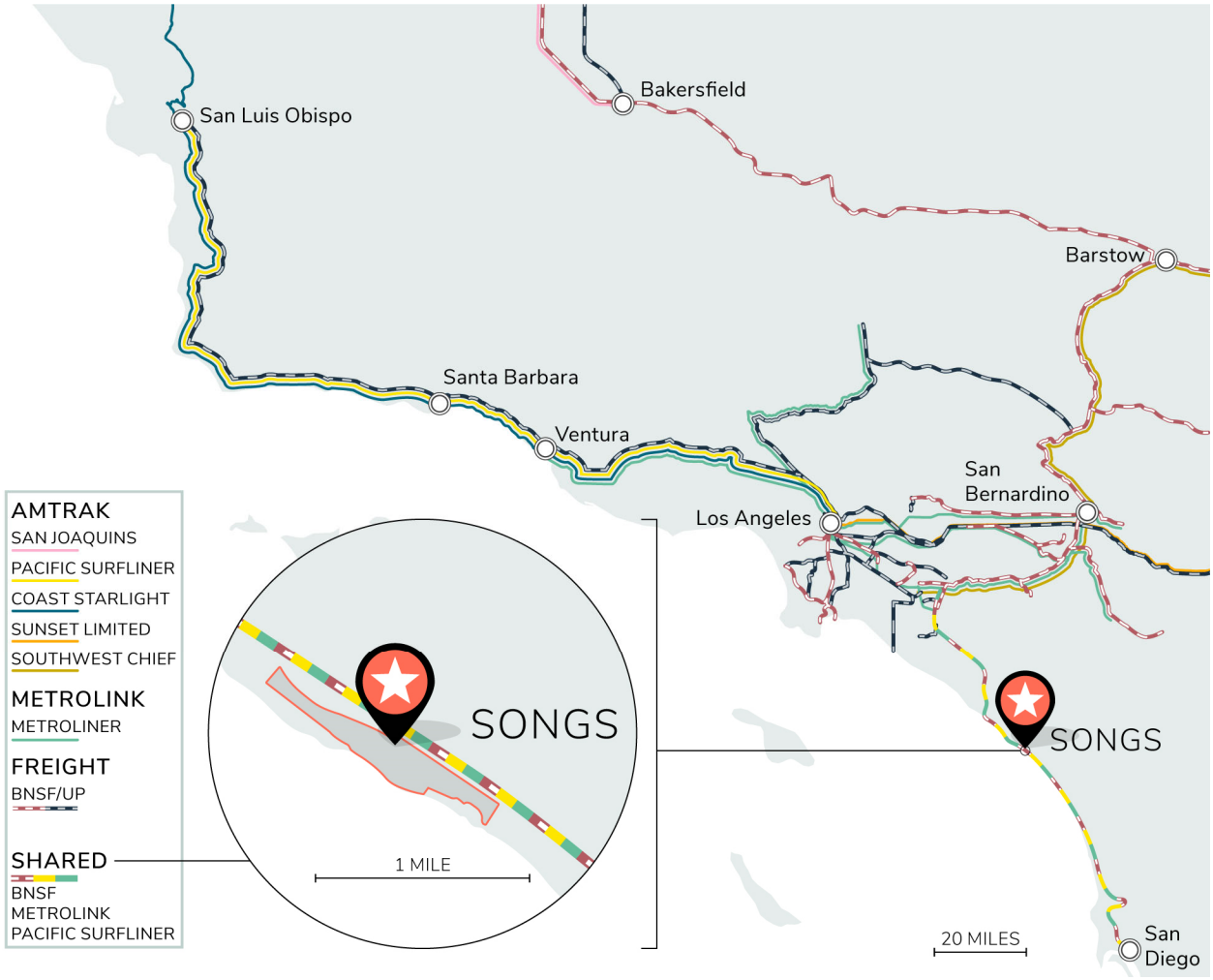
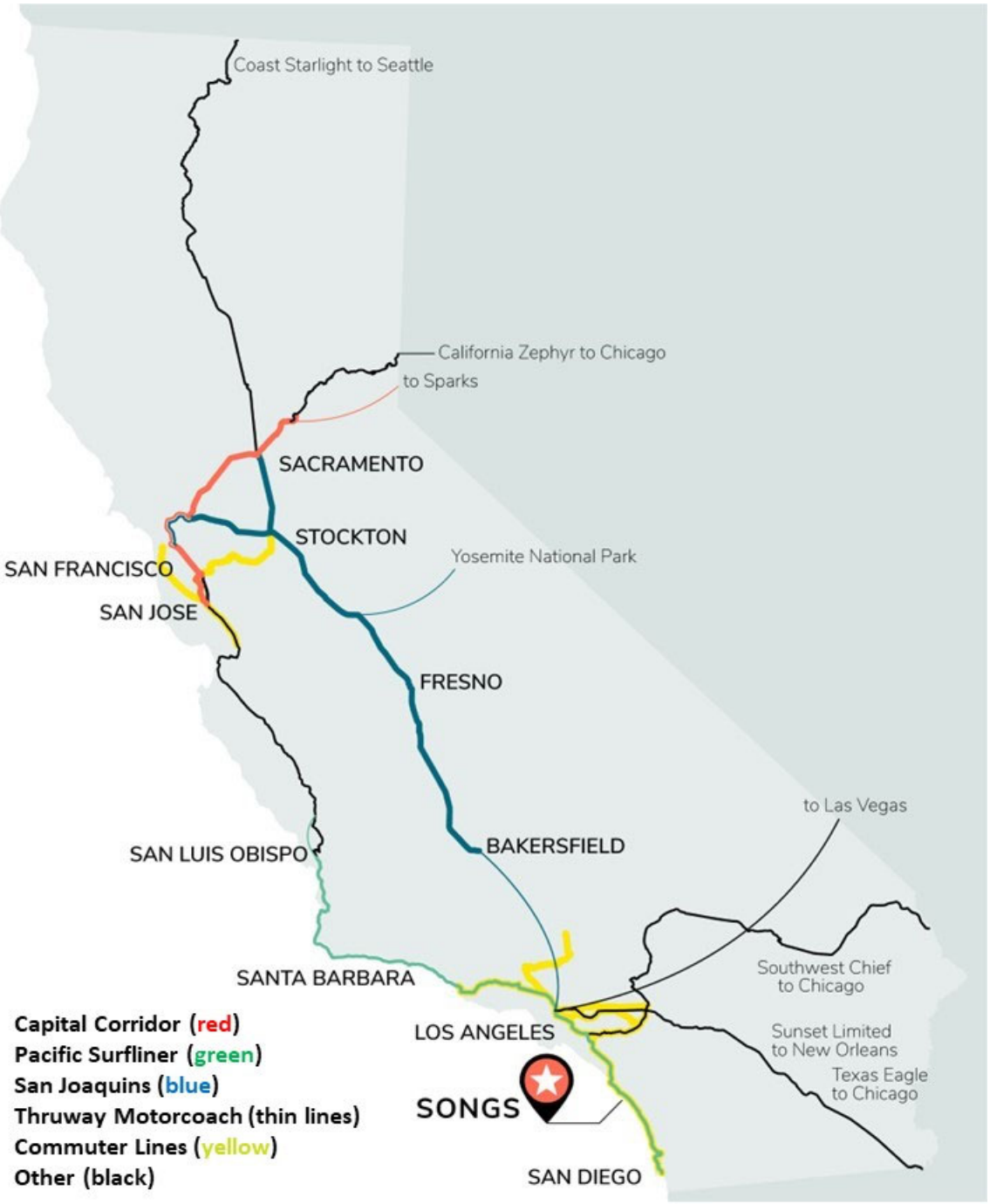


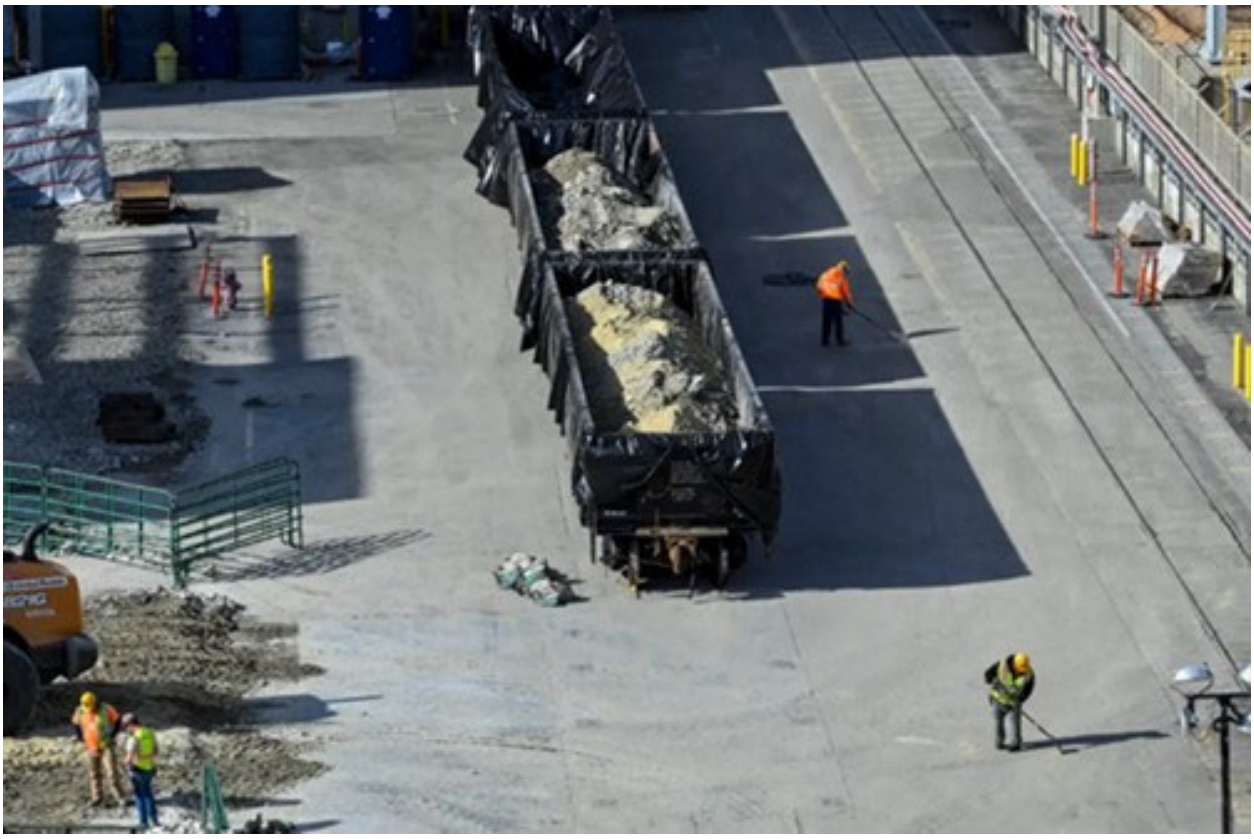
Figure 3-11: Amtrak Trains Currently Operating in California



Since demolition began in 2021, the site has removed over 144 million pounds of the anticipated one billion total pounds of waste for off-site recycling and disposal. Rail and truck waste shipments sent off site in 2022 totaled over 88 million pounds [53]. The majority of outbound shipments during decommissioning have been transported from the site by rail to the Energy*Solutions*' disposal site in Clive, UT, located on Class I railroad, the UP. It is estimated that by the end of decommissioning, 5,500 carloads of material will move from the site for disposal.

Figure 3-12 shows workers loading gondola railcars with crushed cement destined for Clive, UT for disposal in December 2021. The shipments are pulled by BNSF and travel to Barstow railyard and then to West Colton, CA yard to interchange with UP. From there, the UP moves the cars to Clive, UT. Transit time is approximately 4 days for this joint line route. It is 840 rail miles from the site to Clive, UT.

Figure 3-12: Loading of Gondola Railcars at SONGS



In 2020, the San Diego Times reported [54]:

- "About 285,000 tons (570 million pounds) of material at SONGS will be labeled Class A, the lowest level. It makes up the vast majority of the plant's remains and will be sent to the Energy*Solutions* disposal facility in Clive, UT. Most of the waste will be sent by rail.
- Some 35 tons of Class B and C low-level waste will get shipped by truck to the Waste Control Specialist facility in the West Texas town of Andrews. Bilovsky estimates the shipments will amount to about six to eight truckloads.

An additional 125 tons of material classified as higher than Class C low-level waste will remain at SONGS. The waste will be put into 12 horizontal canisters – the same type of canisters Edison used to store spent fuel assemblies at the original storage site at the north end of SONGS." [54]

A breakdown of the decommissioning waste totals as of August 2022, published by SONGS Decommissioning Solutions on the progress at the plant, is shown in **Figure 3-13**.

Figure 3-13: SONGS Disposal by the Numbers

By the numbers; SONGS dismantlement

$4.5 billion: Total estimated cost
1.094 billion: The pounds of material that will be removed
195,000: How many pounds of waste each rail car can hold
370: The number of rail carloads shipped out so far
5,500: How many shipments will be made by completion of the job

Source: SONGS Decommissioning Solutions

Most of the rail traffic leaving the site is in private gondola railcars weighing 200,000 lbs. each, shipping 12 to 15 at a time **Figure 3-14**. Some of the other car types used for outbound shipments during decommissioning include private covered gondolas **Figure 3-15** and covered hoppers **Figure 3-16**.

Figure 3-14: Gondola Movements on SONGS Site

Figure 3-15: Covered Gondola Cars at SONGS Site

Figure 3-16: Covered Hopper Cars at SONGS Site

One of the most publicized rail shipments to leave the site was the reactor pressure vessel (RPV) from Unit 1, which was prepared on-site in 2019 (width shaved to meet the clearance requirements ¾ inch on each side), loaded in May 2020 and departed May 24, 2020, for the Energy*Solutions*' disposal site in Clive, UT. The RPV had been staged near the ISFSI for 20 years. It was moved from this location on a double-wide hydraulic trailer (see **Figure 3-17**) and moved to a track just outside the plant where it was transloaded onto a specialized 36-axle private railcar called a Schnabel car (see **Figure 3-18** and **Figure 3-19**).

Figure 3-17: Double-Wide Movement of RPV along the 6% Grade from the Storage Location next to the ISFSI to the Load Track Outside the Plant [11]

Figure 3-18: 36-Axle Schnabel Car Loaded with RPV from SONGS Unit 1 [55]

Figure 3-19: 36-Axle Schnabel Car Loaded with RPV from SONGS Unit 1 Ready to Go [55]

The total package plus the skid weighed 770 tons. The 6% grade in the plant was a factor in selecting the loading location and at the time the shipment took place, the track in the plant had not yet been refurbished. The short line refused to come into the plant to switch the loaded car and they were not permitted to use the storage track outside the plant for loading because the short line serving the plant at that time refused to grant permission for operational reasons. Shortly before the shipment, the BNSF resumed operations on this line for freight services, although BNSF always switched the plant for unit/special train operations.

The Schnabel car adjusts vertically and horizontally to accommodate mechanical shifting during transportation to negotiate difficult or tight clearance areas. A private crew moves with the Schnabel car in a caboose, and they execute the adjustments to the car to allow passage through pinch points along the route. The railroad crew does not adjust the car. This operation took place during COVID-19 so there were multiple challenges in addition to the engineering challenges of the shipment, such as the 100-year-old railroad bridge over San Juan Creek that required added support (stands) under all spans of the bridge to allow the loaded Schnabel to pass over the bridge safely.

The ultimate dimensions of the RPV package for transport were 38ft 6in long x 15ft 6in wide (diameter) x 19ft 4½in high. To meet the approved clearance, the package had to be shaved to reduce it by ¾in on each side. Even with the reduction in the width of the package, the transport could not be completed directly on rail to Clive, UT. There were bridge issues along the route (see **Figure 3-20**) and ultimately, the move involved a HHT from SONGS to the load track, transfer onto the private railcar, movement by rail to Apex, NV, transload onto another specialized trailer for the final over-the-road transport to Clive, UT (see **Figure 3-21**).

The final route for the RPV included 360 miles on rail and 350 miles on highway to reach the disposal site. **Figure 3-22** and **Figure 3-23** show the unit being unloaded from the HHT and placed into the ground at Clive where it sits next to other large components in the Large Component Cell, **Figure 3-24**.

Figure 3-20: Tight Clearance for SONGS Unit 1 RPV on Bridge for Rail [55]

Figure 3-21: Final Leg (HHT) of the SONGS Unit 1 RPV to Clive, UT [55]

Figure 3-22: Moving Unit 1 SONGS RPV into Clive, UT Disposal Facility [55]

Figure 3-23: Unloading of Unit 1 SONGS RPV at Clive, UT Disposal Facility [55]

Figure 3-24: Unit 1 SONGS RPV in Large Component Disposal Cell of Clive, UT Disposal Facility [55]

Table 3-4 lists the rail carriers in the geographic area.

Table 3-4: Rail Carrier Operating Near SONGS [1]

Rail Carrier	Railroad Class	Notes
BNSF	Class I Freight	The BNSF is the Class I railroad that serves the SONGS site. It is the only rail carrier capable of switching the site.
UP	Class I Freight	UP is the next closest Class I carrier to the site. It regularly interchanges traffic with the BNSF in West Colton, CA for joint line movements departing the site. The interchange takes place 2 days per week.
Amtrak: • Pacific Surfliner • Coast Starlight • Southwest Chief • Sunset Limited • Texas Eagle (Intercity Rail)	Class I Passenger	Operating over mainline track outside the plant, along the west coast, parallel to I-5, serving approximately 43,000 passengers per month in 2017.
Metrolink	Commuter	Connects Los Angeles county's metro rail and Metro bus system, and other commuter rail lines and Amtrak.
Coaster Commuter Train	Commuter	San Diego County's commuter train
Sprinter Train	Commuter	San Diego County's hybrid rail service

As shown in **Figure 2-7,** track was identified for loading the outbound SNF trains. It is close to the gates of the ISFSIs and allows for loading the train with minimal switching, while allowing two tracks to be used for staging empties, buffers, and the security car away from loading operations. The secure area including fencing will have to be extended to include the train loading operations, as well as the train staging area.

Two direct rail routes were considered from the SONGS site to GCUS as identified in **Table 3-5**. The only difference between the routes is that Route A is a direct BNSF movement, with no other carriers in the route, while the Route H is a joint-line route between BNSF and UP. The joint line route (Route H) is a more southern route than the BNSF direct route. According to START, the second route (Route H) is slightly longer in transit time at 60 hours than the first, while Route A is 8 hours less.

Route L involves a transload just outside the plant, in addition to a HHT at the ISFSIs. All carriers involved are Class I railroads.

Table 3-5: Potential Rail Routes to GCUS

Route Identification	Total Distance (Miles)	Total Travel Time (min/hrs)	Route Description	Challenges/Considerations
Route A	2,189	3,420/57	Rail direct from SONGS to GCUS, BNSF direct. Developed using START from expert rail route knowledge, minimum distance.	Benefits include only one Class I railroad in the route, least transit time and most direct route.
Route H	2,344	3,600/60	Direct rail from SONGS to GCUS using a joint-line route (BNSF-UP). Developed using START with Minimum Travel Time filter.	The travel time is not accurate as START doesn't account for additional time at interchanges between carriers. This is a good route but it involved two Class I carriers which increases costs and transit time.
Route L	2,102	3,060/51	HHT from SONGS to closest rail track, across from San Onofre State Park, BNSF direct to GCUS. Developed using START and from expert rail route knowledge.	This route was developed using the closest rail track to the site, in the event a transload track was necessary. One complication is that the track is owned by BNSF and would require a purchase to load there.

Route Identification	Total Distance (Miles)	Total Travel Time (min/hrs)	Route Description	Challenges/Considerations
Route P	2,780	8.340/139	HHT from SONGS to Camp Pendleton boat ramp, barge to MOTCO, rail to GCUS, BNSF direct.	This route was selected because it is an existing boat ramp located in a secure area potentially where casks could be barged to another rail siding.
Route Q	6.076	45,840/764	HHT from SONGS to San Diego port, vessel through Panama Canal to either Port of Houston or NOLA, rail to GCUS	This route has multiple transloads, and critical lifts with multiple modes. There are more direct routes with less overall transit time than this route.
Route N	6,121	46,200/770	HHT from SONGS to Los Angeles Port, vessel through Panama Canal to Port of Houston or NOLA, rail to CGUS	Similar to Route Q, this route has multipe transloads and critical lifts with multiple modes.

As previously discussed, there currently is sufficient rail infrastructure on the SONGS site to conduct a rail shipping campaign directly from the site. This would involve the least amount of handling and would involve a very short HHT movement from the ISFSIs to the on-site transloading location. The short HHT movement from the ISFSIs to the train loading location is approximately 355ft and will not require any trucking permits because the movements are completely on private property.

3.3 Barge/Vessel Routes

SONGS is located directly on the Pacific Ocean; however, there is no existing barge slip or dock at the site. There is an elevation difference between the ISFSIs and the beach which abuts the SONGS property.

At the time the plant was built there was an attempt to construct a barge slip [9], but it was unsuccessful due to waves and current activity, and today, the site remains without direct barge access.

In 2008 and 2010, inbound shipments of replacement steam generators were imported from Kobe, Japan to the Ports of Los Angeles and Long Beach. They were transloaded onto ABS barges and barged south of the plant to the Del Mar Boat Basin dock at Camp Pendleton. They were loaded onto tracked vehicles and traveled over the beach from Camp Pendleton following military transit routes (see **Figure 3-25**) and then entered I-5 for the remainder of the transport to reach Old Pacific Highway and entered the site for delivery. This transport used an unusual combination of private and public roads (and beaches) to reach the site. With environmental concerns, it is unlikely that

this type of transport would be permitted today with SNF, but it certainly could be investigated if barge were a serious mode alternative for outbound shipments of SNF from SONGS.

Figure 3-25: Shipment of Replacement Steam Generators on Beach 2009

Photo courtesy of California Public Utilities Commission

The easiest way to ship by barge mode from the site would be to move the casks from SONGS by HHT or rail to a viable port with existing infrastructure where the casks could be directly discharged onto barges/vessels (if possible) for the water portion of the transport. As part of the analysis, several ports were identified that currently have appropriate facilities and infrastructure in place to properly transload the casks from HHT to barge/vessel. Vessels would be required for movement through the Panama Canal to comply with the International Maritime Organization (IMO) regulations and other applicable regulations. HHT shipments as the first leg of the water transport would require obtaining OTR permits or rail clearances to the ports.

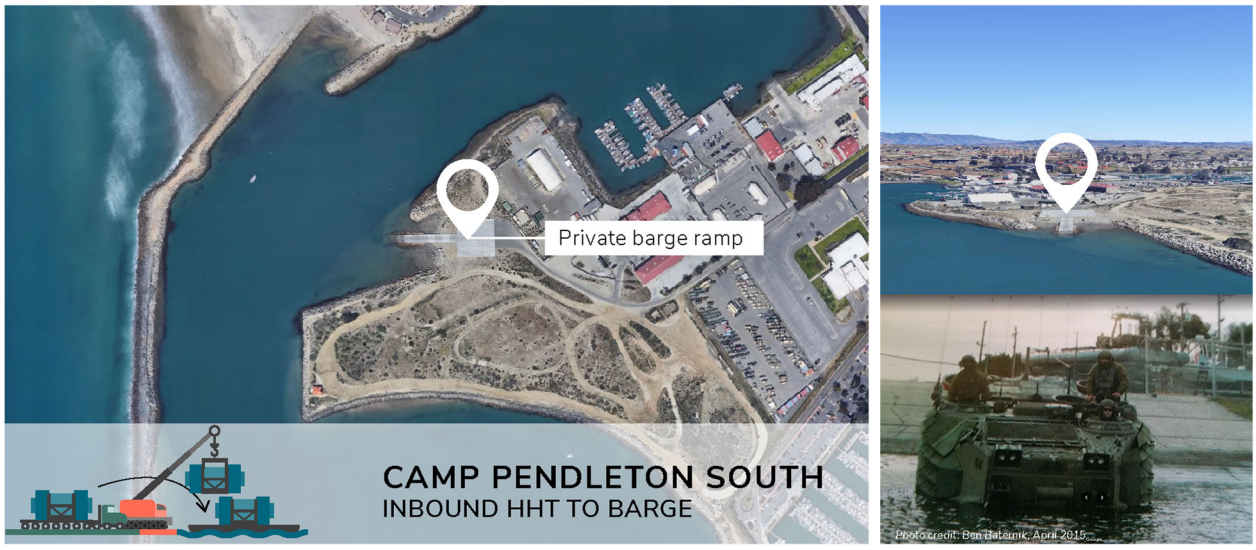
The closest commercial ports to the site are the Ports of Los Angeles, Long Beach and San Diego. Each has breakbulk terminals although the majority of the traffic moving through these ports is container traffic (intermodal containers). Both the Ports of Long Beach and Los Angeles are ranked number 1 and 2 in the top ten U.S. intermodal ports by volume of containers moved [56].

1. Port of Los Angeles, CA - more than 9.2 million TEU in 2020, 10.7 million twenty-foot equivalent unit (TEU) in 2021
2. Port of Long Beach, CA - more than 8.1 million TEU in 2020, 9.38 million TEU 2021
3. Port of San Diego, CA - ranks in the top 30 ports of the United States for intermodal shipments, coming in at 27th. Primary port of entry for the following automobiles: Honda, Fiat, Audi, Mazda, Acura, Isuzu, Volkswagen, Nissan, Mitsubishi Fuso, and Hino Motors into America [57].

START [1] pulled the statistics for the vessel marine routes. Two of the routes were moving north via HHT from SONGS to the Ports of Los Angeles and Long Beach and moving south to Port of San Diego. At both ports, the casks would be loaded onto vessel for the marine movement from the port through the Panama Canal to either the Port of Houston or Port of New Orleans, where the casks would be transloaded directly onto railcars for the final transport segment to GCUS. The total distance and transit times are listed in **Table 3-6**.

START [1] also identified the barge route from SONGS via HHT to Camp Pendleton for transloading onto barge for the marine transport to MOTCO where the casks would be transloaded onto railcars for the final rail segment to GCUS. The Camp Pendleton barge landing site is shown in **Figure 3-26**.

Figure 3-26: Camp Pendleton Barge Landing Site



At this time there is no option to conduct a direct transfer from rail to vessel at both Port of Los Angeles and Port of Long Beach because the track needs to be upgraded/repaired. As a result of not being able to conduct a direct discharge from railcar to the vessel, additional transfers/lifts would be required if the inbound movement was by rail. Neither port has identified a schedule for the repairs to the track.

If the casks are moved by HHT from SONGS to Port of Los Angeles or Port of Long Beach, the cask could be lifted directly onto the vessel using ships' gear. This would be an expensive and cumbersome logistical move because of the number of truckloads it would take to complete the campaign.

The inherent complications of these rail-to-port routes include additional critical lifts, passing other viable rail locations where a transload could take place and the complexity of moving the SNF through the Panama Canal and under the Golden Gate Bridge. These marine options were much more complex than the direct rail shipment options from the SONGS site. All three ports are extremely busy with container or automobile traffic.

As with all barge or vessel shipments, weather conditions must constantly be monitored to ensure safe passage from the origin port to destination port.

Table 3-6: Potential Barge/Vessel Routes

Route Identification	Total Distance (Miles)	Total Travel Time (min/hrs)	Route Description	Challenges / Considerations
Route N	770/46,200	6,121	HHT from ISFSI to commercial Port of Los Angeles by vessel to Port of Houston/New Orleans via Panama Canal, transload to rail for movement to GCUS.*	Multiple critial lifts, movement through a more densely populated area, port is very conjested, potential delays at the Panama Canal due to volume.
Route Q	764/45,840	6,076	HHT from ISFSI to commercial Port of San Diego, vessel movement to Port of Houston/New Orleans via Panama Canal, transload to rail for movement to GCUS.*	Multiple critial lifts, port is busy with automobile imports, potential delays at the Panama Canal due to volume.
Route P	2,780	139/8,340	HHT SONGS to Camp Pendleton barge ramp for transload onto barge, movement to MOTCO, transload to rail for movement to GCUS	Need permission from military to use the boat ramp, perceived concern about movement to MOTCO.

* Note: Movement through the Panama Canal must go by vessel according to IMO [64].

3.4 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-selection was based on comparing routes containing the same modes of transport (i.e., truck routes were not screened based on characteristics of barge routes). The result is that one or more routes are identified for each viable mode of transport from the site 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. Sustained travel on routes with steep grades.

4. Bridge(s)/overpass(s) 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.[4]

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 were applied to a number of potential routes in **Table 3-7** for screening before being assessed in the MUA process. After applying the above screening criteria, a total of six possible routes were identified and are included for further evaluation in the MUA:

1. Direct Rail from Site BNSF to GCUS (i.e., referred to as "A. Rail – Min. Time BNSF" in the MUA) – see **Figure 3-27**.
2. Direct Rail using joint line route with BNSF and interchange to UP to GCUS (i.e., referred to as "H. Rail – Min. Time BNSF-UP" in the MUA) – see **Figure 3-28**.
3. HHT to rail transload outside SONGS (across from San Onofre State Park), rail to GCUS using BNSF route (i.e., referred to as "L. HHT to Rail – Transload at San Onofre State Park" in the MUA) – see **Figure 3-29**.
4. HHT to Port of Los Angeles, by vessel thru the Panama Canal to Port of Houston, rail to GCUS (i.e., referred to as "N. HHT-Vessel-Rail to Los Angeles Port to Port Houston via Panama Canal" route in the MUA) – see **Figure 3-30**.
5. HHT to Camp Pendleton barge to MOTCO rail to GCUS (i.e., referred to as "P. HHT-Barge-Rail to Camp Pendleton to MOTCO" in the MUA) – see **Figure 3-31**.
6. HHT to Port of San Diego, vessel thru the Panama Canal to Port of Houston, rail to GCUS (i.e., referred to as "Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal" in the MUA) – see **Figure 3-32**.

[4] 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.

Table 3-7: Routes Versus Screening Criteria

Route	Screening Criteria										
	1 – Time/Distance	2 - Clearance	3 – Steep Grades	4 – Bridge Weight	5 – Infrastructure	6 – Insufficient Track	7 – No Permit Class 7	8 – # Interchanges	9 – High-Density	10 - HRCQ	Other
HHT minimum population route to GCUS from START [1]	X										Does not meet project specification
HHT minimum distance route to GCUS from START [1]	X										Does not meet project specification
HHT minimum transit time route to GCUS from START [1]	X										Does not meet project specification
HHT to on-site barge landing					X	X					No on-site barge landing
Route L - HHT to rail track outside plant (transload site) across from San Onofre State Park (near beach parking lot) on BNSF rail											
HHT to rail track outside plant (transload site) within Camp Pendleton South							X				Active military base
HHT to rail track outside plant (transload site) at Camp Pendleton Commissary Track		X		X							Active military base
HHT to Ace Welding & Fabrication Building in Oceanside, CA						X					Track against building
Weber Plywood & Lumber in Tustin, CA						X		X			Track against building

Route	Screening Criteria										
	1 – Time/Distance	2 - Clearance	3 – Steep Grades	4 – Bridge Weight	5 – Infrastructure	6 – Insufficient Track	7 – No Permit Class 7	8 – # Interchanges	9 – High-Density	10 - HRCQ	Other
Impression Vanity in Irvine, CA						X					Curved track
Braun Medical in Irvine, CA						X			X		Active shipper
Undetermined Shipper in Tustin, CA						X					Track between buildings
Superpacc in Tustin, CA						X			X		Track between buildings
Naval Construction Battalion in Port Hueneme, CA	X								X		Busy port and requires permission
Shinoda Design Center in Santa Ana, CA						X					Tracks along buildings
Behr Paint in Santa Ana, CA		X				X					
Plastics Express in Anaheim, CA	X					X					Busy transload facility
Caravan Global – Warehouse and Fulfillment in Carson, CA	X					X					Potential track condition
Ventura Transfer Co. in Carson, CA	X					X					

Route	Screening Criteria										
	1 – Time/Distance	2 - Clearance	3 – Steep Grades	4 – Bridge Weight	5 – Infrastructure	6 – Insufficient Track	7 – No Permit Class 7	8 – # Interchanges	9 – High-Density	10 - HRCQ	Other
801 E. Anaheim St. in Wilmington, CA	X										
Weber Logistics in San Diego, CA	X					X					
PQ Corp. in South Gate, CA	X					X					Congested
Titan Terminal & Transport in South Gate, CA	X										
Route A - Direct Rail from Site on BNSF											
Route H - Direct Rail from Site on BNSF with interchange to UP											
Direct Rail from SONGS using other rail routes	X	X	X	X				X			
Route N - HHT to Los Angeles Port – Vessel to Port Houston via Panama Canal – Rail											
Route P - HHT to Camp Pendleton – Barge to MOTCO – Rail											
Route Q - HHT to San Diego Port – Vessel to Port of Houston via Panama Canal - Rail											

Route	Screening Criteria										
	1 – Time/Distance	2 - Clearance	3 – Steep Grades	4 – Bridge Weight	5 – Infrastructure	6 – Insufficient Track	7 – No Permit Class 7	8 – # Interchanges	9 – High-Density	10 - HRCQ	Other
HHT to Camp Pendleton – Barge to other Port – Rail	X		X		X	X	X	X			
HHT to Port of Long Beach – Vessel to Port of Houston via Panama Canal – Rail						X					
HHT to other potential barge landings	X				X						
HHT to other ports for vessel loading	X						X		X	X	

Note: The highlighted rows indicate routes that have not been screened out and will be further analyzed in the MUA in **Section 5.0**.

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 3-27: A. Rail – Min. Time BNSF

Figure 3-28: H. Rail – Min. Time BNSF-UP

Figure 3-29: L. HHT to Rail – Transload at San Onofre State Park

Figure 3-30: N. HHT-Vessel-Rail to Los Angeles Port to Port Houston via Panama Canal

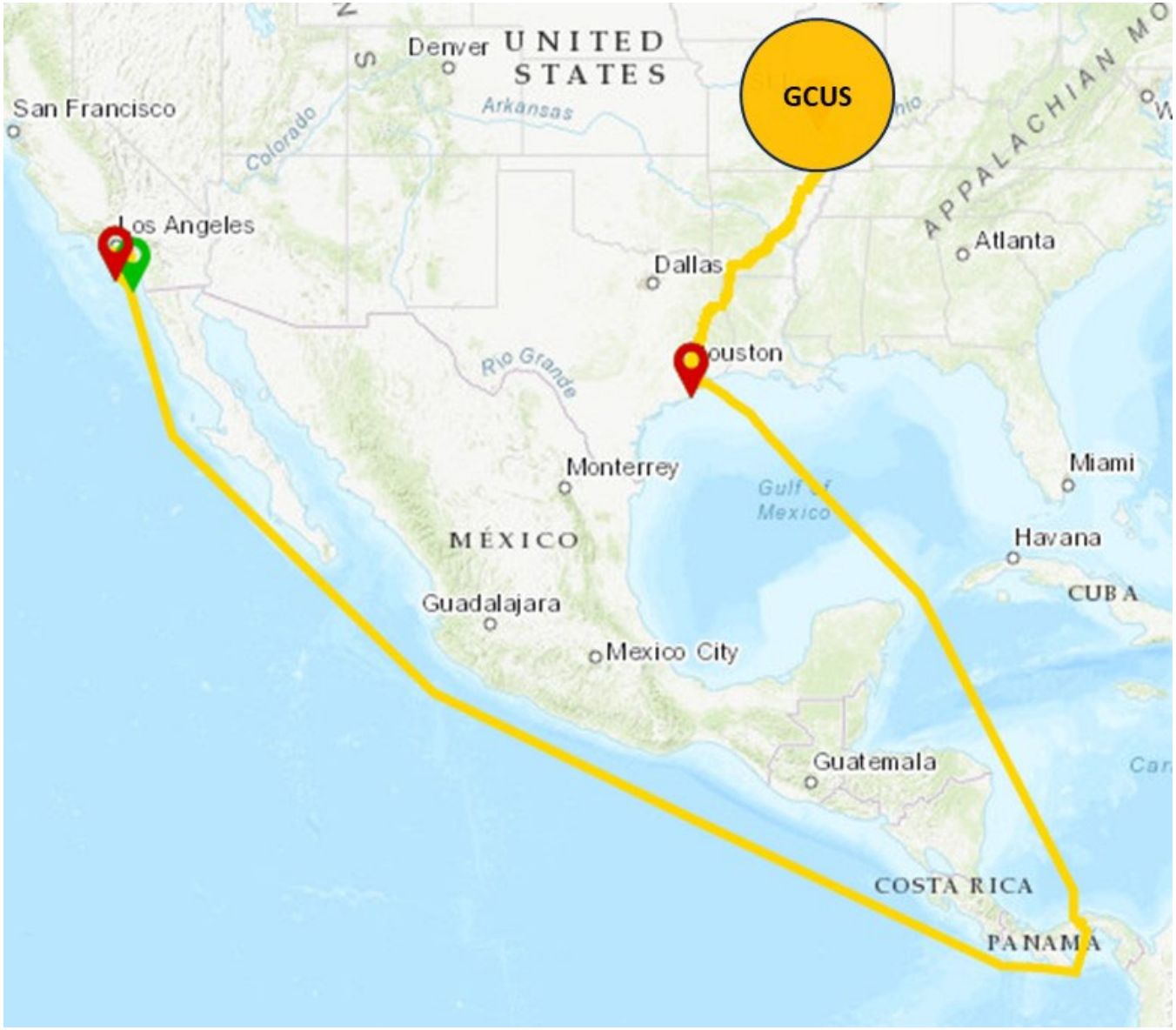


Figure 3-31: P. HHT-Barge-Rail to Camp Pendleton to MOTCO

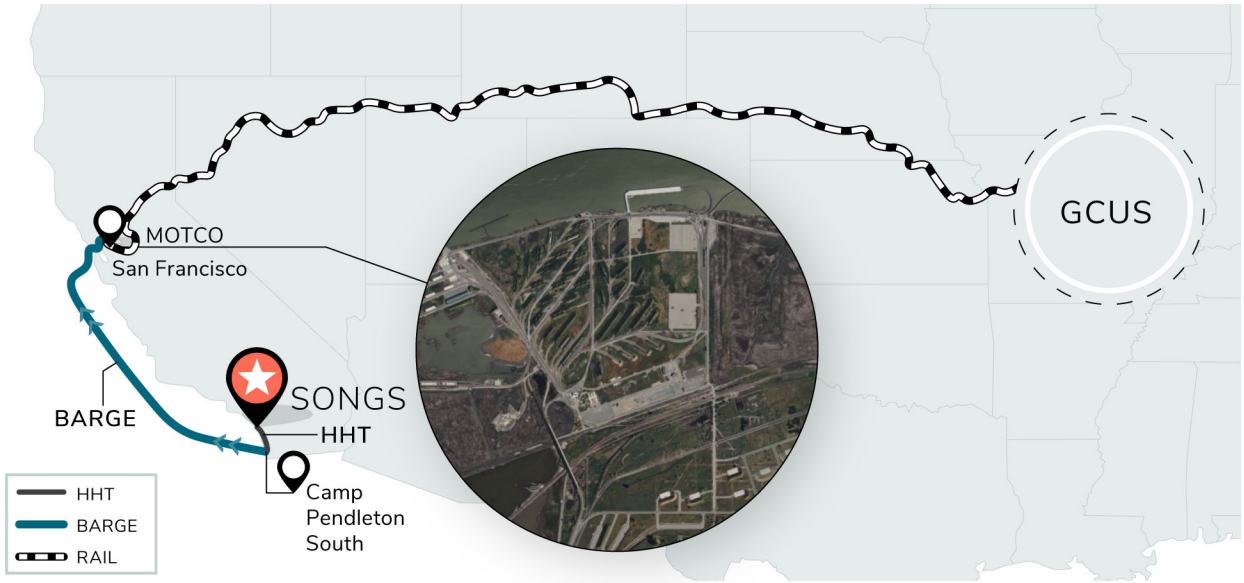
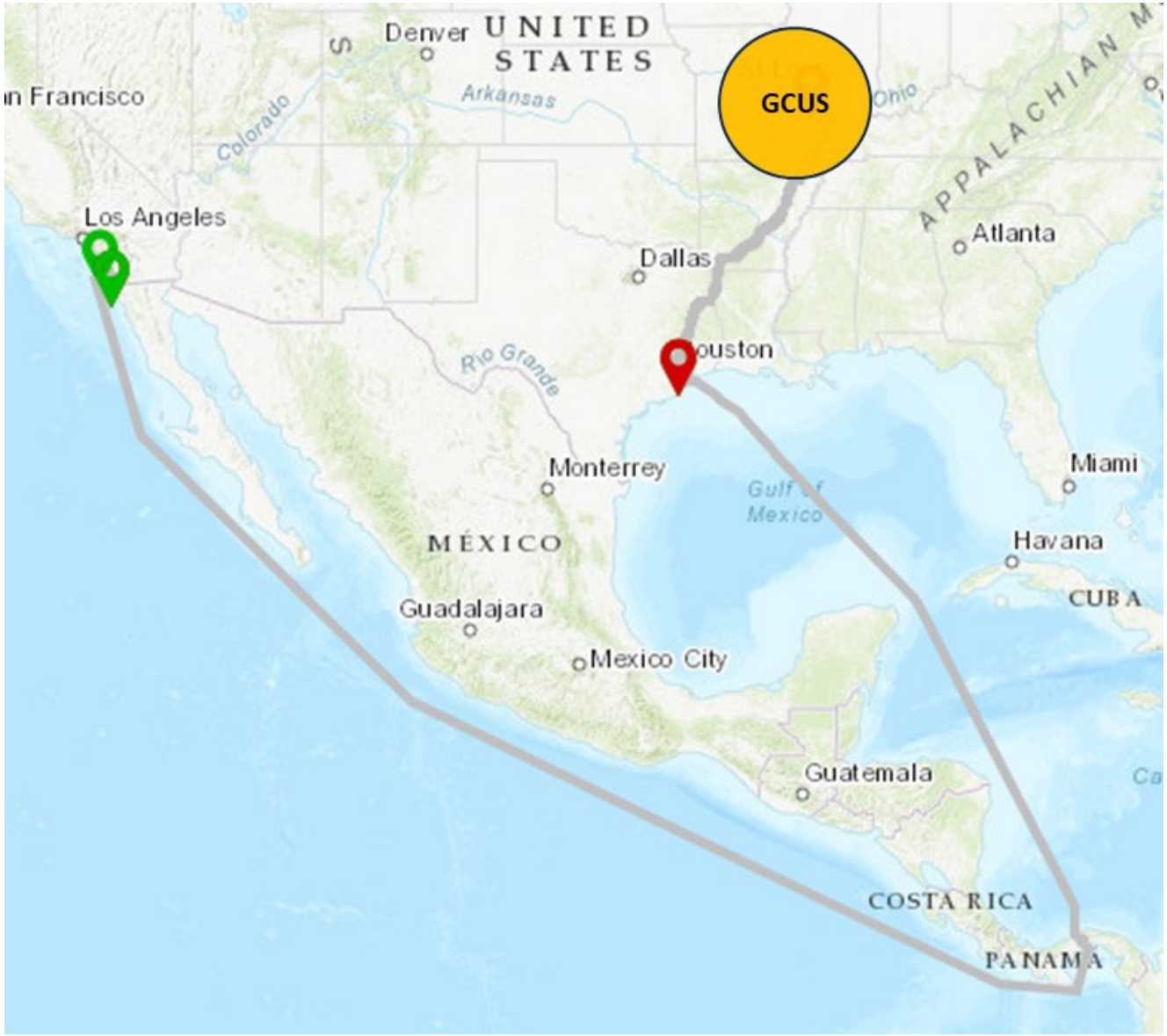


Figure 3-32: Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal



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4.0 PARTICIPATING ENTITIES

This section identifies participating entities/persons this report assumed would be involved in the overall de-inventory implementation for the SONGS ISFSI and summarizes some aspects of their potential roles. By providing this information, which is current as of the date of this report but may need to be updated at the time that shipments will occur, 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 future 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 [24], including package and conveyance radiological controls, routing, hazard communication, and carrier training. Assuming DOE takes custody of the material at/from 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.[5] 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 (see for example DOE Order 460.2B "Departmental Materials Transportation Management" [48]). 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.[6]

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

[5] 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 (42 U.S.C. 10175(a)). 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 (42 U.S.C. 10175(b)). 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.

[6] Although this report assumes that DOE would be the responsible entity for a federal 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.

- Utility employees, SCE
- Subcontractors: crane suppliers, riggers, etc.
- Transportation: truck operator, rail carrier, barge transportation operator, private escorts for dimensional loads, State Police and Local Law Enforcement Agency (LLEA)
- Cask suppliers
- U.S. Coast Guard (USCG) (if a barge 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 in accordance with 42 U.S.C. 10175(b), 10 CFR 73.37, 10 CFR 71.97, and/or NUREG-0561 Revision 2 [23], as appropriate
- 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**. An evaluation of Tribal entities that might be impacted during de-inventory operations was performed, and an initial evaluation by the START code [1] did not identify any Tribes impacted by activities at the site itself but for the six routes to be evaluated by the MUA in the following chapter identified multiple Tribal Nations within the transportation routes. This will need to be evaluated further once actual destination facilities are identified.

Table 4-1: Participating Entity Functional Identification

Function Group	Entity
Site	Site Management
	Safety
	Quality
	Document Control
	Security
	Craft Support
	Support Functions
Transportation	Transportation Supervision
	Equipment Operator (driver)

Function Group	Entity
	Security
	Shipment Response/Tracking
	Support Functions
Rail Transload Facility	Operations Supervisor
	Security
	Craft Support
	Shipment Response/Tracking
	Quality
Authorities	DOE
	State
	Local
	DOT
	Federal Railroad Administration (FRA)
	Federal Motor Carrier Safety Administration (FMCSA)
	U.S. Transportation Security Administration (TSA)*
	U.S. Coast Guard (USCG)
	NRC
	Pipeline and Hazardous Materials Safety Administration (PHMSA)
Site & Route Communities	Tribal Nations
	Community Engagement/Advisory Boards

**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.

(a)(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.

(b) omitted as for other than irradiated fuel

(c) Procedures for submitting advance notification. (1) The notification must be made in writing to:

(i) The office of each appropriate governor or governor's designee;

(ii) The office of each appropriate Tribal official or Tribal official's designee; and

(iii) The Director, Office of Nuclear Security and Incident Response.

Therefore, in accordance with the above regulation, advance notification would be provided to the following groups to coordinate transport in an actual de-inventory campaign. For transport of radioactive material [32], interface is required with the entities listed in **Table 4-1** ("*Authorities*" and "*Site & Route Communities*"), as applicable, for various purposes including exchanges of planning information, requests for and receipts of authorizations/approvals, and receipt of applicable rules and guidance.

Listed below is contact information for some of the relevant state (California) governing authorities 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.

California – Office of the Governor

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

Office of the Governor
1315 10th Street
Sacramento, CA 95814
Phone: 916-445-2841
Fax: 916-558-3160
Email: govapps.gov.ca/gov40mail

California – Governor's Designee for Notification of SNF Shipments

Listed below is the contact information for the Governor's designee for notification of SNF shipments.

Primary:
Justin Cochran, Ph.D.
Emergency Coordinator & Nuclear Advisor to Chair David Hochschild
California Energy Commission
715 P Street
Sacramento, CA 95814
Work/cell phone: 916-698-2549
Email: justin.cochran@energy.ca.gov

Secondary:
John G. Fassell, CHP
Chief, Inspection, Compliance and Enforcement Program
CDPH – Radiologic Health Branch
MS-7610, P.O. Box 997414
Sacramento, CA 95899-7414
Phone: (916)437-8071 (Cell) (916)445-2196 (Office)
Fax: 916-341-0173

California – Department of Transportation

Caltrans
1120 N Street
Sacramento, CA 95814
916-654-2852
https://dot.ca.gov

Mark Tollefson
Undersecretary of Transportation
California State Transportation Agency
400 Capitol Mall, Suite 2340
Sacramento, CA 95814
(916) 323-5400
(916) 323-5440 fax
Email the State Transportation Agency at contact.us@calsta.ca.gov

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

Oversize/Overweight Permits Office
1120 N Street
Sacramento, CA 95814

Mailing address:
P.O. Box 942874

MS # 41
Sacramento, CA 94274-0001

Office Phone Number: (916) 322-1297
General Email: Oversize.Overweight.Permits@dot.ca.gov
(Applications may not be sent by e-mail.)

SONGS ISFSI Site Management

Julie C. Holt, P.E.
SONGS Decommissioning
San Onofre Nuclear Generating Station
Mobile: 949-429-9252
Email: Julie.c.holt@sce.com

Site HHT-Crane & Rigging Providers

Hydraulic Cranes, LLC
10805 Painter Avenue
Santa Fe Springs, CA 90670
Phone: (562) 944-6149
Fax: (562) 944-3879
Email: info@hydcranes.biz

Barnhart Crane
15534 Garfield Avenue
Paramount, CA 90723
562-661-4923

Railroad Transportation Contacts

Serving Railroad for SONGS – BNSF *
1 Coaster Way
Camp Pendleton, CA 92055
888-428-2673
*(operating out of Stuart Mesa, CA railyard)

Barge Operators

Barge contact for radioactive shipments:
Bos Smith
Stevens Towing Company
4176 Highway 165
Yonges Island, SC 29449

843-889-2254

Cask Supplier

Listed below is the contact information for suppliers of the transport casks and related equipment discussed in this report.

TN Americas LLC
https://www.orano.group/en/expertise/facilities/service-and-engineering-activities/nuclear-packages-and-services-sites
Roger Maggi
Sales & Marketing
Orano TN
Tel: 410-910-6872
Roger.Maggi@orano.group

Holtec International
https://holtecinternational.com/
1001 N US Highway 1
Jupiter, FL 33477 USA
Tel: 856-797-0900

5.0 MULTI-ATTRIBUTE UTILITY ANALYSIS

As noted in **Section 3.0**, there are several potential routes for shipping the MP197HB's and the HI-STAR 190's from the SONGS ISFSI to a railcar on a Class I railroad that can take them to their penultimate or ultimate destination (i.e., a federal consolidated interim storage site or a repository, respectively). The diversity of these routes reflects the multiple viable approaches to shipping the MP197HB's and HI-STAR 190's (i.e., by direct rail, HHT, or barge), and the access of SONGS 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 (e.g., attributes). The MUA provides a transparent, rational, and defensible analysis that is easy to 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 objectives. Utility theory is a systematic approach for quantifying an individual's or team of individuals' ratings/predilection. 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 evaluators' priorities.

The MUA has been selected as the assessment approach for the purpose of this report to evaluate the viable modes and routes (options) for moving the MP197HB and HI-STAR 190 containing SNF and GTCC LLW from the SONGS ISFSI. In this section, an MUA using a value model, which identifies predilections towards 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 SONGS ISFSI.

5.1 Description of MUA Applied to the SONGS ISFSI

The three primary steps of MUA used 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 to be considered. Once alternative options (routes and modes), objectives (attributes), and performance measures (metrics) have been clearly defined, the predilections 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 among the performance measures for each route. 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.

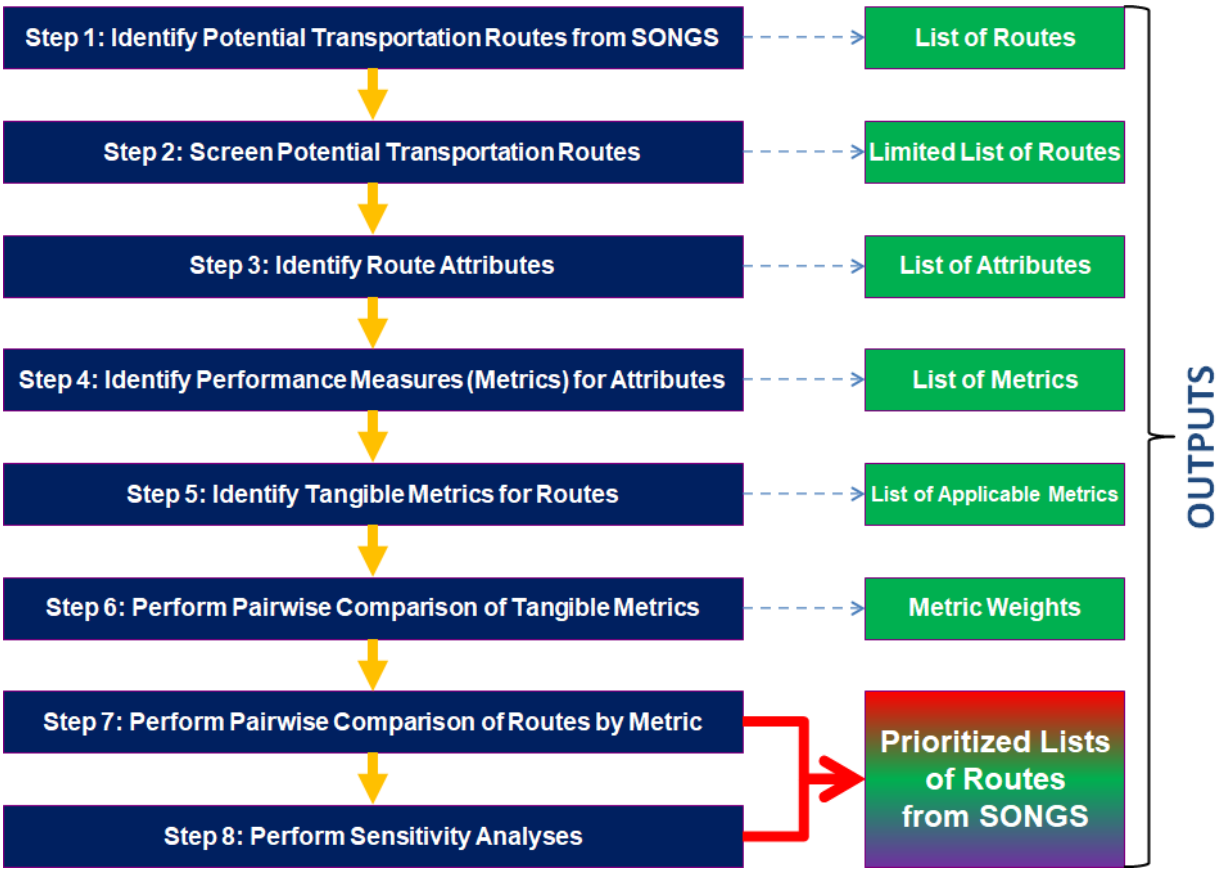
The main steps of the MUA applied to the routes from the SONGS ISFSI are identified in **Figure 5-1** and are as follows:

1) Identify the potential modes and routes for transporting the MP197HB's and the HI-STAR 190's from the SONGS ISFSI; see **Section 3.0**.

2) Due to the large number of potential routes from the SONGS ISFSI identified in Step 1, a set of screening criteria is developed and applied to reduce the number of routes per mode to a limited group for further evaluation; see **Section 3.4** (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 MP197HB's and the HI-STAR 190's from the SONGS 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, examine each attribute's metrics, and identify the ones that could tangibly differ between two or more of these modes and routes; see **Section 5.3.1**.
6) Each team member performs a pairwise comparison between each of the tangible metrics, which are subsequently quantified, resulting in a relative ranking of the metrics based on individual ratings and are 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 team collectively performs another pairwise comparison between the tangible metrics for each route (to ensure the SMEs' predilections are incorporated and not diluted by the ratings of other individuals), and the results are 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 are 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 **Sections 5.4** and **5.5**.

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

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



5.2 Description of Evaluated Routes

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

- Transfer directly to on-site rail siding (direct-to-rail),
- Transport by HHT to a nearby rail transload site (HHT-to-rail),
- Transport by HHT to a nearby landing, transfer to a barge, and then transfer to a railcar (HHT to barge to rail), and
- Transport by HHT to a nearby port, transfer to a vessel, and then transfer to a railcar (HHT to vessel 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 six routes identified in **Section 3.4**:

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) 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 HRCQ shipments.
11) Other.

These criteria have been developed based on the Orano team's experience from previous de-inventory studies and as many of these criteria make practical sense. The reasons for the screening of potential routes identified in **Section 3.0** are documented in **Table 3-7**. The routes unscreened and remaining to be evaluated by the MUA are as follows:

1) An all-rail route with the railcars loaded on the on-site SONGS rail spur and then travel about 2,200 miles to GCUS via one rail carrier (BNSF) (referred to as "A. Rail-min. time BNSF" route in the MUA);
2) An all-rail route with the railcars loaded on the on-site SONGS rail spur and then travel about 2,350 miles to GCUS via two rail carriers (BNSF and UP) (referred to as "H. Rail-min. time BNSF-UP" route in the MUA);
3) A HHT route of about 2 miles east to near San Onofre State Park to where a transload occurs from the HHT to railcars and then travel by rail for about 2,200 miles to GCUS via one rail carrier (BNSF) (referred to as "L. HHT to Rail-Transload at San Onofre State Park" route in the MUA);

4) A HHT route of about 19 miles south to Camp Pendleton in Del Mar, CA to a barge landing where a transload occurs from the HHT to a barge and then travel by barge about 550 miles to Military Ocean Terminal Concord (MOTCO) where a transload occurs from barge to railcars and then travel by rail about 2,220 miles to GCUS via one rail carrier (referred to as "P. HT-Barge-Rail to Camp Pendleton to MOTCO" route in the MUA);
5) A HHT route of about 61 miles south to Port of San Diego, CA where a transload occurs from the HHT to a vessel and then travel by vessel about 5,200 miles via the Panama Canal to Port of Houston, TX where a transload occurs from vessel to railcars and then travel by rail about 850 miles to GCUS via one rail carrier (referred to as "Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal" route in the MUA); and
6) A HHT route of about 61 miles north to Los Angeles Port, CA where a transload occurs from the HHT to a vessel and then travel by vessel about 5,250 miles via the Panama Canal to Port of Houston, TX where a transload occurs from vessel to railcars and then travel by rail about 850 miles to GCUS via one rail carrier (referred to as "N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal" route in the MUA).

5.3 Evaluation of Routes

To evaluate each of these six 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 six 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 of changes to the weighting of the metrics on the route hierarchy.

5.3.1 Identification of Attributes and Metrics

The attributes identified to characterize the 'ideal' route are given 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 [22][25][26][27][28][29][30][31][32][33][34], and on the large body of past MUA activities performed on nuclear waste management evaluations[35][36][46][47].

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 six 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 attribute, for which no tangible differences in the waste production 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). A total of 27 metrics will be evaluated for each route and contrasted against the other routes. This number is larger than evaluated in previous MUAs for previous de-inventory studies primarily because of the difficulty of getting evaluation data from the START [1] program, which unlike previous studies provided data that could be used to eliminate approximately 8 to 10 of the metrics this evaluation was unable to reduce.

Table 5-1: Attributes and Associated Metrics

Attribute	Metric	Y/N	Comments
Cost[7]	On-Site Rental Equipment Costs (e.g., mobile cranes)	Y	Tangible difference between on-site equipment needed for HHT versus railcar loading activities.
	Hardware Procurement Costs (e.g., transfer cask)	N	Hardware is expected to be relatively the same for all the routes as transfer from storage overpack to transportation cask will occur for all modes of transport.
	Infrastructure Improvement Costs (e.g., rail improvement, fortifying roads/bridges)	N	HHT route to rail appears to require some infrastructure improvements, but transload sites appear to have sufficient existing rail to perform the transload activities.
	Labor and Permitting Costs	Y	Labor and permitting costs are expected to vary between the HHT, rail, and barge/vessel routes as HHT and barge/vessel will require more labor to perform and HHT and barge/vessel are expected to require more permitting costs over direct rail.
	Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	Y	Direct rail not expected to require additional costs, whereas HHT and barge/vessel routes will require more costs.
	Cost of Rail Transport (e.g., costs associated with use of multiple rail carriers 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.

[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
Environmental Impact	Gaseous Effluent Release	N	Although vehicle 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)	Y	Aesthetic changes may be needed for HHT routes from SONGS.
	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	No route environment characteristics appear to be an issue for any of the routes as the steep climb from the site applies to each route.
	Impact of Weather to Route (e.g., limited availability of route or instability of weather)	Y	Weather is expected to impact ocean routes more adversely than the other routes.
	Number of Water Areas Nearby Route (e.g., number of bridges crossed)	Y	According to START [1] the number of water crossings will be significantly different between the routes, especially considering the barge/vessel route will be on the water for a significant portion of their routes.
	Number of Sensitive Environmental Areas Nearby Route (e.g., endangered species habitats)	Y	The sensitive environmental area per square mile is different between the routes according to START [1] data.
Institutional Considerations	Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churches)	Y	Based on results from START[1], the routes show different numbers of mass gathering places and educational institutions.
	Number of Tribal Lands Crossed	Y	Based on results from START [1], the routes show differences between the number of Tribal lands crossed.
	Public Acceptability of Route	Y	This subjective metric will be evaluated as done in the previous evaluations based on the expert opinion of the Orano team and will consider nearby features of the routes.
Permitting	Ease of Permit Procurement	Y	HHT and vessel routes are expected to have some difficulty in procuring State permits relative to the rail routes.
	Number of Permits	Y	Number of permits for the HHT and vessel routes are greater than the direct rail transport routes.
	Insurability of Route	Y	HHT and rail routes to be indemnified by DOE (Price Anderson Act), but unclear of the vessel route through international countries (e.g., vessel routes through Panama Canal).

Attribute	Metric	Y/N	Comments
Resource Requirements	Number of Personnel involved in Transfer	N	Impact considered to be covered by cost and safety metrics.
	Quantity of Hardware Needed	N	Impact considered to be covered by cost metric.
	Availability of Specialty Equipment (e.g., rigging, transfer cask)	Y	Specialty equipment for HHT and barge routes is needed to perform the loading of the HHT and the transloading of the barge and stands needed for the barge.
Safety	Cumulative Worker Exposure (α handling time & number of workers)	Y	HHT and barge/vessel routes are expected to have higher cumulative exposure due to additional handling events (transloads) and longer routes, but cumulative worker exposure is expected to be low for all routes.
	Cumulative Population Dose along Route (α population density)	Y	According to START [1], the population exposed along a route will vary between the various routes (noting all exposures will meet regulatory limits and be negligibly small).
	Risks Associated with Number of Lifting Activities	Y	HHT and barge/vessel routes will require an additional transload and associated lifts over the direct-from-site transloaded rail routes.
	Average Accident Frequency on Route	Y	According to START [1], the average accident frequency along a route may vary 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	START [1] indicates differences between the routes.
Schedule	Transit Duration per Conveyance and Consist	Y	START [1] identified duration differences between the HHT, barge/vessel, and rail routes.
	Duration for Infrastructure Improvement (e.g., including dredging, fixing rail line)	N	No significant infrastructure improvements are expected on any of these routes.
	Ease of Access to Transload Site (e.g., consider usage of existing site)	Y	Military ports may require additional paperwork to gain access to.
	Immediacy of Ability to Perform Transfer (e.g., ability to train crew)	Y	Maritime shipments require more preparations than HHT and rail shipments.
	Size of conveyance (# of casks per shipment)	Y	HHT routes will have 1 cask moved per shipment while loading railcar, whereas all rail routes directly from the site will be loaded at the site 5 casks at a time.

Attribute	Metric	Y/N	Comments
Security/ Vulnerability	Security Vulnerability of Route	Y	Routes are considered to have different security vulnerabilities, especially barge/vessel.
	Availability of Security Escort for Route	Y	International security agreements will need to be put into place for routes outside of the U.S.
	Number of Police Stations Nearby Route	Y	The number of police stations nearby each of the routes is different per START [1].
Waste Generation	Quantity of Radiological Waste Produced from Normal Ops	N	A minimum amount of radiological 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-radiological 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 among these metrics was performed by each of the 9 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 9 individuals of the Orano-led team (which included subject matter experts in transportation, safety, operations, and licensing) to ensure a reasonable cross-section of 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 "Transport to Rail Class I Costs" metric (e.g., costs associated with transload activities and rental costs for a HHT, trailer, and/or barge) is pairwise compared against the other metrics on a favorability scale. For example, the "Transport to Rail Class I Costs" metric is rated mildly favorable against the "Transit Duration per Conveyance," but is rated more unfavorable against "Cumulative Population Dose along Route." These ratings are interpreted to mean that there is a slight benefit seen to reducing the monies spent on the transport to rail at the expense of increasing the duration of the transit per conveyance (e.g., renting a tug that may operate at a lower speed but costs less than a tug operating at a higher speed, then this evaluator would slightly favor utilizing the slower tug even though that may increase the transit duration). However, if there were an improvement to the transport to Rail Class I that resulted in an increased cost but could be performed to improve (reduce) the cumulative population dose along the route (e.g., utilization of a more shielded trailer to reduce dose exposures to the population from the cask), and then this will be a more favored/encouraged outcome.

With 27 tangible metrics to be evaluated, 351 pairwise evaluations had to be performed by each individual. **Attachment A** shows the entire pairwise evaluation for these metrics. 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, which would have been very 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), and
- 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 nine 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 eleven 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).

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

   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).

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

   where B = averaged biased relative weight.

4) The "Maximum" value as established from the eleven individual assessments.

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

As shown in **Figure 5-2** and **Table 5-3**, the tangible metrics with the highest ratings (based on average weighting method) are Cumulative Population Dose, Cumulative Worker Exposure, and

Risks Associated with Number of Lifting Activities which rated at about 5.5%, 5.4%, and 5.2% of the total weight, respectively. The lowest rated tangible metrics (based on average weighting method) are Route Aesthetic Changes Needed, Number of Water Areas Nearby Route, and Number of Police Stations Nearby Route, which rated at about 2.5%, 2.7%, and 2.8% of the total weight, respectively. The ranking and weights of all the tangible metrics in descending order (based on average weighting method) are shown **Table 5-3**.

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
Transport to Rail Class I Costs				x				Cost of Rail Transport
Transport to Rail Class I Costs		x						Route Aesthetic Changes Needed
Transport to Rail Class I Costs		x						Impact of Weather to Route
Transport to Rail Class I Costs		x						Number of Water Areas Nearby Route
Transport to Rail Class I Costs		x						Number of Sensitive Environmental Areas Nearby Route
Transport to Rail Class I Costs			x					Number of Non-Easily-Mobilizable Populations
Transport to Rail Class I Costs			x					Number of Tribal Lands Crossed
Transport to Rail Class I Costs						x		Public Acceptability of Route
Transport to Rail Class I Costs	x							Ease of Permit Procurement
Transport to Rail Class I Costs	x							Number of Permits
Transport to Rail Class I Costs					x			Insurability of Route

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
Transport to Rail Class I Costs				x				Availability of Specialty Equipment
Transport to Rail Class I Costs						x		Cumulative Worker Exposure
Transport to Rail Class I Costs						x		Cumulative Population Dose along Route
Transport to Rail Class I Costs							x	Risks Associated with Number of Lifting Activities
Transport to Rail Class I Costs			x					Average Accident Frequency on Route
Transport to Rail Class I Costs			x					Number of Fire Stations & Trained Personnel Nearby Route
Transport to Rail Class I Costs			x					Transit Duration per Conveyance
Transport to Rail Class I Costs				x				Ease of Access to Transload Site
Transport to Rail Class I Costs				x				Immediacy of Ability to Perform Transfer
Transport to Rail Class I Costs			x					Size of conveyance
Transport to Rail Class I Costs						x		Security Vulnerability of Route
Transport to Rail Class I Costs						x		Availability of Security Escort for Route

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
Transport to Rail Class I Costs		x						Number of Police Stations Nearby Route

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

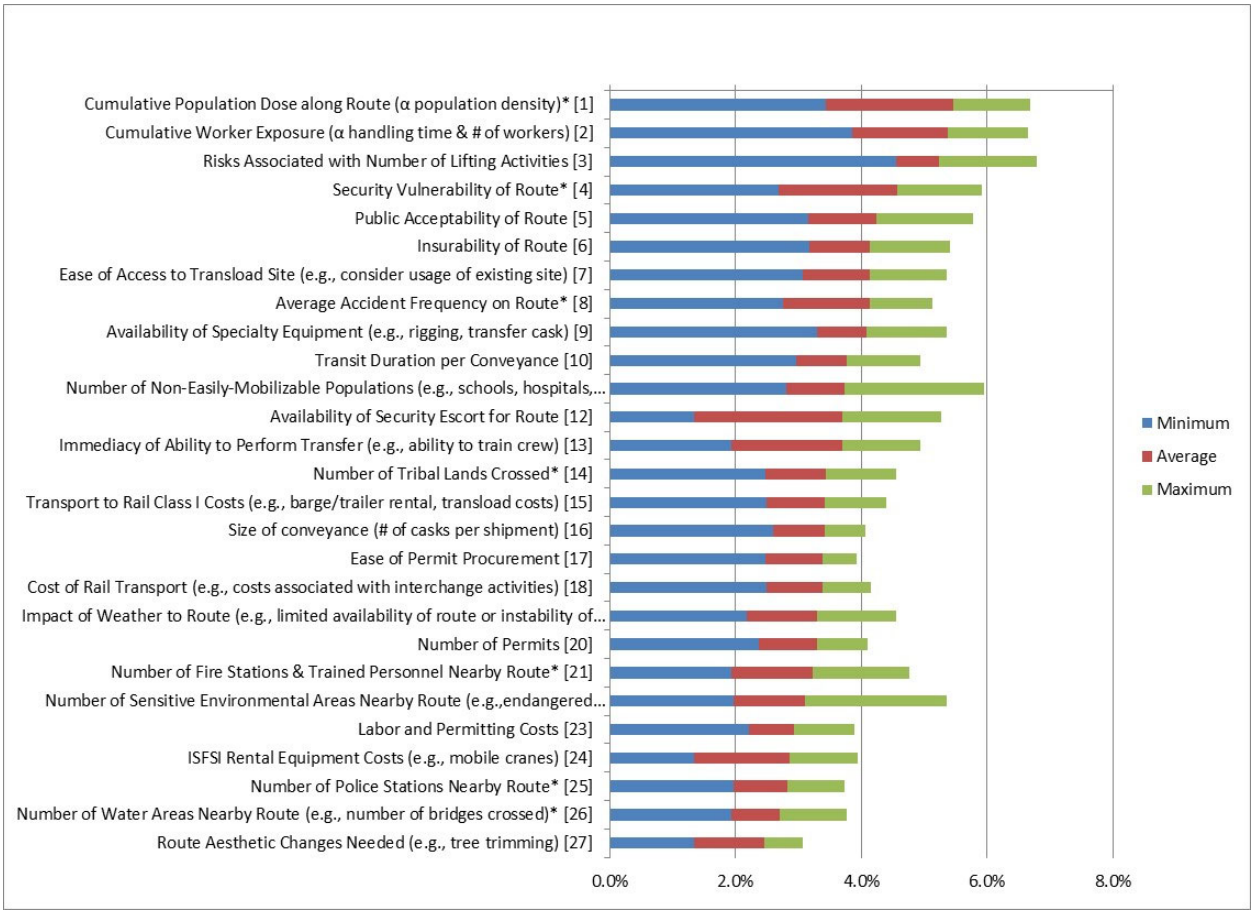


Table 5-3: Weighting of Tangible Metrics

Rank	Minimum	Average Weight	Biased Weight	Maximum	Metric
1	3.44%	5.47%	5.47%	6.70%	Cumulative Population Dose along Route
2	3.85%	5.38%	5.38%	6.65%	Cumulative Worker Exposure
3	4.56%	5.24%	5.24%	6.79%	Risks Associated with Number of Lifting Activities
4	2.68%	4.57%	4.57%	5.91%	Security Vulnerability of Route
5	3.16%	4.24%	4.24%	5.77%	Public Acceptability of Route
6	3.18%	4.14%	4.14%	5.41%	Insurability of Route

Rank	Minimum	Average Weight	Biased Weight	Maximum	Metric
7	3.06%	4.13%	4.13%	5.37%	Ease of Access to Transload Site
8	2.75%	4.13%	4.13%	5.13%	Average Accident Frequency on Route
9	3.30%	4.09%	4.09%	5.37%	Availability of Specialty Equipment
10	2.97%	3.77%	3.77%	4.94%	Transit Duration per Conveyance
11	2.80%	3.72%	3.72%	5.96%	Number of Non-Easily-Mobilizable Populations
12	1.33%	3.70%	3.70%	5.27%	Availability of Security Escort for Route
13	1.92%	3.69%	3.69%	4.94%	Immediacy of Ability to Perform Transfer
14	2.47%	3.44%	3.44%	4.56%	Number of Tribal Lands Crossed
15	2.49%	3.42%	3.42%	4.39%	Transport to Rail Class I Costs
16	2.59%	3.41%	3.41%	4.06%	Size of conveyance
17	2.47%	3.38%	3.38%	3.92%	Ease of Permit Procurement
18	2.49%	3.38%	3.38%	4.15%	Cost of Rail Transport
19	2.18%	3.30%	3.30%	4.56%	Impact of Weather to Route
20	2.37%	3.29%	3.29%	4.11%	Number of Permits
21	1.92%	3.23%	3.23%	4.77%	Number of Fire Stations & Trained Personnel Nearby Route
22	1.97%	3.10%	3.10%	5.37%	Number of Sensitive Environmental Areas Nearby Route
23	2.21%	2.92%	2.92%	3.89%	Labor and Permitting Costs
24	1.33%	2.86%	2.86%	3.94%	ISFSI Rental Equipment Costs
25	1.97%	2.83%	2.83%	3.73%	Number of Police Stations Nearby Route
26	1.92%	2.69%	2.69%	3.77%	Number of Water Areas Nearby Route

Rank	Minimum	Average Weight	Biased Weight	Maximum	Metric
27	1.33%	2.45%	2.45%	3.06%	Route Aesthetic Changes Needed

5.3.3 Route Assessments

With the ranking 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 rating was afforded greater influence than were the ratings of the other individuals on the team if there was a difference.

An alternative approach would be 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 ratings can be established which will ensure a fairly consistent basis in the ranking of the metrics (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 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 data used to perform this comparison by metric is provided here.

5.3.3.1 On-Site Rental Equipment Costs

Most of the rental costs for on-site equipment are expected to be the same for each route (e.g., mobile crane and trailer). All the rail-only routes will have the same rental equipment and hence are no different from one another. The routes using HHT will require the on-site equipment to remain longer on the site as only one cask is moved per HHT, whereas the rail-only routes move 5 casks per shipment. This longer duration will result in increased on-site rental costs for the routes using HHT. The HHT-to-rail route will have a short 2 mile HHT route to travel and hence, its on-site costs will be less than the HHT-to-barge/vessel-to-rail routes. Similarly, the HHT-to-barge-to-rail route will travel fewer HHT miles and hence, will be more favorable to the HHT-to-vessel-to-rail routes.

5.3.3.2 Labor and Permitting Costs

The routes using HHT are expected to have higher labor and permitting costs relative to the rail-only routes costs, as the HHT routes are expected to have higher permitting costs, as local permits for the HHT are required, whereas no local permits are necessarily needed for the rail-only routes. Furthermore, labor costs for the routes using HHT are expected to be higher due to the off-site transload activities the rail-only routes will not have. Thus, the HHT-to-rail route will be more

unfavorable compared to the rail-only routes. The HHT-to-barge/vessel-to-rail routes will be strongly unfavorable compared to the rail-only routes and more unfavorable to the HHT-to-rail route.

5.3.3.3 Transport to Rail Class I Costs

For the transport to rail costs (not including on-site costs), each of the six routes were evaluated by the team to have a cost benefit or cost penalty relative to the other routes based primarily on costs associated with rental of barges, tugs, and HHTs as related to the number of transload activities. For rail-only routes, no transport to rail costs were identified beyond those already covered by the on-site rental costs and hence, they all evaluated neutrally against one another and more or strongly favorable against the other routes. For the HHT-to-rail route, the costs are associated with: (1) a HHT to move one transportation cask from the ISFSI at a time to the rail transload site and (2) the rental of a crane to move the transportation cask from the HHT to railcar at the transload site. For HHT-to-barge/vessel-to-rail routes, the costs are associated with: (1) a HHT to move one transportation cask at a time from the ISFSI to the port or barge landing; (2) the rental of a crane to move the transportation cask from the HHT to the vessel or barge; and (3) the rental of a crane to move the transportation cask from the barge/vessel to the railcar at the transload site. In addition to these rental costs, costs associated with the distance required to be covered for each route (excepting the rail portion which is covered by the next metric) and the number of shipments required to be performed for each route will impact this assessment. Hence, the rail-only routes were deemed to have equivalent (negligible) costs to one another and were mildly favored over the HHT-to-rail route, more favored over the HHT-to-barge-to-rail route, and strongly favored over the HHT-to-vessel-to-rail routes (longest distance traveled) for this metric.

5.3.3.4 Cost of Rail Transport

The two rail-only routes are nearly identical with the route having one interchange between rail lines being mildly unfavored over the route with no interchanges. The HHT-to-rail route and the HHT-to-barge-to-rail route have a rail length nearly equivalent to the rail-only route with no interchanges and hence, evaluated neutrally against it. Interestingly, the HHT-to-vessel-to-rail routes involve the shortest rail distances to GCUS as they are first shipped to Houston, TX for transload to rail and hence, evaluated mildly to more favorable against the rail-only and HHT-to-rail routes.

5.3.3.5 Route Aesthetic Changes Needed

The only aesthetic changes considered to potentially impact the evaluated routes involves the HHT-to-barge/vessel-to-rail routes. These routes may be impacted by the need to clear the HHT portion of the routes to the barge landing and potentially to the ports and hence, were evaluated to be mildly unfavorable against the other routes.

5.3.3.6 Impact of Weather to Route

The routes involving HHT and a barge/vessel were considered to be more vulnerable to weather conditions than the rail-only routes, with the routes involving a barge/vessel potentially being more vulnerable to the weather impact (e.g., hurricanes) than the HHT-to-rail route. The shorter distance traveled by the barge compared to the vessels, that travel through the Panama Canal, make the route using the barge mildly favored over the routes using the vessel.

5.3.3.7 Number of Water Areas Nearby Route

Data provided by START [1] in Table 5-4 sort of allowed for the evaluation of this metric with the rail-only routes mildly or more favorable over the routes utilizing barges and vessels primarily based on a comparison of the water areas and the fact that the barge and vessel routes spend a large amount of their travel time on the water. The START data in Table 5-4 has some inconsistencies in it likely related to definitions internal to the program. Nevertheless, these are the inconsistencies the Orano team identified in this data: (1) route A. and route L. differ by only a 2 mile HHT route, yet the water crossings drop by 8 in those 2 miles (while the water areas are essentially equal as expected); (2) unclear why route P. has so many more water crossings relative to the other routes; and (3) unclear why the water areas between routes N. and Q, are different, especially considering the route with the lower water areas actually spends more time on the water.

Table 5-4: Water Crossings and Areas for Each Route [1]

Parameter	Route					
	A. Rail-min. time BNSF	H. Rail-min. time BNSF-UP	L. HHT to Rail-Transload at San Onofre State Park	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	P. HT-Barge-Rail to Camp Pendleton to MOTCO	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Water Crossings	207	156	199	72	309	75
Water Areas (per mi^2)	41.0	38.4	41.0	64.3	114.8	73.6

5.3.3.8 Number of Sensitive Environmental Areas Nearby Route

Using data produced from the START program [1], each route could be evaluated for the quantity (square miles) of environmentally sensitive areas and protected areas crossed. Based on these results (see **Attachment D**), the quantity of environmentally sensitive and protected areas crossed by each route ranged from 104 to 585 square miles and 676 to 2,307 square miles, respectively. These areas are small compared to the total land crossed by the entire routes. Nevertheless, according to START [1], some routes do have advantages over others with the two HHT-to-vessel-to-rail routes having the least sensitive areas (by factor of greater than 4) and the remaining routes having generally the same values. For the protected areas, the two HHT-to-vessel-to-rail routes and the rail-only route with one interchange have the least protected areas along the routes, followed by the rail-only route with no interchanges and the HHT-to-rail route, and with the HHT-to-barge-to-rail route is a factor of 3 greater than the other routes. However, the level of favorability of the HHT-to-vessel-to-rail routes were tempered somewhat during the evaluation against the other routes due to the large fraction of these routes on waterways that we considered a sensitive environmental area not clearly captured by the START data. Hence, no strongly favorable or unfavorable selections were made during the evaluation of this metric.

5.3.3.9 Number of Non-Easily-Mobilizable Populations

Using data produced from the START program [1], each route was 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 routes with barge/vessel usage due to the low populations found along the barge/vessel portion of these routes. The rail-only route with one interchange had the highest non-easily-mobilized populations and thus rated more unfavorably against the other routes.

5.3.3.10 Number of Tribal Lands Crossed

Data from START [1] is normally utilized to evaluate this metric, unfortunately the data received from this program for this metric appears to be improperly reported as seen in **Attachment D** where the data ranges from 0.01 per square mile for the HHT-to-vessel-to-rail routes to 116 per square mile for the rail-only route without interchanges and the HHT-to-rail route. The low value for the HHT-to-vessel-to-rail routes is inconsistent with data received from START for all the prior de-inventory reports [22][25][26][27][28][29][30][31][32][33][34]. Instead the evaluation team, based on its experience and prior experience with the de-inventory reports utilized the following assessment of the routes for this metric: the fewest Tribal lands expected to be crossed involved the HHT-to-vessel-to-rail routes as the majority of these routes involved water transport and the rail route from Houston, TX to GCUS is expected to have few Tribal lands; the HHT-to-barge-to-rail route is expected to have the next fewest Tribal lands crossed based on its more northerly rail route; the rail-only route with one interchange is expected to have the next fewest Tribal lands crossed; and the rail-only route without an interchange and the HHT-to-rail route are expected to have the most Tribal lands crossed based on a detailed investigation of these rail routes.

5.3.3.11 Public Acceptability of Route

The evaluation of public acceptability varied among some of the routes. The rail-only routes were judged to be most favorable over the other rates principally due to the lack of off-site activities (e.g., trucking and transloading), utilizing rail lines with regular commercial service, and not traveling through public waterways and their associated environmentally sensitive areas. The rail-only routes were mildly favored over the HHT-to-rail route, more favored over the HHT-to-barge-to-rail route, and strongly favored over the HHT-to-vessel-to-rail routes.

5.3.3.12 Ease of Permit Procurement

The rail-only routes were either more favorable over the other routes because they do not require permits, whereas the HHT portions of the other routes would require state permits, which are considered not necessarily easy to procure in CA, especially for a HHT going to Los Angeles or San Diego. The 2-mile HHT portion of the HHT-to-rail route was judged to be not as difficult to procure a permit for compared to those for Los Angeles and San Diego.

5.3.3.13 Number of Permits

As noted in the previous section, the rail-only routes do not require permits and hence, all the rail-only routes were judged to be mildly favorable over the short HHT routes and more favorable over

the longer HHT routes that likely require more permits as they cross over more local government jurisdictions.

5.3.3.14 Insurability of Route

All the routes were established to be insurable, but the routes that moved through international waters (e.g., to the Panama Canal) require alternative insurance to the domestic insurance required for the other routes and hence, the routes involving vessels were mildly unfavored over the other routes.

5.3.3.15 Availability of Specialty Equipment

This evaluation identified the concern with the availability of specialty equipment at multiple locations found at significant distances from one another. Specifically, the HHT-to-vessel-to-rail routes, where rigging for lifting transportation casks would be required at 3 different locations that are separated by significant distance: the ISFSI, the port of departure Los Angeles/San Diego, and the port of arrival Houston. A similar concern was identified for the HHT-to-barge-to-rail route, though the ISFSI and the Camp Pendleton barge landing sites are not separated by as great a distance.

5.3.3.16 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 routes (equivalent of one or two on-site transload activities) having a slight advantage over the HHT-to-rail route (equivalent of one on-site transload activity and one off-site transload activity) and a larger advantage over the HHT-to-barge/vessel-to-rail routes. Worker exposure levels would 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, a significant fraction of the cumulative worker exposure would occur at the SONGS Holtec ISFSI, where the stack-up transfer operations to move the canisters to the transportation casks take place and apply to each route through the handling of the Holtec system.

- Lifting operations involving the transfer of a Holtec MPC from the HI-STORM UMAX VVM to HI-STAR 190 transportation overpack (noting the TN MP197HB is loaded in the horizontal orientation) (3 to 4 lifts):
    - Lift MPC from HI-STORM UMAX VVM into HI-TRAC transfer cask
    - Option 1 (at-grade operation):
        - Lift HI-TRAC with MPC to over HI-STAR 190
        - Lower MPC from HI-TRAC into HI-STAR 190
    - Option 2 (below-grade operation):
        - Lower MPC from HI-TRAC into HI-STAR 190
    - Lift HI-STAR 190 (at-grade or below-grade) and place on down-ender and down-end cask into horizontal orientation

- Transfer to on-site rail (one or two lifts):
    - For Holtec HI-STAR 190 (one or two lifts):
        - Lift the HI-STAR 190 overpack (loaded with the canister) from the down-ender in the horizontal orientation and place it into its cradle on either the on-site trailer or directly on to the cask railcar.
        - Lift the HI-STAR 190 transport cask from on-site trailer to cask railcar.
    - For TN MP197HB (one lift):
        - Lift the TN MP197HB from the transfer trailer and place it into its cradle directly on to the cask railcar.
- Transfer to HHT then to rail (two or three lifts):
    - For Holtec HI-STAR 190 (one or two lifts):
        - Lift the HI-STAR 190 overpack (loaded with the canister) from the down-ender in the horizontal orientation and place it into its cradle on either the on-site trailer or directly on to the HHT trailer.
        - Lift the HI-STAR 190 transport cask from on-site trailer to HHT trailer.
    - For TN MP197HB (one lift):
        - Lift the TN MP197HB from the transfer trailer and place it into its cradle directly on to the HHT trailer.
    - Lift of TN MP197HB or HI-STAR 190 transport cask and cradle from HHT trailer to cask railcar at transload site.
- Transfer to HHT then to barge/vessel then to rail (three or four lifts):
    - For Holtec HI-STAR 190 (one or two lifts):
        - Lift the HI-STAR 190 overpack (loaded with the canister) from the down-ender in the horizontal orientation and place it into its cradle on either the on-site trailer or directly on to the HHT trailer.
        - Lift the HI-STAR 190 transport cask from on-site trailer to HHT trailer.
    - For TN MP197HB (one lift):
        - Lift the TN MP197HB from the transfer trailer and place it into its cradle directly on to the HHT trailer.
- Lift of TN MP197HB or HI-STAR 190 transport cask and cradle from HHT trailer to barge or vessel at transload site.
- Lift of TN MP197HB or HI-STAR 190 transport cask and cradle from barge or vessel to cask railcar at transload site.

Based on these assessments and the duration of transport on each of the individual routes, the rail-only routes are mildly favored over the HHT-to-rail route and more favored over the HHT-to-barge/vessel-to-rail routes.

5.3.3.17 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 transport overpacks 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 ratings 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 5-5**. 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. The evaluation team noted some issues with the below START data, namely the population densities for the routes using vessels appear to be extremely high considering a majority of these routes involve traveling long-distances by vessel where population densities are expected to be low.

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

ID	Route Description	Average Population Density (Persons/Square Mile)[1]	Total Exposed Population Estimate[2] (Thousands)
A	Rail-min. time BNSF	390	816
H	Rail-min. time BNSF-UP	641	1,449
L	HHT-to-Rail – Transload at San Onofre State Park	1,321	815
N	HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6,720	723
P	HHT-Barge-Rail to Camp Pendleton to MOTCO	770	804
Q	HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	4,718	599

[1] Data established by START [1] 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. Note the values listed in this column are the maximum from the segments of the route.

[2] Established by multiplying the cumulative population density by the route distance and the buffer width (800 m).

5.3.3.18 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 5.3.3.16**. Based on this assessment, the rail-only routes were deemed more favorable over the HHT-to-rail route and strongly favorable over the HHT-to-barge/vessel-to-rail routes due to the additional transload operation taking place off-site with different equipment and personnel. These risks are minimized by the protection afforded the transportation overpacks 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 overpack system (i.e., MP197HB and HI-STAR 190). Hence, although this parameter provides some predilection to rail-only routes, the overall risk to public and worker safety associated with a lifting activity is deemed negligible.

5.3.3.19 Average Accident Frequency on Route

Data produced from START [1] is normally used to evaluate this metric, however the accident likelihood per mile data was not identified for any of the rail portions of the routes and the vessel data from the Port of San Diego was also missing in the recent output from this program as shown in **Table 5-6**. Due to the lack of this data, which is important to each of the six routes, the team assumed the vessel data for the Los Angeles segment applied to the San Diego segment and the rail accident likelihoods are proportional to one another based on the distance traveled on the rail route. Based on these results, the lowest accident likelihood is associated with the HHT-to-barge-to-rail route followed by the HHT-to-rail route, the rail-only routes, and finally the HHT-to-vessel-to-rail routes.

Table 5-6: Average Accident Frequency Over Each Route [1]

Accident Rate (per mi per yr)	Route					
	A. Rail-min. time BNSF	H. Rail-min. time BNSF-UP	L. HHT to Rail-Transload at San Onofre State Park	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	P. HT-Barge-Rail to Camp Pendleton to MOTCO	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Accident Likelihood HHT	n/a	n/a	0.000000842	0.00002293	0.000006998	0.000022858
Accident Likelihood Barge/Vessel	n/a	n/a	n/a	0.002061161	0.000248032	Data missing*
Accident Likelihood Rail	Data missing					
Total Accident Likelihood (without rail)	n/a	n/a	0.000000842	0.002084091	0.000255030	0.002084019

Accident Rate (per mi per yr)	Route					
	A. Rail-min. time BNSF	H. Rail-min. time BNSF-UP	L. HHT to Rail-Transload at San Onofre State Park	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	P. HT-Barge-Rail to Camp Pendleton to MOTCO	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Factor Increase Over Lowest Rate	n/a	n/a	1 x	2475 x	303 x	2475 x

* This data was assumed to be conservatively equivalent to the data for route N.
** The rail accident data was assumed to be proportional to the distance travelled by the rail segment.

5.3.3.20 Number of Fire Stations and Trained Personnel Nearby Route

Using data produced from the START program [1], each route was evaluated for the number of fire stations along the routes. Based on these results (see **Attachment D**), the number of fire stations along each route was highest for the rail-only with a single interchange, followed by the HHT-to-barge-to-rail route, the rail-only with no interchange route, the HHT-to-rail route, and finally the HHT-to-vessel-rail routes.

5.3.3.21 Transit Duration per Conveyance

The transit duration for each route was roughly estimated during the team meeting and arrived at the following estimates and with transit only estimates summarized in **Table 5-7**:

1. Rail-min. time BNSF:
    a. For Holtec system:
        i. Loading Cask: load MPC into HI-TRAC transfer cask from VVM, move loaded HI-TRAC transfer cask to over HI-STAR 190 transport overpack, load MPC into HI-STAR 190 transport overpack from HI-TRAC transfer cask, and down-end HI-STAR 190 transport overpack and place into transport cradle (2 days per MPC).
        ii. Prepare and load HI-STAR transport overpack in cradle and transfer onto cask railcar and secure to railcar (1 day per transport overpack).
        iii. Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).
        iv. Thus, approximately 16 days for 5 loaded HI-STAR 190 transport overpacks to load onto a full consist.
        v. Total Rail Transit Duration from START [1]: 52 hours.
    b. For TN system:

i. Loading Cask: load DSC from NUHOMS AHSM into MP197HB transport overpack (1 day per DSC).

ii. Prepare and load MP197HB transport overpack in cradle and transfer onto cask railcar and secure to railcar (1 day per transport overpack).

iii. Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).

iv. Thus, approximately 11 days for 5 loaded MP197HB transport overpacks to load onto a full consist.

v. Total Rail Transit Duration from START [1]: 52 hours.

2. Rail-min. time BNSF-UP:

   a. Same as for the first route except Total Rail Transit Duration from START [1]: 60 hours.

3. HHT-to-Rail Transload at San Onofre State Park:

   a. For Holtec system:

      i. Loading Cask: load MPC into HI-TRAC transfer cask from VVM, move loaded HI-TRAC transfer cask to over HI-STAR 190 transport overpack, load MPC into HI-STAR 190 transport overpack from HI-TRAC transfer cask, and down-end HI-STAR 190 transport overpack and place into cradle (2 days per MPC).

      ii. Prepare and load HI-STAR 190 transport overpack in cradle and transfer onto HHT trailer and secure (1 day per transport overpack).

      iii. HHT transfers HI-STAR 190 transport overpack from SONGS to transload site located outside of San Onofre State Park (2 hours per trip or ½ day per transport overpack for round trip)

      iv. Lift from trailer HI-STAR 190 and transportation cradle and place on cask railcar and secure to railcar (1 day per transport overpack)

      v. Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).

      vi. Thus, approximately 23½ days for 5 loaded HI-STAR 190 transport overpacks to load onto a full consist.

      vii. Total Rail Transit Duration from START [1]: 51 hours.

   b. For TN system:

      i. Loading Cask: load DSC from NUHOMS AHSM into MP197HB transport overpack (1 day per DSC).

      ii. Prepare and load MP197HB transport overpack in cradle and transfer onto HHT trailer and secure (1 day per transport overpack).

iii. HHT transfers MP197HB transport overpack from SONGS to transload site located outside of San Onofre State Park (2 hours per trip or ½ day per transport overpack for round trip)

iv. Lift from trailer MP197HB and transportation cradle and place on cask railcar and secure to railcar (1 day per transport overpack)

v. Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).

vi. Thus, approximately 18½ days for 5 loaded MP197HB transport overpacks to load onto a full consist.

vii. Total Rail Transit Duration from START [1]: 51 hours.

4. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal:

   a. For Holtec system:

      i. Loading Cask: load MPC into HI-TRAC transfer cask from VVM, move loaded HI-TRAC transfer cask to over HI-STAR 190 transport overpack, load MPC into HI-STAR 190 transport overpack from HI-TRAC transfer cask, and down-end HI-STAR 190 transport overpack and place into cradle (2 days per MPC).

      ii. Prepare and load HI-STAR 190 transport overpack in cradle and transfer onto HHT trailer and secure (1 day per transport overpack).

      iii. HHT transfers HI-STAR 190 transport overpack from SONGS to transload site at Los Angeles Port (4 hours per trip or ½ day per transport overpack for round trip)

      iv. Lift from HHT trailer HI-STAR 190 and transportation cradle and place on vessel and secure (1 day per transport overpack)

      v. Vessel transfers five HI-STAR 190 transport overpacks from Los Angeles Port to Port of Houston (745 hours or 31 days per trip)

      vi. Lift from vessel HI-STAR 190 and transportation cradle and place on cask railcar and secure to railcar (1 day per transport overpack)

      vii. Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).

      viii. Thus, approximately 59½ days for 5 loaded HI-STAR 190 transport overpacks to load onto a full consist.

      ix. Total Rail Transit Duration from START [1]: 770 hours.

   b. For TN system:

      i. Loading Cask: load DSC from NUHOMS AHSM into MP197HB transport overpack (1 day per DSC).

      ii. Prepare and load MP197HB transport overpack in cradle and transfer onto HHT trailer and secure (1 day per transport overpack).

iii. HHT transfers MP197HB transport overpack from SONGS to transload site at Los Angeles Port (4 hours per trip or ½ day per transport overpack for round trip)

iv. Lift from HHT trailer MP197HB and transportation cradle and place on vessel and secure (1 day per transport overpack)

v. Vessel transfers five MP197HB transport overpacks from Los Angeles Port to Port of Houston (745 hours or 31 days per trip)

vi. Lift from vessel MP197HB and transportation cradle and place on cask railcar and secure to railcar (1 day per transport overpack)

vii. Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).

viii. Thus, approximately 54½ days for 5 loaded MP197HB transport overpacks to load onto a full consist.

ix. Total Rail Transit Duration from START [1]: 770 hours.

5. HT-Barge-Rail to Camp Pendleton to MOTCO:

   a. For Holtec system:

      i. Loading Cask: load MPC into HI-TRAC transfer cask from VVM, move loaded HI-TRAC transfer cask to over HI-STAR 190 transport overpack, load MPC into HI-STAR 190 transport overpack from HI-TRAC transfer cask, and down-end HI-STAR 190 transport overpack and place into cradle (2 days per MPC).

      ii. Prepare and load HI-STAR 190 transport overpack in cradle and transfer onto HHT trailer and secure (1 day per transport overpack).

      iii. HHT transfers HI-STAR 190 transport overpack from SONGS to Camp Pendleton barge transload site (2 hours per trip or ½ day per transport overpack for round trip)

      iv. Lift from HHT trailer HI-STAR 190 and transportation cradle and place on barge and secure (1 day per transport overpack)

      v. Barge transfers five HI-STAR 190 transport overpacks from Camp Pendleton barge site to MOTCO (84.5 hours or 3.5 days per trip)

      vi. Lift from barge HI-STAR 190 and transportation cradle and place on cask railcar and secure to railcar (1 day per transport overpack)

      vii. Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).

      viii. Thus, approximately 32 days for 5 loaded HI-STAR 190 transport overpacks to load onto a full consist.

      ix. Total Rail Transit Duration from START [1]: 139 hours.

   b. For TN system:

i. Loading Cask: load DSC from NUHOMS AHSM into MP197HB transport overpack (1 day per DSC).

ii. Prepare and load MP197HB transport overpack in cradle and transfer onto HHT trailer and secure (1 day per transport overpack).

iii. HHT transfers MP197HB transport overpack from SONGS to Camp Pendleton barge transload site (2 hours per trip or ½ day per transport overpack for round trip)

iv. Lift from HHT trailer MP197HB and transportation cradle and place on barge and secure (1 day per transport overpack)

v. Barge transfers five MP197HB transport overpacks from Camp Pendleton barge site to MOTCO (84.5 hours or 3.5 days per trip)

vi. Lift from vessel MP197HB and transportation cradle and place on cask railcar and secure to railcar (1 day per transport overpack)

vii. Complete Rail Consist (e.g., add buffer cars, locomotives, and escort car) (~1 day).

viii. Thus, approximately 27 days for 5 loaded MP197HB transport overpacks to load onto a full consist.

c. Total Rail Transit Duration from START [1]: 139 hours.

6. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal:

a. Same as for the fourth route except Total Rail Transit Duration from START [1] is 764 hours and vessel transfers of five transport overpacks from Port of San Diego to Port of Houston (739 hours or 30.7 days per trip).

Table 5-7: Route Transit Durations [1]

Distance (miles)	Route					
	A. Rail-min. time BNSF	H. Rail-min. time BNSF-UP	L. HHT to Rail-Transload at San Onofre State Park	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	P. HT-Barge-Rail to Camp Pendleton to MOTCO	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
HHT	0	0	2	61	19	61
Barge/Vessel	0	0	0	5,218	591	5,173
Rail	2,189	2,344	2,100	842	2,170	842

Distance (miles)	Route					
	A. Rail-min. time BNSF	H. Rail-min. time BNSF-UP	L. HHT to Rail-Transload at San Onofre State Park	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	P. HT-Barge-Rail to Camp Pendleton to MOTCO	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Total Duration (hrs)	52	60	51	770	139	764
Number of Rail Interchanges	0	1	0	0	0	0

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 will still result in HHT transport durations of less than 1 day since the distances are short. The values shown above do not account for the multiple trips that will be required by HHT to and from the site.

Using the data in Table 5-7 from START [1], the above handling times, and assuming approximately 1 day to perform a rail interchange, the pairwise comparisons were performed between the various routes.

5.3.3.22 Ease of Access to Transload Site

The evaluation team examined each of the transload sites for ease of access and established the rail-only routes had the least issues with access, followed by the HHT-to-rail route which was expected to have minimal issues with accessing the transload site near the San Onofre State Park, followed by the HHT-to-barge-to-rail route which was expected to have some issues with gaining access to the Camp Pendleton barge launch and transload condition, and finally the HHT-to-vessel-to-rail routes were expected to pose the most issues with access to commercial ports of San Diego and Los Angeles as access is through heavily populated areas.

5.3.3.23 Immediacy of Ability to Perform Transfer

The evaluation team assessed that the transfer operations for the rail-only routes were able to perform transfers as expeditiously as possible, whereas the HHT-to-rail route was expected to be able to perform transfers after the transload site was set-up, the HHT-to-barge-to-rail route was also expected to be able to perform transfers after an assessment of the water depth was performed and the transload site set-up, and finally the HHT-to-vessel-to-rail routes were assessed to be the least immediately able to perform transfers as the difficulty of setting-up transload sites at the departure and arrival ports was expected to be a challenge.

5.3.3.24 Size of Conveyance

Since the HHT can only move one cask per shipment and the rail-only routes will be loaded directly on the site, the size of the initial conveyance will be more favorable for the rail-only routes.

5.3.3.25 Security Vulnerability of Route

The evaluation team considered the overall security vulnerability of each route through evaluation of the length and duration of the route, the proximity of large population bodies, the number of transload activities and interchanges between rail carriers, the number of local law enforcement facilities near the routes, and an initial assessment of the vulnerability of the route to security concerns. Based on these items, the rail-only route without any interchanges was considered the more secure route followed by the rail-only route with one interchange followed by the HHT-to-rail route followed by the HHT-to-vessel-to-rail routes with the San Diego route mildly favored over the Los Angeles route.

5.3.3.26 Availability of Security Escort for Route

The assessment of this metric established that only the routes involving the Panama Canal have any issue with security escort availability, since this required an international security escort. However, this was judged to be a mild disadvantage to these routes over the other routes.

5.3.3.27 Number of Police Stations Nearby Route

Using data produced from the START program [1], each route was evaluated for the number of police stations along the routes. Based on these results (see **Attachment D**), the number of police stations along each route was highest for the rail-only with a single interchange, followed by both the rail-only with no interchange route and the HHT-to-rail route, and then the HHT-to-barge-to-rail route and finally the HHT-to-vessel-rail routes.

5.4 Route Recommendations

Using the metric information identified for the routes listed in the previous section, the Orano-led team held a conference 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' rankings 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. **Table 5-8** provides an example of the pairwise comparison performed by the de-inventory team for the metric related to the Number of Sensitive Environmental Areas Nearby 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 number of sensitive environmental areas metric. The favorability scale listed in this figure is the same as identified for the pairwise comparison of the tangible metrics (see **Table 5-2**). As an example, the fifth row of the evaluation (excluding the header row) shows that the "A. Rail-min. time BNSF" route is more unfavorable when compared to the "Q. HHT-Vessel-Rail to San Diego Port to Port Houston via Panama Canal" to GCUS route for the metric related to the Number of Sensitive Environmental Areas Nearby Route, which is reflective of the information provided in **Section 5.3.3.18**.

With 27 tangible metrics and 6 routes to be evaluated, the team performed 405 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 5-3** shows the resulting relative weighting of the

routes in order of the highest rated (A. Rail-min. time BNSF) to the least rated (N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal). **Table 5-10** 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 Metric" results, which are based on zeroing out the weights associated with the safety 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 or Public Acceptability Metric" results, which are based on zeroing out the weights for the safety and public acceptability metrics and re-normalizing the "Average Weights" from **Table 5-3**.

Table 5-8: 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
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*	A. Rail-min. time BNSF					x			H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

As shown in **Figure 5-3** and **Table 5-10**, the routes with the highest ratings (based on average weighting method) are: Rail-min. time BNSF and Rail-min. time BNSF-UP. The route with the least favored rating (based on average weighting method) is the HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal. The top two routes are approximately 33% to 59% favored over the last three routes, indicating some definitive predilection towards these two routes with direct loading of rail on the SONGS ISFSI site.

Figure 5-3: Resulting List of Prioritized Routes from the SONGS ISFSI Site

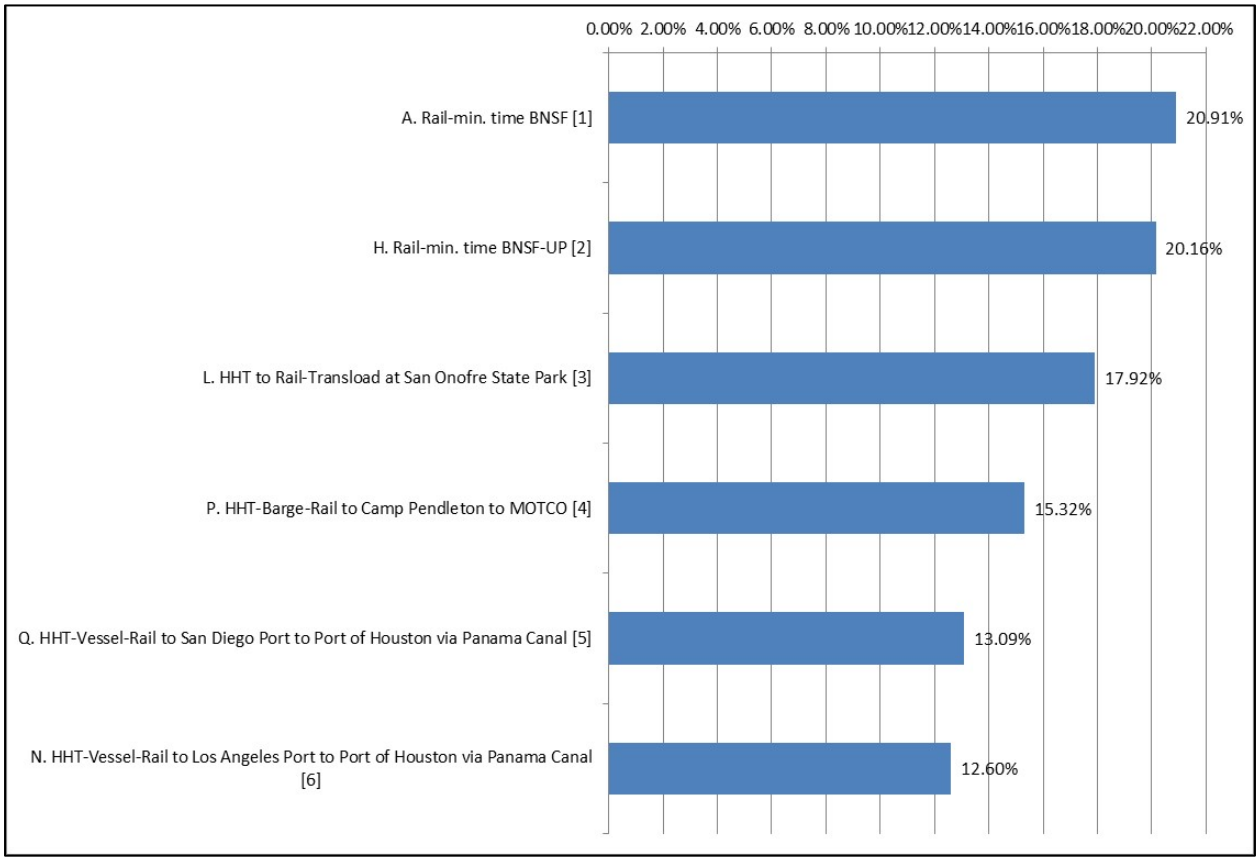


Figure 5-4 shows the impact each tangible metric had on the overall scoring of each route. There is no single dominant metric identified in this figure as the 27 metrics dilute the scoring. However, this figure does show the two most favored routes (direct rail from the site) received significantly greater contributions from the following tangible metrics: risks associated with number of lifting activities, cumulative worker exposure, security vulnerability of routes, and public acceptability of routes. Whereas the HHT routes received significant contributions from the following tangible metrics: number of Tribal lands crossed and cost of rail transport.

Since the safety metric will be established by regulation to be acceptable, the metrics related to safety may not be needed to distinguish routes from one another; hence, an alternative weighting scheme was examined to establish the impact of using no safety metrics. As shown in **Table 5-10**, the highest-scored route did not change position when the safety metrics are removed from the evaluation with and without removal of the public acceptability metric. Similarly, the removal of

only the public acceptability metric results in no change to the ranking of the routes. Additional analyses and sensitivity results were performed on these metrics to examine their impact on the rankings in **Section 5.5**.

Table 5-10 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 5-11, **Table 5-12**, **Table 5-13**, **Table 5-14, Table 5-15,** and **Table 5-16** 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 "Average Accident Frequency on Route" in **Table 5-14**, results are presented using a weight of 2.75% for the "Average Accident Frequency on Route" (instead of the 4.13% in **Table 5-3**) with the other metrics proportionally re-normalized. The results indicate no change occurs to the overall ranking. **Figure 5-5** summarizes the minimum, average, and maximum results presented in **Table 5-11**, **Table 5-12**, **Table 5-13**, **Table 5-14, Table 5-15,** and **Table 5-16** for the minimization of individual metrics. As can be seen from these results, the Rail-min. time BNSF route from SONGS to GCUS remains robustly ranked as the most favored route for the removal of the SNF from the SONGS ISFSI (at this time).

Table 5-17, Table 5-18, Table 5-19, Table 5-20, Table 5-21, and **Table 5-22** 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 "Public Acceptability of Route" in **Table 5-19**, results are presented using a weight of 5.77% for the "Public Acceptability of Route" (instead of the 4.24%), with the other metrics proportionally re-normalized. The results indicate that there is no change in the ranking of the routes. **Figure 5-6** summarizes the minimum, average, and maximum results presented in **Table 5-17, Table 5-18, Table 5-19, Table 5-20, Table 5-21,** and **Table 5-22** 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 and GTCC LLW from the SONGS ISFSI.

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 routes with direct shipment from the SONGS ISFSI as the favored routes) for the removal of the SNF and GTCC LLW from the SONGS ISFSI, with the Rail-min. time BNSF route ranking the highest in all the evaluations. The other rail-only route ranked second in these results, the HHT-to-rail route ranked 3, the HHT-to-barge-to-rail route ranked 4, the HHT-to-vessel-to-rail via San Diego port ranked 5, and the HHT-to-vessel-to-rail via Los Angeles ranked 6 (last) in all of these results.

As a result of the MUA and its sensitivity analyses, the prioritized list of routes from the SONGS ISFSI is found in **Table 5-9**.

Table 5-9: Prioritized list of routes from SONGS ISFSI

Rank	Prioritized Route
1	A. Rail-min. time BNSF
2	H. Rail-min. time BNSF-UP
3	L. HHT to Rail-Transload at San Onofre State Park
4	P. HHT-Barge-Rail to Camp Pendleton to MOTCO
5	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
6	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal

Figure 5-4: Impact of Each Tangible Metric on Each Route's "Score"

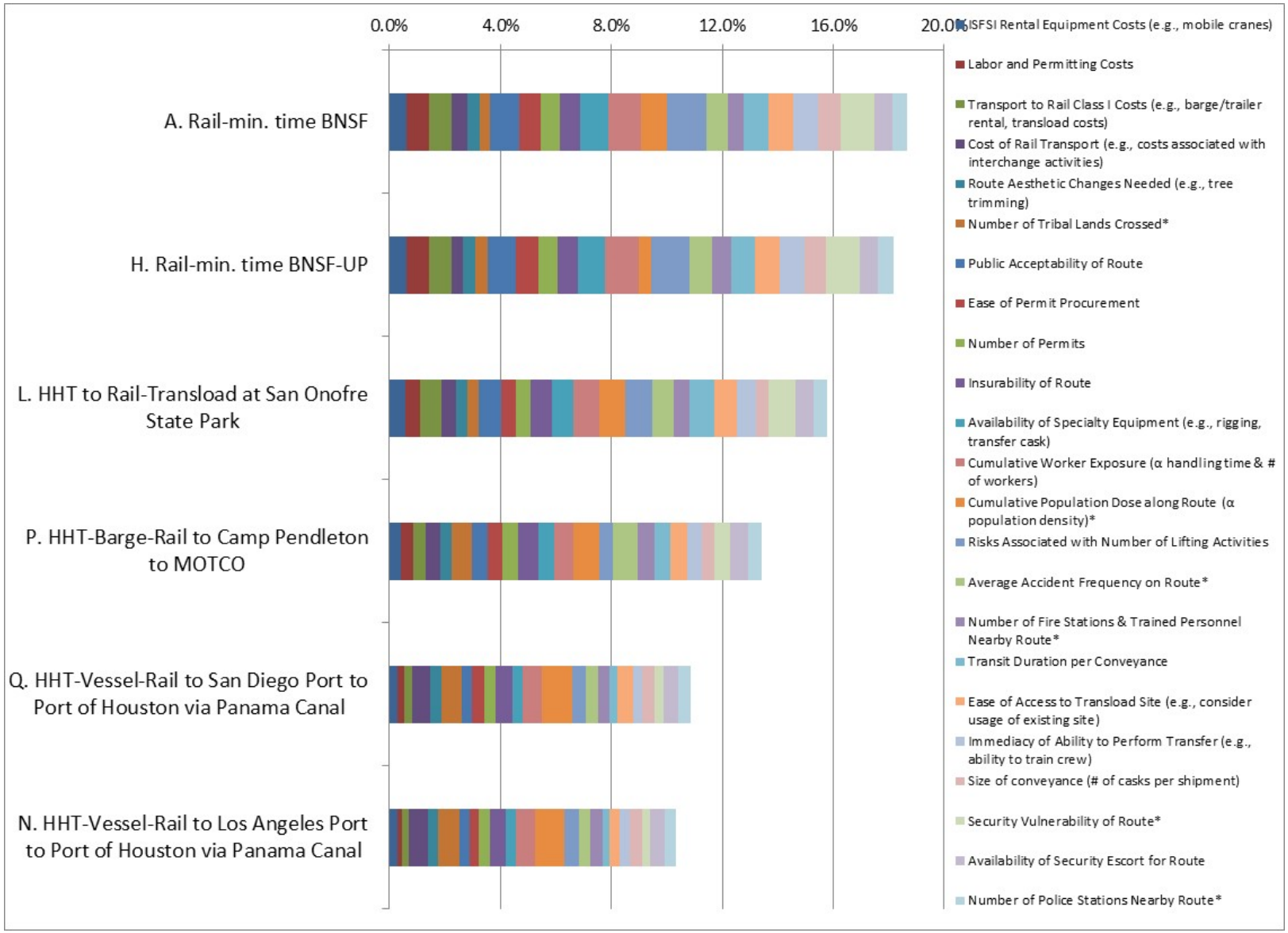


Table 5-10: Weighting of Routes

Nominal Results:	Unweighted		Average Weight		Biased Weight		No Safety Metric		No Public Acceptability Metric		No Safety or Public Acceptability Metric	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.70%	1	20.91%	1	20.91%	1	20.95%	1	20.76%	1	20.75%
H. Rail-min. time BNSF-UP	2	20.14%	2	20.16%	2	20.16%	2	20.43%	2	19.97%	2	20.20%
L. HHT to Rail-Transload at San Onofre State Park	3	17.82%	3	17.92%	3	17.92%	3	17.96%	3	17.85%	3	17.87%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.76%	6	12.60%	6	12.60%	6	12.38%	6	12.77%	6	12.59%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.37%	4	15.32%	4	15.32%	4	15.29%	4	15.38%	4	15.37%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.21%	5	13.09%	5	13.09%	5	12.99%	5	13.28%	5	13.23%

Table 5-11: Weighting of Routes at Minimum Metric Value (Part 1 of 6)

Metric Minimized:	On-Site Rental Equipment Costs		Labor and Permitting Costs		Transport to Rail Class I Costs		Cost of Rail Transport		Route Aesthetic Changes	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.89%	1	20.87%	1	20.88%	1	20.96%	1	20.94%
H. Rail-min. time BNSF-UP	2	20.12%	2	20.11%	2	20.12%	2	20.23%	2	20.18%
L. HHT to Rail-Transload at San Onofre State Park	3	17.88%	3	17.92%	3	17.87%	3	17.93%	3	17.93%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.64%	6	12.65%	6	12.66%	6	12.54%	6	12.57%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.32%	4	15.32%	4	15.34%	4	15.31%	4	15.31%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.14%	5	13.13%	5	13.14%	5	13.03%	5	13.06%

Table 5-12: Weighting of Routes at Minimum Metric Value (Part 2 of 6)

Metric Minimized:	Impact of Weather to Route		Number of Water Areas Nearby Route		Number of Sensitive Environmental Areas Nearby Route		Number of Non-Easily Mobilized Populations		Number of Tribal Lands Crossed	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.91%	1	20.93%	1	21.00%	1	20.95%	1	21.01%
H. Rail-min. time BNSF-UP	2	20.15%	2	20.16%	2	20.22%	2	20.27%	2	20.23%
L. HHT to Rail-Transload at San Onofre State Park	3	17.90%	3	17.91%	3	17.99%	3	17.93%	3	17.98%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.62%	6	12.57%	6	12.48%	6	12.54%	6	12.52%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.31%	4	15.37%	4	15.34%	4	15.28%	4	15.25%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.11%	5	13.07%	5	12.97%	5	13.03%	5	13.01%

Table 5-13: Weighting of Routes at Minimum Metric Value (Part 3 of 6)

Metric Minimized:	Public Acceptably of Route		Ease of Permit Procurement		Number of Permits		Insurability of Route		Availability of Specialty Equipment	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.88%	1	20.89%	1	20.91%	1	20.94%	1	20.89%
H. Rail-min. time BNSF-UP	2	20.11%	2	20.13%	2	20.15%	2	20.18%	2	20.12%
L. HHT to Rail-Transload at San Onofre State Park	3	17.90%	3	17.94%	3	17.93%	3	17.92%	3	17.91%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.65%	6	12.63%	6	12.61%	6	12.59%	6	12.63%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.33%	4	15.31%	4	15.30%	4	15.29%	4	15.33%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.14%	5	13.09%	5	13.10%	5	13.08%	5	13.12%

Table 5-14: Weighting of Routes at Minimum Metric Value (Part 4 of 6)

Metric Minimized:	Cumulative Worker Exposure		Cumulative Population Exposure		Risks Associated with Number of Lifts		Average Accident Frequency on Route		Number of Fire Stations	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.89%	1	20.91%	1	20.87%	1	20.93%	1	20.97%
H. Rail-min. time BNSF-UP	2	20.12%	2	20.16%	2	20.11%	2	20.17%	2	20.15%
L. HHT to Rail-Transload at San Onofre State Park	3	17.93%	3	17.92%	3	17.92%	3	17.90%	3	17.93%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.60%	6	12.60%	6	12.63%	6	12.64%	6	12.58%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.36%	4	15.32%	4	15.36%	4	15.23%	4	15.28%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.10%	5	13.09%	5	13.12%	5	13.13%	5	13.09%

Table 5-15: Weighting of Routes at Minimum Metric Value (Part 5 of 6)

Metric Minimized:	Transit Duration per Conveyance		Ease of Access to Transload Site		Immediacy of Ability to Perform		Size of Conveyance		Security Vulnerability	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.89%	1	20.91%	1	20.85%	1	20.89%	1	20.79%
H. Rail-min. time BNSF-UP	2	20.13%	2	20.15%	2	20.08%	2	20.13%	2	20.04%
L. HHT to Rail-Transload at San Onofre State Park	3	17.87%	3	17.90%	3	17.89%	3	17.96%	3	17.87%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.66%	6	12.64%	6	12.67%	6	12.60%	6	12.73%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.32%	4	15.32%	4	15.34%	4	15.33%	4	15.36%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.14%	5	13.08%	5	13.17%	5	13.09%	5	13.20%

Table 5-16: Weighting of Routes at Minimum Metric Value (Part 6 of 6)

Metric Minimized:	Availability of Security Escort for Route		Number of Police Stations Nearby	
Route	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.91%	1	20.94%
H. Rail-min. time BNSF-UP	2	20.16%	2	20.16%
L. HHT to Rail-Transload at San Onofre State Park	3	17.92%	3	17.92%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.60%	6	12.59%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.32%	4	15.30%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.09%	5	13.08%

Table 5-17: Weighting of Routes at Maximum Metric Value (Part 1 of 6)

Metric Minimized:	On-Site Rental Equipment Costs		Labor and Permitting Costs		Transport to Rail Class I Costs		Cost of Rail Transport		Route Aesthetic Changes	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.93%	1	20.97%	1	20.95%	1	20.88%	1	20.90%
H. Rail-min. time BNSF-UP	2	20.18%	2	20.22%	2	20.20%	2	20.09%	2	20.15%
L. HHT to Rail-Transload at San Onofre State Park	3	17.95%	3	17.91%	3	17.96%	3	17.90%	3	17.91%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.58%	6	12.54%	6	12.55%	6	12.66%	6	12.62%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.31%	4	15.31%	4	15.29%	4	15.32%	4	15.32%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.06%	5	13.05%	5	13.05%	5	13.14%	5	13.11%

Table 5-18: Weighting of Routes at Maximum Metric Value (Part 2 of 6)

Metric Minimized:	Impact of Weather to Route		Number of Water Areas Nearby Route		Number of Sensitive Environmental Areas Nearby Route		Number of Non-Easily Mobilized Populations		Number of Tribal Lands Crossed	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.92%	1	20.90%	1	20.75%	1	20.82%	1	20.81%
H. Rail-min. time BNSF-UP	2	20.17%	2	20.15%	2	20.04%	2	19.90%	2	20.07%
L. HHT to Rail-Transload at San Onofre State Park	3	17.94%	3	17.93%	3	17.78%	3	17.89%	3	17.84%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.59%	6	12.65%	6	12.84%	6	12.75%	6	12.70%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.33%	4	15.24%	4	15.27%	4	15.41%	4	15.39%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.07%	5	13.12%	5	13.32%	5	13.23%	5	13.19%

Table 5-19: Weighting of Routes at Maximum Metric Value (Part 3 of 6)

Metric Minimized:	Public Acceptably of Route		Ease of Permit Procurement		Number of Permits		Insurability of Route		Availability of Specialty Equipment	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.97%	1	20.93%	1	20.92%	1	20.87%	1	20.96%
H. Rail-min. time BNSF-UP	2	20.22%	2	20.17%	2	20.16%	2	20.13%	2	20.21%
L. HHT to Rail-Transload at San Onofre State Park	3	17.94%	3	17.91%	3	17.91%	3	17.92%	3	17.94%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.55%	6	12.59%	6	12.60%	6	12.63%	6	12.56%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.29%	4	15.32%	4	15.33%	4	15.35%	4	15.30%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.03%	5	13.09%	5	13.08%	5	13.11%	5	13.04%

Table 5-20: Weighting of Routes at Maximum Metric Value (Part 4 of 6)

Metric Minimized:	Cumulative Worker Exposure		Cumulative Population Exposure		Risks Associated with Number of Lifts		Average Accident Frequency on Route		Number of Fire Stations	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.93%	1	20.87%	1	21.00%	1	20.90%	1	20.85%
H. Rail-min. time BNSF-UP	2	20.18%	2	20.01%	2	20.26%	2	20.15%	2	20.16%
L. HHT to Rail-Transload at San Onofre State Park	3	17.91%	3	17.91%	3	17.92%	3	17.93%	3	17.90%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.61%	6	12.69%	6	12.56%	6	12.58%	6	12.63%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.28%	4	15.34%	4	15.23%	4	15.38%	4	15.36%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.09%	5	13.18%	5	13.04%	5	13.06%	5	13.10%

Table 5-21: Weighting of Routes at Maximum Metric Value (Part 5 of 6)

Metric Minimized:	Transit Duration per Conveyance		Ease of Access to Transload Site		Immediacy of Ability to Perform		Size of Conveyance		Security Vulnerability	
Route	Rank	Result	Rank	Result	Rank	Result	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.95%	1	20.92%	1	20.96%	1	20.93%	1	21.00%
H. Rail-min. time BNSF-UP	2	20.19%	2	20.17%	2	20.21%	2	20.18%	2	20.24%
L. HHT to Rail-Transload at San Onofre State Park	3	17.99%	3	17.94%	3	17.94%	3	17.89%	3	17.95%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.53%	6	12.57%	6	12.56%	6	12.61%	6	12.52%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.31%	4	15.31%	4	15.30%	4	15.30%	4	15.28%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.02%	5	13.10%	5	13.04%	5	13.09%	5	13.01%

Table 5-22: Weighting of Routes at Maximum Metric Value (Part 6 of 6)

Metric Minimized:	Availability of Security Escort for Route		Number of Police Stations Nearby	
Route	Rank	Result	Rank	Result
A. Rail-min. time BNSF	1	20.87%	1	20.89%
H. Rail-min. time BNSF-UP	2	20.12%	2	20.15%
L. HHT to Rail-Transload at San Onofre State Park	3	17.92%	3	17.91%
N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.63%	6	12.62%
P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.35%	4	15.33%
Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.11%	5	13.10%

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

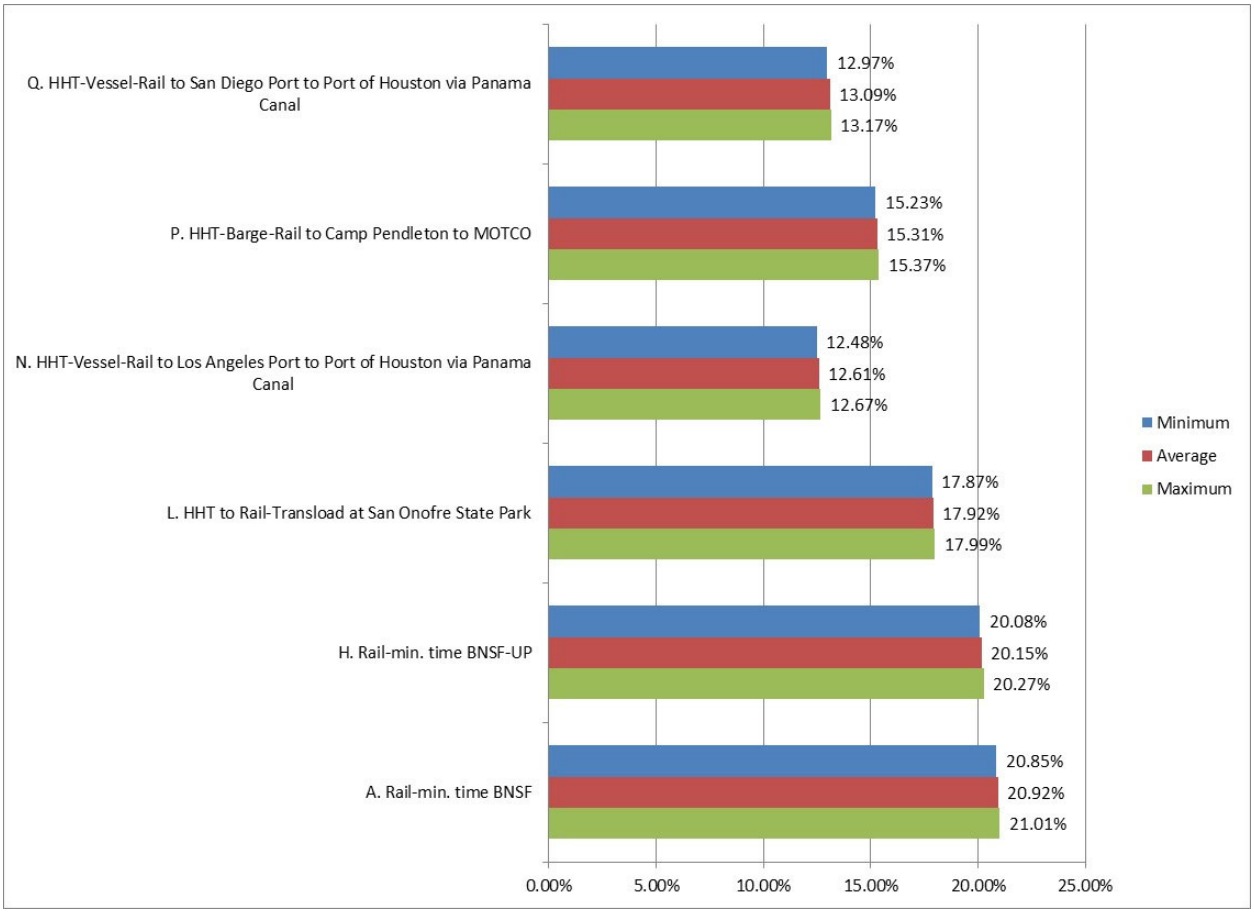
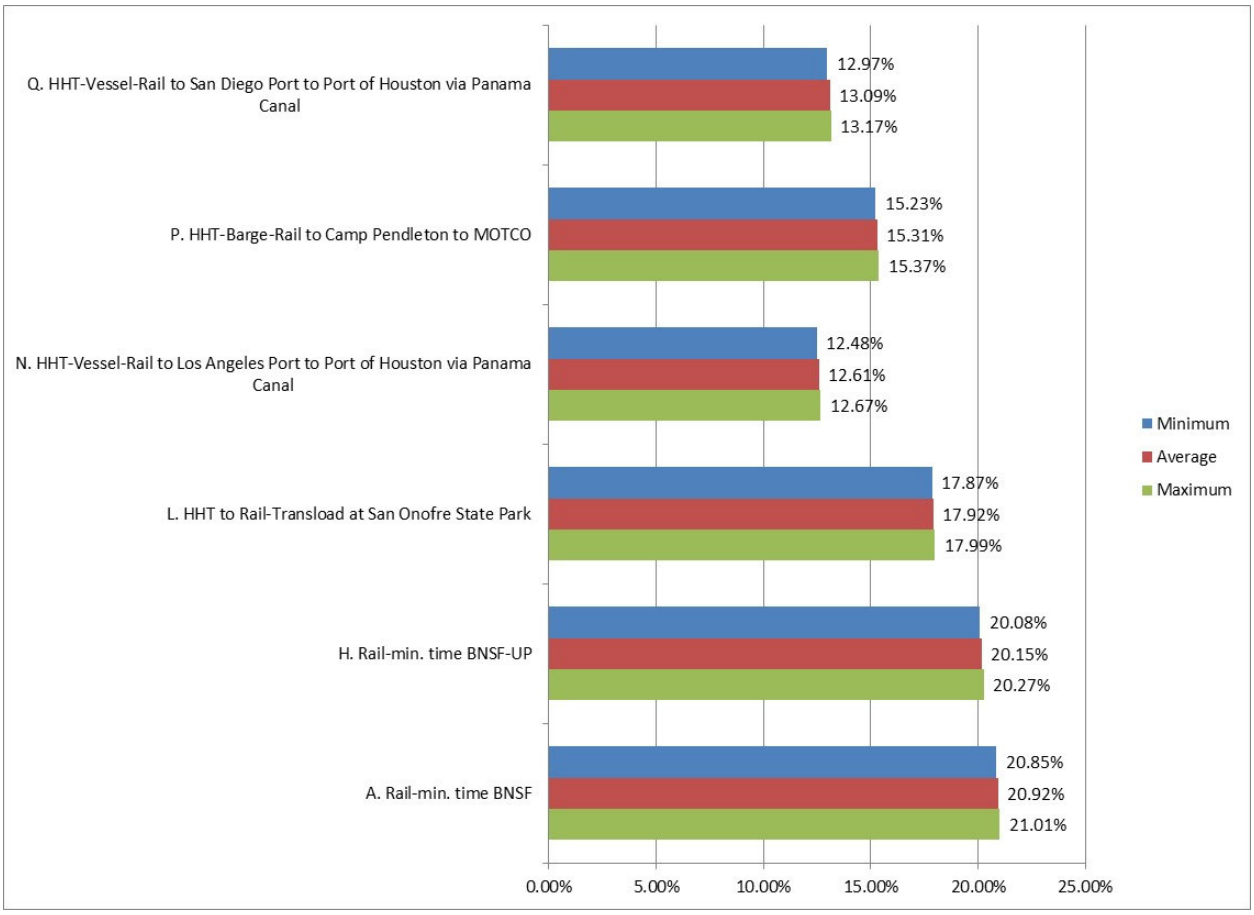


Figure 5-6: Minimum, Average, and Maximum Results from Sensitivity Analysis for Maximization of Each Metric



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 5-10**. 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 then may be necessary to distinguish between routes and may over or under emphasize the difference between routes. For example, as noted in **Section 5.3.3.17** 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 more 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 5-10** 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

These specific safety 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 5-7**, was examined. Since these four metrics were ranked, by average, within the top five metrics from the pairwise comparison by individual team members, the suppression of the span of the pairwise comparison could impact the route rankings. However, as shown in the previous section, the results of this MUA have shown no variance regardless of which individual parameter was perturbed and hence, the only means expected to change the ranking is to change multiple metrics weights at the same time and potentially changing the overall weighting schemes.

Figure 5-7: Example of Suppression Span for Cumulative Population Dose Range

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. Rail-min. time BNSF		x						H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF					x			N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP						x		L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park					x			N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

(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. Rail-min. time BNSF			x					H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF				x				N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP					x			L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP					x			N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

(after suppression)

In **Figure 5-7**, 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 5-8 and **Table 5-23** shows the modified rankings when the above safety metrics evaluation ranges are all suppressed. **Figure 5-9** shows the contribution each tangible metric makes to the scoring for each route.

Table 5-23 compares the results from the original assessment and the modified results using the suppressed span. These results show none of the routes change position, but the separation between the results has slightly tightened up. Hence the rail routes from the SONGS site remain the highest ranked routes, which is consistent with the results identified by the other sensitivity analyses included in this report.

Figure 5-8: Resulting List of Prioritized Routes from the SONGS ISFSI for the Suppression of Span for Safety Metrics

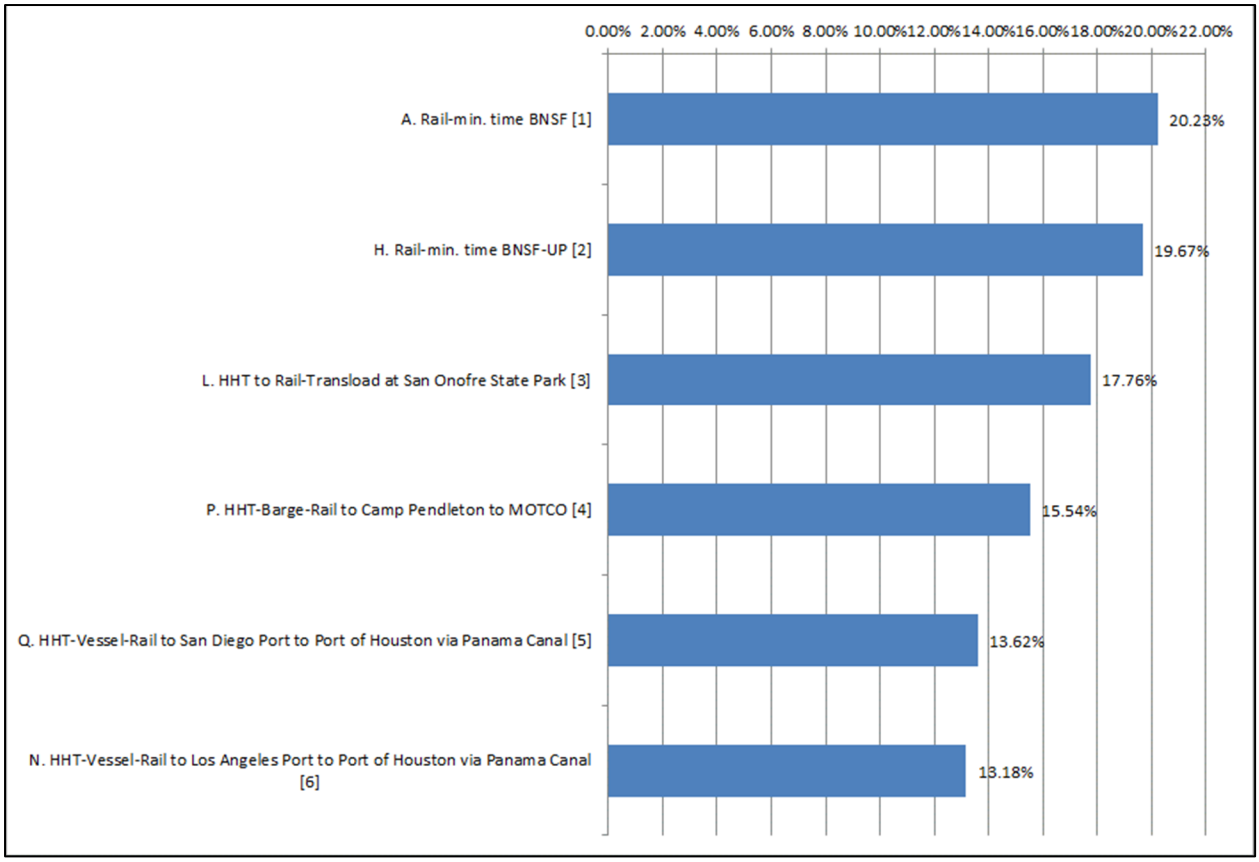


Figure 5-9: Impact of Each Tangible Metric on each Route's Scoring for the Suppression of Span for Safety Metrics

Table 5-23: Comparison of Original MUA Results to the Suppressed Span MUA Results

Suppression Results		Routes	Original Results	
Rank	Avg		Rank	Avg
1	20.23%	A. Rail-min. time BNSF	1	20.70%
2	19.67%	H. Rail-min. time BNSF-UP	2	20.14%
3	17.76%	L. HHT to Rail-Transload at San Onofre State Park	3	17.82%
6	13.18%	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.76%
4	15.54%	P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.37%
5	13.62%	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.21%

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:

- Removal of the public acceptability metric and the following safety metrics:
  - 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 metric
- Removal of the above public acceptability metric, safety metrics, and the following security metrics:
  - The security vulnerability of route metric
  - The availability of security escort for route metric
  - Number of police stations nearby route metric
- Changing of the weighting scheme

Results shown in **Figure 5-10** and **Table 5-24** for the removal of the public acceptability metric and the safety metrics show the rankings remain the same as were established from the average weights with the rail-only routes from SONGS to GCUS remaining the top ranked routes. Results shown in **Figure 5-11** and **Table 5-25** for the removal of the public acceptability metric, the safety metrics, and the security metrics also show no changes from the original rankings.

The final sensitivity analysis performed involved changing the weighting scheme to provide more importance to metrics that have significant favorability differences between routes. The relative weighting scheme is shown in **Section 5.3.2** and in this assessment the scheme is weighted more heavily towards the strongly favorable and unfavorable results. The weights changed as follows: strongly favorable from 11 (+5) to 17 (+8), more favorable from 9 (+3) to 12 (+3), mildly favorable from 7 (+1) to 10 (+1), neutral from 6 (0) to 9 (0), mildly unfavorable from 5 (-1) to 8 (-1), more unfavorable from 3 (-3) to 6 (-3), and strongly unfavorable from 1 (-5) to 1 (-8).

Figure 5-12 and **Table 5-26** show the results of this assessment against the original rankings and again identify no change in the order of the routes.

Overall, the rail routes from SONGS to GCUS are consistently the highest-ranked routes for transloading the transportation casks, with the Rail-min. time BNSF route finishing ranked at the top under every sensitivity assessment. However, this site does require additional assessment prior to final selection and some of the specific issues requiring resolution include but are not limited to the rail line at the on-site transload site remaining viable for use until the time they are actually required to be used and the rail routes meeting the required clearances.

Figure 5-10: Impact of Removing the Public Acceptability and Safety Metrics

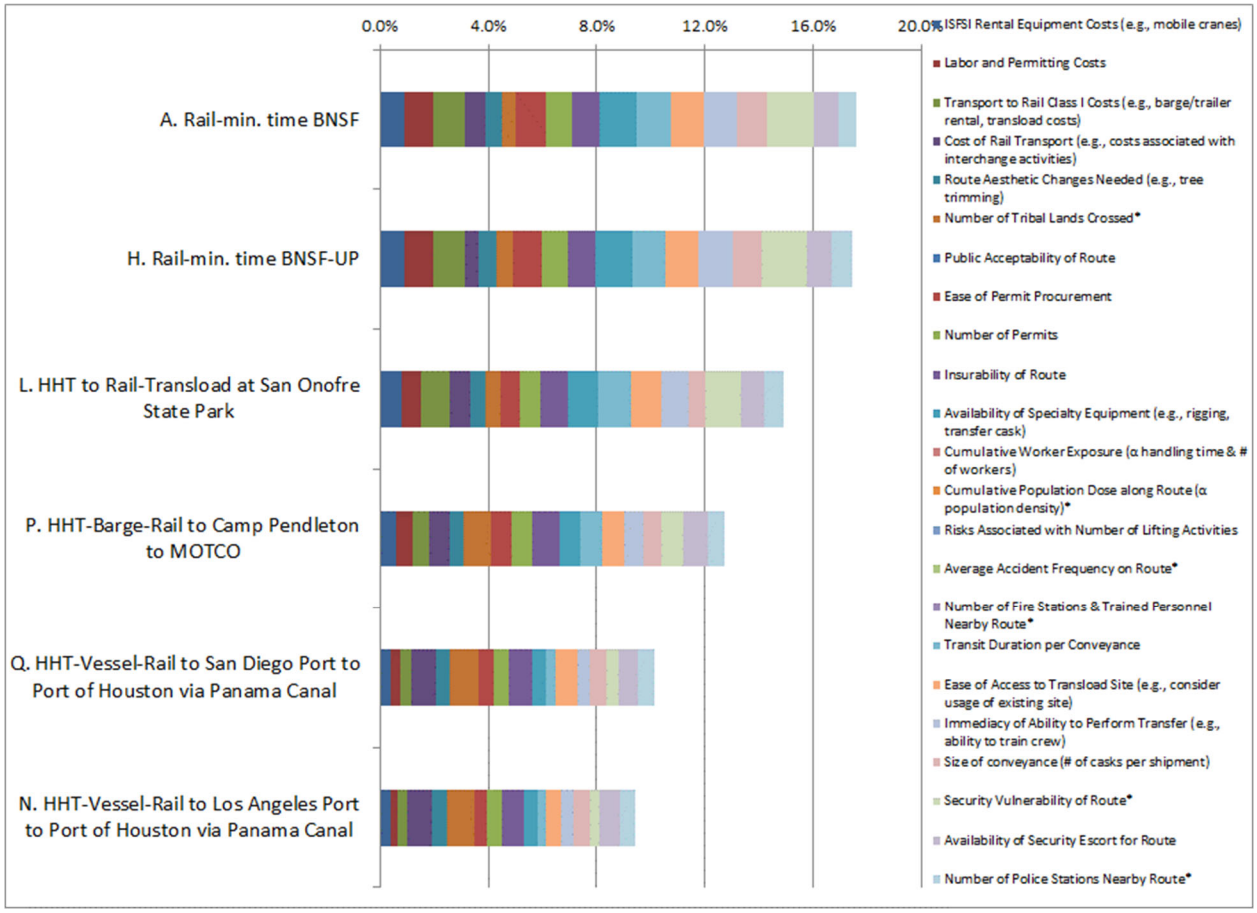


Table 5-24: Results from the Deletion of the Public Acceptability Metric and Safety Metrics

No Public Acceptability Metric and Safety Metrics Results		Routes	Original Results	
Rank	Avg		Rank	Avg
1	20.75%	A. Rail-min. time BNSF	1	20.70%
2	20.20%	H. Rail-min. time BNSF-UP	2	20.14%
3	17.87%	L. HHT to Rail-Transload at San Onofre State Park	3	17.82%
6	12.59%	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.76%
4	15.37%	P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.37%
5	13.23%	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.21%

Figure 5-11: Impact of Removing the Public Acceptability Metric, Safety Metrics, and Security Metrics

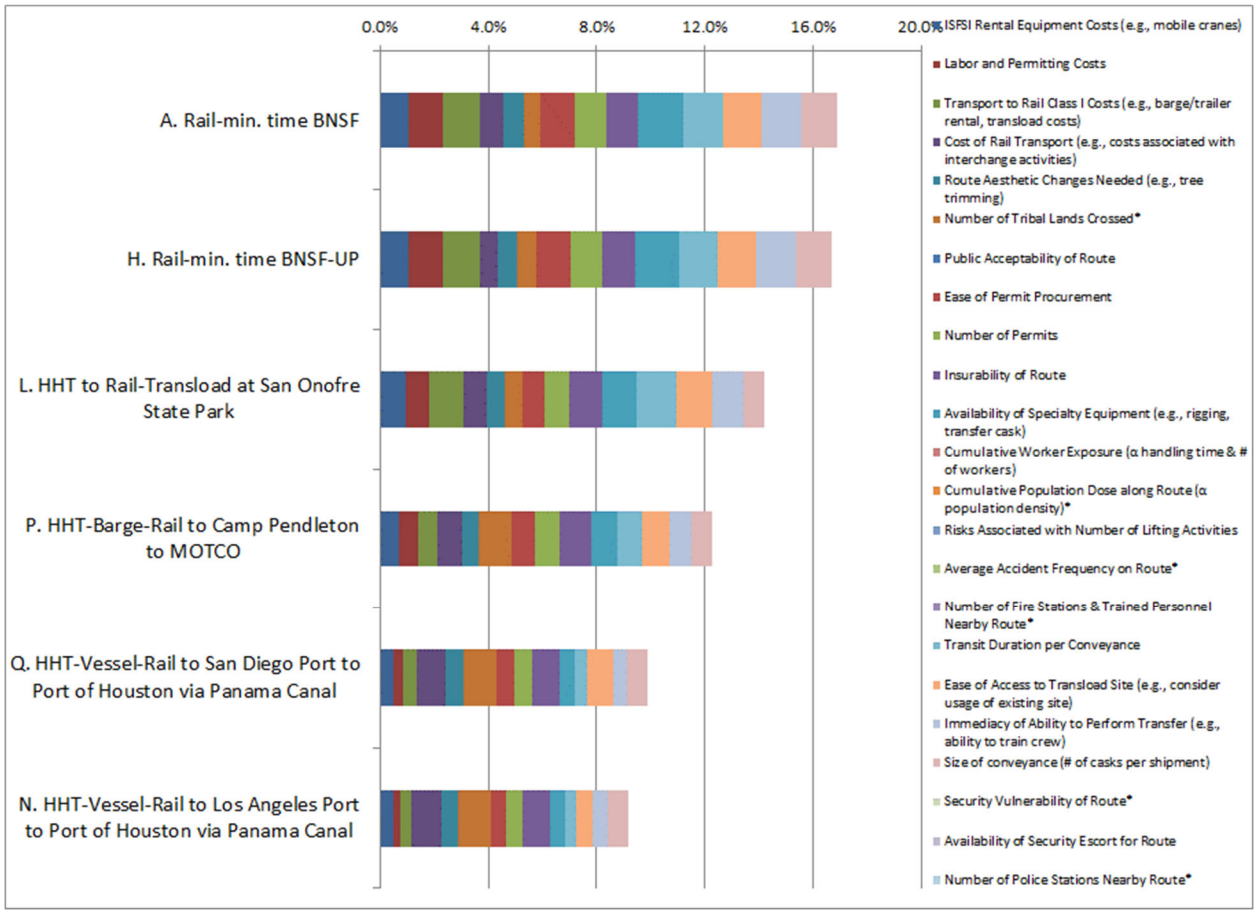


Table 5-25: Results from the Deletion of the Public Acceptability Metric, Safety Metrics, and Security Metrics

No Public Acceptability Metric Results		Routes	Original Results	
Rank	Avg		Rank	Avg
1	20.58%	A. Rail-min. time BNSF	1	20.70%
2	19.94%	H. Rail-min. time BNSF-UP	2	20.14%
3	17.71%	L. HHT to Rail-Transload at San Onofre State Park	3	17.82%
6	12.87%	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.76%
4	15.36%	P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.37%
5	13.55%	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.21%

Figure 5-12: Impact of Changing the Weighting Scheme

Table 5-26: Results from Impact of Changing the Weighting Scheme

Change in Weighting Scheme		Routes	Original Results	
Rank	Avg		Rank	Avg
1	20.89%	A. Rail-min. time BNSF	1	20.70%
2	20.13%	H. Rail-min. time BNSF-UP	2	20.14%
3	17.96%	L. HHT to Rail-Transload at San Onofre State Park	3	17.82%
6	12.60%	N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal	6	12.76%
4	15.32%	P. HHT-Barge-Rail to Camp Pendleton to MOTCO	4	15.37%
5	13.09%	Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal	5	13.21%

6.0 CONCEPT OF OPERATIONS FOR RECOMMENDED APPROACH

6.1 Overview of Operations and Assumptions for TN Americas MP197HB and Holtec HI-STAR 190 Systems

The operations associated with the de-inventory of SONGS fuel and GTCC LLW stored on-site will require leasing or purchasing transportation casks, on-site transfer equipment, auxiliary equipment, ancillary systems including mobile crane(s) and lifting equipment, development/confirmation of training program materials, training of operating personnel and supervisors, preparation and approval of site operating procedures, facility operational readiness review, dry run operations, de-inventory activities, and transportation operations, and demobilization of equipment from the site. Due to the complexity of these operations, the sequence of activities is divided into five groups:

1) Mobilization operations: procurement/lease and delivery of required equipment to the site;
2) Operational readiness: operating procedure preparation and approval, training program development, operator training, equipment checkouts, dry run(s), and operational readiness review(s);
3) ISFSI site operations: performance of canister transfer operations from the VVMs to the transport casks respectively, for off-site transports;
4) Rail transport operations; and
5) Demobilization of equipment and personnel from the SONGS site.

Based on the number of canisters to be loaded and shipped from the SONGS ISFSI (i.e., 123 canisters with SNF and 9 GTCC LLW waste canisters[8]), it is recommended to load and ship five MP197HB and then another five HI-STAR 190 transport casks for the off-site transport campaign by rail transport with a total of ten transport cask systems each committed to the de-inventory shipping campaign. Shipment of the empty casks from GCUS will be transported on two dedicated trains.

The following assumptions were used in planning the canister transfers, loading, and off-site shipment campaign:

1) Five MP197HB casks, including impact limiters, and intermodal transport cradle with integral tie-downs and personnel barrier are all available;
2) Five HI-STAR 190 casks, including impact limiters, and intermodal transport cradle with integral tie-downs and personnel barrier are all available;
3) A complete set of acceptable transfer system equipment will be present and ready for use when the de-inventory operations commence.

[8] Note that 4 more GTCC LLW waste canisters are expected to be loaded during decommissioning activities at the SONGS site and hence, another consist will be required to ship all the canisters from the site that is not currently captured by this report.

4) The maintenance activities required to be performed in Chapter 8 of the SAR will be completed and up-to date (see **Table 6-2** and **Table 6-3**):
5) Canister and contents have been evaluated and are compliant with the cask SAR;
6) Fuel/canister is assumed transportable for these activities (e.g., 10 CFR Part 71 dose and thermal limits are met);
7) Transfer operations on-site will include both the ISFSI and transloading site and will be part of the 10 CFR Part 50 assessment or Final Safety Analysis Report (FSAR) under 10 CFR Part 72;
8) A mobile crane would be used to transfer the 'assembled' transportation cask (i.e., MP197HB or HI-STAR 190 cask, cradle, impact limiters, and personnel barrier) to the railcar(s) at the transfer station. This crane would also be used to rotate the HI-STAR 190 transportation casks between the vertical and horizontal orientations; and
9) Dry runs of the site operations, transport operations, and the transloading operations would be conducted to ensure equipment and procedures are adequate to perform the task in a safe and efficient manner.
10) A below grade transfer station will be provided by the site for transferring the MPCs from the VCT to the HI-STAR 190 transportation cask.

6.1.1 Pre-Mobilization/Mobilization

Table 6-1 lists the activities required to prepare for and remove SNF and GTCC LLW from the SONGS ISFSI.

Table 6-1: Activities to Prepare and Remove SNF and GTCC LLW from SONGS ISFSI

Task		Task Activity Description
Programmatic Activities to Prepare for Transport Operations from the SONGS Site		
1	Assemble Project Organization	Assemble management teams; identify decommissioned site existing infrastructure, constraints, and transportation resource needs; and develop interface procedures.
2	Acquire Transportation Cask, Hardware, Railcars, Off-Site HHT, and Transport Services	Develop specifications, solicit bids, issue contracts, and initiate preparations for shipping campaigns; includes procurement of transport packagings including impact limiters, personnel barriers, intermodal transport cradles, if required; procurement of AAR (Association of American Railroads) Standard S-2043 railcars; and procurement of off-site transportation services including rail and HHT as applicable.

Task		Task Activity Description
3	Acquire/Lease Required Ancillary Equipment	Equipment will need to be leased and shipped to site for setup and checkout prior to start of the training program and performance of the dry run(s). In addition, there will likely be limited staffing at the SONGS ISFSI site, so outside contractor crews will need to be assembled, trained, and evaluated to perform all transfer operations.
4	Prepare Transfer Area and Equipment in accordance with the requirements of the SONGS FSAR	A transfer area will be established near the ISFSI to perform MPC transfer operations at a below grade transfer station. Transfer of the DSCs will occur at the door of each HSM with a transfer trailer loaded with a MP197HB cask aligned to make the transfer and transport the transfer trailer to the railcar.
5	Conduct Preliminary Logistics Analysis and Planning	Determine fleet size, transport requirements, and modes of transport.
6	Coordinate with Stakeholders	Coordinates with carriers and makes notifications to federal, state, and applicable Tribal nations. Assess and select routes and modes of transport and support training of transportation emergency response personnel.
7	Develop Campaign Plans/Procedures (e.g., prepare, review, and approve all required site operating procedures for the canister unloading from the VVMs and transfer/loading into the transportation casks, preparation and testing of the casks, and procedures for all the major and auxiliary components and systems)	Develop plans, policies, and procedures for on-site operational interfaces and acceptance, support operations, and in-transit security operations. Initial drafts of MPC unloading operations can be prepared from procedures initially prepared during the original loading campaign. Similar procedures will be required for the auxiliary equipment including transfer operations. New site procedures will be required for the handling of the transport casks, transfer operations, transfer trailer operations, proper tie-down and securing of the cask packages to the railcar/intermodal transport cradle, evacuation and backfilling of the cask cavity with helium, helium leakage testing of the cask containment boundary seals, etc. All approved procedures will require review and approval by SONGS Independent Safety Review (ISR).

Task		Task Activity Description
Operational Activities to Prepare, Accept, and Transport from SONGS		
8	Conduct Readiness Activities (e.g., In-Processing, Badging, Training, and Dry Run(s) of All Personnel, Procedures, and Operations)	Assemble and train on-site 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 Quality Assurance (QA)/Quality Control (QC) personnel would need to be trained and qualified to perform the operating procedures in accordance with SONGS's Systemic Approach to Training Programs. Training would require classroom, on-the-job training (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	Transmit canister load reports and transportation related documents	Assemble canister load reports and the applicable transportation documents and transmit to the un-loading facility.
10	Load for Off-Site (ISFSI) Transport	Unload storage systems and transfer MPCs to transport casks, install loaded casks onto intermodal transport cradles, installing impact limiters and personnel barrier.
11	Accept for Off-Site (ISFSI) Transport	Accept loaded casks onto transport conveyance for off-site ISFSI transportation and shipment to the designated destination.
12	Transport	Ship shutdown site casks.

6.1.2 Operational Readiness

6.1.2.1 Site-related Operational Readiness Items

Prior to the performance of an Operational Readiness Review and Assessment, the assembled de-inventory project team would be required to be trained and competence confirmed in all required planned site operations and contingencies. All equipment would need to be delivered, assembled, and proper operation verified. Required procedures and project instructions would need to be 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 executed safely. It also ensures that the project team and procedures comply 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 SONGS ISFSI. The following subsection will discuss the operational readiness required to ensure operations at SONGS are ready to commence and can be performed in a safe and regulatory compliant manner.

A review of the SONGS FSAR, the transportation cask's SARs, and the applicable CoCs will need to be performed to verify that the contents of the canisters meet the required content conditions and quantities listed in the storage and transportation CoCs and Approved Contents. The contents

(form and quantity) of the canisters would require verification for compliance with the current revision of the CoC for the transport cask systems (refer to [67] and [68]) at the time of shipment.

Operations management would ensure quality, safety, and operational readiness. This assessment shall include verification of the roles and responsibilities among the different organizations involved with and performing the work. Communication among the stakeholders, review and approval of procedures, and interfacing with regulators must occur to ensure the processes to execute work have been reviewed are ready to start work. Based on the assumption in this report that DOE shipments would follow the same requirements as any commercial shipper of SNF, NRC is assumed to be involved in the initial routing approval, and those approved routes will be valid for five to seven years as indicated and described below.[9] Once route approval is granted (e.g., by the NRC), notification would be provided prior to each shipment, as the campaign is longer in duration than one train movement.

6.1.2.2 Personnel-Related Operational Readiness Items

A training program would be implemented for all project personnel, which would require a qualified trainer to oversee and conduct the training on the systems with operationally qualified personnel to perform the OJT and TPE portions of the training program. The training program should include the following requirements and elements:

Classroom Training:

- Module 1 – HI-STORM, HI-STAR 190, NUHOMS HSM, and MP197HB Systems Overview
- Module 2 – HI-TRAC and Transfer Adapter Operations
- Module 3 – HI-STORM VVM Handling and Movement
- Module 4 – On-site HHT Operations (including prime mover) if required
- Module 5 – Off-site HHT (SPMT) Operations including Prime Mover
- Module 6 – MPC Unloading Operations from HI-STORM VVM
- Module 7 – DSC Unloading Operations from NUHOMS HSM
- Module 8 – HI-STAR 190 Transport Cask Handling and Loading Operations
- Module 9 – MP197HB Transport Cask Handling and Loading Operations
- Module 10 – HI-STAR 190/MP197HB Transport Cask Intermodal Transport Cradle Tie-Down and Transloading Operations
- Module 11 – Preparation of HI-STAR 190 Transport Cask for Transport
- Module 12 – Preparation of MP197HB Transport Cask for Transport
- Module 13 – HI-STAR 190 Transport Cask Containment O-Ring Helium Leakage Testing

[9] 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.

- Module 14 – MP197HB Transport Cask Containment O-Ring Helium Leakage Testing
- Module 15 – Use of Measuring and Test Equipment (M&TE)
- Module 16 – Radiological Concerns and ALARA (As Low As Reasonably Achievable) Planning
- Module 17 – Regulatory Requirements
- Module 18 – Supervisor Training
- Module 19 – Contingency SONGS Procedures
- Module 20 – General Lifting and Rigging Operations
- Module 21 – Site Access Training

On the Job Training:

- OJT-1 – Perform Pre-Use Inspections (VVM, HI-TRAC, HI-STAR 190/MP197HB casks, VCT, and other support equipment)
- OJT-2 – Perform Periodic Inspections (VVM, HI-TRAC, HI-STAR 190/MP197HB casks, VCT, and other support equipment)
- OJT-3 – Prepare a HI-STORM VVM and a HI-TRAC for MPC transfer
- OJT-4 – Prepare an HSM for DSC transfer
- OJT-5 – Off-Load Empty HI-STAR 190 Transport Cask from Intermodal Transport Cradle
- OJT-6 – Off-Load Empty MP197HB Transport Cask from Intermodal Transport Cradle
- OJT-7 – Perform MP197HB Setup for DSC transfer from HSM
- OJT-8 – Perform HI-TRAC Setup for MPC transfer from VVM
- OJT-9 – Perform HI-STAR 190 Setup for MPC transfer from HI-TRAC
- OJT-10 – Movement of HI-TRAC to/from ISFSI to Transfer Station
- OJT-11 – MPC Loading into HI-TRAC
- OJT-12 – MPC Loading into HI-STAR 190 Transport Cask
- OJT-13 – DSC Loading into MP197HB Transport Cask
- OJT-14 – Movement of MP197HB transfer trailer to/from ISFSI/HSM
- OJT-15 – HI-STAR 190 Transport Cask Lid Installation and Torqueing, and Cavity Evacuation, Backfill, and Helium Leakage Testing
- OJT-16 – MP197HB Transport Cask Lid Installation and Torqueing, and Cavity Evacuation, Backfill, and Helium Leakage Testing
- OJT-17 – Perform Loaded HI-STAR 190 Package Down-ending and Preparation for Transport
- OJT-18 – On-site and Off-site HHT Operations

- OJT-19 – General Lifting and Rigging Operations
- OJT-20 – On-site and Off-site Intermodal Transport Cradle Handling Operations

The qualification of welder and NDE personnel to meet applicable requirements and qualified crane operators are third party vendor-provided services that are not included in the scope of the site training program.

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

Operational dry runs with canister mock-ups to perform the transport cask loading operation will be conducted at SONGS for the HI-STAR 190 cask, MP197HB cask, and support equipment. This includes preparation of the transfer station and VVM for MPC transfer, transfer of the canister into the transportation cask, testing, and transfer of the cask onto the transport skid.

Prior to any operation or transfer equipment handling, a pre-job briefing with the operations staff would be conducted to review procedures, verify training of staff, discuss any safety/quality-related concerns and practices, and verify adequate resources are available to support the activity. 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.

Communication and interfacing with the applicable stakeholders will ensure readiness. These stakeholders include, but are not limited to, SONGS, DOE, and State, Tribal, and local authorities, as well as the SONGS Community Engagement Panel [11]. In addition, it is anticipated that the NRC on-site and Region IV inspectors would be provided unfettered access to observe and provide regulatory oversight throughout the entire preparation, construction, operating procedure and approval process, and training/dry run program. The applicable stakeholder entities should be involved in key aspects of the project, i.e., planning, development of concepts, training, readiness approval, and performing oversight on any dry run operations. This includes reviewing procedures and possibly performing audits/assessments to ensure operational readiness. As additional readiness verification, an independent team of dry cask storage and transport experts should 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 training program and witnessed by DOE, NRC, and stakeholders. Additionally, and as applicable, these entities would be involved in event response planning and mitigation, including contingency SONGS emergency 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 SONGS, NRC, and DOE would participate as observer/regulator/participant for each shipment.

6.1.2.3 Transportation-related Operational Readiness Items

Equipment Readiness determined through review of the following:

- Document insurance requirements of the contract are in place,
- Transportation equipment certifications are current and would be for the duration of the SONGS transportation cycle,

- All vehicles have required registrations (as applicable),
- All vehicles have current inspections,
- Radiological packaging meets all current requirements,
- Packages are correctly identified (i.e., all required markings and placards are displayed properly, and are available at the site prior to beginning the operation),
- Copies of inspections are provided for equipment to be used to handle and transport the transport casks,
- Copies of all procedures associated with the transportation of the transport casks are provided, and
- Proper documentation that the required security plan is in place and has been approved.

Transportation Personnel Readiness:

- Key personnel and their qualifications are identified,
- Required background checks are current and requirements of coverage of drug and alcohol programs are met,
- Copies of the training materials are provided and required trainings are current for all employees involved,
- All personnel are in possession of and working from the correct procedures and Radiation Work Permits (RWPs) and copies are provided,
- All private security personnel have required weapons certifications to cover the SONGS transportation cycle,
- Transportation personnel would be monitored for radiological exposure, if required, and
- Proper equipment and personnel are available to monitor workers and equipment for contamination, if required.

Transportation Readiness Notifications:

- Proper notifications have been made to the Tribes, NRC, State and local governments, DOT, USCG, and DOE, as applicable, and copies are provided. Any water served or adjacent facility is required to have an active and updated safety and security plan, which must be reviewed and approved by the USCG. If a plan exists, it should be confirmed by the shipper and updated as to the actual operations designed to take place on the site during the campaign;
- All required permits to transport SNF are prepared and/or in place;
- Proper notification requirements are being met for the receiving facility; and
- Scheduled meetings and briefings that would be conducted for all phases of the shipments are identified.

6.1.3 Site Operations TN Americas System

Each NUHOMS canister transfer sequence and loading into the MP197HB cask will encompass multiple major elements.

6.1.3.1 Receiving the Cask and Preparation for Canister Loading

An inspection of the empty cask system and intermodal skid will be performed to verify no damage has occurred to the cask and intermodal skid during transport. Additionally, radiation and contamination surveys will be performed to the cask system to verify acceptable levels.

Once the inspections and surveys have been completed and verification that all equipment needed to perform the cask loading is in place, operations will remove the personnel barrier and impact limiters from the cask. The bolts that secure the personnel barrier to the cask intermodal skid will be removed. The personnel barrier will be removed from the intermodal skid/cask and positioned at a location for storage. The personnel barrier and associated hardware will be inspected for damage and additional surveys of the exposed cask surfaces will be performed to verify levels are acceptable.

The three impact limiter hoist rings will be inspected, the impact limiter hoist ring plugs/bolts removed, and the hoist rings installed to the front impact limiter. The tamper indicator will be removed. The crane operator will apply a slight load to the impact limiter to aid in removal of the 12 impact limiter bolts. Operations will remove the impact limiter bolts from the cask and store them. Each bolt will be inspected for damage and surveys of the bolts will be performed as needed.

Once all the bolts have been removed from the impact limiter, the crane operator, with support from riggers, will swing the front impact limiter from the cask body and store. Once this is completed, the cask tie-downs to the intermodal skid will be removed. The on-site transfer trailer will be positioned at a location for loading the empty cask onto the transfer trailer. The impact limiter and cask lid area exposed surfaces will be surveyed for contamination. Additional inspections will be performed on the impact limiter shell for any dents or penetrations or any evidence of weld cracking or other damage which could result in water in-leakage.

Once the front impact limiter has been removed, the crane operator and riggers will attach to the rear impact limiter. This operation for removal of the rear impact limiter is the same process as discussed above for the front impact limiter.

Once both impact limiters have been removed, the cask has been surveyed for contamination, and levels are acceptable, operations, with support from a radiological control technician (RCT), will obtain a sample of the atmosphere on the inside of the cask cavity. During removal of the vent plug and bolt, RCT coverage will be needed to verify that contamination levels are within the acceptable levels. If contamination levels are not acceptable, operations will be stopped, the cask will be placed in a safe configuration, and management notified.

The crane will be attached to the cask and slowly lift the cask from the railcar and swing the cask into position over the on-site transfer trailer with the cask lid facing to the back of the transfer trailer. At this point, the crane operator will slowly lower the cask onto the on-site transfer trailer and into the skid positioning system. The crane will be disconnected from the cask and the skid tie-downs will be attached to secure the cask to the transfer skid.

Once the cask surveys have been completed and levels confirmed, operations will remove the front cradle tie down strap and the front trunnion covers from the cask and perform an inspection of the

two front cask trunnions including bolts and thread area, seals, mounting blocks, bolt holes on the cask body, and trunnion lifting surfaces for damage that would cause an unsafe condition during docking and transfer operations. Once the inspections are completed, the front trunnions will be installed onto the cask body and the trunnion bolts torqued as required in the cask SAR.

It should be noted that only the front cask trunnions will be installed on the cask body to allow an anchor point to secure the cask to the HSM for docking purposes and loading of a canister into the cask.

6.1.3.2 Canister Loading into the Cask

In preparation for canister loading, the port plugs and port plug bolts will be removed from the vent, drain, and test ports. RCT will survey the plugs and port areas for contamination. Plugs and bolts will be inspected for damage and new O-ring seals installed.

Concurrently, the cask ram access closure plate will be removed by first removing the 12 cover bolts. RCT will survey bolts as needed. As the cover is removed, RCT coverage would be needed during the cover plate removal. Using the crane, the cover is removed. Once the cover is removed and surveyed, the metal seal will be removed and inspected for damage, including the cover plate and cask body seal surface areas, and the cover plate bolts. Operations staff will install a new seal on the cover plate and store.

A cask lid-handling device will be attached to the cask lid and a slight load will be applied to the rigging to aid in the removal of the cask lid bolts. Operations staff will loosen all bolts and then remove the bolts and store, and RCT will survey bolts as needed. Once the bolts are all removed and with support from RCT, the cask lid will be removed, surveyed, and stored in a location for inspection.

Operations staff will remove and discard the cask lid seals and perform an inspection on the cask lid, the lid/body seal surfaces for damage, cask lid bolts, and the cask body bolt holes for any damage. Once the inspection is completed, new lid seals will be installed onto the cask lid. The cask lid will be placed in a storage location.

RCT will perform a survey of the internal cask cavity for contamination and direct any decontamination if required.

Using the target aligning system on the cask, trailer, HSM, and using a transit, the transfer trailer will be positioned in front of the HSM to be discharged.

The HSM door-lift fixture will be positioned to the HSM door and the fixture mounting bolts installed and torqued. Operations staff will raise the crane slightly to preload the door to aid in the HSM door bolt removal. With support from RCTs, the HSM door bolts will be removed. Operations staff will continue to remove the HSM door while RCT continues radiation and contamination monitoring during the operation. At any time, if the radiation or contamination levels exceed the approved limits, the operation will be stopped, equipment placed in a safe configuration, and management notified. Once the HSM door is removed, it will be placed in a storage location.

RCT will conduct additional surveys and monitoring of the canister and verify the levels are acceptable. Operations will inspect the canister and canister grapple for any signs of degradation from storage and remove the seismic restraints. Once the inspection has been completed, the

transfer trailer and cask will be positioned, aligned, leveled, and docked to the HSM using the cradle positioning system.

Once the cask is docked with the HSM and the alignment verified, the cask will be connected to HSM restraints and secured to the HSM. Concurrently, the hydraulic ram system will be installed and aligned for connecting the grapple to the canister.

Using the ram system hydraulics, the ram will be connected to the canister via the canister grapple. The canister will be pulled into the cask. Operations staff will monitor the progress to ensure the alignment and canister transfer into the cask is achieved. RCT will continue to monitor the radiation as this operation is conducted. In the event the canister becomes wedged or is not able to be transferred into the cask, operations staff will stop and place the equipment in a safe configuration and notify management.

Once the canister is fully inserted into the cask, operations will disconnect the grapple from the canister and position the ram for the installation of the cask ram closure plate. RCT will continue to monitor radiation/contamination levels. Operations will rig to the ram access closure plate and install it onto the cask. The 12 bolts will be installed and torqued as required by the cask SAR.

Concurrently, operations will remove the cask-to-HSM restraints and prepare the transfer trailer to un-dock from the HSM. Operations staff will rig the cask lid and position the lid for installation onto the cask. The transfer trailer will be moved away from the HSM far enough for the installation of the cask lid. RCT will monitor radiation and contamination during this operation to verify the levels are acceptable. Once the trailer is in position and surveys completed, the canister unloading flange will be removed from the cask and the canister sleeve spacer ring will be installed in the cask opening. The cask lid will then be positioned and installed onto the cask. The cask lid bolts will be installed , the crane will disconnect from the lid, and operations will torque the lid bolts as required in the cask SAR.

RCT will perform additional contamination surveys on the cask and area to verify acceptable levels. The transfer trailer will be positioned as required for leak testing of the cask. Concurrently, the HSM door will be reinstalled.

Operations staff will remove the vent port plug and connect the leak test system to the vent port. The cask cavity will be evacuated and then backfilled with helium. Helium leak tests will then be performed to verify the containment boundary seals are acceptable. These tests include checking the port plug bolt seals of the vent and drain ports and the interspace between the lid and ram access cover seals. **Figure 6-1** depicts the process flow for cask assembly leak testing verification. Then, the cask front trunnions will be removed from the cask and the cask trunnion covers installed. After installation of the front trunnion covers, the front tie-down strap will be reinstalled over the cask and secured to the intermodal skid.

6.1.3.3 Cask Final Assembly and Preparation for Shipment

Once the cask leak test has been completed, the loaded transfer trailer will be moved to the on-site transloading site. The Primary Mobile Crane, along with a horizontal lift beam, would be used to transfer the loaded MP197HB cask from the transfer trailer to the transportation cradle. The cask is secured to the transportation cradle using the associated cradle securement straps and preparations would be made for the installation of the impact limiters. A visual inspection of the cask and cradle would be performed to look for any damage that would reduce the safety function

of the cask. The RCT would perform a radiation and contamination survey of the cask shell. Concurrently, a visual inspection of the two cask impact limiters and bolts would be performed to look for dents, tears, and removed thread material or other damage.

Using one of the mobile cranes, the riggers would attach one of the two impact limiters and position it onto the MP197HB cask. The impact limiter bolts would then be installed and torqued to the appropriate levels. This activity would be repeated for installation of the second impact limiter followed by security seals being installed on each impact limiter.

After both impact limiters have been installed, an inspection of the labeling and marking on the cask would then be conducted, and any additional labeling would be applied, as required by DOT. One of the mobile cranes would attach to the personnel barrier, and the barrier would be lifted and installed/secured to the transportation cradle. The RCT performs an additional radiation survey of the assembled transportation system to verify the radiation and contamination levels are compliant with NRC and DOT requirements.

Prior to loading the MP197HB cask on the railcar, verification that the railcar system has been inspected and that all maintenance is current, would be performed. Additionally, inspections of the car would be made to verify that the required load securement hardware is properly installed.

The Primary Mobile Crane, along with the required rigging, would be attached to the four lifting attachment points on the transportation cradle. The crane would then slowly lift the cask and position the load over the railcar, lifting the load only as high as required to safely clear the railcar deck. Once in position, the cradle would be slowly lowered onto the railcar, in alignment with the load configuration drawings being sure to account for center of gravity and overall permit dimensions when loaded onto the railcar. Then, the cradle would be secured to the railcar using the appropriate connection mechanisms. The crane and rigging would then be disconnected from the cradle and stored.

The RCT performs additional surveys of the cask once it is loaded onto the railcar, to verify radiation levels meet the DOT requirements. Temperature measurements would also be taken to ensure the accessible surfaces of the cask are within the acceptable limits. At this point, the two axial end stops would be lifted and positioned onto the railcar, using one of the mobile cranes, and then secured to the railcar. The shipper would do the final pre-shipment inspections of the load in preparation for shipment of the cask.

Figure 6-1: MP197HB Assembly Verification Leak Test Flow Chart

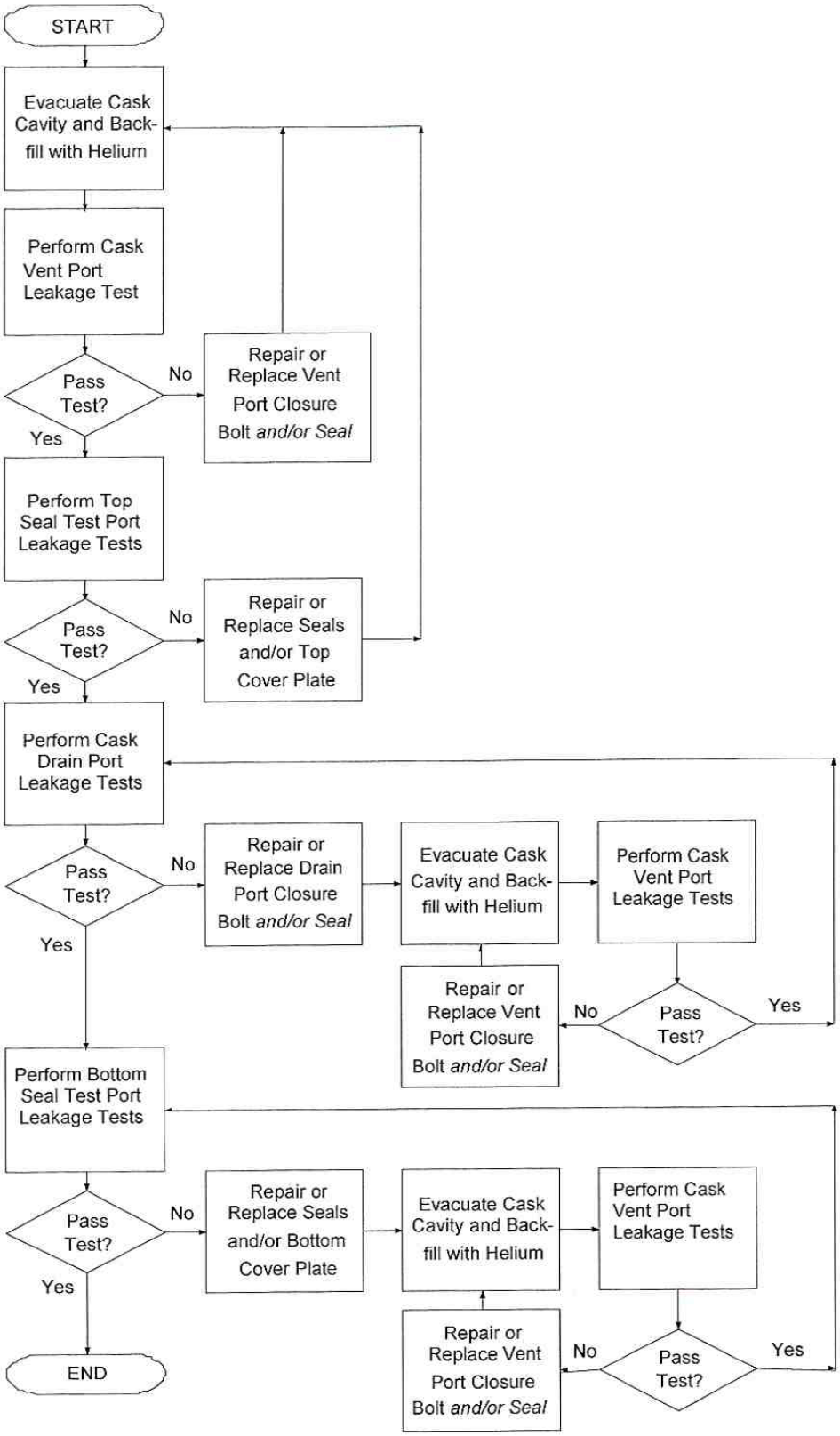


Table 6-2: Maintenance Program Schedule

Maintenance Program Schedule MP197HB	
Task/Activity	**Frequency**
Visual inspection of cavity	Prior to loading
Visual inspection of O-rings	Prior to loading
Visual inspection of neutron shield shell segments for structural or penetration damage	Prior to loading
Visual inspection of cask lid bolts and lid port coverplate bolts	Prior to installation (each use)
Visual and Proper Function Inspection of Cask	Prior to and during each use
Visual inspection of lifting trunnions and rotation trunnions	Prior to and during each use
Periodic leakage rate test of cask lid and lid port coverplate containment O-rings	Annually during use
Pre-shipment leakage rate test of cask lid and lid port coverplate containment O-rings	Prior to each loaded transport
Maintenance leakage rate test of containment system	After replacement or repair of containment boundary components
Replacement of lid and lid port coverplate metallic O-rings	Prior to each loaded transport
Visual inspection of impact limiters for structural or penetration damage	Prior to each loaded transport
Impact Limiters Leak Test	Once every five years

6.1.4 Site Operations Holtec HI-STAR 190 System

6.1.4.1 Receiving the Cask and Preparation for Canister Loading

Prior to beginning operations, the transfer equipment would be configured and positioned as follows: the Primary Mobile Crane would be located such that it is able to reach the transfer station, down-ending area, and the cask railcar. The HI-TRAC and the HI-STAR 190 up/down-ending device would be located near the transfer station. The leak test system and a stand for temporary storage of the VVM and HI-STAR 190 cask lids would be located nearby.

Once the transfer equipment is staged and ready, the Primary Mobile Crane would be used to remove the empty HI-STAR 190 cask from the railcar. The axial end stops would be disconnected and removed from the railcar deck. Then, after disconnecting the devices used to secure the transportation cradle to the railcar, the entire cask assembly, including the transportation cradle, would be lifted off of the railcar and placed in the down-ending area. The personnel barrier and the impact limiters would then be removed, as well as the straps used to secure the cask to the transportation cradle.

Using the horizontal lifting fixture, the Primary Mobile Crane would be used to transfer the cask from the transportation cradle to the up/down-ending device. Using the Primary and Secondary Mobile cranes, the cask would be up-ended and placed in a vertical orientation next to the transfer station. The VCT would then be used to position the HI-STAR 190 cask into the below-grade transfer station. The lid bolts would be removed from the HI-STAR 190 cask and then the cask lid would be removed and stored. Inspections would be performed on the cask lid bolts, the lid seal and sealing surfaces on the cask lid and body, and to ensure the cask is free of liquids and debris. As required by the final cask cavity and canister lengths, a lower spacer would be installed into the cavity of the HI-STAR 190 cask. The eddy current inspection test ring and the HI-STAR 190 mating device would then be installed onto the top of the HI-STAR 190 cask.

The VVM to be unloaded would be prepared for MPC transfer by removing the flue extensions and then removing the VVM lid. At this point, additional shielding would be positioned between the open VVM based on direction from the RCT. The VVM mating device would be installed in preparation for receiving the HI-TRAC.

6.1.4.2 Canister Loading into the Cask

The VCT would engage the HI-TRAC and position it on top of the VVM mating device. The HI-TRAC door and mating device drawer would be opened. Once the door is fully opened, the MPC rigging is lowered and manually attached to the MPC lid lifting lugs. The MPC would then slowly be lifted a few inches and the lift would stop and hold the load to ensure that there are no issues with binding during the transfer operation. RCT monitoring of the lifting of the MPC into the HI-TRAC would be performed to ensure ALARA and radiological controls are maintained. The VCT hoist would continue to lift the MPC into the HI-TRAC. Once the MPC is fully lifted into the HI-TRAC, the shield door would be closed and the MPC slowly lowered onto the door until it is noted that the MPC rigging load is reduced or slack. RCTs would perform follow-up surveys for radiation and contamination.

Any previously installed temporary shielding would be removed from around the VVM and the VCT would move the HI-TRAC and dock it to the HI-STAR 190 mating device. The VVM mating device would then be removed to allow replacement of the VVM lid and flue extensions.

The VCT would then position the HI-TRAC over the HI-STAR 190 cask. Using the VCT hoist, the MPC would be lifted up slightly from the HI-TRAC shield door. Once it is confirmed the MPC is off the door, the door would be opened. RCT coverage during the lifting operation would be required to monitor radiation levels during transfer operations to ensure ALARA and radiological controls are met. The MPC would be lowered into the HI- STAR 190 cask while performing the eddy current surface inspection of the MPC. The additional shielding would be removed and then the rigging would be manually removed from the MPC lid, lifted into the HI-TRAC, and the HI-TRAC door would be closed. RCT would perform radiation and contamination surveys of the HI-TRAC and the opening of the HI-STAR 190 cask for radiation and contamination. The VCT would then move the HI-TRAC to a staging area.

6.1.4.3 Cask Final Assembly and Preparation for Shipment

Once the HI-STAR 190 cask has been loaded, an upper spacer would be installed as needed. An inspection would be performed on the transportation cask seal surfaces to verify the areas did not sustain any damage during transfer and loading of the MPC and spacer into the HI-STAR 190

cask. After the inspection is complete, the Primary Mobile Crane would rig to the HI-STAR 190 cask lid and position over the unit. Verification would be obtained that the lid seal is in place prior to the lid being lowered onto the HI-STAR 190 cask, and the lifting rigging removed. The cask lid bolts would be installed and torqued as required in the cask SAR.

The VCT would then be used to lift the loaded HI-STAR 190 cask from the transfer station and place it in the up/down-ending device. Additional surveys would be performed by RCTs to verify contamination and radiation are within the specified values. Once the HI-STAR 190 cask has been closed, the cask cavity leak test would be performed to verify the MPC integrity, and then the interior would be vacuum-dried and backfilled with helium. The leak test system for the cask lid annulus would then be positioned and set-up for use. With support from an RCT, the cask lid annulus test port plug and seal would be removed, and the RCT would survey the items and area for radiation and contamination.

The leak test system would then be attached to the test port on the cask lid. The testing and operation of the leak test system must be completed using approved processes and procedures provided by the system manufacturer (Holtec). If the leak test fails, work must be placed in a safe configuration and management notified. Failure of this test would be an indication that the cask containment boundary may have failed. Once the test is completed and passed, the leak test system would be disconnected from the test port, the test port plug, and a new seal would be installed and torqued to the appropriate levels.

With support from an RCT, the cask vent port cover plate would be removed and surveyed. An inspection of the port plug would be performed to verify the plug is not loose. Then the leak test system would be attached to the vent port test fixture and to the vent port. At this point, the leak test of the vent port seal would be performed as directed by the leak test procedure. If the test does not pass, notify management of the condition. Failure of this test would be an indication the cask containment boundary on the cask vent port has failed. As a contingency, the vent port plug may be removed, inspected, seal replaced, and retested. Once the leak tests have been completed, the vent cover plate would be reinstalled and torqued to the appropriate levels.

With support from an RCT, the cask drain port cover plate would be removed and surveyed. An inspection of the port plug would be performed to verify the plug is not loose. Then, the leak test system would be attached to the drain port test fixture and to the drain port. At this point, the leak test of the drain port seal would be performed as directed by the leak test procedure. If the test does not pass, management should be notified of the condition. Failure of this test would be an indication that the cask containment boundary on the cask drain port has failed. As a contingency, the drain port plug may be removed, inspected, seal replaced, and re-tested. Once the leak tests have been completed, the drain port cover plate would be reinstalled and torqued to the appropriate levels.

If not previously performed, the neutron shield relief devices would be inspected and replaced if necessary. Additional tests of the cask neutron shield and thermal performance would then be performed, and the results compared against the required criteria.

The Primary and Secondary Mobile Cranes would both be connected to the up/down-ending device. Using the two mobile cranes, the cask would be lifted slightly while attached to the up/down-ending device. It would be rotated into the horizontal position and lowered down. Once the cask is rotated, the cranes would be disconnected from the up/down-ending device.

The Primary Mobile Crane would be attached to the horizontal lifting fixture and the fixture, with associated rigging, would be positioned over the cask and attached for transferring to the transportation cradle. The up/down-ending device is then disconnected from the cask and the Primary Mobile Crane would lift, transfer, and position the cask onto the transportation cradle.

Once the transfer is completed, the lifting fixture would be removed from the cask and stored. The cask is secured to the transportation cradle using the associated cradle securement straps and preparations would be made for the installation of the impact limiters. A visual inspection of the cask and cradle would be performed to look for any damage that would reduce the safety function of the cask. The RCT would perform a radiation and contamination survey of the HI-STAR 190 cask shell. Concurrently, a visual inspection of the two HI-STAR 190 cask impact limiters and bolts would be performed to look for dents, tears, and removed thread material or other damage. Prior to installing the impact limiters, security seals would be installed on the cask lid bolts.

Using one of the mobile cranes, the riggers would attach one of the two impact limiters and position it onto the HI-STAR 190 cask. The impact limiter bolts would then be installed and torqued to the appropriate levels. This activity would be repeated for installation of the second impact limiter followed by security seals being installed on each impact limiter.

After both impact limiters have been installed, the cask trunnions would be rendered inaccessible. An inspection of the labeling and marking on the cask would then be conducted, and any additional labeling would be applied, as required by DOT.

One of the mobile cranes would attach to the personnel barrier, and the barrier would be lifted and installed/secured to the transportation cradle. The RCT performs an additional radiation survey of the assembled transportation system to verify the radiation and contamination levels are compliant with NRC and DOT requirements.

Prior to loading the HI-STAR 190 cask on the railcar, verification that the railcar system has been inspected and that all maintenance is current, would be performed. Additionally, inspections of the car would be made to verify that the required load securement hardware is properly installed.

The Primary Mobile Crane, along with the required rigging, would be attached to the four lifting attachment points on the transportation cradle. The crane would then slowly lift the cask and position the load over the railcar, lifting the load only as high as required to safely clear the railcar deck. Once in position, the cradle would be slowly lowered onto the railcar, in alignment with the load configuration drawings being sure to account for center of gravity and overall permit dimensions when loaded onto the railcar. Then, the cradle would be secured to the railcar using the appropriate connection mechanisms. The crane and rigging would then be disconnected from the cradle and stored.

The RCT performs additional surveys of the cask once it is loaded onto the railcar, to verify radiation levels meet the DOT requirements. Temperature measurements would also be taken to ensure the accessible surfaces of the cask are within the acceptable limits. At this point, the two axial end stops would be lifted and positioned onto the railcar, using one of the mobile cranes, and then secured to the railcar. The shipper would do the final pre-shipment inspections of the load in preparation for shipment of the cask.

Table 6-3: Maintenance Program Schedule

Maintenance Program Schedule HI-STAR 190	
Task/Activity	**Frequency**
Cask and impact limiter surface visual inspection	Prior to loading the loaded MPC into the cask
Cask closure fasteners/bolts visual inspection	Prior to installation and/or prior to transport
Cask trunnion visual inspection	Prior to loading the loaded MPC into the cask
Impact limiter and impact limiters fasteners visual inspection	Prior to installation and/or prior to transport
Neutron shield relief device visual inspection	Prior to package transport
Pre-shipment leakage rate test of cask containment system seals	Prior to package transport following each MPC loading into the cask
Pre-shipment leakage rate test of MPC containment boundary for MPC's containing High Burnup Fuel (HBF)	Prior to package transport following each MPC loading into the cask
Periodic leakage rate test of cask containment system seals	Prior to package transport if period from last test exceeds 1 year
Periodic leakage rate test of MPC containment boundary for MPC's containing HBF	Prior to package transport if period from last test exceeds 1 year
Maintenance Leakage Rate Test of Cask containment boundary	Following maintenance, repair or replacement of containment system components
Seal replacement for Closure Lid and/or Port Cover Plate	Following removal of closure bolting if the seal is not reusable or if the reusable seal is found to be damaged, is not free of debris, exhibits excessive compression set or does not meet the maintenance leakage rate test or pre-shipment test or if required based on seal design life limitations
Bolt replacement (Service Life) for Closure Lid	Every 225 bolting cycles for SA-564/705 630 Every 256 bolting cycles for SB-637
Bolt replacement (Service Life) for port Cover Plate Bolts	558 bolting cycles for the bolt specified in drawing package referenced in the CoC
Containment Top Forging closure bolt thread Service Life	1000 bolting cycles for the bolt specified in drawing package referenced in the CoC
Neutron shield relief device replacement	As required by the manufacturer's O&M manual
Periodic Neutron Shield Test	Within 5 years prior to shipment
Periodic Thermal Test	Within 5 years prior to shipment

Maintenance Program Schedule HI-STAR 190	
Task/Activity	**Frequency**
MPC Enclosure Vessel pressure boundary structural integrity as confirmed by MPC aging management program for MPCs stored beyond the duration of the initial 20-year license period under the provisions of 10CFR72	Prior to package transport following each MPC loading into the cask
MPC Enclosure Vessel Shell Surface Defect Inspection for MPCs containing HBF and stored beyond 5 years under the provisions of 10CFR 72. MPCs passing inspection (approved for transport) must be shipped within 5 years	Prior to transport. This test may be conducted based on a statistical testing approach as indicated in Subsection 8.1.8 and Table 8.1.11 . The statistical approach may result in inspection of every MPC or the user may elect not to follow the statistical approach and instead inspect every MPC
Post-Shipment Fuel Integrity Acceptance Test	Prior to package transport following each MPC loading into the cask (pre-shipment) and post-shipment, as applicable
10CFR72 Aging Management Program (AMP) Based HBF Integrity Acceptance Test	Prior to package transport

6.1.5 Transport Operations

6.1.5.1 Special Permit Requirements

The following permits for transporting the loaded transportation casks from the SONGS ISFSI would have to be obtained by the shipper:

- A formal clearance submission will be submitted to the originating Class I rail carrier. For the purposes of this project, the goal is to deliver the overpacks from the SONGS site to the Class I railroad, BNSF Railway, which would clear the entire route with all participating railroads and
- The shipper, for the purposes of this report, would be DOE, and the shipments are assumed to be conducted by commercial carriers like comparable commercial shipments. Therefore, although typically not required for DOE shipments, it is assumed for purposes of this report that DOE would file an application with the NRC for an approved rail route from the SONGS site to the GCUS (identified destination).

Note: A formal clearance submission is required for all dimensional[10] shipments on all rail carriers involved in the full route. With loading at the recommended track location within the SONGS site, the clearance will be submitted to BNSF Railway for the rail movement and it will clear the entire route to the final destination, in this case to the GCUS.

[10] The railroad industry definition of dimensional is any oversized cargo with respect to length, height, or weight of a non-standard shipment.

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. Presently, BNSF requires a $1,000 fee for conducting a clearance evaluation/lane (route selected). 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, ballast, or any other loading configuration specifics important to the railcar, and
    b) Center of gravity measurements and total weight of the unit plus the railcar, and
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 [43] 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 six 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 seven years for rail routes. The NRC would approve routes for a period of five years for combination routes (truck-to-rail siding, transloading, and rail to final destination). The minimum amount of time to submit cleared routes to the NRC for approval is 90 days; however, six months is preferred.

Once the rail route is cleared by all involved railroads, the clearance is valid for six months for railroad purposes; should the campaign take longer than six 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 six 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 other dimensional traffic moving in the same lane.

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 SONGS to be used for lifting or transloading the transportation casks onto the railcars. The permits will 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.

6.1.5.2 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 SONGS are listed as tasks in **Table 6-1**.

These identified actions are based on the assumption that DOE would be responsible for shipping to and operating the federal consolidated interim storage facility or repository. Based on these tasks, the characteristics of the site's inventories of SNF, the on-site 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.

6.1.5.3 Additional Coordination Efforts

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 within the parties would ensure all aspects of the lift and securement plan are considered and planned; and
- 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.

Description of Activities Necessary to Coordinate with the on-site rail transload operations:

- Determine if railroad police are available and will be present during any stops along the rail route on the way to the destination. Railroad police or railroad management can provide extra observation in railyards to deter rail fans, which typically "chase" dimensional

shipments along the rail route and other trespassers in the yards, or other nefarious parties from interfering with the shipment;

- Hold initial meetings with the Class I carrier, BNSF, to explain the movement, provide estimated number of trains to ship, discuss the dedicated train requirement, and begin rate negotiations for the costs to move the trains;
- Mention current safety and security measures for the site to ensure the rail carrier is aware of all special considerations and operating procedures for shipment of this commodity.
    - Note and discuss safety features that will be added to the site: fence, lights, defined perimeter, etc., as required for the individual site,
    - 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 the transload campaign. Coordinating operating hours and access to the plant is important for planning release of the loaded train and consideration of the current rail operations on the division and normal operating parameters at the plant,
    - Open communication with all rail carriers on the route to ensure a smooth transition at any interchange points. In this case, only one Class I railroad is involved in the route to the GCUS,
    - Hold initial meetings with the 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, and
    - Communicate that all requirements have been exceeded for the intended site and operations.

6.1.5.4 Transportation-Related Operational Readiness Items

Equipment Readiness is Determined through Review of the Following:

- Insurance requirements of the contract are in place;
- 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 operation;
- Inspections for equipment to be utilized to handle and transport the transportation casks to the on-site rail siding have been conducted and copies provided;

- Proper documentation is provided to demonstrate the required security plan is in place and has been approved by the USCG for rail transload activities taking place on a site located on or near the water;
- The on-site transload is located within SONGS, a private facility with water access. This access potentially provides access to the loaded train so SONGS/shipper will inform the USCG when rail operations commence, so it will be aware of the ISFSI transfer trailer transport and train loading activity on the site and possibly evoke a Marine Safety Zone during active operations if required or deemed appropriate by the Captain of the Port (COTP); and
- If SONGS has an existing Maritime Transportation Security Act (MTSA) plan in effect for the plant site, adopt that plan and make necessary additions to include the on-site transfer trailer transport from the ISFSI to the rail transload site activities and submit the revision to the USCG for approval.

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, and
- Ensure proper equipment and personnel are available to monitor workers for contamination, if required.

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;
- It is recommended that any water served or adjacent facility should have an active safety and security plan in place while campaign activities are taking place;
- The USCG must review and approve the MTSA plan or updated plan if one already exists for the transload site;

- Provide copies of and ensure all required permits to transport SNF are prepared and/or in place;
- Ensure proper notification requirements are being met for the disposal/storage facility; and
- Identify scheduled meetings and briefings that would be conducted for all phases of the shipments, including with the SONGS Community Engagement Panel.

6.1.5.5 Transport Operations

Prior to any transportation operation, a pre-job briefing would be performed with the operations staff, including security escorts and staff that would be tracking the shipment. This briefing would be conducted to review procedures, verify training of staff, discuss any safety/quality-related concerns and practices, and verify adequate resources are available to support the activity including verification that prerequisite conditions are met. This would include, but not be limited to, all cask inspections and testing completed, routes having been inspected and approved, and receipt of management approval to ship.

Performance of a visual inspection of the installed cask, intermodal cradle, and personnel barrier assures that it is assembled correctly and in unimpaired physical condition. The visual inspection includes checking for cracks on the intermodal cradle main beam web-to-flange- welds, the beam webs, plus checking the tie-down structure for any signs of distortion or failure.

Before the rigging is removed from the cradle, while the unit is on the railcar, initial measurements are taken to confirm proper placement on the railcar with respect to center of gravity and to ensure compliance within the clearance window. Once the crew has confirmed correct placement on the car, the rigging is removed from the cradle and the boom of the crane would swing away from the loaded railcar.

The crew then proceeds to secure the cradle to the railcar ensuring compliance with the AAR Open Top Loading Rules. Specifically, all restraint values would meet the stated requirements of 7.5G x 2G x 2G [43] the requirement from the DOT and what is required for load securement in the NUHOMS MP197HB cask SAR [16] and HI- STAR 190 cask SAR[17].

Once the transportation cask is secured to the railcar and internal inspections of the transportation cask and the loaded train are completed, the Rail Transload Facility Supervisor will request the railroad inspection. Once the inspector measures and approves the cars for shipment, the Rail Transload crew shall air test the train if air brakes are on the train and perform a visual inspection of the train's safety devices. The appropriate party should issue the electronic bill of lading (BOL) to the serving rail carrier, the BNSF.

The crew will then attach the Global Positioning System (GPS)/Impact Recorders (or other telemetric units or similar approved devices) to the loaded train to provide 24/7 on-demand GPS location information using the most current monitoring sensor technology available at the time. The device will also record any impacts (from switching, etc.) that occur at more than 4 mph. Impact recorders are not required by regulation or the rail carriers but are commonly used by dimensional shippers for high-value and sensitive machinery to record any impacts (switching) and forces exerted on the loaded cars during transportation. Simultaneously, the Transload Facility Supervisor electronically releases the loaded train to the rail carrier.

Once these steps have been completed, the shipment is considered ready for transport. Additional steps to be performed prior to release of the shipment include but are not limited to preparation of transportation-related documentation, BOLs, permits, and other transportation-related documents to ensure compliance with regulations, notifications of States and Tribes and regulatory agencies as required, and communication with the Movement Control Center (MCC) and security team.

Once the serving rail carrier, BNSF notifies the SONGS site of the intended switch time, the train will be prepared for movement from the private loading track. Upon arrival of the rail carrier train crew at the secure area where the train is staged, the Rail Transload Supervisor will unlock the gate and allow entry of the BNSF train crew into the site. This will be a documented and manned release of the loaded train from the secure area of the SONGS facility to the BNSF train crew. The chocks should be removed from the staged train and the railroad locomotive will attach to the loaded train and pull it from the facility. Once coupled the Rail Transload Supervisor unlocks the gate to allow the train to exit the property with the Rail Transload Security Team (armed security escorts) in the escort car.

The rail carrier and SONGS Transload Facility Manager will document the manned interchange in writing.

The BNSF train will leave the facility and proceed to GCUS. No stops will take place from the time the train leaves the SONGS site until it clears the commuter train lines and reaches the Barstow railyard. The Class I carrier will provide advance notification to each railyard in the route including the destination at GCUS railyard to coordinate the arrival and manned delivery to the GCUS. Any stops along the route for refueling and changing the crew would result in the train being stopped only at interim railyards where it will be guarded by railroad police during the minimal stops. An estimated transit schedule will be provided to the shipper for the entire train movement. The ability to monitor and trace the train will be limited to need-to-know personnel.

Upon arrival at the GCUS, the BNSF train crew will document the manned interchange, deliver the loaded train to the designated track and personnel, and then disengage its locomotives. At this point, the Class I carrier’s obligations for delivery have been satisfied.

6.1.6 Demobilization

Once the de-inventory project (campaign) operations have been completed, demobilization will commence. This is the process of removing all the equipment and materials used during the operation at the SONGS ISFSI and returning it to its proper owner in accordance with rental / 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 exterior canister surfaces are potentially contaminated, as discussed earlier, large components, such as the VCT, HI-TRAC, lift yokes, chain hoists, etc. would be decontaminated as needed, approved for free release, and returned to the owner(s) for storage. Specialized equipment (e.g., the vacuum drying and leak test systems) would be decontaminated as feasible and returned to the owner.

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 intermodal

skids, lift yokes, and the like would be decontaminated, placed in an assembled condition, and returned to DOE for storage and maintenance.

Demobilization of ancillary equipment from each site would be accomplished in the same manner as it was mobilized. Forklifts, man lifts, diesel air compressor(s) 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 VVMs and AHSMs would remain on-site for disposition by SONGS as potentially contaminated and activated materials. In addition, the ISFSI site, after removal of all fuel storage systems, 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 truck to its storage facility. This process takes approximately one week to complete. 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.

6.2 Resource Requirements / Staffing

At the SONGS site:

- Operations Manager;
- Cask Operations Shift Supervisor;
- Training Specialist;
- Procedure Writers;
- Radiation Protection;
- 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;
- Riggers;
- Rail Transload Supervisor;
- Rail Transload Security Team (as applicable);

- Cask Operations Technicians/Mechanics;
- Tractor, Driver, and Equipment Operators;
- QA/QC Specialist; and
- Security Personnel.

6.3 List of Ancillary Equipment

Additional equipment needed is listed in **Table 6-4**, **Table 6-5**, and **Table 6-6** (noting items identified with a single asterisk "*" are specific to the Holtec system and items identified with a plus sign "+" are specific to the TN system).

Table 6-4: Additional Equipment for SONGS Transfer

Additional Equipment for SONGS Transfer	
Standard tools	These include Personal Protective Equipment (PPE), communications equipment, wrenches.
HI-TRAC Transfer Cask*	To provide shielding and physical protection when moving the canister from the VVM to the transportation cask.
VCT*	Vertical Cask Transporter to move the transfer cask from the VVM to the transportation cask. Includes a hoist for lifting and lowering the MPC.
VVM Mating Device*	Used as a shielding interface between the VVM and the HI-TRAC.
HI-STAR 190 Mating Device*	Used as a shielding interface between the HI-TRAC and the HI-STAR 190.
Transfer Station* (facility upgrade)	Below grade pit for placement of the HI-STAR 190 cask during loading.
MPC Spacers (SONGS Specific)*	Used to fill the axial gaps between the MPC and HI-STAR 190 cask.
Eddy Current Inspection Test Ring*	Used to inspect the MPC as it is loaded into the HI-STAR 190 cask.
Transfer Trailer+	Used to move the MP197HB cask around the site.
Transfer Skid+	Used to support the MP197HB cask while on the transfer trailer.
Cask to HSM Restraints+	Used to secure the cask to the HSM during DSC movements.
Hydraulic Ram System+	Used to move the DSC between the HSM and MP197HB cask.
Water supply and 1,000-gal tank*	Used to fill the HI-TRAC water jacket.
Temporary shielding*	Used to provide additional shielding around the HI-TRAC during canister movements.
Mobile load cell*	Used to verify the appropriate weights are within tolerance during transfer of the MPC.
Standard rigging and supplies	To be provided by the site for use in lifts.

Additional Equipment for SONGS Transfer	
Specialized Rigging	To be provided by cask vendor as needed.
Jacks (if used)	Support loading the railcars.

* Holtec-specific equipment
+ TN-specific equipment

Table 6-5: Equipment for the Transload Facility

Equipment for the On-site Rail Transload Area	
Primary Mobile Crane	To transfer the overpack to the transportation cradle and to load the cask onto the transportation trailer.
Secondary Mobile Crane	Assisting in the down-ending operation of the Holtec cask. This 150-ton crane would also be used for handling the cask lids, installation of the impact limiters and personnel barrier, and other lifts at the SONGS site.
Up/Down-Ending Device*	Used with a crane to rotate the Holtec cask from the vertical position to horizontal orientation.
Horizontal Lifting Fixture*	To transfer the cask from the down-ending area to the transportation cradle.
Man basket/ lift	To reach the top of casks and assist in any operation that is required to safely extend reach.
Leak Testing System*/+	Used to perform leak testing of the canister and transportation cask.

* Holtec-specific equipment
+ TN-specific equipment

Table 6-6: Rail Equipment (per consist)

Rail Equipment (per consist)	
Locomotive(s)	Dedicated for the train movement and at least two required.
Buffer cars	Used to provide buffer between loaded over-pack cars and all other cars, per clearances.
Load (cask) cars	Heavy duty flat cars.
Escort car	Houses the armed security team.
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.

Rail Equipment (per consist)	
GPS/impact recorder units	One per loaded over-pack 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 rail carrier but are an additional means of ensuring safety and security in the handling of the units during transportation.

6.4 Sequence of Operations / Schedule

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

The sequence of operation timeline, **Figure 6-2**, outlines the operations associated with loading, shipping, and return of the trains removing the SONGS canisters from the ISFSI. This timeline assumes that two train consists will be utilized, each with the capability of shipping up to five casks per consist. It is also assumed that five TN MP197HB and five Holtec HI-STAR 190 transport casks will be utilized. It is important to point out that the operation timeline in the report does not require all TN or all Holtec canisters to be shipped first or even that a train consist includes only one type of transportation cask. Those details do not impact the overall schedule provided in this report and will be established in subsequent planning activities as it gets closer to the transport date.

The cask loading operations include receiving and preparing the empty transportation casks, transferring the canisters from the VVMs to the transport casks, preparing the casks for transport (e.g., evacuation, helium back-fill, leakage testing), securing the cask/intermodal transport intermodal skids, placement and securement of the cask/skid assemblies onto the railcars, and preparing the railcars for shipment. This evolution is estimated to take approximately four 8-hour days per cask. A full train consist of five canisters will take approximately twenty days with a single crew or twelve days with two crews performing some activities in parallel, which is what this schedule is based upon.

The transit times listed in **Figure 6-2** are provisional and may change as route details and operations are better defined. This schedule is based on two crews working in parallel at the SONGS site as well as another two crews working at the GCUS site. The total round-trip transit time, from the initial transfer of a canister from a VVM to the return of the empty transportation casks is approximately 46 days. Once a train consist departs from the SONGS site, the second consist can be brought in and processed, taking another 46 days to complete the round trip. This overlap is depicted in **Figure 6-2**.

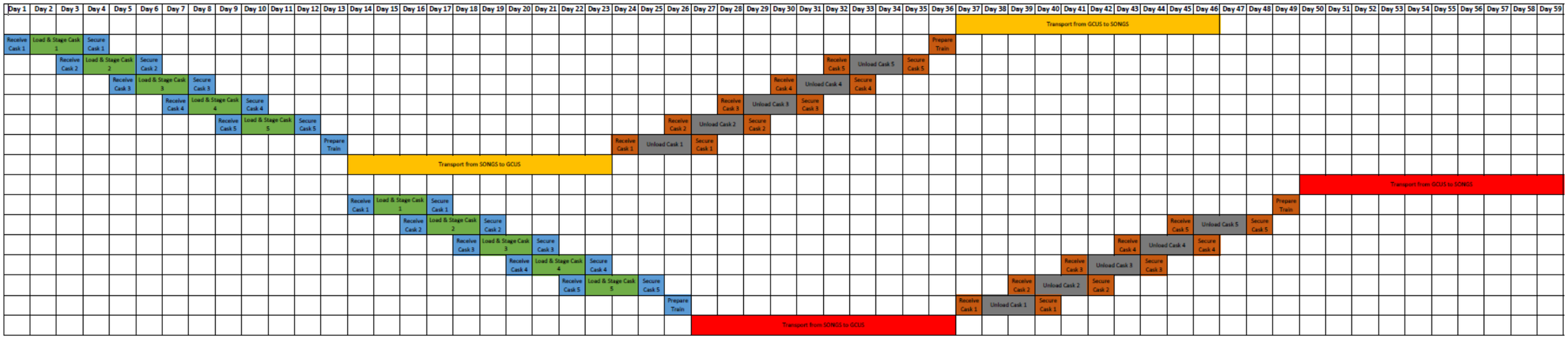
For a campaign where two train consists are available, containing five transportation casks each, the timeline for complete removal of all 132 canisters would require 25 round trip shipments of five transport casks per shipment and two final round trip shipments with three HI-STAR 190 casks and then four MP197HB casks over a total period of 105 weeks.[11] Since there are 14 more

[11] Note that 4 additional GTCC LLW TN canisters are expected to be loaded during decommissioning and will require an additional consist for the TN systems not currently accounted for here.

HI-STAR 190 casks compared to the MP197HB casks, the last two transports would utilize the same train consist with no overlap of shipments. It is worth noting that no margin, or contingency, has been added to this schedule.

Table 6-7 estimates the resource requirements needed to support this de-inventory campaign. An additional fifteen weeks of planning and preparation is added before the start of the first campaign. The level of detail is the week.

Figure 6-2: Sequence of Operations



Assumptions:

1 Two (2) trains are used, each consisting of five (5) cask railcars
2 Starting condition is five (5) empty transportation casks at SONGS secured to railcars
3 Operations occur 8 hours/day and 7 days/week
4 Railspur is located adjacent to the transfer station (no on-site transfer to reach train)
5 Two (2) operation crews working in parallel at both SONGS and GCUS (four crews total)
6 Three (3) days to receive (empty), inspect, prepare, load, and stage the loaded transportation cask
7 One (1) day to load and secure a single transportation cask onto cask railcar
8 One (1) day to prepare the train for transport
9 Ten (10) days to travel between SONGS and GCUS
10 One (1) train on site at a time
11 Three (3) days to receive (loaded), inspect, prepare, unload, and stage the empty transportation cask
12 One (1) day to load and secure a single transportation cask onto cask railcar
13 One (1) day to prepare the train for transport
14 Ten (10) days to travel between GCUS and SONGS
15 No margin is added in the above durations

Legend:

Crew 1 Operations
Crew 2 Operations
Crew 3 Operations
Crew 4 Operations
Consist 1 Transport
Consist 2 Transport

Table 6-7: Operations Timeline with Required Resources

	Major steps for a 132 canister campaign	Resources required [in full-time equivalent]*											Estimated Duration
		OM	COSS	TS	PW	RP	TC	CO	RM	EO	QS	SP	
1	Detailed operations planning, campaign preparation, equipment mobilization, procedure preparation and approval, training program, pre-loading review(s) and dry run(s)	1	4	1	2	2	1	2	12	4	2	3	15 weeks prior to 1st campaign
2	On-site transfer of the SNF and GTCC LLW canisters and preparation of 5 packages	1	4	1	0.5	2	1	2	12	4	2	3	13 days per 5-cask campaign
3	Shipment to destination by rail	0.5			0.5		2						10 days per 5-cask campaign
4	Unloading	0.5	4		0.5		1		12	4	2		13 days per 5-cask campaign
5	Return transport of empty casks	0.5					2						10 days per 5-cask campaign

***Key:**

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

6.5 As Low As Reasonably Achievable (ALARA) Planning

Specific requirements are provided in 10 CFR 72.126 “Criteria for radiological protection” that address radiological control measure 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 worksite 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; and
- 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 20 and 10 CFR 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 RCTs are mobilized and ready to support operations at the pad (estimated at one supervisor and three RCTs per shift);
- Sufficient quantity of radiation control equipment and consumable supplies on hand to support the planned work activities (PPE, signage for posting, radioactive waste 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; and
- In addition to the RCTs, workers that are supporting operation have been trained and qualified to the applicable Rad Worker Program requirements.

6.6 Quality Assurance Requirements

All quality-affecting activities associated with cask handling operations including transportation would be controlled under an NRC-approved Quality Assurance Plan (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. The licensee's QAP is to be used to control activities related to use of a packaging for the shipment of licensed material performed by the licensee (qualified cask user/operator) in accordance with 10 CFR Part 71.

A QAP would be applied to the design, analysis, fabrication, and testing of the components that are important to safety and the support equipment that is either important to safety or safety-related. Additionally, the licensee's QAP would be used to control transportation activities per the licensee's QAP and applicable 10 CFR Part 71 requirements.

Fabrication of important safety components and support equipment 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 SONGS campaign organized over 120 calendar weeks is $34.3M. 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 in the current timeframe (2024). This section provides a breakdown of the estimated campaign costs of de-inventorying the SONGS 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:

- Any costs for work at the GCUS (labor, equipment, infrastructure, etc.) are not included.
- Two sets of 5 transport casks, 5 pairs of impact limiters, 5 personnel barriers, 5 transport cradles for loading and unloading a canister into the cask, and ancillary equipment as detailed in **Sections 2.3.1** and **2.3.2**, are provided by the cask vendors (one set of MP197HB and one set of HI STAR 190). Ancillary equipment to prepare the transport cask for transportation (tooling, lifting yoke, spreader bar, leak test equipment, vacuum drying system, etc.) will be supplied by the cask vendor. No estimate is provided here for this equipment.
- Two sets of railcars consists, each being dedicated to one set of five casks. The cask railcars, escort car, buffer cars, locomotives, etc. are provided by DOE. No estimate is provided here.
- 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.
- It is assumed that no covered building would be used at the designed transload location. No cost for construction of a new building, new pad, or pad modification is considered here, other than the transfer station to load the HI-STAR 190.
- Only the shipment preparation and the train transport to the selected short line to Class I transfer location (here directly on the site). Train delivery to the final destination and return shipment of the empties by train are not included. For scheduling purpose, the destination is considered to be GCUS. Only the cost of the loaded casks transports from the origin site to the Class I railroad is included.
- 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 assumptions are made at this point to assess their cost, as they may exist at the time of need for the shipment.
- No additional on-site fencing and lighting is considered.
- A total of 27 iterations (15 for Holtec casks, 12 for TN casks) of 7 working weeks each will be necessary to complete the de-inventory. In addition, another iteration of 15 weeks is added upfront and will happen before the first shipment for campaign readiness, procedure writing, dry run, testing, and training purpose.

- Each train consist being dedicated to a set of transport casks, the critical path of the campaign schedule is based on 15 iterations (12 iterations with both types of casks and 3 with the HI-STAR 190 only) of 7 weeks following 15 weeks of preparation. The total duration of the campaign is estimated to be 120 weeks. The resources on site are supporting the loading of both sets of casks, alternatively, as described in **Section 6.0**. All the equipment and personnel mobilized on site are assumed to stay at the site for 120 calendar weeks.
- Pre-loading canister inspection activities are not included in the cost estimates.
- Does not account for potential impact of additional specific local regulatory requirements, if applicable, and assumed labor performed by vendor-approved specialists.

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 off-site road survey would be expected.

An estimated amount of $100,000 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 the crew identified in **Table 6-7** and part-time engineering staff support.

The estimated cost for the Management crew for the 120-week campaign is $3.9 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 included in this estimate.

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, one 150-ton crane, and operators for 120 weeks at the shipper site and one large forklift, two man baskets, miscellaneous supplies, a transporter, a telescopic handler and the mobilization/demobilization of the equipment would be approximately $6.4 million for the duration of the SONGS campaign. More details are provided in **Section 6.0**.

Additional equipment is also necessary for the transfer and lifting of the TN and HOLTEC systems, as detailed in **Section 2.3**. The equipment will be provided by the dry storage system vendors or by SONGS. Lease cost, the mobilization and demobilization costs of this equipment are not provided here.

7.4 Site modifications

A new below grade transfer station allowing the vertical loading of the HI-STORM MPC from the HI-TRAC transfer cask into the HI-STAR 190 transportation cask is needed. This will require the structural evaluation of the soil condition, excavation of the soil deep enough to allow the construction and reinforcement needed to the structure, installation of steel reinforcement and/or rebar, and pouring of the concrete. The costs estimated for this effort is in the millions of dollars, with the precise value having to be estimated by the site to account for specific requirements from the site license, heavy loads program, and local construction permits. The costs for this site modification are not included in this estimate.

Office trailers will be provided for the duration of the project. The total estimated costs for the office trailers and their mobilization and demobilization is $150,000 for the duration of the project. Utilities are to be provided by the site.

The site decommissioning activities are assumed complete by the time the de-inventory campaign starts.

No additional significant modification of the site is required to support the operation as described in **Section 6.0**.

7.5 In-Transit Security

The security at the shipping site and at the receiving site would be ensured by the crew already in place at the site and is therefore not included in this estimate. The security in transit on the train to the final destination is not included in this cost estimate.

7.6 Cask Transportation Services

The Cask Transportation Services team would consist of a Transport Coordinator located on site who would coordinate the transport operations with the rail carrier, provide support to the shipper in the preparation of shipping documentation, and support the 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, rail carrier, 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**).

The transportation costs include the preparation and coordination of the loaded cask shipments on railcars from the origin site to the location where the short line meets the class I railroad, at the immediate proximity of the site. No rail carriage costs are included in this section. Only the costs for the railroad clearance and pre-departure inspection are included.

The estimated costs for the cask transportation services support are $4.6 million for the entire campaign.

7.7 On-site Operations

The shipping site operations would be composed of the crew listed in **Section 6.4**. The estimate for the whole crew for the on-site operation is $19.3 million for the entire campaign.

7.8 Breakdown of the Costs by Activity

This section provides a breakdown of the estimated $34.3 million cost of de-inventorying the SONGS site, by activity, and to the extent cost information is currently available.

- Equipment (e.g., transportation casks, railcars, cranes, movers, etc.): >$6.4 million (cost of casks and railcars is currently unknown)
- Transportation services to reach the Class I carrier: $4.6 million
- Management and labor: $23.1 million
- Infrastructure: $0.15 million (costs for the transfer station are not included but would be estimated in the order of several million dollars).

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 include: cask 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 (3rd quarter of 2024), 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 MP197HB and the HI-STAR 190) and are similar to one another.
- The maintenance activities projected for the railcars are representative of DOE's recently completed railcar design of the Atlas cask car [58] 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 SONGS ISFSI and the portion of the facility and communication equipment needed to support the shipments from the SONGS ISFSI (see **Section 7.9.2** for more details).

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 SONGS site to the GCUS site, which is a point-to-point distance of approximately 2,200 rail miles, costs were developed to be comparable to current market rates for radioactive materials rail shipments and include:

- Total Estimated Costs: $1,200,000 to $2,000,000/consist (per round trip)
- Therefore, the average freight cost of shipping the consist, which is assumed to be made up of 5 cask cars loaded with transportation casks either containing SNF or empty, 2 buffer cars[12], and an escort car, is approximately $1,600,000 (2024). This value includes the shipment of the consist from SONGS to GCUS and the return trip of the empty transportation casks on a dedicated train for the loaded movement and merchandise train for the empty return and includes the use of two locomotives in both directions. Since the selected route includes no interchanges, no switching charges are included in this estimate.

7.9.2 Estimate of Emergency Response Center Operation Costs

The estimated 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 training.
- 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 (rail carriers, trucking companies, etc.), 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 documentation.
- 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 safeguard's information, and appropriate training. Additional emergency training such as FEMA training would also be useful.

The estimated cost for a crew satisfying these assumptions is between $2 and $2.7 million (2024) per year. This number is considered independent of the number of shipments and includes the costs for an office and associated communication equipment.

[12] Two buffer cars are assumed to be a satisfactory number. However, more buffer cars may be required or conservatively added based on route clearances, axle loads, and results from testing of full consists (part of DOE's current Fortis/Atlas railcar program).

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 SONGS ISFSI, as opposed to costs associated with maintaining a fleet of railcars 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 rail carriers 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 are estimated to be approximately $100/month/car.
- Cask car (12 axles) maintenance costs are estimated to be approximately $200/month/car.
- Escort car (4 axles) maintenance costs are estimated to be approximately $250/month/car.
- Costs associated with administering a fleet maintenance program are not included.
- The period of performance is assumed to be 2.5 years for the 120-week estimated transport campaign schedule.

The above costs associated with the maintenance of a fleet of railcars 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 are included in the above costs. However, these costs are estimated to only cover the cars in use for the de-inventory of the SONGS ISFSI, rather than the costs associated with establishing and maintaining a facility and fleet for the larger inventory of railcars 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 railcars considering:

- Administrative costs are estimated to range from $40,000 to $100,000 per year 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 rail carrier and a portion is covered in freight rates. Maintenance work beyond routine serving of the cars is estimated to be in the range of $5,000 to $25,000 (2024) per major inspection period for the five cask cars and between $2,000 and $10,000 (2024) for the two buffer cars. This cost estimate covers a single maintenance occurrence, when the car is inspected, and major maintenance is performed. Typically, major maintenance can occur every 100,000 miles, annually, or at a five-year routine inspection, whichever comes first. Due to the sensitive nature of the composition of the escort car,

details on the cost for maintenance services are not readily available, but for estimating purposes a range of $10,000 to $50,000 (2024) per major inspection period should be assumed for an escort car. This cost includes maintenance activities involving the rail portion/undercarriage of this car (e.g., trucks, axles, etc.), but does not include any repairs or upgrades to the electronics/instruments located on the escort car.

Using this data, a range of $17,000 to $85,000 (2024) per major inspection period would cover the maintenance costs for the consist to be used to de-inventory the SONGS ISFSI; however, the more probable cost is approximately $19,000 (2024) per major inspection period.

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 ANSI (American National Standards Institute) 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 ½ time ASNT Level II cask operator, and a part time ASNT level III procedure writer/reviewer.

Given these assumptions, the estimated annual transportation cask maintenance costs will range from $2.1 to $3.2 million (2024) per facility, which is assumed to handle only one cask at a time.

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 SONGS' ISFSIs 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 SONGS ISFSIs, 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 (DOT regulations for shipping hazardous materials); 10 CFR 71.97 (advance notification); 10 CFR 73.20 (general performance requirements), 73.37 (requirements for irradiated reactor fuel in transit) and 73.72 (advance 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 ISFSIs and the on-site transload area to navigable waters, the MTSA is assumed to govern the SONGS 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 rail carrier would be notified the site is being declared a "rail secure area" (due to the transload operation) and maintained and protected with physical security measures to prevent unauthorized access, in accordance with 49 CFR 1580. This means all provisions of the Security Plan would be adhered to and enforced and, effectively, a layered security approach would be established to govern the site for ISFSI transload operations, 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: An 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 analyses from point of origin (SONGS) 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 and GTCC LLW 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; and

- 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 and GTCC LLW in transportation and identify any areas of concern.

8.4 Selecting 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 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;
- 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; and
- 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; and
- The RSAT will be comprised of security and risk professionals from licensees, security contractors, 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, rail carriers, 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 [37]; and
- 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" [38] and the "Enhancing Security of Hazardous Materials Shipments Against Acts of Terrorism or Sabotage" [37].

8.8 Developing 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/cannot be used during the entire project;
- What level of distribution will be allowed and how that will be administered and monitored; and
- Develop and approve all distribution lists and approved contacts.

8.9 Developing a 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 (SONGS and on-site transload track).

When a site handling hazardous material, 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 pleasure 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 [39]. The materials subject to these rules include explosive, toxic inhalation hazards (TIH), poisonous inhalation hazard (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 and
    - To receivers only located in 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, and
    - 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 rail carrier until the transfer has been completed and appropriately documented by both the shipper and rail carrier;

- 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 [39] (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 rail carrier 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 rail carrier for review or approval, but the shipper must inform the serving railroad that the plan exists; and
- 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):

- The transport vehicle is:
    - Occupied by at least two individuals, one of whom serves as an armed escort, and escorted by an armed member of the local law enforcement agency in a mobile unit of such agency; 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.
- 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.
- 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.
- 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 an MCC. The MCC shall:

- Provide positive confirmation of the location, status, and control over the shipment,
- 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).
- 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.
- 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/Vessel Shipments

Specific provisions for protection of in-transit barge/vessel 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 SONGS 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 [40]; and
- 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, and
- 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 a 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 [41].

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)) [42].

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 apart 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 [41].

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. Shippers 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 SONGS, on-site HHT transport beginning with all transfer operations conducted at SONGS to transfer the overpacks from the ISFSIs to the transfer trailers for the on-site transport to the on-site rail siding (existing lead 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 SONGS 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 SONGS Site-Specific Considerations for the Emergency Response Plan

The MUA identified the highest ranked route for transporting the SNF from SONGS to be a direct rail route, where the transportation casks would be directly loaded onto railcars at the site. Since SONGS is located directly on the Pacific Ocean, 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 two ISFSIs on site, and the rail transload area, as it pertains to safety and security of the sites from the coastline. The respective COTPs from the Eleventh 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 rail carrier, BNSF, stating that the area meets the requirements of a "rail secure area" and contact information will be supplied to the rail carrier. There is no requirement, as stated earlier, for the rail carrier to approve the Security Plan.

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

The site Security Plan for SONGS, 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)(10)(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

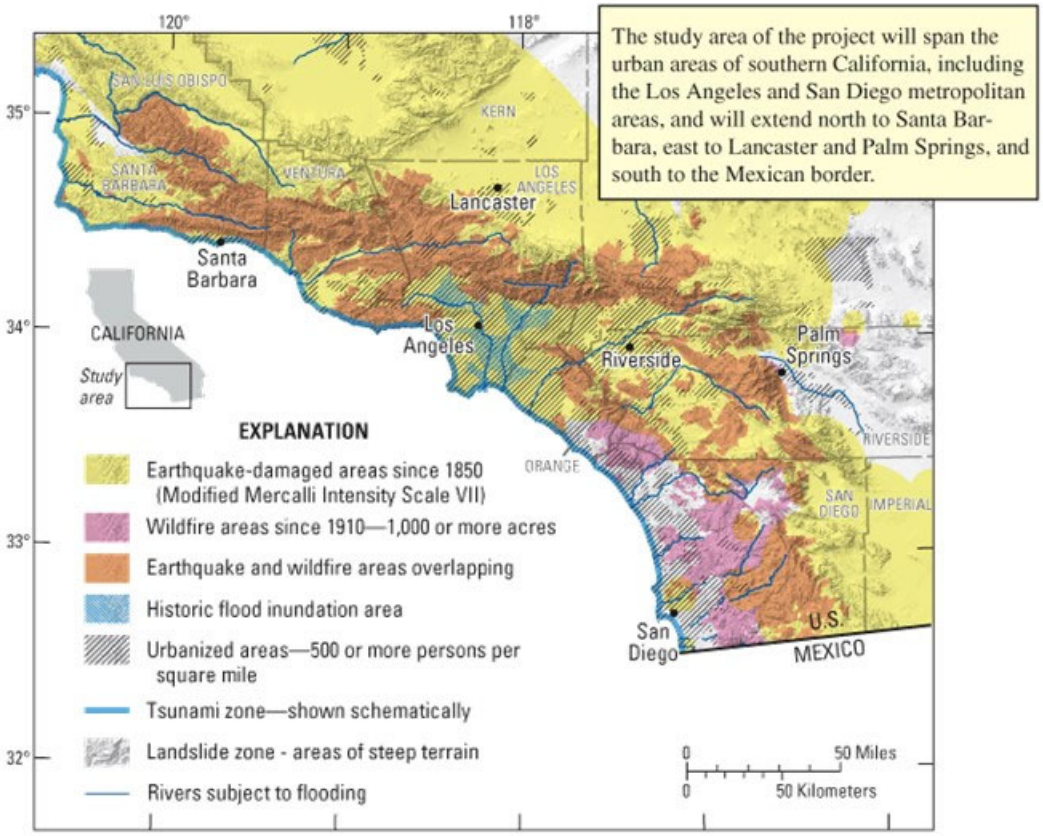
observation of waterway approaches and adjacent areas. Hence, any MTSA requirements for the site are presumed to become part of the overall Security Plan for the site.

Additional considerations should include natural disaster planning and contingency plans for flooding, hurricanes, and fire events. There are several resources available through the U.S. Army Core of Engineers (USACE) for assistance with emergency planning including the Flood Handbook. National Oceanic and Atmospheric Administration (NOAA) provides forecasting data to help determine chances of flooding based on geographical areas. Additional resources may be found at FEMA Flood Map (https://www.fema.gov/flood-maps). Both FEMA and the California Governor's Office of Emergency Services provide on-line information concerning weather related risks and hazards in southern California.

The Multi-Hazards Demonstration Project (MHDP) states:

> "Every year since 2000, when the population of the eight counties of southern California was nearly 19.7 million people, an estimated 276,000 more people become at risk from primary and secondary natural hazards." This study area geographically includes the SONGS site. These natural hazards include earthquakes, floods, tsunamis, landslides and coastal collapse, and wildfires (see **Figure 9-1**).

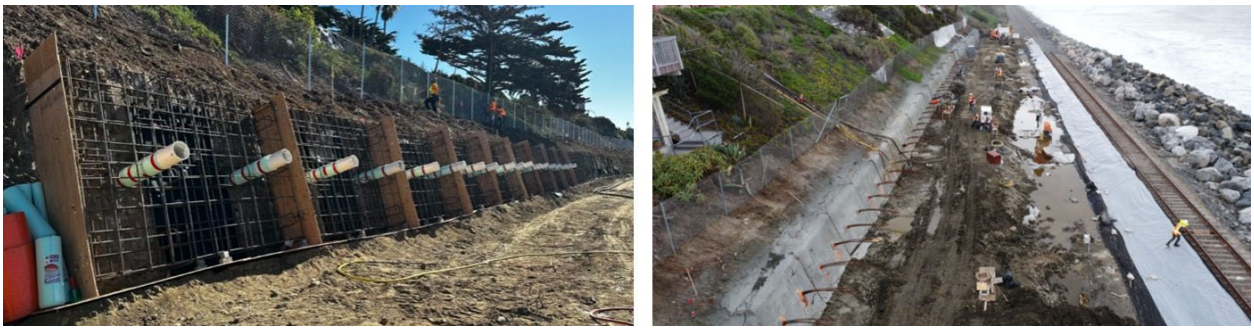
Figure 9-1: Hazards of Southern California [59]



In January 2023, a rail stabilization project was underway to install ground anchors into the slope above the railroad tracks [in San Clemente] to prevent the recurring landside incidents which stop rail traffic between Orange County, CA and San Diego, CA. In September 2021, " . . . 18,000 tons of boulders were added to the beach revetment to support the slope and recently, more boulders have been added". Railway Track and Structures reported that "Before September, the slope had pushed the rails closer to the water by more than 28 inches in just over a year." [60]

The Orange County Transportation Authority, in coordination with Metrolink, has completed emergency work to stabilize the railroad tracks in San Clemente. The emergency fix, which began in October 2022, included installing 220 ground anchors – each 133 feet long – into the bedrock below, securing two rows of 110 grade beams that helped stabilize the hillside above. The wall included approximately 1,000 cubic yards of shotcrete to help protect the railroad track. **Figure 9-2** shows some of the construction of this hillside stabilization project.

Figure 9-2: Construction of the San Clemente Rail Stabilization Project [60]



One day after tropical storm Hillary made landfall in California, UP reported two of its rail lines going into Los Angeles were out of service due to washouts caused by the storm. In addition to the track situation, it had difficulty getting crews into place because of road closures and electrical outages. Then in April 2023, approximately 4.48 rail miles north of SONGS, there were landslides in San Clemente, CA which threatened encroachment onto the rail track below. "All passenger and freight service between San Diego and Orange counties will continue to be suspended because of debris that is still falling following a landslide in San Clemente." [62]

Since there is a substantial grade on the site, care should be taken to chock railcar wheels and apply brakes diligently to prevent railcars and loaded trains from rolling. Surprisingly, loaded railcars are very quiet when rolling, and serious injury or death can result from cars moving on their own.

Figure 9-3: View of Landslides towards Rail Tracks Near San Clemente, CA [63]

Further Rail Expansion in the Southern California Area:

The site should be aware of the state government's plans to increase rail commuter traffic in the area. Approved plans for expanding the commuter services and to build and integrate a high-speed rail system are in process and depending on the timeline, may affect the ability of the SNF to ship from the site. **Figure 9-4** shows the phases of the high-speed rail project and the impact on existing freight and commuter rail lines in the area.

The California Department of Transportation's California State Rail Modernization Plan (2023 Draft) integrates the High-Speed Rail (HSR) system into its long-range passenger rail plan [15]. The map in **Figure 9-4** shows how the HSR system will provide connections to long distance (Amtrak) as well as commuter rail services at the north and south ends of the HSR system. The Interim Initial Operating Segment runs in the Central Valley from Merced (north end) to Bakersfield (south end).

Figure 9-4: California Rail Modernization Plan [15]

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. For the Holtec system, identify the location the above-grade or below-grade stack-up operations will occur to move the MPC from the transfer cask (HI-TRAC) to the transport cask (HI-STAR 190) and the down-ending operation for the transport cask on the SONGS site. In this report, a new below-grade transfer station is assumed to be built for the transfer of the MPC into the transportation cask. This configuration allows for the stack-up operation of the VCT with the transfer cask to be moved over the transportation cask and the MPC transferred down into the transport cask (instead of lifting the transfer cask loaded with the MPC to on top of the transport cask). In addition to identifying the location of the stack-up operation, the cranes and associated rigging needed to perform the lifting operations (e.g., lifting of the transport cask from the below-grade transfer station) for the Holtec system and any additional fencing or ISFSI boundary changes needed to allow for this operation to occur need to be identified.
2. Examine the on-site path from each of the ISFSIs to the selected railcar loading area and evaluate the need for improvements to ensure acceptable conditions of transport exist.
    a. For the TN system, this includes identifying the load path the transfer trailer with the loaded transport cask (in the horizontal orientation) will take from the TN ISFSI to the railcar loading area.
    b. For the Holtec system, this includes identifying the load path the VCT with the loaded transport cask (in the vertical orientation) will take from the Holtec ISFSI to the down-ending location (if not down-ended at the ISFSI – in which case, identify the means to move the horizontal cask from the ISFSI to the railcar loading area) and from the down-ending location to the railcar loading area.
3. The TN DSCs and the Holtec MPCs 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 and verification that the canister integrity has been maintained. It is recommended to allocate two to three years for this activity, which could involve licensing actions that may occur as a result of, for example, an updated storage license that may not have a conforming update performed to the transportation 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 certificate holders prior to transportation of each canister to be offered for transport.
4. The transportation casks to be used need to be finalized. While this report recommends using the MP197HB for all the TN DSCs on-site and the HI-STAR 190 for all of the Holtec MPCs on-site, there are other options that may want to be evaluated, such as the HI-STAR 100 and the HI-STAR 100MB, and potentially additional options available at the time of transportation preparations, such as the TN Eagle. The MP197HB will require licensing action to include the 24PT1 canisters as allowable content. The TN Eagle, which was

recently licensed under docket 71-9382, includes the 24PT1 and 24PT4 canisters as allowable content.

5. Establish planned shipment date from the SONGS ISFSI and verify:
    a. The CoC for the transportation packages are valid,
    b. The contents, as loaded in the DSC and MPC canisters are compliant to the applicable CoC requirements (e.g., dose and thermal transport limits are satisfied), and
    c. Ability for permitting the transportation activities along the selected route(s).
6. Establish equipment needs for transportation:
    a. Procurement of the necessary transfer station, transfer cask, transfer cask mating device, and transfer cask lift yoke, and
    b. Procurement of the necessary transportation casks, up-/down-ending device, associated impact limiters, transport cradles, personnel barriers, and vertical lifting yoke and horizontal lift beam.
7. Establish electrical power requirements for performing operations and verify availability at SONGS ISFSI.
8. Due to the potential significant impacts of the conditions and assumptions identified in **Section 7.9** for the estimated costs associated with activities involving the rail shipment of transportation casks (much less two different brands of transport 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 in Section 7.9, 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.
9. Prepare site for rail loading through:
    a. Maintaining or rebuilding the identified rails in **Figure 2-7** to the proposed transfer pad and the two parallel long tracks identified in **Section 3.2** which allow for the staging of empties, buffer, and the security cars away from loading operations.
    b. Extending the ISFSI security fences to encompass the railcar loading location, such as recommended in **Figure 2-7**, and the train staging area (two long parallel tracks).
    c. Preparing load paths from each ISFSI to the transfer pad identified in **Figure 2-7**.

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Attachment A: Full Pairwise Comparison for the Tangible Metrics

Please Place a Single x per line/row where you believe the importance of metric in column 1 falls against the metric in column 2								
Column 1 Metrics	**Strongly Favorable**	**Column 1 More Favorable**	**Column 1 Mildly Favorable**	**Neither Favorable (Neutral)**	**Column 2 Mildly Favorable**	**Column 2 More Favorable**	**Strongly Favorable**	**Column 2 Metrics**
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)								Route Aesthetic Changes Needed (e.g., tree trimming)
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)								Insurability of Route
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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)								Ease of Access to Transload Site (e.g., consider usage of existing site)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Size of conveyance (# of casks per shipment)
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Security Vulnerability of Route*
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Availability of Security Escort for Route
ISFSI Rental Equipment Costs (e.g., mobile cranes)								Number of Police Stations Nearby Route*
Labor and Permitting Costs								Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)
Labor and Permitting Costs								Cost of Rail Transport (e.g., costs associated with interchange activities)
Labor and Permitting Costs								Route Aesthetic Changes Needed (e.g., tree trimming)
Labor and Permitting Costs								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Labor and Permitting Costs								Number of Water Areas Nearby Route (e.g., number of bridges crossed)*
Labor and Permitting Costs								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*
Labor and Permitting Costs								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*
Labor and Permitting Costs								Number of Tribal Lands Crossed*
Labor and Permitting Costs								Public Acceptability of Route
Labor and Permitting Costs								Ease of Permit Procurement
Labor and Permitting Costs								Number of Permits
Labor and Permitting Costs								Insurability of Route
Labor and Permitting Costs								Availability of Specialty Equipment (e.g., rigging, transfer cask)
Labor and Permitting Costs								Cumulative Worker Exposure (α handling time & # of workers)
Labor and Permitting Costs								Cumulative Population Dose along Route (α population density)*
Labor and Permitting Costs								Risks Associated with Number of Lifting Activities
Labor and Permitting Costs								Average Accident Frequency on Route*
Labor and Permitting Costs								Number of Fire Stations & Trained Personnel Nearby Route*
Labor and Permitting Costs								Transit Duration per Conveyance
Labor and Permitting Costs								Ease of Access to Transload Site (e.g., consider usage of existing site)
Labor and Permitting Costs								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Labor and Permitting Costs								Size of conveyance (# of casks per shipment)
Labor and Permitting Costs								Security Vulnerability of Route*
Labor and Permitting Costs								Availability of Security Escort for Route
Labor and Permitting Costs								Number of Police Stations Nearby Route*

Please Place a Single x per line/row where you believe the importance of metric in column 1 falls against the metric in column 2								
Column 1 Metrics	**Strongly Favorable**	**Column 1 More Favorable**	**Column 1 Mildly Favorable**	**Neither Favorable (Neutral)**	**Column 2 Mildly Favorable**	**Column 2 More Favorable**	**Strongly Favorable**	**Column 2 Metrics**
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Cost of Rail Transport (e.g., costs associated with interchange activities)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Route Aesthetic Changes Needed (e.g., tree trimming)
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)								Insurability of Route
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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)								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)								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)								Size of conveyance (# of casks per shipment)
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)								Availability of Security Escort for 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)								Route Aesthetic Changes Needed (e.g., tree trimming)
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)								Insurability of Route
Cost of Rail Transport (e.g., costs associated with interchange activities)								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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)								Ease of Access to Transload Site (e.g., consider usage of existing site)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Cost of Rail Transport (e.g., costs associated with interchange activities)								Size of conveyance (# of casks per shipment)
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)								Availability of Security Escort for Route
Cost of Rail Transport (e.g., costs associated with interchange activities)								Number of Police Stations Nearby Route*

Please Place a Single x per line/row where you believe the importance of metric in column 1 falls against the metric in column 2								
Column 1 Metrics	**Strongly Favorable**	**Column 1 More Favorable**	**Column 1 Mildly Favorable**	**Neither Favorable (Neutral)**	**Column 2 Mildly Favorable**	**Column 2 More Favorable**	**Strongly Favorable**	**Column 2 Metrics**
Route Aesthetic Changes Needed (e.g., tree trimming)								Impact of Weather to Route (e.g., limited availability of route or instability of weather)
Route Aesthetic Changes Needed (e.g., tree trimming)								Number of Water Areas Nearby Route (e.g., number of bridges crossed)*
Route Aesthetic Changes Needed (e.g., tree trimming)								Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*
Route Aesthetic Changes Needed (e.g., tree trimming)								Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*
Route Aesthetic Changes Needed (e.g., tree trimming)								Number of Tribal Lands Crossed*
Route Aesthetic Changes Needed (e.g., tree trimming)								Public Acceptability of Route
Route Aesthetic Changes Needed (e.g., tree trimming)								Ease of Permit Procurement
Route Aesthetic Changes Needed (e.g., tree trimming)								Number of Permits
Route Aesthetic Changes Needed (e.g., tree trimming)								Insurability of Route
Route Aesthetic Changes Needed (e.g., tree trimming)								Availability of Specialty Equipment (e.g., rigging, transfer cask)
Route Aesthetic Changes Needed (e.g., tree trimming)								Cumulative Worker Exposure (α handling time & # of workers)
Route Aesthetic Changes Needed (e.g., tree trimming)								Cumulative Population Dose along Route (α population density)*
Route Aesthetic Changes Needed (e.g., tree trimming)								Risks Associated with Number of Lifting Activities
Route Aesthetic Changes Needed (e.g., tree trimming)								Average Accident Frequency on Route*
Route Aesthetic Changes Needed (e.g., tree trimming)								Number of Fire Stations & Trained Personnel Nearby Route*
Route Aesthetic Changes Needed (e.g., tree trimming)								Transit Duration per Conveyance
Route Aesthetic Changes Needed (e.g., tree trimming)								Ease of Access to Transload Site (e.g., consider usage of existing site)
Route Aesthetic Changes Needed (e.g., tree trimming)								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Route Aesthetic Changes Needed (e.g., tree trimming)								Size of conveyance (# of casks per shipment)
Route Aesthetic Changes Needed (e.g., tree trimming)								Security Vulnerability of Route*
Route Aesthetic Changes Needed (e.g., tree trimming)								Availability of Security Escort for Route
Route Aesthetic Changes Needed (e.g., tree trimming)								Number of Police Stations Nearby Route*
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)								Insurability of Route
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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)								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)								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)								Size of conveyance (# of casks per shipment)
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)								Availability of Security Escort for 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)*								Insurability of Route
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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)*								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)*								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Size of conveyance (# of casks per shipment)
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)*								Availability of Security Escort for Route
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*								Number of Police Stations Nearby Route*

Please Place a Single x per line/row where you believe the importance of metric in column 1 falls against the metric in column 2								
Column 1 Metrics	**Strongly Favorable**	**Column 1 More Favorable**	**Column 1 Mildly Favorable**	**Neither Favorable (Neutral)**	**Column 2 Mildly Favorable**	**Column 2 More Favorable**	**Strongly Favorable**	**Column 2 Metrics**
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)*								Insurability of Route
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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)*								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)*								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*								Size of conveyance (# of casks per shipment)
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)*								Availability of Security Escort for 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)*								Insurability of Route
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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)*								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)*								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Size of conveyance (# of casks per shipment)
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)*								Availability of Security Escort for Route
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*								Number of Police Stations Nearby Route*
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*								Insurability of Route
Number of Tribal Lands Crossed*								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Number of Tribal Lands Crossed*								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Number of Tribal Lands Crossed*								Size of conveyance (# of casks per shipment)
Number of Tribal Lands Crossed*								Security Vulnerability of Route*
Number of Tribal Lands Crossed*								Availability of Security Escort for Route
Number of Tribal Lands Crossed*								Number of Police Stations Nearby Route*

Please Place a Single x per line/row where you believe the importance of metric in column 1 falls against the metric in column 2								
Column 1 Metrics	**Strongly Favorable**	**Column 1 More Favorable**	**Column 1 Mildly Favorable**	**Neither Favorable (Neutral)**	**Column 2 Mildly Favorable**	**Column 2 More Favorable**	**Strongly Favorable**	**Column 2 Metrics**
Public Acceptability of Route								Ease of Permit Procurement
Public Acceptability of Route								Number of Permits
Public Acceptability of Route								Insurability of Route
Public Acceptability of Route								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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								Ease of Access to Transload Site (e.g., consider usage of existing site)
Public Acceptability of Route								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Public Acceptability of Route								Size of conveyance (# of casks per shipment)
Public Acceptability of Route								Security Vulnerability of Route*
Public Acceptability of Route								Availability of Security Escort for Route
Public Acceptability of Route								Number of Police Stations Nearby Route*
Ease of Permit Procurement								Number of Permits
Ease of Permit Procurement								Insurability of Route
Ease of Permit Procurement								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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								Ease of Access to Transload Site (e.g., consider usage of existing site)
Ease of Permit Procurement								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Ease of Permit Procurement								Size of conveyance (# of casks per shipment)
Ease of Permit Procurement								Security Vulnerability of Route*
Ease of Permit Procurement								Availability of Security Escort for Route
Ease of Permit Procurement								Number of Police Stations Nearby Route*
Number of Permits								Insurability of Route
Number of Permits								Availability of Specialty Equipment (e.g., rigging, transfer cask)
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								Ease of Access to Transload Site (e.g., consider usage of existing site)
Number of Permits								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Number of Permits								Size of conveyance (# of casks per shipment)
Number of Permits								Security Vulnerability of Route*
Number of Permits								Availability of Security Escort for Route
Number of Permits								Number of Police Stations Nearby Route*
Insurability of Route								Availability of Specialty Equipment (e.g., rigging, transfer cask)
Insurability of Route								Cumulative Worker Exposure (α handling time & # of workers)
Insurability of Route								Cumulative Population Dose along Route (α population density)*
Insurability of Route								Risks Associated with Number of Lifting Activities
Insurability of Route								Average Accident Frequency on Route*
Insurability of Route								Number of Fire Stations & Trained Personnel Nearby Route*
Insurability of Route								Transit Duration per Conveyance
Insurability of Route								Ease of Access to Transload Site (e.g., consider usage of existing site)
Insurability of Route								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Insurability of Route								Size of conveyance (# of casks per shipment)
Insurability of Route								Security Vulnerability of Route*
Insurability of Route								Availability of Security Escort for Route
Insurability of Route								Number of Police Stations Nearby Route*

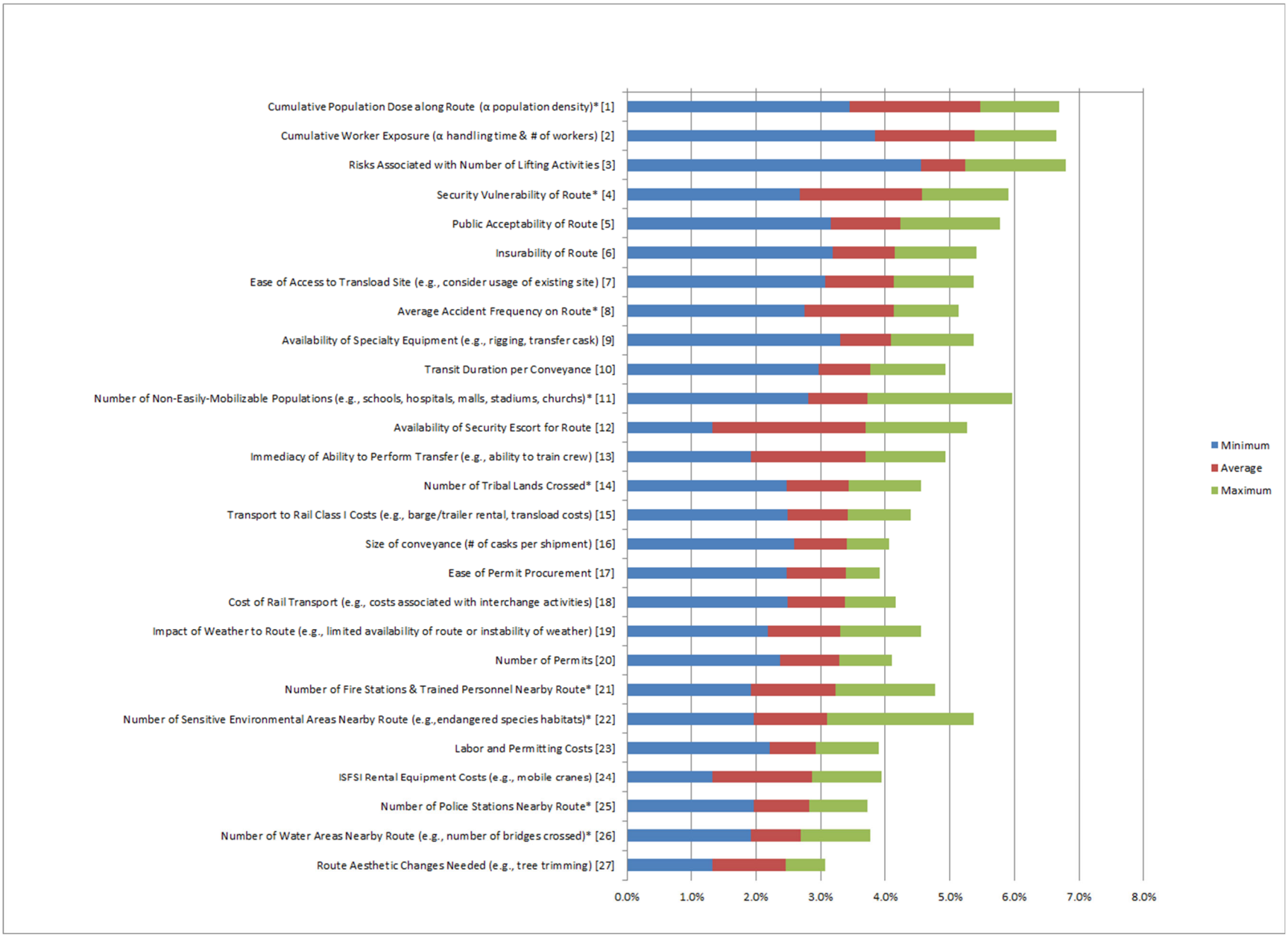
Please Place a Single x per line/row where you believe the importance of metric in column 1 falls against the metric in column 2								
Column 1 Metrics	**Strongly Favorable**	**Column 1 More Favorable**	**Column 1 Mildly Favorable**	**Neither Favorable (Neutral)**	**Column 2 Mildly Favorable**	**Column 2 More Favorable**	**Strongly Favorable**	**Column 2 Metrics**
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Cumulative Worker Exposure (α handling time & # of workers)
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Cumulative Population Dose along Route (α population density)*
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Risks Associated with Number of Lifting Activities
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Average Accident Frequency on Route*
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Number of Fire Stations & Trained Personnel Nearby Route*
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Transit Duration per Conveyance
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Ease of Access to Transload Site (e.g., consider usage of existing site)
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Size of conveyance (# of casks per shipment)
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Security Vulnerability of Route*
Availability of Specialty Equipment (e.g., rigging, transfer cask)								Availability of Security Escort for Route
Availability of Specialty Equipment (e.g., rigging, transfer cask)								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)								Ease of Access to Transload Site (e.g., consider usage of existing site)
Cumulative Worker Exposure (α handling time & # of workers)								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Cumulative Worker Exposure (α handling time & # of workers)								Size of conveyance (# of casks per shipment)
Cumulative Worker Exposure (α handling time & # of workers)								Security Vulnerability of Route*
Cumulative Worker Exposure (α handling time & # of workers)								Availability of Security Escort for 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)*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Cumulative Population Dose along Route (α population density)*								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Cumulative Population Dose along Route (α population density)*								Size of conveyance (# of casks per shipment)
Cumulative Population Dose along Route (α population density)*								Security Vulnerability of Route*
Cumulative Population Dose along Route (α population density)*								Availability of Security Escort for Route
Cumulative Population Dose along Route (α population density)*								Number of Police Stations Nearby Route*
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								Ease of Access to Transload Site (e.g., consider usage of existing site)
Risks Associated with Number of Lifting Activities								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Risks Associated with Number of Lifting Activities								Size of conveyance (# of casks per shipment)
Risks Associated with Number of Lifting Activities								Security Vulnerability of Route*
Risks Associated with Number of Lifting Activities								Availability of Security Escort for 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*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Average Accident Frequency on Route*								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Average Accident Frequency on Route*								Size of conveyance (# of casks per shipment)
Average Accident Frequency on Route*								Security Vulnerability of Route*
Average Accident Frequency on Route*								Availability of Security Escort for 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*								Ease of Access to Transload Site (e.g., consider usage of existing site)
Number of Fire Stations & Trained Personnel Nearby Route*								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Number of Fire Stations & Trained Personnel Nearby Route*								Size of conveyance (# of casks per shipment)
Number of Fire Stations & Trained Personnel Nearby Route*								Security Vulnerability of Route*
Number of Fire Stations & Trained Personnel Nearby Route*								Availability of Security Escort for Route
Number of Fire Stations & Trained Personnel Nearby Route*								Number of Police Stations Nearby Route*

Please Place a Single x per line/row where you believe the importance of metric in column 1 falls against the metric in column 2								
Column 1 Metrics	**Strongly Favorable**	**Column 1 More Favorable**	**Column 1 Mildly Favorable**	**Neither Favorable (Neutral)**	**Column 2 Mildly Favorable**	**Column 2 More Favorable**	**Strongly Favorable**	**Column 2 Metrics**
Transit Duration per Conveyance								Ease of Access to Transload Site (e.g., consider usage of existing site)
Transit Duration per Conveyance								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Transit Duration per Conveyance								Size of conveyance (# of casks per shipment)
Transit Duration per Conveyance								Security Vulnerability of Route*
Transit Duration per Conveyance								Availability of Security Escort for Route
Transit Duration per Conveyance								Number of Police Stations Nearby Route*
Ease of Access to Transload Site (e.g., consider usage of existing site)								Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Ease of Access to Transload Site (e.g., consider usage of existing site)								Size of conveyance (# of casks per shipment)
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)								Availability of Security Escort for Route
Ease of Access to Transload Site (e.g., consider usage of existing site)								Number of Police Stations Nearby Route*
Immediacy of Ability to Perform Transfer (e.g., ability to train crew)								Size of conveyance (# of casks per shipment)
Immediacy of Ability to Perform Transfer (e.g., ability to train crew)								Security Vulnerability of Route*
Immediacy of Ability to Perform Transfer (e.g., ability to train crew)								Availability of Security Escort for Route
Immediacy of Ability to Perform Transfer (e.g., ability to train crew)								Number of Police Stations Nearby Route*
Size of conveyance (# of casks per shipment)								Security Vulnerability of Route*
Size of conveyance (# of casks per shipment)								Availability of Security Escort for Route
Size of conveyance (# of casks per shipment)								Number of Police Stations Nearby Route*
Security Vulnerability of Route*								Availability of Security Escort for Route
Security Vulnerability of Route*								Number of Police Stations Nearby Route*
Availability of Security Escort for Route								Number of Police Stations Nearby Route*

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

Metric	1		2		3		4		5		6		7		8		9		Average			Metric
	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	%	Ranking	Average	
ISFSI Rental Equipment Costs (e.g., mobile cranes)	3.75%	12	2.85%	16	2.78%	27	3.09%	20	3.94%	11	2.73%	27	2.78%	27	1.33%	25	2.52%	24	2.9%	24	21.0	ISFSI Rental Equipment Costs (e.g., mobile cranes)
Labor and Permitting Costs	3.73%	13	2.30%	24	3.11%	21	2.21%	27	3.89%	12	2.78%	26	3.11%	21	2.68%	17	2.49%	25	2.9%	23	20.7	Labor and Permitting Costs
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	4.39%	8	4.04%	11	3.11%	21	4.23%	9	3.85%	15	2.92%	25	3.11%	21	2.68%	17	2.49%	25	3.4%	15	16.9	Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)
Cost of Rail Transport (e.g., costs associated with interchange activities)	4.15%	9	3.82%	12	3.04%	24	3.80%	14	3.89%	12	3.47%	14	3.04%	24	2.68%	17	2.49%	25	3.4%	18	16.8	Cost of Rail Transport (e.g., costs associated with interchange activities)
Route Aesthetic Changes Needed (e.g., tree trimming)	2.09%	25	2.14%	26	2.99%	26	2.52%	24	1.97%	25	2.99%	23	2.99%	26	1.33%	25	3.06%	17	2.5%	27	24.1	Route Aesthetic Changes Needed (e.g., tree trimming)
Impact of Weather to Route (e.g., limited availability of route or instability of weather)	3.66%	14	2.18%	25	3.04%	24	4.04%	12	2.66%	22	3.30%	19	3.04%	24	4.56%	8	3.25%	16	3.3%	19	18.2	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)*	2.07%	26	2.04%	27	3.16%	20	2.40%	25	1.92%	27	3.04%	21	3.16%	20	2.68%	17	3.77%	11	2.7%	26	21.6	Number of Water Areas Nearby Route (e.g., number of bridges crossed)*
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*	2.42%	23	2.40%	22	3.28%	17	2.33%	26	1.97%	25	3.02%	22	3.28%	17	5.37%	3	3.85%	10	3.1%	22	18.3	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)*	4.63%	7	2.80%	17	3.28%	17	4.56%	6	2.80%	20	2.94%	24	3.28%	17	5.96%	1	3.28%	15	3.7%	11	13.8	Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*
Number of Tribal Lands Crossed*	3.11%	19	3.44%	15	3.28%	17	4.42%	7	2.47%	24	3.35%	18	3.28%	17	4.56%	8	3.06%	17	3.4%	14	15.8	Number of Tribal Lands Crossed*
Public Acceptability of Route	4.94%	6	5.77%	4	3.58%	10	4.91%	3	3.61%	16	3.16%	20	3.58%	10	4.56%	8	4.04%	7	4.2%	5	9.3	Public Acceptability of Route
Ease of Permit Procurement	3.16%	18	2.47%	19	3.37%	16	3.56%	15	3.16%	18	3.82%	10	3.37%	16	3.63%	13	3.92%	9	3.4%	17	14.9	Ease of Permit Procurement
Number of Permits	3.02%	20	2.37%	23	3.40%	15	2.68%	23	3.02%	19	4.11%	8	3.40%	15	3.63%	13	4.01%	8	3.3%	20	16.0	Number of Permits
Insurability of Route	5.03%	5	5.41%	6	3.58%	10	3.47%	16	3.18%	17	3.51%	13	3.58%	10	5.37%	3	4.13%	6	4.1%	6	9.6	Insurability of Route
Availability of Specialty Equipment (e.g., rigging, transfer cask)	3.37%	16	4.72%	7	3.56%	12	4.27%	8	4.42%	6	4.20%	6	3.56%	12	5.37%	3	3.30%	14	4.1%	9	9.3	Availability of Specialty Equipment (e.g., rigging, transfer cask)
Cumulative Worker Exposure (α handling time & # of workers)	5.46%	2	5.65%	5	6.24%	1	5.03%	2	3.89%	12	3.85%	9	6.24%	1	5.37%	3	6.65%	2	5.4%	2	4.1	Cumulative Worker Exposure (α handling time & # of workers)
Cumulative Population Dose along Route (α population density)*	6.27%	1	5.79%	3	5.96%	2	5.10%	1	4.04%	10	3.44%	15	5.96%	2	5.96%	1	6.70%	1	5.5%	1	4.0	Cumulative Population Dose along Route (α population density)*
Risks Associated with Number of Lifting Activities	5.25%	3	6.24%	1	4.72%	4	4.68%	5	6.79%	1	4.87%	4	4.72%	4	4.56%	8	5.37%	3	5.2%	3	3.7	Risks Associated with Number of Lifting Activities
Average Accident Frequency on Route*	4.13%	10	2.75%	18	3.66%	9	4.80%	4	5.13%	4	3.42%	16	3.66%	9	4.56%	8	5.06%	4	4.1%	8	9.1	Average Accident Frequency on Route*
Number of Fire Stations & Trained Personnel Nearby Route*	2.11%	24	2.47%	19	4.77%	3	3.32%	17	2.71%	21	3.40%	17	4.77%	3	1.92%	23	3.61%	13	3.2%	21	15.6	Number of Fire Stations & Trained Personnel Nearby Route*
Transit Duration per Conveyance	2.99%	21	4.06%	10	3.44%	14	4.18%	10	4.32%	7	4.94%	2	3.44%	14	3.63%	13	2.97%	21	3.8%	10	12.4	Transit Duration per Conveyance
Ease of Access to Transload Site (e.g., consider usage of existing site)	3.54%	15	4.18%	9	3.87%	7	4.13%	11	4.32%	7	4.87%	4	3.87%	7	5.37%	3	3.06%	17	4.1%	7	8.9	Ease of Access to Transload Site (e.g., consider usage of existing site)
Immediacy of Ability to Perform Transfer (e.g., ability to train crew)	3.21%	17	3.61%	14	3.96%	6	3.99%	13	4.84%	5	4.94%	2	3.96%	6	1.92%	23	2.78%	23	3.7%	13	12.1	Immediacy of Ability to Perform Transfer (e.g., ability to train crew)
Size of conveyance (# of casks per shipment)	2.59%	22	3.75%	13	3.49%	13	3.32%	17	4.06%	9	3.56%	12	3.49%	13	3.63%	13	2.80%	22	3.4%	16	14.9	Size of conveyance (# of casks per shipment)
Security Vulnerability of Route*	5.13%	4	5.91%	2	4.39%	5	3.18%	19	5.32%	2	5.46%	1	4.39%	5	2.68%	17	4.65%	5	4.6%	4	6.7	Security Vulnerability of Route*
Availability of Security Escort for Route	3.85%	11	4.37%	8	3.85%	8	2.94%	21	5.27%	3	4.20%	6	3.85%	8	1.33%	25	3.66%	12	3.7%	12	11.3	Availability of Security Escort for Route
Number of Police Stations Nearby Route*	1.97%	27	2.45%	21	3.09%	23	2.85%	22	2.56%	23	3.73%	11	3.09%	23	2.68%	17	3.04%	20	2.8%	25	20.8	Number of Police Stations Nearby Route*

Lowest Rated
Highest Rated


Cumulative Population Dose along Route (α population density)* [1]
Cumulative Worker Exposure (α handling time & # of workers) [2]
Risks Associated with Number of Lifting Activities [3]
Security Vulnerability of Route* [4]
Public Acceptability of Route [5]
Insurability of Route [6]
Ease of Access to Transload Site (e.g., consider usage of existing site) [7]
Average Accident Frequency on Route* [8]
Availability of Specialty Equipment (e.g., rigging, transfer cask) [9]
Transit Duration per Conveyance [10]
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)* [11]
Availability of Security Escort for Route [12]
Immediacy of Ability to Perform Transfer (e.g., ability to train crew) [13]
Number of Tribal Lands Crossed* [14]
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs) [15]
Size of conveyance (# of casks per shipment) [16]
Ease of Permit Procurement [17]
Cost of Rail Transport (e.g., costs associated with interchange activities) [18]
Impact of Weather to Route (e.g., limited availability of route or instability of weather) [19]
Number of Permits [20]
Number of Fire Stations & Trained Personnel Nearby Route* [21]
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)* [22]
Labor and Permitting Costs [23]
ISFSI Rental Equipment Costs (e.g., mobile cranes) [24]
Number of Police Stations Nearby Route* [25]
Number of Water Areas Nearby Route (e.g., number of bridges crossed)* [26]
Route Aesthetic Changes Needed (e.g., tree trimming) [27]
0.0%
1.0%
2.0%
3.0%
4.0%
5.0%
6.0%
7.0%
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. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Labor and Permitting Costs	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF		x						L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF	x							P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP	x							P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal							x	P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Transport to Rail Class I Costs (e.g., barge/trailer rental, transload costs)	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

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
Cost of Rail Transport (e.g., costs associated with interchange activities)	A. Rail-min. time BNSF			x					H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF					x			N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP					x			L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park					x			N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Route Aesthetic Changes Needed (e.g., tree trimming)	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP				x				L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Impact of Weather to Route (e.g., limited availability of route or instability of weather)	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

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
Number of Water Areas Nearby Route (e.g., number of bridges crossed)*	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP				x				L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Number of Sensitive Environmental Areas Nearby Route (e.g.,endangered species habitats)*	A. Rail-min. time BNSF					x			H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Number of Non-Easily-Mobilizable Populations (e.g., schools, hospitals, malls, stadiums, churchs)*	A. Rail-min. time BNSF		x						H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF					x			N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP						x		L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park					x			N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

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
Number of Tribal Lands Crossed*	A. Rail-min. time BNSF					x			H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Public Acceptability of Route	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Ease of Permit Procurement	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF		x						L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

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
Number of Permits	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Insurability of Route	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP				x				L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Availability of Specialty Equipment (e.g., rigging, transfer cask)	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

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
Cumulative Worker Exposure (α handling time & # of workers)	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Cumulative Population Dose along Route (α population density)*	A. Rail-min. time BNSF		x						H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF					x			N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP						x		L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP						x		N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP						x		Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park					x			N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Risks Associated with Number of Lifting Activities	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF		x						L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF	x							P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP	x							P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

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
Average Accident Frequency on Route*	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF					x			L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP					x			L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Number of Fire Stations & Trained Personnel Nearby Route*	A. Rail-min. time BNSF					x			H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Transit Duration per Conveyance*	A. Rail-min. time BNSF			x					H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP				x				L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

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
Ease of Access to Transload Site (e.g., consider usage of existing site)	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Immediacy of Ability to Perform Transfer (e.g., ability to train crew)	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF			x					L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Size of conveyance (# of casks per shipment)	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF		x						L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP		x						N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

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
Security Vulnerability of Route*	A. Rail-min. time BNSF			x					H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF		x						L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF	x							P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP		x						L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP	x							P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park	x							N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park		x						P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park	x							Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal						x		P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO		x						Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
ity Escort for Route	A. Rail-min. time BNSF				x				H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP				x				L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Availability of Security Escort for Route	A. Rail-min. time BNSF					x			H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
Number of Police Stations Nearby Route*	A. Rail-min. time BNSF					x			H. Rail-min. time BNSF-UP
	A. Rail-min. time BNSF				x				L. HHT to Rail-Transload at San Onofre State Park
	A. Rail-min. time BNSF			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	A. Rail-min. time BNSF			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	A. Rail-min. time BNSF			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					L. HHT to Rail-Transload at San Onofre State Park
	H. Rail-min. time BNSF-UP			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	H. Rail-min. time BNSF-UP			x					P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	H. Rail-min. time BNSF-UP			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park			x					N. HHT-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal
	L. HHT to Rail-Transload at San Onofre State Park				x				P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	L. HHT to Rail-Transload at San Onofre State Park			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal					x			P. HHT-Barge-Rail to Camp Pendleton to MOTCO
	-Vessel-Rail to Los Angeles Port to Port of Houston via Panama Canal				x				Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal
	P. HHT-Barge-Rail to Camp Pendleton to MOTCO			x					Q. HHT-Vessel-Rail to San Diego Port to Port of Houston via Panama Canal

Attachment D: Route Information from START for SONGS

Metric are within 800 m. buffer for entire route, unless stated otherwise.	A. Rail-min. time BNSF	H. Rail-min. time Kathy's Route 2 BNSF/UP	L. HHT to Rail-Transload at San Onofre State Park	N. HHT, B, R-Los Angeles Port to Port of Houston, via Panama Canal	P. HHT, B, R-Camp Pendleton to MOTCO	Q. HHT, B, R-San Diego port to Port of Houston, via Panama Canal
Total Distance (mi)	2,189	2,344	2,102	6,121	2,780	6,076
HHT Distance (mi)	0	0	2	61	19	61
Barge/Vessel Distance (mi)	0	0	0	5218	591	5173
Rail Distance (mi)	2189	2344	2100	842	2170	842

Metric are within 800 m. buffer for entire route, unless stated otherwise.	A. Rail-min. time BNSF	H. Rail-min. time Kathy's Route 2 BNSF/UP	L. HHT to Rail-Transload at San Onofre State Park	N. HHT, B, R-Los Angeles Port to Port of Houston, via Panama Canal	P. HHT, B, R-Camp Pendleton to MOTCO	Q. HHT, B, R-San Diego port to Port of Houston, via Panama Canal
Total Distance (mi)	2,189	2,344	2,102	6,121	2,780	6,076
Travel Time (hr)	52	60	51	770	139	764
Accident Likelihood (per mi)	n/a	n/a	0.000000842	0.002084091	0.000255030	0.000022858
Water Crossings	207	156	199	72	309	75
Average Track Class	n/a	n/a	n/a	n/a	n/a	n/a
Average Rail Traffic Density	n/a	n/a	n/a	n/a	n/a	n/a
Total Population	816,112	1,448,593	814,801	722,544	804,463	599,071
Population Density (per mi²)	389.68	641.50	1,321	6,720.21	769.91	4,717.91
Mass Gathering Places	625	1,118	622	489	576	578
Tribal Lands (per mi²)	115.66	18.30	116	0.01	1.69	0.01
Water Areas (per mi²)	40.99	38.44	41	64.27	114.79	73.63
Protected Areas (per mi²)	938.62	676.33	939	719.67	2,307.12	691.88
Sensitive Environmental Area (per mi²)	539.46	481.08	585	104.27	527.76	116.75
Correctional Facilities	28	51	28	18	31	18
Tunnels	1	0	1	0	14	0
Emergency Response Capability	289	422.00	288.00	234.00	335.00	222.00
Fire Stations	151	211.00	150.00	118.00	188.00	111.00
Local Law Enforcement	123	164.00	123	89.00	123.00	88.00
Hospitals	15	47.00	15	27.00	24.00	23.00
Educational Institutions	360	625	359	301	375	264
Grammar Schools	346	589	345	282	372	251
Higher Education	14	36	14	19	3	13
Special Populations					2	
Child Care	284	524	283	260	298	242
Nursing Homes	59	116	59	74	83	74
Railroad Crossings (at grade)	1789	1916	1796	1164	1764	1160