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Technical Evaluation Study

FEASIBILITY OF USING THE IRRADIATED FUEL STORAGE FACILITY (IFSF) TO REMOVE COMMERCIAL USED FUEL FROM THE REA-2023 CASK

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Idaho National Laboratory

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REVISION LOG

Rev.	Date	Affected Pages	Revision Description
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1. INTRODUCTION

The Memorandum of Agreement Concerning Receipt, Storage, and Handling of Research Quantities of Commercial Spent Nuclear Fuel (SNF) at the Idaho National Laboratory (INL) allows the INL to set up a library of research quantities of commercial SNF. The Idaho Nuclear Technology and Engineering Center (INTEC) is storing several large storage casks of commercial SNF. The purpose of this paper is to determine if it is feasible to take one of these large storage casks, the REA-2023 Cask, into the Irradiated Fuel Storage Facility (IFSF) Fuel Handling Cave to retrieve the basket with 9 Surry rods from the cask and to transfer the rods to Materials and Fuels Complex (MFC) for non destructive analysis and destructive assay in the Hot Fuel Examination Facility (HFEF) or another facility.

1.1 Problem Statement

1) Can the REA-2023 physical fit into the IFSF Fuel Handling Cave?

2) Does the crane CRN-SF-001 have the capacity to lift the REA-2023 Cask?

3) Can the cask transfer car TD-GSF-901 transport the REA-2023 Cask into the IFSF Fuel Handling Cave?

4) Does Crane CRN-GSF-101 have the head room and capacity to lift the Surry Basket?

1.2 Acronyms

EDF	engineer design file
ft	feet
HFEF	Hot Fuel Examination Facility
IFSF	Irradiated Fuel Storage Facility
in.	inch
INL	Idaho National Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
lbs	pounds
kW	kilowatt
MFC	Material and Fuel Complex

PCS	Permanent Containment Structure
psig	pounds per square inch gauge
REA	Ridihalgh, Eggers and Associates, INC.
SDD	system design description
SNF	spent nuclear fuel
TAN	Test Area North

2. FACILITY AND COMPONET DESCRIPTIONS

2.1 REA-2023 Cask

The REA-2023 cask is a cylindrical double containment design consisting of an outer shell, an inner containment vessel, lead gamma shielding, and a neutron moderator. The REA-2023 cask is shown in Figure 1. The cask is approximately 16-ft high, 8-ft diameter, and weighs approximately 96 tons fully loaded and 76.91 tons as currently loaded. Table 1 contains the REA-2023 design features and table 2 contains the REA-2023 cask loaded weight. The primary components of the cask are the cask main body, primary and secondary covers, lifting trunnions, and fuel basket insert. The REA-2023 cask was originally designed for both horizontal and vertical storage; however with changes to the fuel basket design discussed below, storage is limited to only the vertical configuration.

Table 1. REA-2023 design features.

Cask overall External length	192.62 in.
Overall external diameter	87.56 in.
Inner stainless-steel shell thickness	0.75 in.
Lead shielding thickness	4.25 in.
Outer stainless-steel shell thickness	2.0 in.
Bottom thickness	7.0 in.
Cavity Length	177.25 in.
Cavity diameter	61.00 in.
Design pressure	50 psig maximum
Design internal heat source	20.8 kW total
Weight (empty)	64.23 tons
Weight (fully loaded)	96 tons

Table 2. REA-2023 as loaded weight.

Items	**Weight (lbs)**
REA-2023 Cask Empty	128,460.00
REA-2023 Insert	4,700.00
Overpack Coffin A	1,531.42
Overpack Coffin B	1,446.75
Overpack Coffin C	2,233.09
Overpack Coffin D	1,359.52
Overpack Coffin H	1,250.42
Overpack Coffin J	3,057.16
Overpack Coffin K	3,032.26
Encapsulation Basket 1	800.00
Encapsulation Basket 2	800.00
Encapsulation Basket 3	800.00
Surry Basket	510.00
LOFT FP-1 Canister	950.00
15 LOFT FP-2 Canister	2,880.00
Total	**153,810.62**
Total in tons	**76.91**

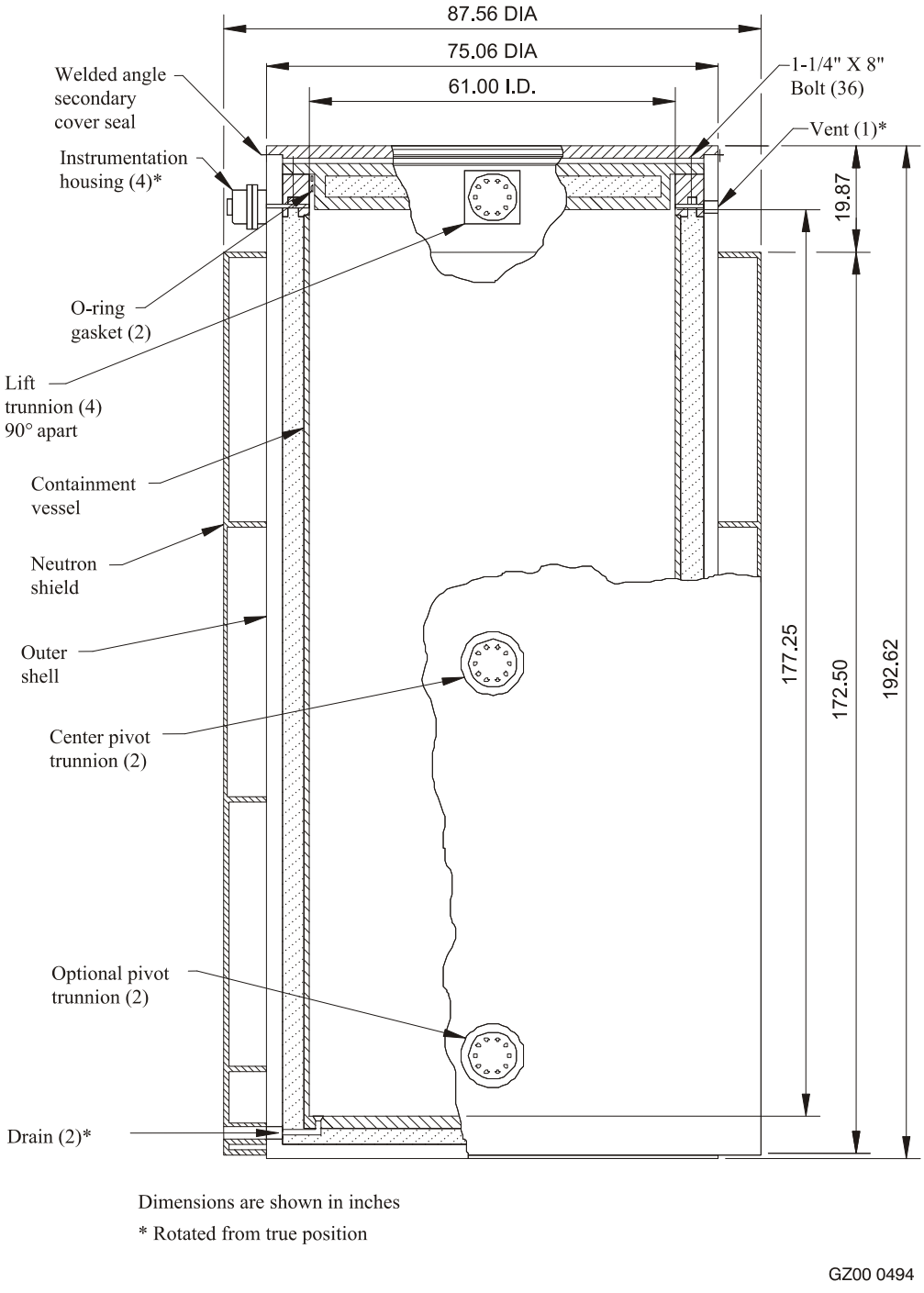

Figure 1. REA-2023 cask.

2.2 Surry Basket

A single Surry fuel storage basket that holds 9 Surry fuel rods is stored in the REA-2023 cask. The Surry fuel storage basket holds the nine rods in perforated tubes. The basket dimensions are 6.6 in. x 7.6 in. by 172 in. long. The Surry fuel storage basket, when loaded with nine fuel rods, weighs 510 lbs. The rods as placed in the basket extend a minimum of 1 in. above the top of the storage basket. This extension allows the rods to be removed from the basket.

2.3 IFSF Cask Receiving Area

The cask receiving area contains a truck ramp, sloping down from west to east lying along the south wall of the storage area and fuel handling cave, which allows fuel-cask-bearing trucks to obtain a lower elevation for unloading and loading casks. The overall plan of the facility is shown in Figures 2 and 3.

2.4 Crane CRN-SF-001

Overhead Crane CRN-SF-001 (see Figure 4) services the cask receiving area. CRN-SF-001 is the oldest of the cranes of the IFSF system. It was originally procured as part of the Fuel Element Cutting Facility project of the late 1950s. The original crane was manufactured by Judson Pacific crane. That vendor has been out of business since the late 1950s and obtaining spare parts can be problematic. Crane CRN-SF-001 can travel the full length of the east-west truck bay.

The crane was originally designed to handle 75 ton loads but is now considered to be a 60 ton crane. The 60-ton capacity is only obtainable when a load beam of appropriate size is slung under the ends of the crane's sheave block assembly. Contractor, Idaho Nuclear Corporation, modified the sheave block by installing a 40-ton hook (originally a Harnischfeger 8F 216-C2) in the center of the load beam and making appropriate modifications to the beam in 1969. The original Harnischfeger hook was replaced in the mid 1980s by a different model Harnischfeger 40-ton hook. The crane load block has two sheaves separated by a large beam. The crane hook is attached at the beam's center. The load block also has a lifting fixture at each end of the beam. Loads can be lifted either from the end fixtures where the beam can act as a spreader bar or from the center hook. The trolley travels 27 ft north to south on the crane bridge, and the maximum hook height is approximately 23 ft 8 in. above the ground level. The crane is equipped with electrical solenoids and mechanical brakes so that in the event of power loss, the crane movements lock up and the load is not dropped.

2.5 Permanent Containment Structure

The Permanent Containment Structure (PCS) (see Figure 2) is a hard walled structure in the cask receiving area that encloses the portion of the transfer car pit located outside the fuel handling cave. It provides containment of possible contamination that could be transferred out from the cave. Inside the PCS, a cask can be surveyed, vented, and decontaminated, if necessary, before

exposing it to the clean environment of the cask receiving area. The PCS is constructed of stainless-steel sheet and carbon-steel angle and channel. The PCS has top and side panels that can open to provide crane access and allow transfer of equipment to and from the cask transfer car. Walk-through doors on the east side of the PCS are provided for personnel access. The doors to the PCS are normally closed when the PCS is not being accessed.

2.6 Cask Transfer Pit

The cask transfer pit, which contains the cask transfer car, is approximately 10 ft wide, 44 ft long, and 18 ft deep (see Figures 2 and 3). The pit extends under the south wall of the fuel handling cave. Approximately one-half of the pit is located in the cask receiving area and the other half in the fuel handling cave. This pit along with the cask transfer car provides radiation shielding during transfer of fuel casks between these areas.

2.7 Cask Transfer Car TD-GSF-901

Cask transfer car TD-GSF-901 in combination with its associated transfer equipment (inserts, adapters, sliding saddles, and transfer devices) is used to support the fuel shipping casks and transfer them between the cask receiving area and fuel handling cave (Figure 5). When positioned in the cask receiving area, the cask transfer car is also capable of isolating the fuel handling cave from the cask transfer pit. This isolation maintains ventilation control and provides radiation shielding between the fuel handling cave and the cask receiving area.

The transfer car is 12 ft wide by 35 ft long, has a 12-in-thick steel deck and weighs 306,000 lbs without its load. The car is mounted on 12 railroad wheels that travel on two steel rails located in the cask transfer pit. The car has a rated capacity of 60 tons and has an overall travel distance of 14 ft. According to some documents, the car was originally designed to a 278 ton capacity, but was never tested to that capacity. A source for the 278 ton capacity has not been located.

The transfer car was fabricated with an 8-ft-7-in. diameter opening located approximately in the center of the car to accommodate various SNF cask configurations. Inserts are designed to adapt the opening in the transfer car to carry specific casks. When a shipping cask, charger, or other container arrives at the storage facility, the proper cask transfer car insert, and, in some cases, an additional adapter plate or device is placed in the cask transfer car opening to support the cask in the cask transfer car.

2.8 Fuel Handling Cave

The Fuel Handling Cave (see Figures 2 and 6) is used to receive fissile and radioactive materials transported in from the cask receiving area on the cask transfer car, transfer materials between shipping casks and storage containers, prepare materials for storage, and condition fuels in the

fuel conditioning station. Fuel is also examined in the fuel handling cave using the in-cell examination system equipment that is remotely operated from the control room. The fuel handling cave is equipped with handling equipment, shielding windows, video cameras, floor wells for temporarily storing fuel, and a shuttle bin for transferring fuel storage canisters between the fuel handling cave and the fuel storage area. In addition, the IFSF is serviced by the cask transfer car to move casks between the fuel handling cave and the cask receiving area.

2.9 Crane CRN-GSF-101

Crane CRN-GSF-101 is a double girder bridge 15 ton remotely operated overhead bridge crane, but is currently rated for 10 tons. The crane is used to move fuel storage canisters, remove and replace cask lids, load and unload fuel from casks, transfer fuel, and move equipment in the fuel handling cave. The maximum hook height of the crane is approximately 21 ft 6 in. (see Figure 3) above the top of the Cask Transfer Car, TD-GSF-901. The crane has sufficient bridge and trolley travel to permit access to all areas of the Fuel Handling Cave.

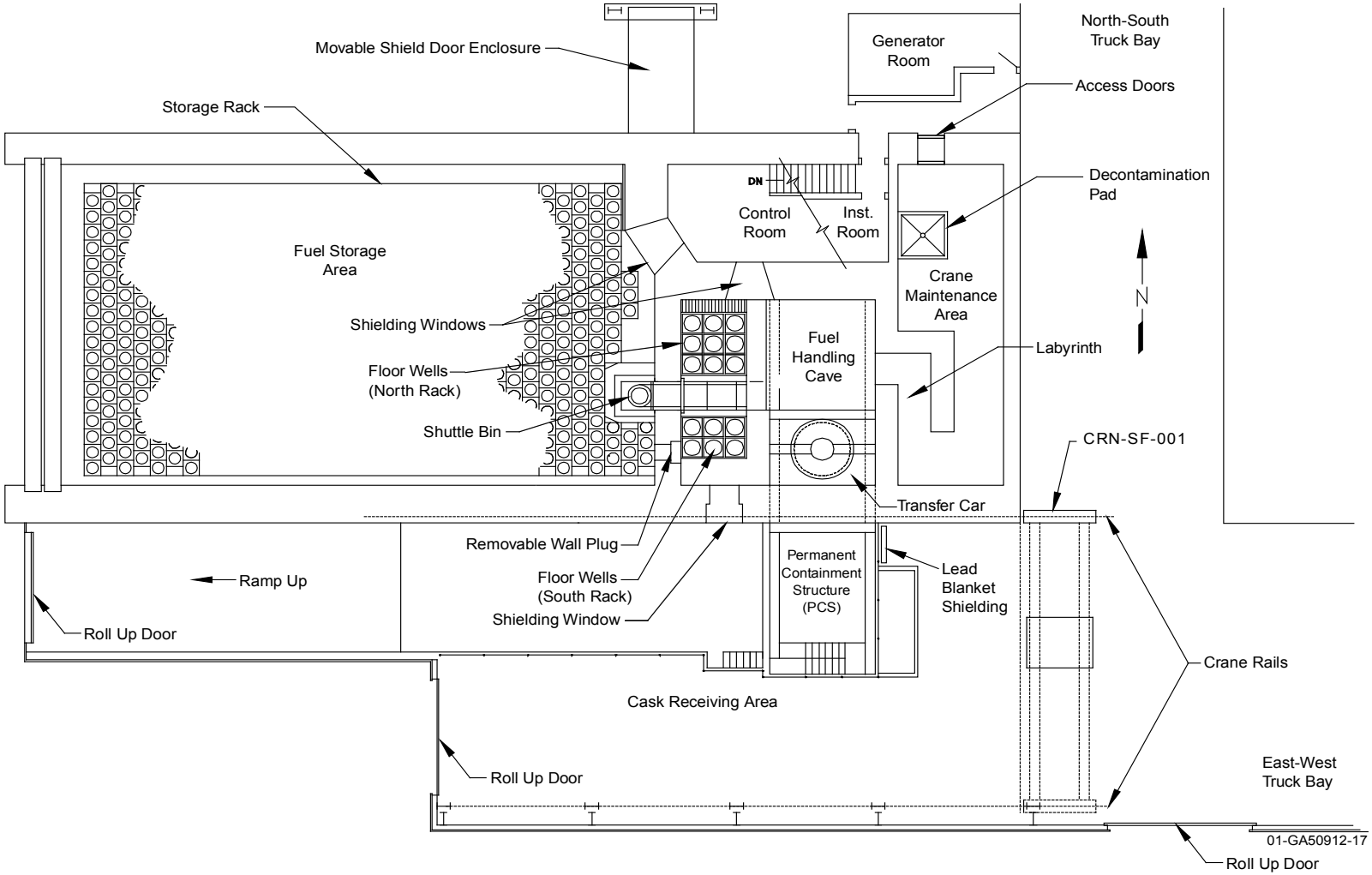

Figure 2. IFSF plan view.

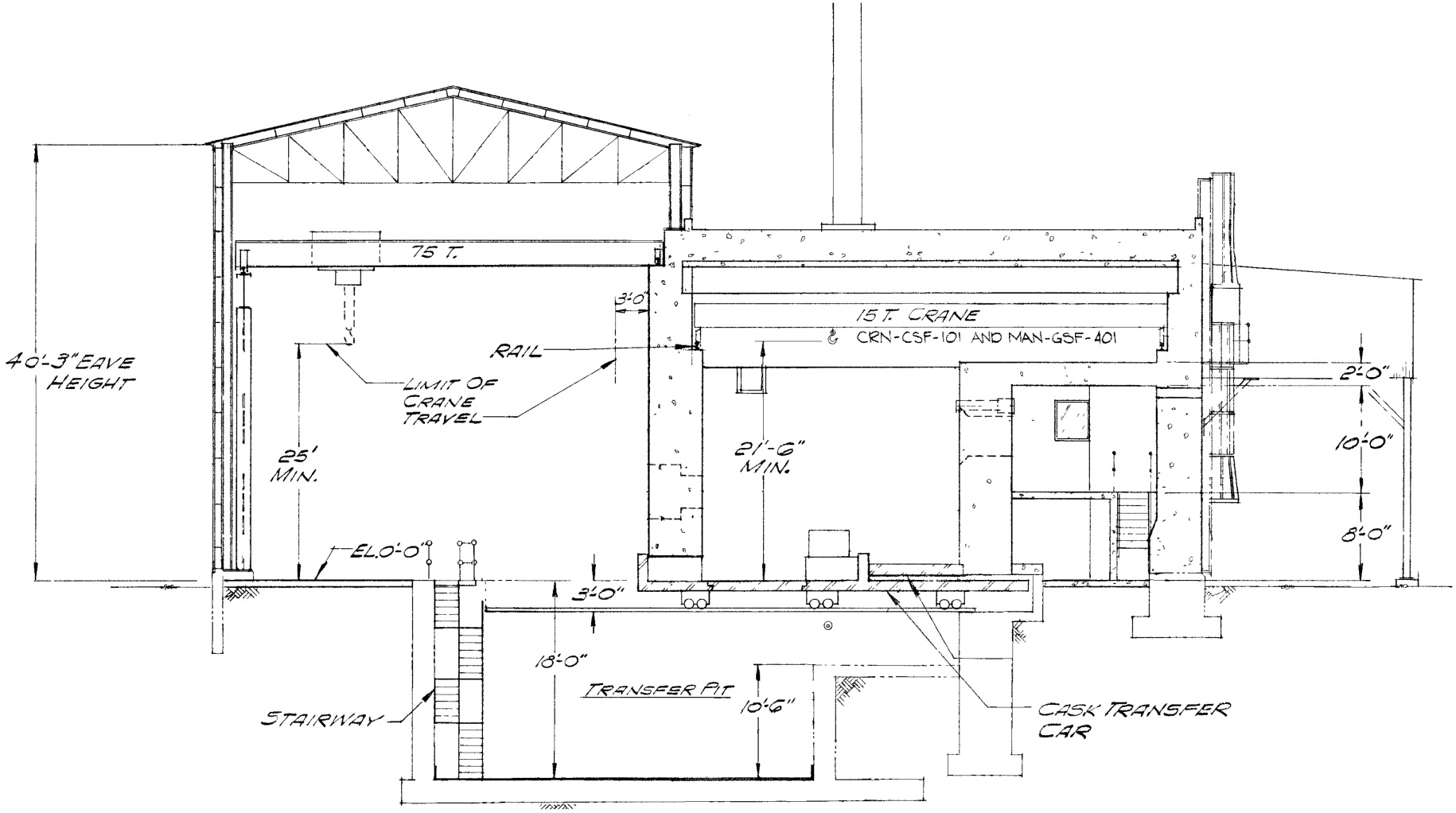

Figure 3. IFSF section view.

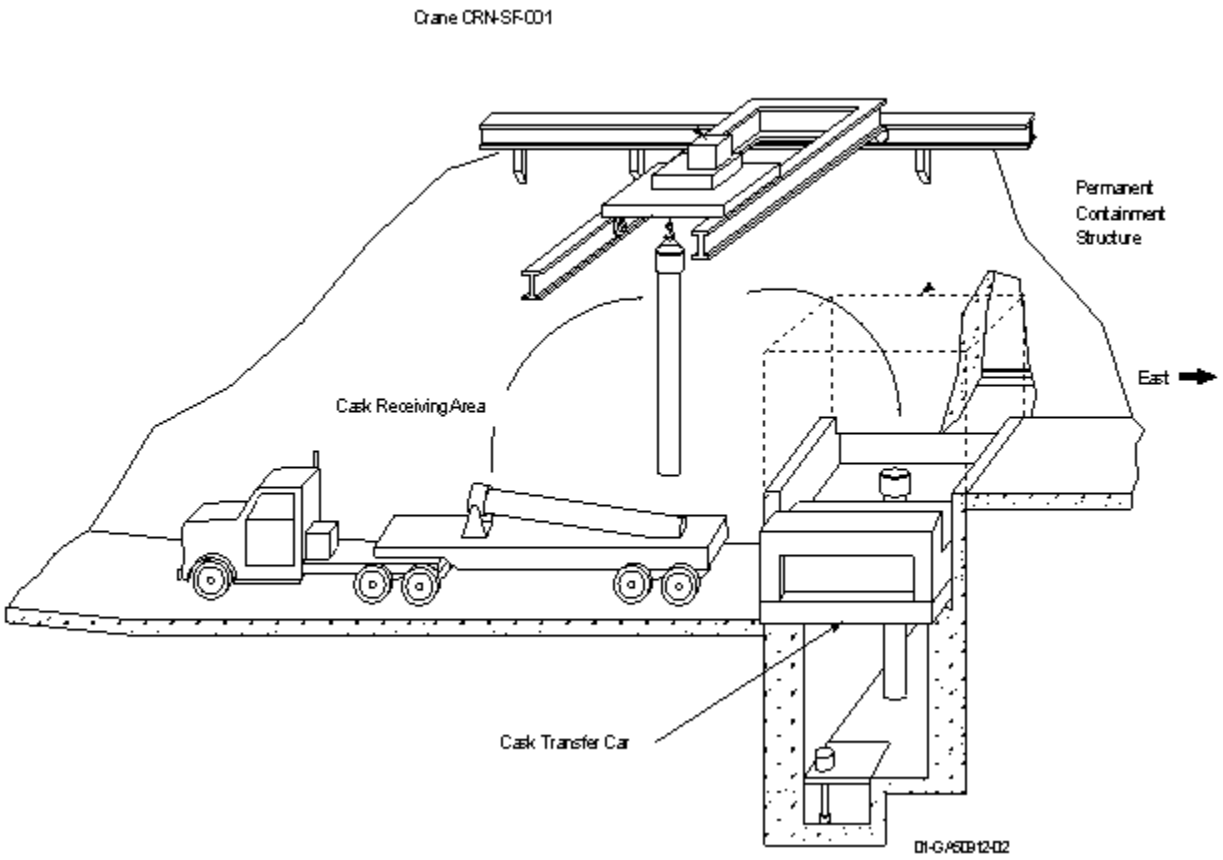

Figure 4. Cask Receiving Area Crane CRN-SF-001

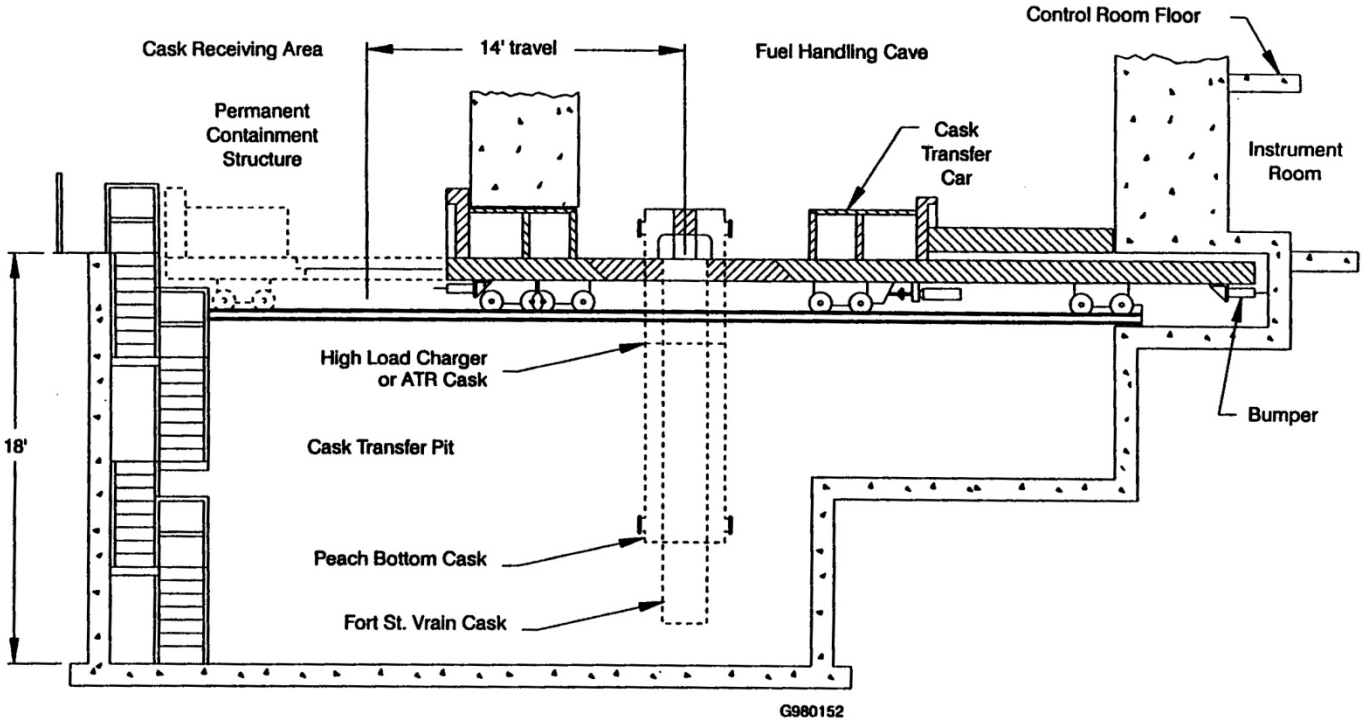

Figure 5. Side view showing transfer car over the transfer pit.

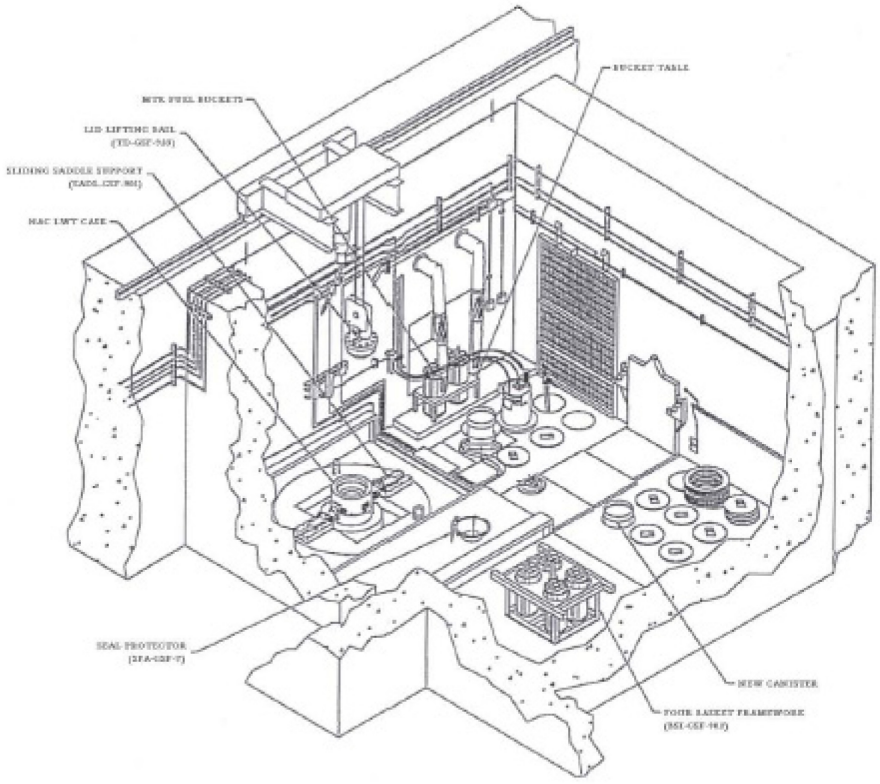

Figure 6. Fuel Handling Cave.

3. RESULTS

Dimensionally the REA-2023 cask can be placed into the IFSF Fuel Handling Cave and there is enough head room in the cave for the Surry Basket to be removed from the cask. Problems arise with the lift capacity of crane CRN-SF-001 and the rated load capacity of the transfer car TD-GSF-901.

Crane CRN-SF-001 was originally designed to handle 75 ton loads but is now considered to be a 60 ton crane. Cask REA-2023 has an actual loaded weight of 76.91 tons. This is a difference of 16.91 tons. EDF-9258 (Conceptual Structural Analysis for Crane Upgrade Capacity of CPP-603 East-West Truck Bay) concludes that the facility as currently constructed can handle a crane capacity of up to 85 tons without major building modifications. With the installation of an 85 ton crane, the REA-2023 cask could be lifted and placed into the transfer car. Another option would be to use a commercial hydraulic gantry system to lift the REA-2023 cask in the IFSF. A hydraulic gantry system has the capacity to lift up to 1100 tons and a hydraulic gantry system was used to place TAN casks on the CPP-2027 cask storage pad (see Figure A-3). Appendix A shows a conceptual layout of how a hydraulic gantry system could be located in the IFSF.

Transfer car TD-GSF-901 has a rated capacity of 60 tons. Cask REA-2023 has an actual loaded weight of 76.91 tons. This is a difference of 16.91 tons plus the weight of an insert design to support the REA-2023 cask. According to some documents, the car was originally designed to a 278 ton capacity, but was never tested to that capacity. A source for the 278 ton capacity has not been located. It appears that the transfer car has the capacity to place the REA-2023 cask into the Fuel Handling Cave but is not rated to do so. A structural analysis of the transfer car would need to be performed to determine if additional capacity is present.

Another concern would be the design of the insert to adapt the opening in the transfer car to carry the REA-2023 cask. The transfer car was fabricated with an 8-ft-7-in. diameter opening located approximately in the center of the car to accommodate various SNF cask configurations. The REA-2023 cask has a diameter of 7-ft-3.56 in. Compared to other casks handled by the transfer car, the REA-2023 cask has a much large diameter.

4. CONCLUSION

The IFSF as currently configured cannot receive the REA-2023 cask into the Fuel Handling Cave to remove the Surry fuel basket. In order for the REA-2023 cask to be transferred into the IFSF Fuel Handling Cave, the following measures would need to be completed:

1) A structural analysis of the transfer car TD-GSF-901 would need to be performed to determine if additional capacity is present. If this analysis does not significantly increase the rated capacity of the transfer car then the Surry fuel basket cannot be removed from the REA-2023 cask in the IFSF Fuel Handling Cave.

2) A new crane needs to be installed in the IFSF East-West truck bay. As stated in EDF-9258, the facility as currently constructed can handle a crane capacity of up to 85 tons without major building modifications. A new 85 ton crane would be able to lift the REA-2023 cask as loaded.

3) If a installing a new crane in the IFSF East-West truck bay proves too difficult or costly, another option would be to use a commercial hydraulic gantry system to lift the REA-2023 cask in the IFSF and place it in the transfer car TD-GSF-901. A hydraulic gantry system has the capacity to lift up to 1100 tons and a hydraulic gantry system was used to place TAN casks on the CPP-2027 cask storage pad. Appendix A shows a conceptual layout of how a hydraulic gantry system could be located in the IFSF.

5. REFERENCES

Drawing 154822, "CPP-603 Irradiated Fuels Storage Facility HTGR Building Sections," Rev. 5, October 10, 1972.

EDF-9258, "Conceptual Structure Analysis for Crane Upgrade Capacity of CPP-603 East-West Truck Bay," Rev. 0, J. L. Coleman, July 7, 2009.

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Packaging RSD Form, "REA-2023," August 17, 2004.

SDD-44, "CPP-603 Irradiated Fuels Storage Facility Transfer Car System," Rev. 5, October 31, 2007.

SDD-54, "CPP-603 Irradiated Fuels Storage Facility Building Structure," Rev. 5, October 31, 2007.

SDD-70, "INTEC CPP-603 Irradiated Fuels Storage Facility (IFSF) Fuel Handling Cranes," Rev. 4, October 31, 2007.

SDD-136, "CPP-2707 Dry Cask Storage Area Casks," Rev. 5, December 17, 2009.

6. APPENDIX A, Conceptual Layout of a Hydraulic Gantry System in the IFSF

A hydraulic gantry system has the capacity to lift up to 1100 tons and a hydraulic gantry system was used to place REA-2023 cask on the CPP-2027 cask storage pad. The layout of the hydraulic gantry system in the IFSF was developed with the computer software package Autodesk Inventor. The program used actual IFSF dimensions and visual scale of the hydraulic gantry system that was used to place the TAN casks on the CPP-2027 cask storage pad. Figures A-1 and A-2 show the proposed layout of the system in the IFSF. Figure A-3 shows a picture of the V-21 cask being lifted by a hydraulic gantry system at TAN.

Bigge Crane and Rigging Company was contacted about providing a hydraulic gantry system to place the REA-2023 cask into the IFSF Fuel Handling Cave. Bigge indicated that they believe they have a hydraulic gantry system that would fit in the IFSF and could lift and lower the REA-2023 cask into the transfer car.

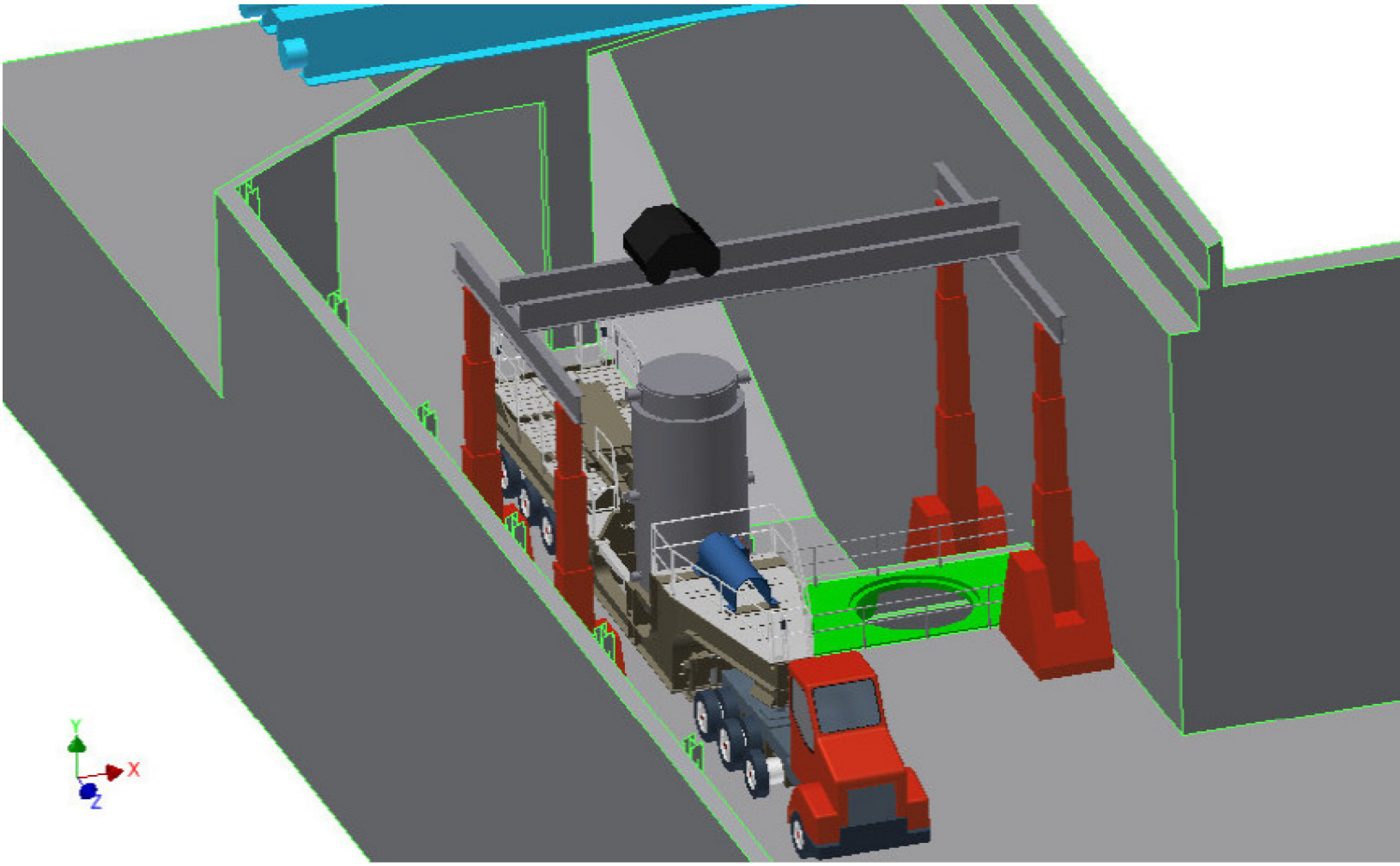

Figure A-1. Proposed layout of a hydraulic gantry system in the IFSF (View #1).

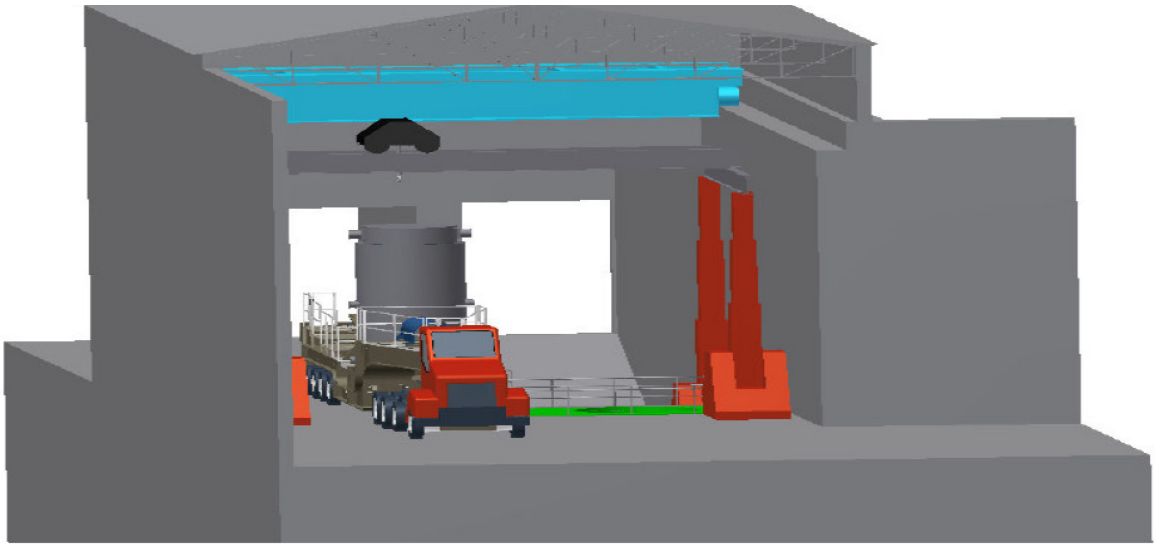

Figure A-2. Proposed layout of a hydraulic gantry system in the IFSF (View #2).

Figure A-3. Hydraulic gantry system lifting the V-21 Cask.