Appendix E
On Site Fuel Transportation

Docket No. 72-20

Intentionally Blank

CONTENTS

1. INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION 2
1.1 Introduction 2
1.1.1 Principle Function of the Installation 3
1.1.2 Location of the ISFSI 3
1.2 General Description of Installation 4
1.2.1 Arrangement of Major Structures and Equipment 4
1.2.2 Principal Design Criteria 5
1.3 General System Description 5
1.3.1 Storage Systems 5
1.3.2 Transfer Systems 5
1.3.3 Auxiliary Systems 8
1.3.4 System Operation 9
1.3.5 Arrangement of Storage Structures 9
1.4 Identification of Agents and Contractors 9
1.5 Material Incorporated by References 9
1.6 References 9

Intentionally Blank

APPENDIX E
ON-SITE TRANSERS OF NUHOMS®-12T DRY SHIELDED CANISTERS
USING THE OS-197 CASK

As stated in Section 1.3.2.1 of the Idaho National Engineering and Environmental Laboratory (INEEL) Three Mile Island Unit 2 (TMI-2) Site Safety Analysis Report (SAR) [1.1], the NUHOMS® -12T Dry Shielded Canisters (DSC) can be moved in any U.S. Nuclear Regulatory Commission (NRC) Part 72-approved cask. The OS-197 Transfer Cask, which is addressed in the standardized NUHOMS® SAR [1.2], is one such cask. Of note, the OS-197 Cask system has been successfully used for the transfer of spent nuclear fuel at Davis-Besse, Duke and Baltimore Gas and Electric. This appendix provides the detailed information necessary to demonstrate that the design of the OS-197 Cask is such that transfers of the -12T DSCs between the INEEL Test Area North (TAN) Site and the Idaho Nuclear Technology and Engineering Center (INTEC) can be performed safely and in accordance with all applicable regulations.

In general, the OS-197 Cask design is based on conditions that envelope those that will apply at INEEL during transfer operations. Table E1.0-1 presents a comparative summary of the OS-197 Cask design basis conditions versus those that will apply when transferring the -12T DSCs at INEEL.

With the exception of seismic requirements, all mechanical loading conditions applicable at INEEL are enveloped by the OS-197 Cask design basis. The significance of the increased seismic acceleration magnitudes is addressed and shown to be acceptable in Section 8.2.1 of this appendix. Of note, a consideration of route-specific hazards concluded that the OS-197 Cask design basis accident drop decelerations remain applicable for the TAN-to-INTEC transfer. The only aspect of the route that provides the potential for an accident that is more significant than an 203 cm (80-in.) drop onto the independent spent fuel storage installation (ISFSI) pad is the Lincoln Boulevard bridge near NRF. As addressed in Section 2.1.2 of this appendix, appropriate operational controls are imposed at the bridge to eliminate this potential hazard.

In addition to mechanical loading conditions, the internal heat load associated with the -12T DSCs is significantly less than the corresponding OS-197 Cask design basis, as is the extreme "hot" ambient temperature. The OS-197 Cask design basis "cold" temperature of -40 °C (-40 °F) is somewhat above the -45.6 °C (-50 °F) applicable at INEEL, but operational restrictions do not allow transfers to initiate when ambient falls below -17.8 °C (0 °F).

With reduced mechanical loads and reduced internal heat loads, only radiological issues associated with use of the OS-197 Cask for transfers of –12T DSCs require detailed assessment. Considering the actual route to be used between TAN and INTEC, and the actual shielding provided by the OS-197 Transfer Cask, new radiological assessments have been performed as documented in Sections 7.0 and 8.2.4.1of this SAR Appendix. All dose rates and doses to operators and the general public are shown to be well within their respective limits.

Table E1.0-1
OS-197 Design Basis Conditions Versus Those Applicable When Transferring –12T DSCs at INEEL

Parameter/Condition	OS-197 Design Basis	Applicable at INEEL
Canister max weight	40,800 kg (90,000 lb)	31,750 kg (70,000 lb)
Gross weight of loaded OS-197 Cask	86,200 kg (190,000 lb)	77,100 kg (170,000 lb)
Max hydraulic ram push-pull force	36,300 kg (80,000 lb)	31,750 kg (70,000 lb)
Max internal heat	24.0 kW	0.86 kW
Extreme ambient temperature range	-40 to 51.7 °C (-40 to 125 °F)	-45.6 to 39.4 °C (-50 to 103 °F)
Earthquake	0.25*g* horizontal 0.17*g* vertical	0.36*g* horizontal 0.24*g* vertical
Tornado winds	Max wind pressure: 19 kPa (397 psf) Max wind speed: 579 km/h (360 mph)	Max wind pressure: 5.9 kPa (123 psf) Max wind speed: 322 km/h (200 mph)
Tornado missiles	Region I (worst case for any region)	Region III
Accident cask drops	Equivalent static deceleration of 75*g* for vertical end drops and horizontal side drops, 25*g* for oblique corner drop	Equivalent static deceleration of 75*g* for vertical end drops and horizontal side drops, 25*g* for oblique corner drop

1. INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

1.1 Introduction

The ISFSI to be constructed at the INEEL is described in the INEEL TMI-2 ISFSI SAR [1.1]. The ISFSI is to be constructed at the INTEC for interim storage of TMI-2 core and core handling debris. The TMI-2 core debris is currently in stainless steel canisters that are stored in a fuel pool at the TAN Site.

When the ISFSI is completed, the TMI-2 core debris will be transferred from the TAN Facility approximately 48 km (30 mi) to the INTEC Site. The original plan, as documented in the INEEL TMI-2 ISFSI SAR [1.1], was to transfer the TMI-2 core debris using the Multi-Purpose MP-187 Transfer/Storage and Transportation Cask. The MP-187 Cask has a 10 CFR 71 license and is approved for over-the-highway transportation. Currently, the MP-187 Cask will not be available to support all of the TMI-2 core debris transfer operations, and the use of the

NUHOMS® OS-197 Transfer Cask is proposed as an alternate. The OS-197 Cask is licensed to the requirements of 10 CFR 72 and is described in the Standardized NUHOMS® SAR [1.2].

As stated in Section 1.3.2.1 of the INEEL TMI-2 ISFSI SAR, the NUHOMS®-12T DSCs can be moved using any NRC 10 CFR 72 [1.3]-approved transfer cask. As described in the Standardized NUHOMS® SAR [1.2], the OS-197 Transfer Cask is approved for the transfer of NUHOMS®-24P or 52B DSCs. The purpose of this appendix is to demonstrate that the OS-197 Cask can be used as an alternate to the MP-187 Cask and meets the design basis requirement in the INEEL TMI-2 ISFSI SAR [1.1].

This report is to be included as Appendix E of the INEEL TMI-2 ISFSI SAR and is written in the same format as the original SAR. All major sections of the original SAR will be addressed by indicating no change or including the new text. The TMI-2 core debris transfer is a one-time campaign and will occur over INEEL Site roads and an 8 km (5-mi) section of remote public highway that will be closed to the public. No other transfer campaigns are planned on the INEEL Site for the OS-197 Cask. The specific transfer route and all hazards and credible accidents were evaluated and are presented in this appendix. Should an off-normal event occur during transfer of the loaded OS-197 Cask, the transfer cask and contents can be returned to the TAN Facility for unloading and inspection.

1.1.1 Principle Function of the Installation

Covered in INEEL TMI-2 ISFSI SAR [1.1].

1.1.2 Location of the ISFSI

Covered in INEEL TMI-2 ISFSI SAR. However, movement of the OS-197 Cask from TAN to INTEC will be treated as an on-site transfer in compliance with 10 CFR 72 requirements [1.3] and public access will be denied to the small portion of Idaho Highway 33 which crosses the INEEL during public highway transfer operations.

1.1.3 Activities and Facilities to be Licensed.

The OS-197 Transfer Cask is to be licensed for use as a transfer cask on the INEEL site to ship TMI-2 core debris from TAN to INTEC.

1.2 General Description of Installation

1.2.1 Arrangement of Major Structures and Equipment

This section is covered by the INEEL SAR, except for the following:

A typical NUHOMS® OS-197 transfer arrangement is illustrated in Figure E1.2-1.

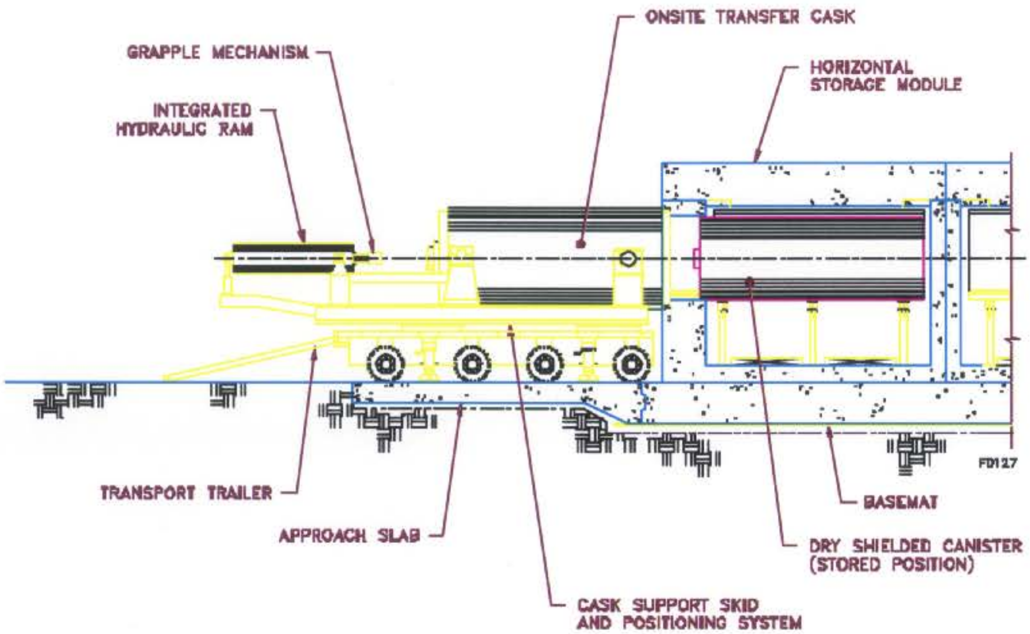


Figure E1.2-1
Typical NUHOMS® System Components, Structures, And Transfer Equipment Using OS-197 Cask

1.2.2 Principal Design Criteria

The key design parameters for the MP-187 Cask and the OS-197 Cask are provided in Table E1.2-1.

Table E1.2-1
Key 10 CFR 72 Design Parameters of the MP-187 Cask and OS-197 Cask

Criteria or Parameter	MP-187 Cask[a] Value	OS-197 Cask[b] Value
Payload	37,000 kg (82,000 lb)	36,300 kg (80,000 lb) dry 40,900 kg (90,000 lb) wet
Gross Weight	113,000 kg (250,000 lb) handling 109,000 kg (240,000 lb) transfer 128,000 kg (282,000 lb) 10 CFR 71 transportation	90,700 kg (200,000 lb) handling 86,200 kg (190,000 lb) transfer
Equivalent Cask Drop Deceleration	75*g* vertical (end) and horizontal (side) 25*g* oblique (corner)	75*g* vertical (end) and horizontal (side) 25*g* oblique (corner)

[a]Design basis of MP-187 Cask, References 1.4 and 1.5.
[b]Design basis of OS-197 Cask, Reference 1.2.

1.3 General System Description

1.3.1 Storage Systems

Covered in INEEL TMI-2 ISFSI SAR.

1.3.2 Transfer Systems

1.3.2.1 Transfer Cask

As stated in Section 1.3.2.1 of the INEEL TMI-2 ISFSI SAR, the NUHOMS®-12T DSCs can be moved on-site using any NRC 10 CFR 72 approved transfer cask. It was originally intended to transfer the TMI-2 DSCs from TAN to INTEC using the MP-187 Cask. However, the MP-187 Cask will not be available for the entire shipping campaign and it is proposed that the OS-197 Transfer Cask be used as an alternate. The NUHOMS® OS-197 Transfer Cask System provides shielding and protection from potential hazards in accordance with 10 CFR 72 during DSC closure operations and transfer to the Horizontal Storage Module (HSM). The OS-197 Transfer Cask has a maximum gross weight of 90.7 Te (100 tons) and is approved for on-site use under 10 CFR 72 [1.2].

The OS-197 Transfer Cask has a 5.00 m (196.75-in.) long inner cavity, a 1.73 m (68-in.) inside diameter and a maximum payload capacity of 36,300 kg (80,000 lb) dry and 40,900 kg (90,000 lb) wet. The transfer cask is designed to meet the requirements of 10 CFR 72 for on-site transfer of the TMI-2 DSCs from the TAN Facility to the HSM. As shown in Figure E1.3-1, the main transfer cask body is constructed from two concentric cylindrical steel shells with a bolted top cover plate and a welded bottom end assembly. The annulus formed by these two shells is filled with cast lead to provide gamma shielding. The transfer cask also includes an outer steel jacket, which can be filled with water for neutron shielding. The top and bottom end assemblies incorporate a solid neutron shield material.

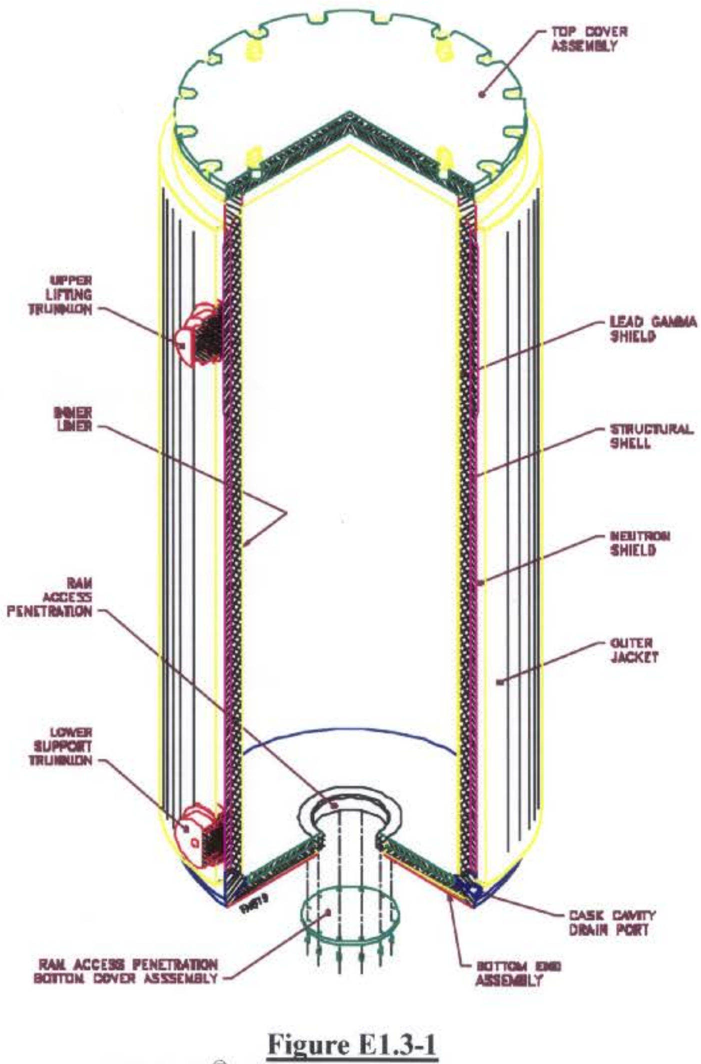
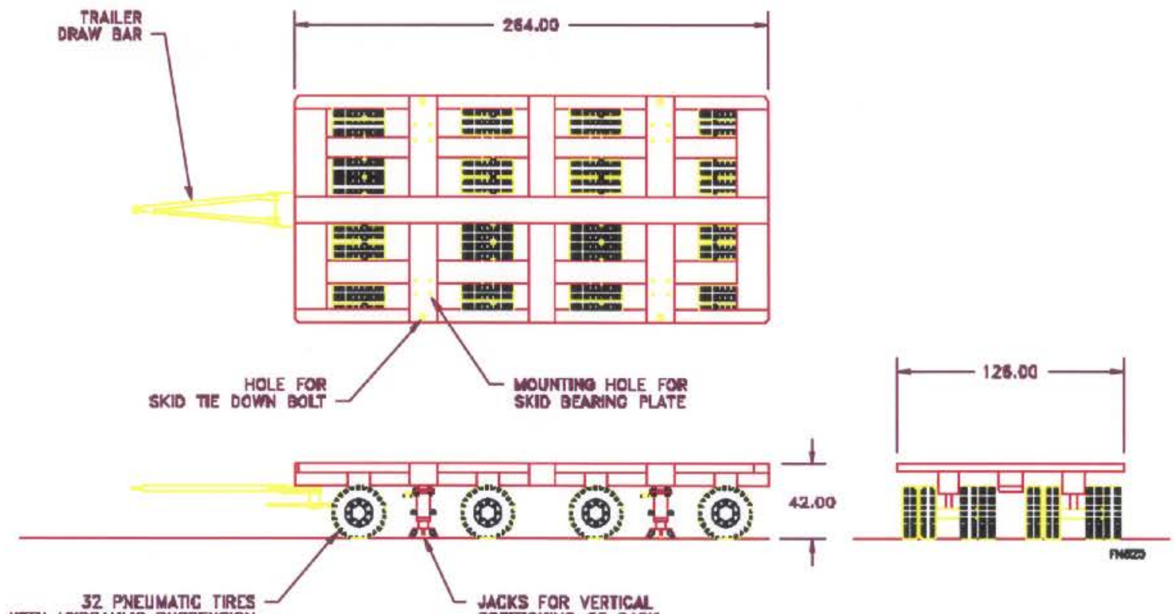


Figure E1.3-1
NUHOMS® OS-197 On-Site Transfer Cask

The transfer cask is designed to provide sufficient shielding to ensure that dose rates are ALARA. Two lifting trunnions are provided for handling the transfer cask at the TAN Facility using a lifting yoke and an overhead crane. Lower support trunnions are provided on the cask for pivoting the transfer cask from/to the vertical and horizontal positions on the support skid/transfer trailer. A cover plate is provided to close the bottom hydraulic ram access penetration of the cask during loading.

1.3.2.2 Transfer Equipment

Transfer Trailer: The NUHOMS® OS-197 Transfer Trailer has been used to successfully transfer casks at other nuclear plants and consists of a heavy industrial trailer with a payload capacity of 113.4 Te (125 tons). The trailer will be used to transfer the cask support skid and the loaded transfer cask between the TAN Facility and the ISFSI. The trailer is designed to ride as low to the ground as possible to minimize the transfer cask height during DSC transfer operations. Figure E1.3-2 shows the heavy haul industrial trailer used with the standardized NUHOMS® system. The trailer is equipped with four hydraulic leveling jacks to provide vertical travel for alignment of the cask with the HSM. The trailer is towed by a conventional heavy haul truck tractor or other suitable prime mover. The nominal trailer bed height during canister transfer to the HSM is such that the transfer cask is typically not elevated more than 1.68 m (5.5 ft) above grade as measured from the lowest point on the cask. This is well below the 2.0 m (80-in.) drop height used as the accident drop design basis of the cask and canister.



Nominal dimensions, in inches.

Figure E1.3-2.
Transfer Trailer for the NUHOMS® OS-197 Cask System

Cask Support Skid: The NUHOMS® OS-197 Cask support skid is similar in design and operation to other cask skids used for on-site transfer of spent fuel. The main difference is that the hydraulic ram is mounted with the skid on the trailer.

The cask support skid utilized for the Standardized NUHOMS® OS-197 System is illustrated in Figure E1.3-3. The TAN Facility crane is used to lower the cask onto the support skid, which is secured to the transfer trailer. The cask support skid is approximately 1.5 m (5 ft) high at the trunnion supports x 3.2 m (10.5 ft) wide x 7.3 m (24 ft) long. With the ram in place, the overall length of the skid and ram is approximately 8.2 m (27 ft). During transfer operations the bottom of the transfer cask is approximately 1.5 m (5 ft) above the ground surface when secured to the support skid/transfer trailer as discussed above.

Hydraulic Ram: The hydraulic ram system consists of a hydraulic cylinder with a capacity and a reach sufficient for DSC loading and unloading to and from the HSM. The hydraulic ram has a capacity of 360 kN (80,000 lbf) and a piston stroke of 6.5 m (21.5 ft). For use at INEEL, the hydraulic ram capacity will be limited to 315 kN (70,000 lbf). Figure E1.3-3 shows the NUHOMS® OS-197 Cask hydraulic ram system. The design of the ram support system provides a direct load path for the hydraulic ram reaction forces during DSC transfer. The system uses an adjustable rear ram support for alignment at the rear of the ram, and a fixed set of trunnion towers as a front support. The design provides positive alignment of the major components during DSC transfer. During DSC transfer the ram reaction forces are transferred through the frame support into the transfer cask, and from the cask to the HSM through the cask restraints.

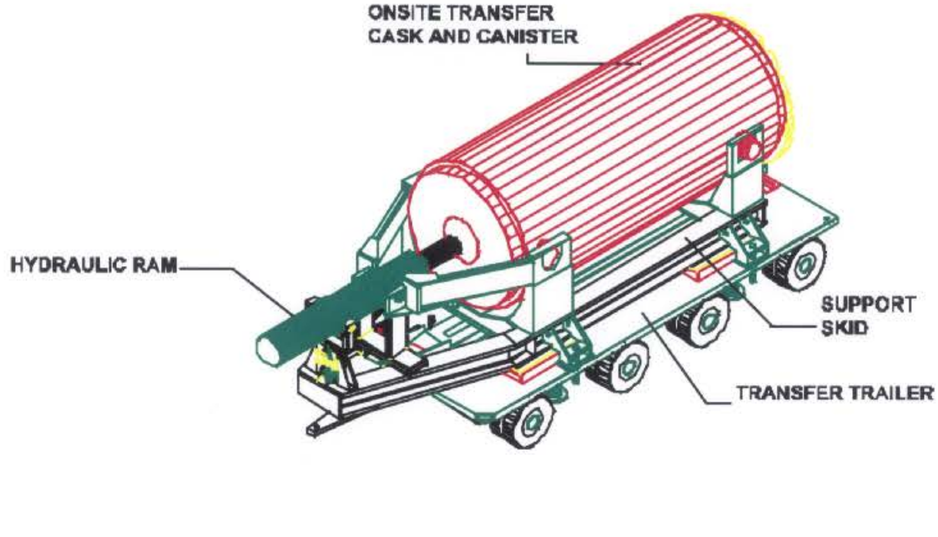


Figure E1.3-3
Typical NUHOMS® OS-197 Cask Support Skid and Hydraulic Ram System

1.3.3 Auxiliary Systems

Covered in INEEL TMI-2 ISFSISAR [1.1].

1.3.4 System Operation

The general on-site system operations for the OS-197 Cask are similar to that of the MP-187 Cask, except that the OS-197 Cask does not have impact limiters, will not be helium leakage rate tested, and cannot be used as a 10 CFR 71-approved transfer cask.

1.3.5 Arrangement of Storage Structures

Covered in INEEL TMI-2 ISFSISAR [1.1].

1.4 Identification of Agents and Contractors

Covered in INEEL TMI-2 ISFSISAR [1.1].

1.5 Material Incorporated by References

This SAR Appendix is self contained and keeps references to other documents to a minimum.

1.6 References

1.1 *The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation*, Docket No. 72-20, Rev. 1, March 1999.

1.2 *Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel*, NUH-003, Rev. 4A, VECTRA Technologies, Inc., June 1996.

1.3 Title 10, *Code of Federal Regulations*, Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste," U.S. Nuclear Regulatory Commission, January 1, 1997.

1.4 *Safety Analysis Report for the NUHOMS® - MP-187 Multi-Purpose Cask*, NUH-005, Revision 9, Transnuclear West, Inc., NRC Docket Number 71-9255, September 1998.

1.5 *Safety Analysis Report for the Rancho Seco Independent Spent Fuel Storage Installation*, Sacramento Municipal Utility District, NRC Docket Number 72-11, October 1993.

Intentionally Blank.

CONTENTS

2. Site Characteristics 1

2.1 Geography and Demography of Site Selected 1

2.1.1 Site Location 1

2.1.2 Site Description 1

2.1.3 Population Distribution and Trends 7

2.1.4 Uses of Nearby Land and Waters 7

2.2 Nearby Industrial, Transportation and Military Facilities 7

2.3 Meteorology 7

2.4 Surface Hydrology 7

2.5 Subsurface Hydrology 7

2.6 Geology and Seismology 7

2.7 Summary of Site Conditions Affecting Construction and Operating Requirements 7

2.8 References 8

Intentionally Blank

2. SITE CHARACTERISTICS

The Three Mile Island –2 Independent Spent Fuel Storage Installation (INEEL TMI-2 ISFSI) is located at the Idaho Nuclear Technology and Engineering Center (INTEC), which is in the Idaho National Engineering and Environmental Laboratory (INEEL). Site characteristics are thoroughly described in the Site Safety Analysis Report (SAR) [2.1]. This chapter adds additional site features encountered during the one-time on-site transfer campaign from Test Area North (TAN) to INTEC using the OS-197 Transfer Cask.

In general, the existing INEEL TMI-2 ISFSI SAR covers the meteorology, hydrology, seismology, geology, volcanism, and demographics of the route from TAN to INTEC. The purpose of this chapter is to describe the transfer route and identify any features that require evaluation in support of the transfer of the loaded OS-197 Cask.

2.1 Geography and Demography of Site Selected

Covered in INEEL TMI-2 ISFSI SAR [2.1].

2.1.1 Site Location

The location of the INEEL TMI-2 ISFSI is described in the Reference 2.1 Document.

The route from TAN to INTEC is approximately 48 km (30 mi). As shown in Figure E2.1-1, TAN is located approximately 48 km (30 mi) north, north east of INTEC, entirely within the INEEL site. The TAN facility is located just north of Idaho Highway 33. Figure E2.1-2 shows the routing of the loaded OS-197 Cask in the vicinity of TAN and onto Lincoln Boulevard. Figure E2.1-1 shows the routing of the loaded OS-197 Casks southwest along Lincoln Boulevard. Figure E2.1-3 shows the routing of the loaded OS-197 Cask from Lincoln Boulevard to the ISFSI in INTEC.

2.1.2 Site Description

The description of the INEEL TMI-2 ISFSI is found in the Reference 2.1 Document.

Figure E2.1-1 indicates the shortest distance, 8.5 km (5.3 mi), from the OS-197 Cask transfer route to the INEEL boundary.

The majority of the transfer route is the same as used to move the TMI-2 canisters to TAN in the late 1980s. Information for the route was taken, in part, from the *Safety Analysis Report for Transportation of TMI-2 Core Debris to and across INEL* [2.2]. It is important to note that much of the roadway was rebuilt by Project S-597140 in fiscal year 1990.

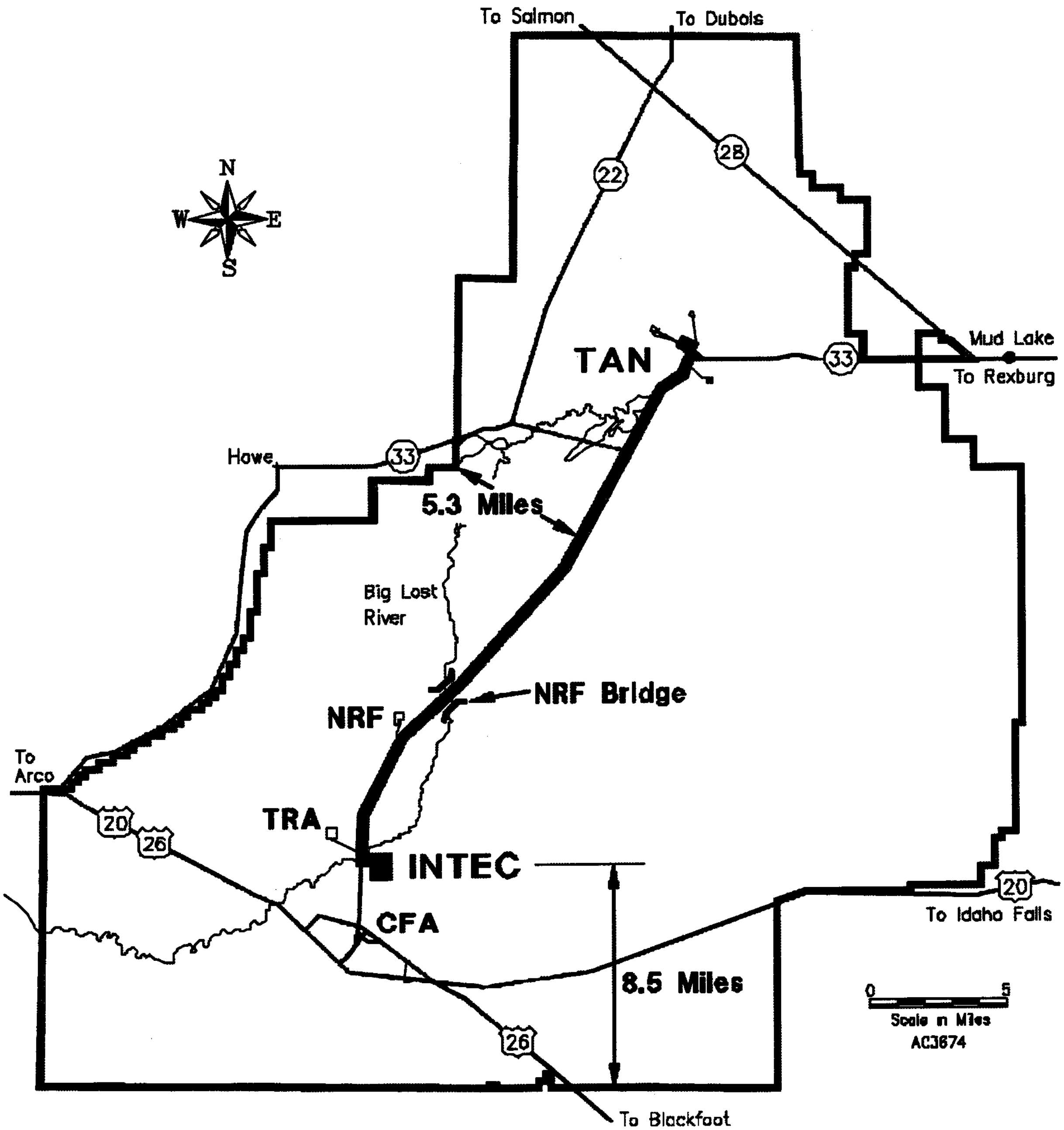
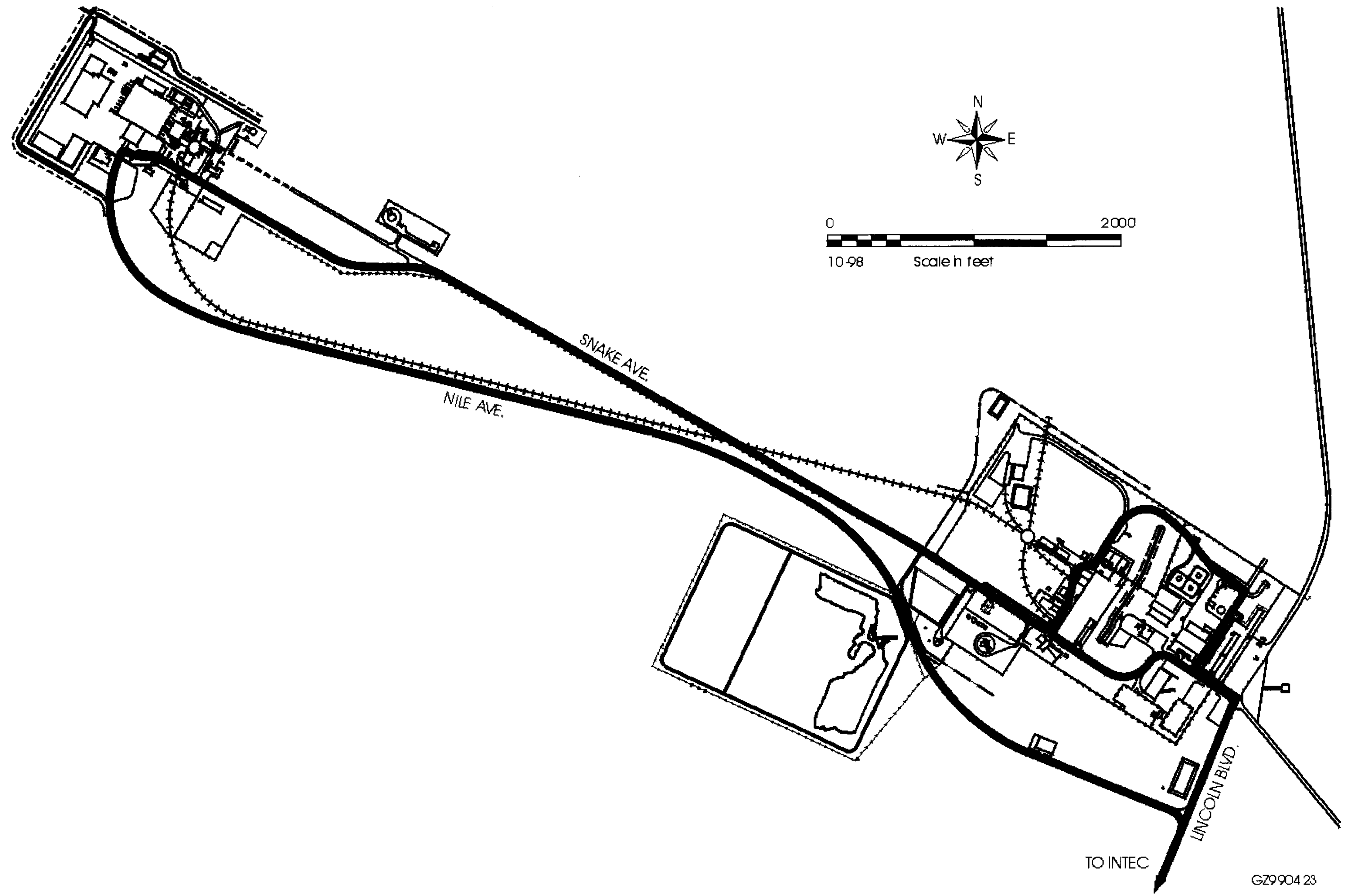


Figure E2.1-2
Map of Idaho National Engineering and Environmental Laboratory.

Figure E2.1-3
Routing of OS-197 Cask in the Vicinity of TAN.



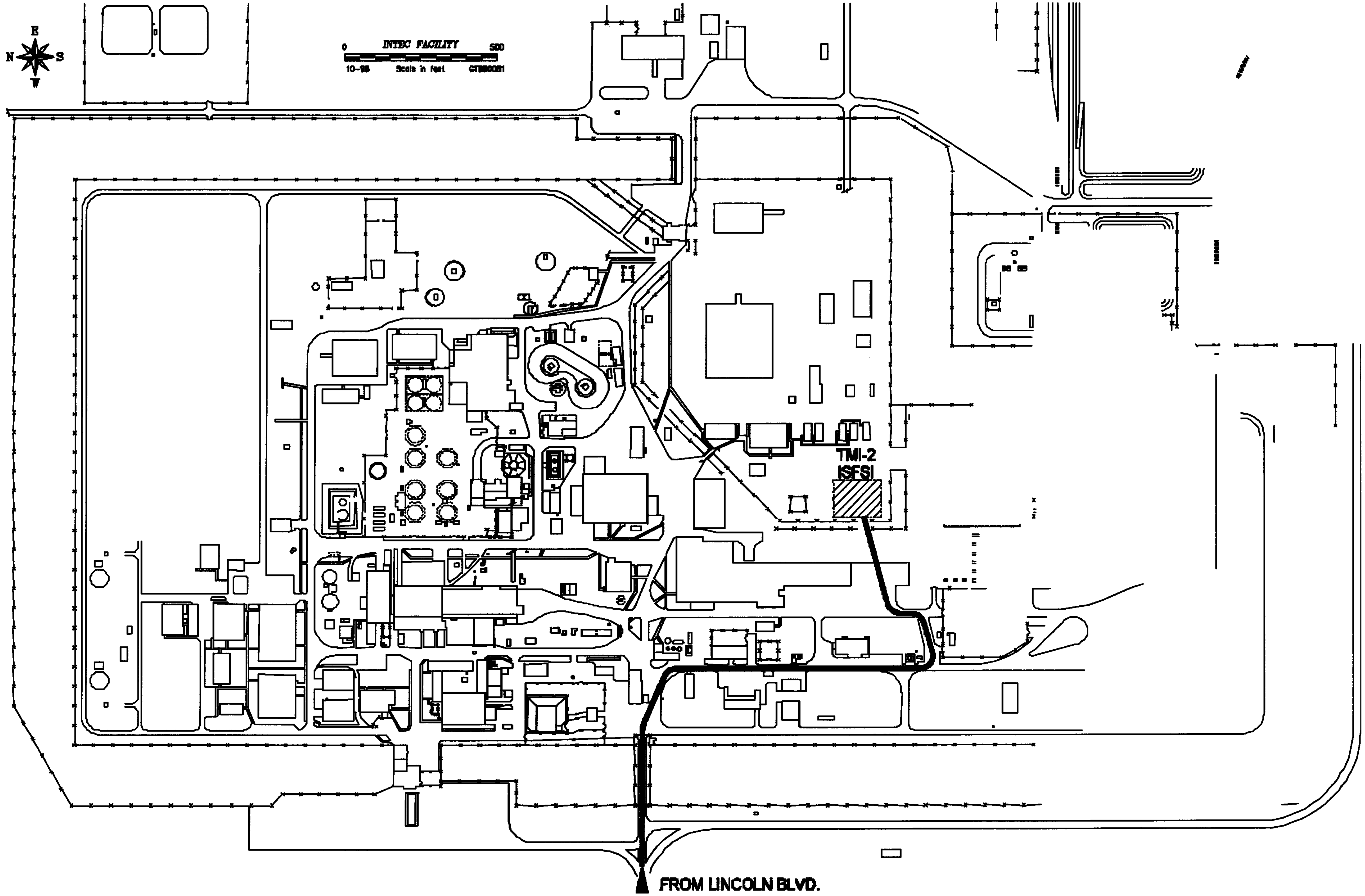


Figure E2.1-4.
INTEC Area Plot Plan

The road surface over the route is paved asphalt or concrete (i.e., no unpaved areas exist) and, as such, is well suited for routine truck transport. In 1986, all important aspects of the route were evaluated and found to be, or made to be, acceptable for the TMI-2 fuel canister transfers that were to be performed using the NuPac 125-B Cask [2.2]. Subsequently, the route was reevaluated in 1997 for the transportation of the canisters in the MP-187 Cask and was found to be acceptable. The gross weight of the OS-197 Cask is 20% less than the MP-187 Cask and only about 5% more than the NuPac 125-B Cask (used without impact limiters).

The same route has also been used for many other heavy-load transfers with some weighing up to 362,874 kg (800,000 lb). These previous transfers, the 1990 roadway upgrades, and the recent evaluation for the MP-187 transport demonstrate that roadway stability is not of concern and that the route is more than suitable for the OS-197 Cask transfer operation. Turning radii and site clearances at major corners have also been reviewed and are adequate for safe operation. Vertical clearances are greater than required. The lowest clearance is a telephone cable near the entrance gate to TAN at 4.83 m (15 ft-10 in.) above the ground.

The road surface along the entire route is generally flat and over 11 m (36 ft) wide with soil shoulders. Consequently, the worst-case accidental drop is postulated to occur at the ISFSI pad (203 cm [80-in.] drop onto 76 cm [30-in.-] thick, under-reinforced concrete slab), which provides greater resistance to a dropped transfer cask than would any roadway or immediately adjacent roadway surface. The only possible exception to this is at the Lincoln Boulevard bridge near NRF, which is discussed in detail below. By demonstrating bridge integrity and by imposing administrative controls, which will ensure that an accident on the bridge is not credible, an accident at the ISFSI pad remains as the worst case to be considered.

2.1.2.1 Bridge Integrity

The Lincoln Boulevard bridge over Big Lost River has a 13.4 m (44-ft) span and a rail-to-rail width of 10.4 m (34 ft-4 in.). This width exceeds the 8.6 m (28.5-ft) roadway width considered safe for transfer of the OS-197 Cask (i.e., 3.2 m [10.5-ft] trailer width plus 2.7 m [9 ft] on each side of the trailer). The bridge is a reinforced concrete structure, which was upgraded by adding precast, prestressed beams to provide adequate capacity for the 1986, TMI-2 canister transfers in the 125-B Cask. In addition, the bridge has been evaluated for transport of the MP-187 Cask and found to be adequate subject to the following restrictions.

1. The load shall traverse the bridge no faster than 8 km/h (5 mph) to reduce the possibility of impact loading the structure.

2. The transporter shall not normally stop on the bridge.

3. The transporter shall travel down the centerline of the bridge (Figure E2.1-4).

With the previously noted, 20% reduction in loaded OS-197 Cask weight versus the MP-187 Cask weight, the bridge is acceptable for OS-197 Cask transfers if these same restrictions are applied. Of note, although the OS-197 Cask trailer has only four axles (versus

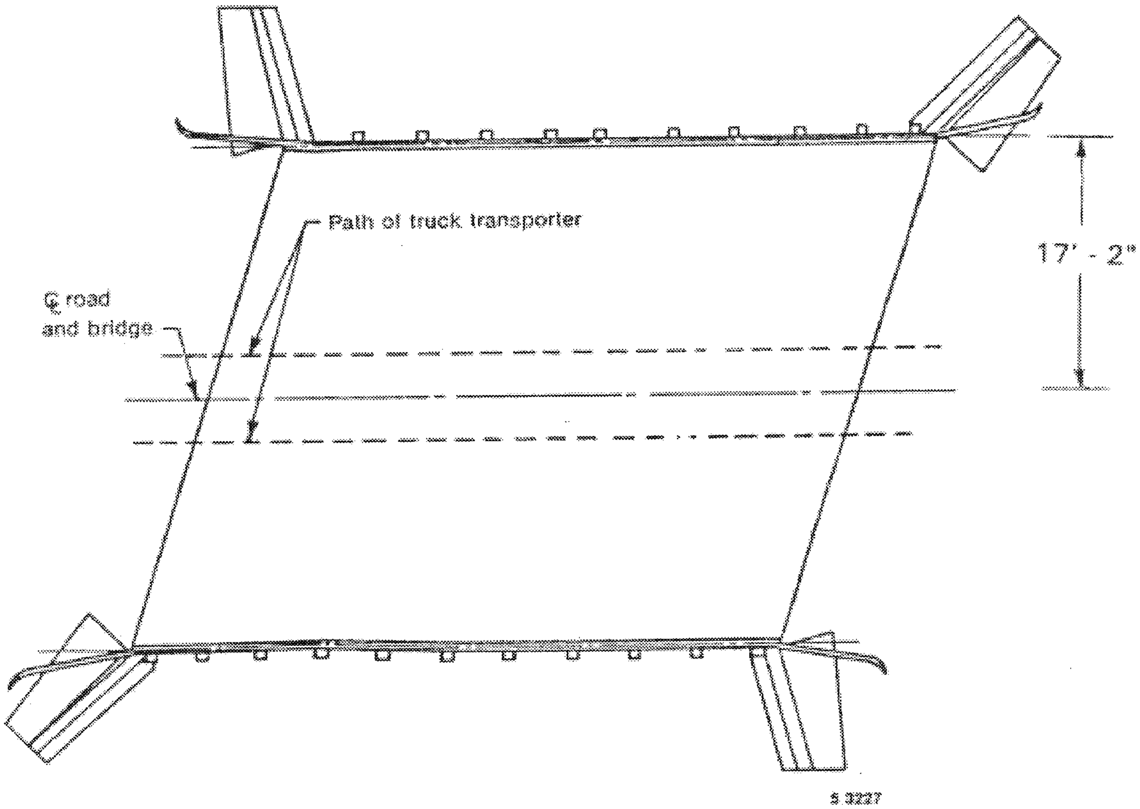


Figure E2.1-4
Transfer Path of Truck Transporter Across the Lincoln Boulevard Bridge.

five for the MP-187 Cask), the load per axle is identical due to the 20% lower total weight for the loaded OS-197 Cask (i.e., 80% of the load and 80% of the axles). Finally, prior to the first transfer of a loaded OS-197 Cask across the bridge, a trial run with a simulated maximum canister load will be made as an added verification of bridge integrity.

2.1.2.2 Potential Accident at the Lincoln Boulevard Bridge

The last item to be addressed is the possibility of a drop accident at the bridge that could be more severe than at the ISFSI pad. With no oncoming or cross-traffic and a very limited time spent on the bridge (e.g., less than 10 seconds per transfer when at 8 km/h [5 mph] for the 13.4 m [44-ft] bridge plus 6.7 m [22-ft] trailer), the only way for a more severe (i.e., greater drop height) accident to occur would be for the transporter to be driven off the side of the bridge. By requiring the trailer to be driven down the center of the bridge at low speed, and by imposing a few additional operational constraints, such an accident becomes noncredible. The specific constraints are as follows. These are in addition to (or refinements of) the constraints needed to ensure bridge integrity as presented in Section 2.1.2.1 of this appendix.

1. The centerline of the transporter is required to be within 0.6 m (2 ft) of the centerline of the bridge when any portion of the trailer is on the bridge surface.

2. Transfers between TAN and INTEC will only occur under conditions of good visibility.

3. Transfers between TAN and INTEC will not take place if snow or ice exists on the bridge surface.

2.1.3 Population Distribution and Trends

The description for the INEEL TMI-2 ISFSI is described in the SAR [2.1].

2.1.4 Uses of Nearby Land and Waters

Covered in the INEEL TMI-2 ISFSI SAR.

2.2 Nearby Industrial, Transportation and Military Facilities

Covered in the INEEL TMI-2 ISFSI SAR.

2.3 Meteorology

Covered in the INEEL TMI-2 ISFSI SAR.

2.4 Surface Hydrology

Covered in the INEEL TMI-2 ISFSI SAR.

2.5 Subsurface Hydrology

Covered in the INEEL TMI-2 ISFSI SAR.

2.6 Geology and Seismology

Covered in the INEEL TMI-2 ISFSI SAR.

2.7 Summary of Site Conditions Affecting Construction and Operating Requirements

The addition of the transfer route from TAN to INTEC will not add appreciably to the impact of the INEEL on the local environment, infrastructure, labor, or population.

Design bases related to Site Characteristics for the ISFSI are found in the INEEL TMI-2 ISFSI SAR. Design bases specific to the OS-197 Cask are as follows (see Chapter 3 of this appendix):

- The OS-197 Cask is designed to operate under ambient temperatures ranging from -40°F to 125°F, which exceeds the 0°F to 103°F operational limits at INEEL.

- The OS-197 Cask is designed to withstand the Region I tornado, which exceeds the INEEL Region III requirements.

The OS-197 Cask is designed to withstand a 0.25*g* horizontal and 0.17*g* vertical seismic acceleration earthquake. Section 8.2.1 of this appendix demonstrates that the INEEL earthquake (0.36 g horizontal, 0.24 vertical) is also acceptable.

2.8 References

2.1 The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation, Docket No. 72-20, Rev. 1, March 1999

2.2 Safety Analysis Report For Transportation of TMI-2 Core Debris To and Across INEL, Revision 1, June 1986, INEEL

CONTENTS

3. Principle Design Criteria 1
3.1 Purpose of Installation 1
3.1.1 Material to be Stored 1
3.1.2 General Operating Functions 1
3.2 Structural and Mechanical Safety Criteria 3
3.2.1 Tornado and Wind Loadings 4
3.2.2 Water Level (Flood) Design 6
3.2.3 Seismic Design Criteria 6
3.2.4 Snow and Ice Loads 6
3.2.5 Load Combination Criteria 6
3.3 Safety Protection System 8
3.4 Classification of Structures, Components, and Systems 8
3.4.1 Dry Shielded Canister 8
3.4.2 Horizontal Storage Module 8
3.4.3 ISFSI Basemat and Approach Slabs 8
3.4.4 Transfer Equipment 8

Intentionally Blank

3. PRINCIPLE DESIGN CRITERIA

3.1 Purpose of Installation

Covered in INEEL TMI-2 ISFSI SAR [3.1].

3.1.1 Material to be Stored

Covered in INEEL TMI-2 ISFSI SAR.

3.1.2 General Operating Functions

Covered in INEEL TMI-2 ISFSI SAR.

3.1.2.1 Handling and Transfer Equipment

The handling and transfer equipment required to implement the NUHOMS® system includes a cask handling crane at the TAN Facility, a cask lifting yoke or slings, a transfer cask, a cask support skid and positioning system, a low profile heavy haul transfer trailer and a hydraulic ram system. This equipment is designed and tested to applicable governmental and industrial standards and is maintained and operated according to the manufacturer's specifications. The equipment has also been used and tested at several nuclear plants. Performance criteria for this equipment, excluding the TAN Facility cask handling crane, is given in the following sections. The criteria are summarized in Table E3.1-1. The NUHOMS®-12T System and the OS-197 Cask are compatible with the TAN Hot Shop Crane.

On-Site Transfer Cask: The loaded DSCs can be moved with a 10 CFR 72 approved transfer cask for on-site moves, or a 10 CFR 71 approved transportation cask. It was originally planned to transfer the loaded DSCs from the TAN Facility to the ISFSI using the MP-187 Cask with impact limiters in place. However, the MP-187 cask may not be available for the entire shipping campaign and the 10 CFR 72 approved OS-197 On-Site Transfer Cask will also be used to ship the DSCs.

The OS-197 Cask provides neutron and gamma shielding adequate for biological protection at the outer surface of the cask. The cask is capable of rotation, from the vertical to the horizontal position on the support skid. The cask has a top cover plate which is fitted with a lifting eye allowing removal when the cask is oriented horizontally. The cask is capable of rejecting a design basis decay heat load of 24 kW to the atmosphere assuming the most severe ambient conditions postulated to occur during normal, off-normal, and accident conditions. This is considerably larger than the TMI-2 DSC design basis heat load of 0.86 kW. The internal cavity of the OS-197 Cask (nominal length of 197 in.) is longer than the NUHOMS®-12T DSC (nominal length of 163.5 in. without filter assemblies). The additional cask length will be filled with spacers at both ends.

Table E3.1-1
NUHOMS® Transfer Equipment Criteria

Component	Requirement	Criteria
Cask Interface	Orientation	Vertical to Horizontal
	Contact Dose	ALARA
	Support Points	Upper Lifting Trunnions and Lower Support Trunnions
Cask Support Skid	Weight Capacity	Cask + DSC
	Cask Positioning	Horizontal Translation and Rotation About Vertical Axis
	Cask Orientation	Allows Vertical to Horizontal Rotation
	Support Points	Upper and Lower Trunnion Pillow Blocks
Transfer Trailer	Payload Capacity	Skid + Cask + DSC
	Cask Positioning	Vertical Translation at Each Corner
	Rigidity	Cask is Solidly Supported During DSC Transfer Operation
Hydraulic Ram	Capacity	360 kN (80,000 lbf) Push and Pull
	Load Limit	Maximum Force is Limitable, and set at 315 kN (70,000 lbf) for NUHOMS®-12T DSC
	Base Mounting	Immobile During DSC Transfer

The NUHOMS® OS-197 Transfer Cask is designed to meet the requirements of 10 CFR 72 for normal, off-normal, and accident conditions. The OS-197 Transfer Cask is designed for the following conditions and is approved for 10 CFR 72 on-site transfers [3.2].

A. Seismic	Regulatory Guide 1.60 [3.3] and 1.61 [3.4]
B. Operational Handling Loads	ANSI/ANS-57.9-1984 [3.5]
C. Accidental Drop Loads	ANSI/ANS-57.9-1984
D. Thermal and Dead Loads	ANSI/ANS-57.9-1984
E. Tornado Wind and Missile Loads	Regulatory Guide 1.76 [3.6] and NUREG-0800 [3.7]

The transfer cask is conservatively evaluated for tornado missile impact. The transfer cask is also designed for tornado wind loads in accordance with 10 CFR 72.122 [3.8]. Since the DSC and the double closure welds on the DSC form the pressure containment boundary for the TMI-2 materials, the transfer cask is not designed for internal pressure.

Cask Transportation Skid and Positioning System Criteria:

Covered in INEEL TMI-2 ISFSI SAR.

Trailer Criteria:

The OS-197 Transfer Cask System has its own dedicated trailer. The trailer criteria is specified in the standardized NUHOMS® SAR [3.2].

Hydraulic Ram System Criteria:

The OS-197 Transfer Cask System has its own dedicated trailer with an on-board hydraulic ram system [3.2]. For use at INEEL, the ram is limited such that a force of no more than 315 kN (70,000 lbf) can be applied to the DSC.

3.1.2.2 Waste Processing, Packaging and Storage Areas

Covered in INEEL TMI-2 ISFSI SAR.

3.2 Structural and Mechanical Safety Criteria

The OS-197 Cask is a 10 CFR 72-approved on-site transfer cask and is designed to protect the DSC and TMI-2 canisters during the on-site transfer from the TAN Facility to the INTEC ISFSI. The OS-197 Cask is designed and analyzed to the extreme environmental conditions and natural phenomena specified in 10 CFR 72.122 [3.8] and ANSI-57.9 [3.5]. Table E3.2-1 summarizes the design criteria for the OS-197 Cask. A description of other structural and mechanical safety criteria and the analyses performed on the OS-197 Cask are provided in Chapter 8 of this appendix.

3.2.1 Tornado and Wind Loadings

The transfer cask is designed for the effects of tornados, in accordance with 10 CFR 72.122. This includes design for the effects of Region I tornado winds and missiles.

3.2.1.1 Applicable Design Parameters

The design basis torando (DBT) intensities used for the NUHOMS® OS-197 Transfer Cask are obtained from NRC Regulatory Guide 1.76. Region I intensities are utilized since they result in the most severe loading parameters. For this region, the maximum total wind speed is 160 m/sec (360 mph), the rotational speed is 130 m/sec (290 mph), the maximum translational speed is 31 m/sec (70 mph), the radius of the maximum rotational speed is 45.7 m (150 ft), the pressure drop across the tornado is 20.7 kN/m^2 (3.0 psi), and the rate of pressure drop is 13.8 kN/m^2 (2.0 psi) per second. The maximum transit time based on the 2.2 m/sec (5 mph) minimum translational speed specified in Region I is not used and an infinite transit time is conservatively assumed. The Region I DBT conditions for the OS-197 Cask are more severe and therefore envelope the INEEL Site Region III requirements.

3.2.1.2 Determination of Forces on Structures

The OS-197 Transfer Cask is evaluated for a 19 kN/m^2 (397 psf) DBT velocity pressure, which envelops that for a closed cylindrical structure such as the cask. The transfer cask stress analysis for tornado wind loads is addressed in Section 8.2 of this appendix.

3.2.1.3 Ability of Structures to Perform

The OS-197 Transfer Cask protects the DSC during transfer to the ISFSI from adverse environmental effects such as tornado winds. The analysis of the OS-197 Cask for tornado effects is addressed in Section 8.2 of this appendix.

Table E3.2-1
Summary of NUHOMS® OS-197 Cask Design Loadings

Component	Design Load Type	SAR Section NUHOMS® Reference	Design Parameters	Applicable Codes
On-Site Transfer Cask:				ASME Code Section III, Subsection NC, Class 2 Component [(Y)]
	Design Basis Tornado Wind	3.2.1	Maximum Wind Pressure: 397 psf Maximum Wind Speed: 360 mph	NRC Regulatory Guide 1.761 and ANSI 58.1-1982
	Flood	3.2.2	Not included in design basis.	10 CFR 72.122 (b)
	Seismic	3.2.3	Horizontal Ground Acc: 025*g* Vertical Ground Acc: 0.17*g*	NRC Regulatory Guide 1.60 and 1.61
	Snow and Ice	3.2.4	A tarp will be used to preclude build-up of snow and ice loads when cask is in use.	10 CFR 72.122 (b)
	Dead Weight	8.1.1.1	a. Vertical orientation, self weight with loaded DSC: 200,000 lb. b. Horizontal orientation self weight with loaded DSC on transfer skid 200,000 lb.	ANSI 57.9-1984
	Normal and Off-Normal Operating Temperatures	8.1.1.1 8.1.2.2	Loaded DSC rejecting 24.0 kW decay heat. Ambient air temperature range: -40°F to 125°F w/solar shield, -40°F to 100°F w/o solar shield.	ANSI 57.9-1984
	Normal Handling Loads	8.1.1.1	a. Upper lifting trunnions – in fuel/reactor building: Stresses ≤ yield with 6 x load and ≤ ultimate with 10 x load b. Upper lifting trunnions – on-site transfer c. Lower support trunnions: proportional weight of loaded cask during down loading and transit to HSM d. Hydraulic ram load of 70,000 lb.*	ANSI N14.6-1993[(Z)] ASME Section III ASME Section III ANSI 57.9-1984
	Off-Normal Handling Loads	8.1.2.1	Hydraulic ram load of 80,000 lb.*	ANSI 57.9-1984
	Accidental Cask Drop Loads	8.2.5	Equivalent static deceleration of 75*g* for vertical end drops and horizontal side drops, and 25*g* for oblique corner drop.	10 CFR 72.122 (b)
	Fire and Explosions	3.3.6	Enveloped by other design basis events	10 CFR 72.122 (c)
	Internal Pressure		N/A – DSC and cask are vented.	10 CFR 72.122 (h)

[(X)]The transfer cask is not part of the cask storage system, which for NUHOMS®-12T consists of the canister and module.
[(Y)]ASME Subsection NCA does not apply.
[(Z)]The trunnion design stress allowables are consistent with that of lifting devices governed by ANSI N14.6.
(*)The relief valves on the ram will be set to ensure that no more than 70,000 lbf will be generated in either normal or off-normal handling conditions for use at INEEL.

3.2.2 Water Level (Flood) Design

The OS-197 On-Site Transfer Cask is not explicitly evaluated for flood effects. ISFSI procedures will ensure that the transfer cask is not used for DSC transfer during flood conditions.

3.2.3 Seismic Design Criteria

The seismic design accelerations for the OS-197 Cask are 0.25*g* horizontal and 0.17*g* vertical. The analysis of the OS-197 Cask for the somewhat higher seismic loading applicable to the INEEL is addressed in Section 8.2 of this appendix.

3.2.4 Snow and Ice Loads

Covered in INEEL TMI-2 ISFSI SAR.

3.2.5 Load Combination Criteria

3.2.5.1 Horizontal Storage Module

Covered in INEEL TMI-2 ISFSI SAR.

3.2.5.2 Dry Shielded Canister

Covered in INEEL TMI-2 ISFSI SAR.

3.2.5.3 On-Site Transfer Cask

The OS-197 On-Site Transfer Cask is a non-pressure retaining component that is shown by analysis to meet the stress allowables of the ASME Code [3.9] Subsection NC for Class 2 components. The cask is conservatively designed by utilizing linear elastic analysis methods. The load combinations considered for the transfer cask normal, off-normal, and postulated accident loadings are shown in Table E3.2-2. Service Levels A and B allowables are used for all normal operating and off-normal loadings. Service Levels C and D allowables are used for load combinations which include postulated accident loadings. Allowable stress limits for the upper lifting trunnions and upper trunnion sleeves are conservatively developed to meet the requirements of ANSI N14.6 [3.10] for a non-redundant lifting device for all cask movements within the TAN Facility. The maximum shear stress theory is used to calculate principal stresses in the cask structural shell. The appropriate dead load and thermal stresses are combined with the calculated drop accident scenario stresses to determine the worst case design stresses. The transfer cask structural design criteria are summarized in Table E3.2-3 and Table E3.2-4. The transfer cask accident analyses are presented in Section 8.2 of this appendix. The effects of fatigue on the transfer cask due to thermal cycling are addressed in Section 8.3.4 of this appendix. The OS-197 Cask trunnions were load tested to 150% of the maximum design load during fabrication.

Table E3.2-2
OS-197 Transfer Cask Load Combinations and Service Levels

Load Case		Normal Operating Conditions					Off-Normal Conditions		Accident Conditions				
		1	2	3	4	5	1	2	1	2	3	4	5
Dead Load/Live Load		X	X	X	X	X	X	X	X	X	X	X	X
Thermal w/DSC	0° to 100°F Ambient	X	X	X	X	X			X	X	X	X	X
	-40° to 125°F Ambient						X	X					
Handling Loads (critical lifts)	Vertical	X											
	Downending		X										
	Horizontal			X									
Handling Loads (non-critical)	Transfer				X		X		X				
	DSC Transfer					X		X		X			
Seismic									X	X			
Drop	Vertical										X		
	Corner											X	
	Horizontal												X
ASME Code Service Level		A	A	A	A	A	B	B	C	C	D	D	D
Load Combination No.		A1	A2	A3	A4	A5	B1	B2	C1	C2	D1	D2	D3

Table E3.2-3
Structure Design Criteria for OS-197 On-Site Transfer Cask

Item	Stress Type	Stress Values[(a)]		
		Service Levels A and B	Service Level C	Service Level D
Transfer Cask Structural Shell	Primary Membrane	S_m	1.2 S_m	Smaller of 2.4 S_m or 0.7 S_u
	Primary Membrane + Bending	1.5 S_m	1.8 S_m	Smaller 3.6 S_m or S_u
	Primary + Secondary	3.0 S_m	N/A	N/A
Trunnions (b)	Membrane and Membrane + Bending	Smaller of $S_y/6$ or $S_u/10$	N/A	N/A
	Shear	Smaller of 0.6 $S_y/6$ or 0.6 $S_u/10$	N/A	N/A
Fillet Welds	Primary	0.5 S_m	0.6 S_m	Smaller of 1.2 S_m or 0.35 S_u
	Secondary	0.75 S_m	N/A	N/A

(a) Values of S_y, S_m, and S_u versus temperature are given in Table 8.1-3 of Reference 3.2.
(b) These allowables apply to the upper lifting trunnions for critical lifts governed by ANSI N14.6. The lower support trunnions and the upper lifting trunnions for all remaining loads are governed by the same ASME Code criteria applied to the cask structural shell.

Table E3.2-4
Structural Design Criteria for OS-197 Cask Bolts

Service Levels A, B, and C	
Average Service Stress	$< 2\ S_m$
Maximum Service Stress	$< 3\ S_m$
Service Level D	
Average Tension	Smaller of S_y or 0.7 S_u
Tension + Bending	S_u
Shear	Smaller of 0.6 S_y or 0.42 S_u
Interaction	Interaction equation of Appendix F (F-1335.3) of ASME Code [3.9]

3.3 Safety Protection System

Covered in INEEL TMI-2 ISFSI SAR.

3.4 Classification of Structures, Components, and Systems

3.4.1 Dry Shielded Canister

Covered in INEEL TMI-2 ISFSI SAR.

3.4.2 Horizontal Storage Module

Covered in INEEL TMI-2 ISFSI SAR.

3.4.3 ISFSI Basemat and Approach Slabs

Covered in INEEL TMI-2 ISFSI SAR.

3.4.4 Transfer Equipment

3.4.4.1 Transfer Cask and Cask Rigging

The OS-197 On-Site Transfer Cask is "important to safety" since it protects the DSC during handling and transfer operations and is part of the primary load path used while handling the DSC at the TAN Facility and while inserting the DSC into the HSM. The transfer cask is designed, constructed, and tested in accordance with "important to safety" requirements as defined by 10 CFR 72, Subpart G, paragraph 72.140(b).

The rigging used for handling the cask at the TAN Facility is not important to safety and is a part of the licensed activities addressed by this document.

3.4.4.2 Other Transfer Equipment

Covered in INEEL TMI-2 ISFSI SAR.

3.4.5 Auxiliary Equipment

Covered in INEEL TMI-2 ISFSI SAR.

3.5 Decommissioning Considerations

Covered in INEEL TMI-2 ISFSI SAR.

3.6 References

3.1 The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation, Docket No. 72-20, Rev. 1, March 1999.

3.2 Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, NUH-003, Rev. 4A, VECTRA Technologies, Inc., June 1996.

3.3 U.S. Atomic Energy Commission, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Regulatory Guide 1.60, Revision 1 (1973)

3.4 U.S. Atomic Energy Commission, "Damping Values for Seismic Design of Nuclear Power Plants, Regulatory Guide 1.61 (1973).

3.5 American National Standard, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)," ANSI/ANS 57.9-1984, American Nuclear Society, La Grange Park, Illinois (1984).

3.6 U.S. Atomic Energy Commission," Design Basis Tornado for Nuclear Power Plants," Regulatory Guide 1.76 (1974).

3.7 U.S. Nuclear Regulatory Commission, "Missiles Generated by Natural Phenomena," Standard Review Plan NUREG-0800, 3.5.1.4 (Formerly NUREG-76/087), Revision 2 (1981).

3.8 U.S. Government, "Licensing Requirements for the Storage of Spent Fuel in an Independent Spent Fuel Storage Installation (ISFSI)", Title 10 Code of Federal Regulations, Part 72, Office of the Federal Register, Washington, D. C.

3.9 American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1983 Edition with Winter 1985 Addenda.

3.10 America National Standard, "For Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 Kg) or More," ANSI N14.6-1986. American National Standards Institute, Inc., New York, New York (1986).

CONTENTS

4. Installation Design 1
4.1 Summary Description 1
4.1.1 Location and Layout of Installation 1
4.1.2 Principal Features 1
4.2 Storage Structures 1
4.2.1 Design Basis and Safety Assurance 1
4.2.2 Compliance with General Design Criteria 1
4.2.3 Structural Specifications 1
4.2.4 Installation Layout 1
4.2.5 Individual Unit Description 2
4.3 Auxiliary Systems 4
4.4 Decontamination System 4
4.5 Transfer Cask and Lifting Hardware Repair and Maintenance 4
4.5.1 Routine Inspection 4
4.5.2 Annual Inspection 4
4.6 Cathodic Protection 5
4.7 Fuel Handling Operation System 5
4.7.1 Structural Specifications 5
4.7.2 Installation Layout 5
4.7.3 Individual Unit Descriptions 5
4.7.4 Transfer Equipment Design Codes and Standards 12
4.8 References 13

Intentionally Blank

4. INSTALLATION DESIGN

4.1 Summary Description

This chapter provides a detailed description of the OS-197 Cask that will be used to transfer the TMI-2 DSCs on the INEEL Site.

4.1.1 Location and Layout of Installation

Covered in INEEL TMI-2 ISFSI SAR [4.1].

4.1.2 Principal Features

Covered in INEEL TMI-2 ISFSI SAR.

4.2 Storage Structures

4.2.1 Design Basis and Safety Assurance

Covered in INEEL TMI-2 ISFSI SAR.

4.2.2 Compliance with General Design Criteria

Covered in INEEL TMI-2 ISFSI SAR.

4.2.3 Structural Specifications

Covered in INEEL TMI-2 ISFSI SAR.

4.2.4 Installation Layout

Covered in INEEL TMI-2 ISFSI SAR.

4.2.5 Individual Unit Description

4.2.5.1 Horizontal Storage Module (HSM)

Covered in INEEL TMI-2 ISFSI SAR.

4.2.5.2 Dry Shielded Canister (DSC)

The NUHOMS®-12T DSC is a cylindrical steel vessel used for the confinement of up to 12 TMI-2 canisters. The DSC is dimensionally similar to the standard NUHOMS®-24P system DSC, but is 23.5 in. shorter. During transfer operations, this shorter length is made up by installing internal spacers into the OS-197 Cask cavity. These internal spacers are clamped in the cask bottom and bolted to the lid of the cask. The top spacer has cutouts for the vent and purge housings. The bottom spacer includes a keyway to receive the DSC grapple ring key to ensure that the DSC will not rotate during transfer operations.

The remainder of the DSC description is the same as given in Section 4.2.5.2 of the INEEL TMI-2 ISFSI SAR [4.1].

4.2.5.3 Transfer Cask

Originally it was planned to transfer the TMI-2 DSCs using the MP-187 Cask. However, the MP-187 Cask will not be available for the entire transfer campaign and the OS-197 Cask is planned to be used as an alternate.

The OS-197 On-Site Transfer Cask is a nonpressure-retaining cylindrical vessel with a welded bottom assembly and bolted top cover plate. The transfer cask is designed for on-site transfer of the DSC from the TAN Facility to the ISFSI at the INTEC site.

The transfer cask provides the principal biological shielding and heat rejection mechanism for NUHOMS®-12T DSC and TMI-2 canisters during handling at the TAN Facility, DSC closure operations, transfer to the ISFSI, and transfer to the HSM. The transfer cask also provides primary protection for the loaded DSC during off-normal and drop accident events postulated to occur during the transfer operations (see Chapter 8 of this Appendix). The NUHOMS® OS-197 Transfer Cask is illustrated in Figure E1.3-1. Drawings of the transfer cask are contained at the end of this appendix.

The OS-197 Transfer Cask is constructed from three concentric cylindrical shells to form an inner and outer annulus. The inner annulus is filled with lead and the outer annulus provides space for a liquid neutron shield. The two inner shells are welded to heavy forged ring assemblies at the top and bottom ends of the cask as shown in Figure E1.3-1. Rails fabricated from a hardened, non-galling, wear resistant material coated with a high contact pressure dry film lubricant are provided to facilitate DSC transfer. The transfer cask is fabricated from stainless steel.

The support members for the outer shell of the solid neutron shield are angled at 45° with respect to the transfer cask structural shell to enhance shielding and decay heat removal. Solid neutron shielding materials are used in the top and bottom end closures to provide effective radiological protection.

Two trunnion assemblies are provided in the upper region of the cask for lifting of the transfer cask at the TAN Facility, and for supporting the cask on the skid during transfer to the ISFSI. An additional pair of trunnions in the lower region of the cask are used to position the cask on the support skid, serve as the rotation axis during down-ending of the cask, and provide support for the bottom end of the cask during transfer operations. There are no testing requirements per the ASME Code for the transfer cask trunnions. Neither the transfer cask nor the trunnions are special lifting devices per ANSI N14.6 [4.2]. For the OS-197 Cask, a one-time pre-service load test of the trunnions was performed at a load equal to 150% of the 100 ton design load followed by an examination of all accessible trunnion welds.

The OS-197 Cask bottom ram penetration cover plate is a water tight closure used during DSC closure operations in the cask decon area and during cask handling operations. For use in the dry TAN hot shop, the ram cover plate seals are optional. The circular projection on the transfer cask bottom cover plate is dimensioned to ensure that the DSC does not contact any surface of the bottom cover plate assembly.

Alignment of the DSC with the OS-197 Cask is achieved by the use of permanent alignment marks on the DSC and cask top surfaces and the alignment of the key/keyways on the grapple ring and the cask bottom spacer. These marks facilitate orienting the DSC to the required azimuthal tolerances for satisfactory insertion of the DSC into HSM, and assure that the vent and purge ports align with the precast HSM access openings and HEPA filter enclosure.

The cask may be moved using a specially designed non-redundant yoke or slings. The yoke, or slings, balance the cask weight between the two upper trunnions and have sufficient margin for any minor eccentricities in the cask vertical center of gravity which may occur. The yoke and slings are designed and fabricated to meet the requirements of ANSI N14.6. The test load for the yoke and other lifting devices is 300% of the design load, with annual inspection, to meet ASNI N14.6 requirements.

The structural materials and licensing requirements for the NUHOMS® OS-197 Transfer Cask are delineated on the appendix drawings. In general, these requirements are in accordance with the applicable portions of the ASME Code, Section III, Division 1, Subsection NC for Class 2 vessels except that Subsection NCA does not apply. The cask is designated as an atmospheric pressure vessel and therefore a pressure test is not required. The cask is not N-stamped. The upper lifting trunnions and trunnion sleeves are conservatively designed in accordance with the ANSI N14.6 stress allowable requirements for a non-redundant lifting device and are load tested to 150% of the design basis load. All structural welds are ultrasonically examined or tested by the dye penetrant method as appropriate for the weld joint configuration. These stringent design and fabrication requirements ensure the structural integrity of the transfer cask and performance of its intended safety function.

4.3 Auxiliary Systems

Covered in INEEL TMI-2 ISFSI SAR.

4.4 Decontamination System

Covered in INEEL TMI-2 ISFSI SAR.

4.5 Transfer Cask and Lifting Hardware Repair and Maintenance

The OS-197 Transfer Cask is designed to minimize maintenance and repair requirements. Any maintenance that may be required during the INEEL transfer operations may be performed at existing INEEL facilities or any suitable location since transfer cask contamination levels are maintained below transferable limits.

4.5.1 Routine Inspection

The following inspections will be performed prior to each use of the transfer cask and lifting hardware:

A. Visual inspection of the cask exterior for cracks, dents, gouges, tears, or damaged bearing surfaces. Particular attention is to be paid to the cask trunnions and lifting yoke.

B. Visually inspect all threaded parts and bolts for burrs, chafing, distortion, or other damage.

C. Check all quick-connect fittings to ensure their proper operation.

D. Visually inspect the interior surface of the cask for any indications of excessive wear to bearing surfaces.

E. Visual inspection of neutron shield jacket.

4.5.2 Annual Inspection

The following inspection shall be performed on an annual basis:

- Examine the cask trunnions and cask lifting yoke or slings.

Any parts which fail the inspection shall be repaired or replaced as appropriate.

Any indications of damage, failure to operate, or excessive wear will be evaluated to ensure that the safe operation of the cask is not impaired. Damage which impairs the ability of the cask to properly function will be repaired or replaced. This work may be performed at on-site DOE facilities, or at an approved vendor's facility. Repairs will be performed in accordance with the manufacturer's or cask designer's recommendations.

4.6 Cathodic Protection

Covered in INEEL TMI-2 ISFSI SAR.

4.7 Fuel Handling Operation System

Covered in INEEL TMI-2 ISFSI SAR.

4.7.1 Structural Specifications

The codes and standards for the OS-197 Transfer Cask and Transfer Equipment are described in Section 4.7.4 of this appendix.

4.7.2 Installation Layout

Covered in INEEL TMI-2 ISFSI SAR.

4.7.3 Individual Unit Descriptions

4.7.3.1 TAN Hot Shop Equipment/Operations Overview

Covered in INEEL TMI-2 ISFSI SAR.

4.7.3.2 OS-197 Cask

The OS-197 Cask is a cylindrical vessel with a bottom end closure assembly and a bolted top cover plate as shown in Figure E1.3-1. The cask's cylindrical walls are formed from three concentric steel shells with lead poured between the inner liner and the structural shell to provide gamma shielding during DSC transfer operations. The outer shell forms an annular vessel that can be filled with water to provide neutron shielding during DSC transfer operations.

The cask bottom end assembly is welded to the cylindrical shell assembly and includes two closure assemblies for the ram grapple access penetration. A bolted cover plate will be installed for INEEL transfer operations.

The top cover plate is bolted to the top flange of the cask during transfer from the TAN Facility to the ISFSI. The top cover plate assembly consists of a thick structural plate with a thin shell encapsulating solid neutron shielding material. Two upper lifting trunnions are located near the top of the cask for downending/uprighting and lifting of the cask at the TAN Facility and for support during transfer operations. Two lower trunnions, located near the base of the cask, serve as the axis of rotation during downending/uprighting operations and as supports during transfer to the ISFSI.

For the transfer operations between TAN and INTEC, the OS-197 Cask neutron shield can be either left empty or filled with water. The maximum cask surface dose rate is 111 mrem/h combined gamma and neutron with an empty neutron shield. With the neutron shield filled with water, the maximum cask surface dose rate is 51 mrem/h combined gamma and neutron (see Section 7.3 of this appendix).

The transfer cask is designated important to safety since it provides biological shielding and structural protection for the DSC from impact loads. The codes and standards used to design and fabricate the transfer cask are presented in Section 4.7.4 of this appendix.

4.7.3.3 Transfer Cask Lifting Yoke

The lifting yoke is a special lifting device which provides the means for performing all cask handling operations within the TAN Facility. It is designed to support a loaded transfer cask. A lifting pin connects the TAN Facility cask handling crane hook and the lifting yoke. The lifting yoke is shown in Figure E4.7-1. Lifting slings can also be used to lift the cask.

The lifting yoke is a passive, open hook design with two parallel lifting beams fabricated from thick, high-strength carbon steel plate material, with a decontaminable coating. The lifting yoke engages the outer shoulder of the transfer cask lifting trunnions. To facilitate ease of shipment and maintenance, all yoke subcomponent structural connections are bolted.

The lifting yoke is designated "important to safety" since it is in the direct load path of the cask, but is not part of the licensed activities addressed by this document. The codes and standards used to design and fabricate the lifting yoke are presented in Section 4.7.4 of this appendix.

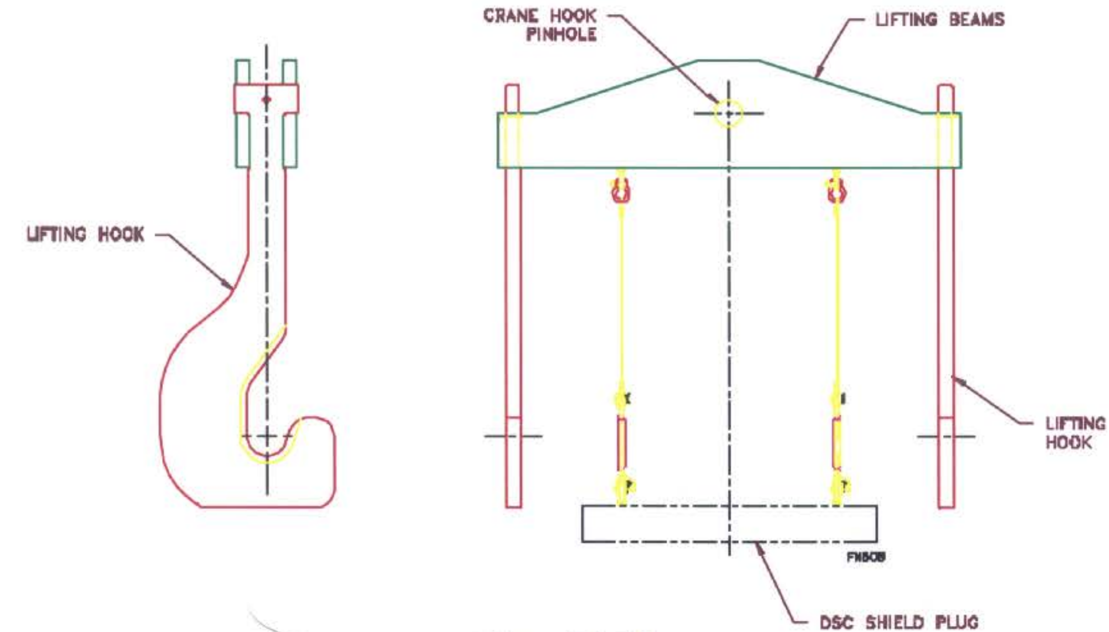


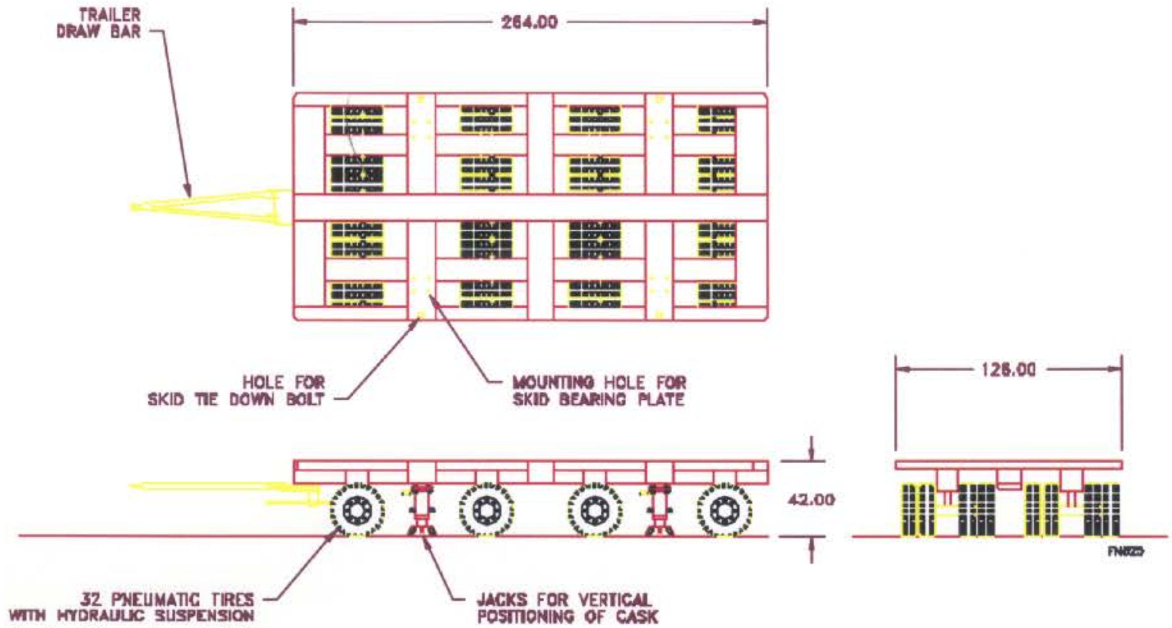
Figure E4.7-5
NUHOMS® OS-197 Transfer Cask Lifting Yoke.

4.7.3.4 Transfer Trailer

The transfer trailer is designed for use with the NUHOMS® OS-197 Transfer Equipment. Its function is to move the OS-197 Cask and cask support skid from the TAN Facility to the ISFSI location. Once there, the trailer is raised and remains passive during the transfer of the DSC into the HSM.

The trailer is a commercial grade item of the type commonly used to haul very heavy loads such as transformers, boilers, and construction equipment. An illustration of the trailer is shown in Figure E4.7-2. The codes and standards governing the design and construction of the trailer are provided in Section 4.7.4 of this appendix.

The loading sequence for the cask is shown in Figure E4.7-3. The transfer trailer and other transfer equipment are shown in its configuration at the HSM in Figure E1.2-1. The trailer itself is considered not important to safety since its failure would not result in a cask drop exceeding the cases evaluated in Chapter 8 of this appendix.



Nominal dimensions in inches.

Figure E4.7-6
Typical NUHOMS® Transfer Trailer.

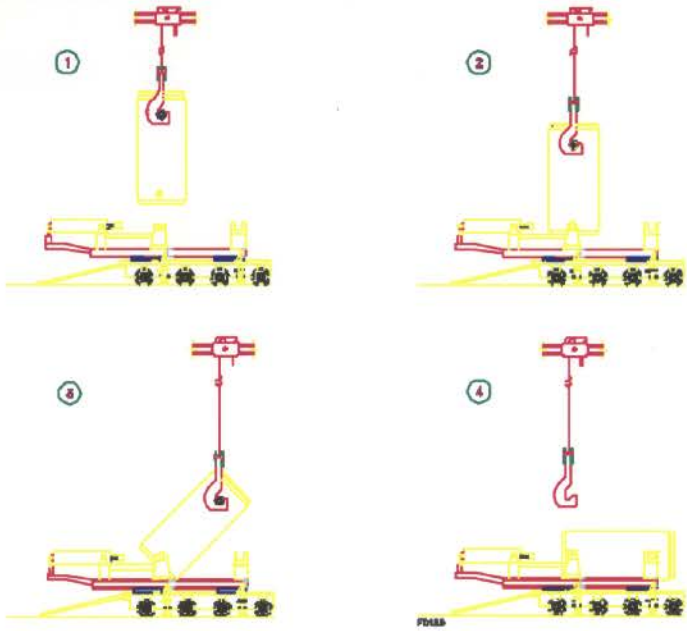


Figure E4.7-7
NUHOMS® OS-197 Transfer Cask Downending Sequence.

The trailer is configured with a 4x2 axle dolly. Eight hydraulic suspensions carry four pneumatic tires each and are located in four axle lines. Hydraulic suspensions enable coupled steering of all axles around a common point, thus minimizing tire scuffing and the resulting damage to pavement and tires. The suspensions also allow other advantages, such as adjustable deck height, in-situ lockout for repair of failed suspensions or tires, and automatic compensation for road surface irregularities. The trailer has multi-wheel braking using industrial grade air/spring brakes. The brakes automatically lock on loss of air pressure from the tractor.

4.7.3.5 Skid Positioning System

The functions of the skid positioning system (SPS) are to hold the cask support skid stationary (with respect to the transfer trailer) during cask loading and transfer, and to provide alignment between the transfer cask and the HSM prior to insertion of the DSC. It is composed of tie down or travel lock brackets and bolts, three hydraulically powered horizontal positioning modules, four hydraulic lifting jacks, and a hydraulic supply and control skid. The SPS hardware, which is located on the transfer trailer, is illustrated in Figure E4.7-4.

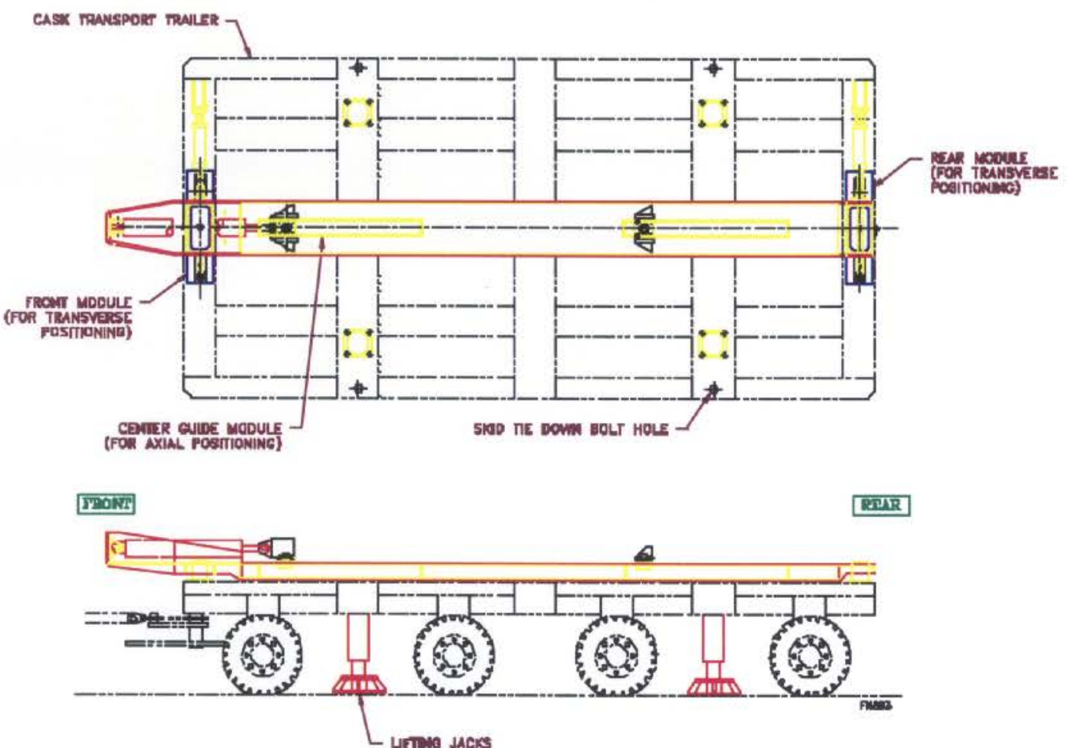


Figure E4.7-8
NUHOMS® Skid Positioning System (SPS).

The codes and standards governing the design and construction of the SPS are provided in Section 4.7.4 of this appendix. The SPS is considered not important to safety since its failure would not result in a cask drop as severe as the cases evaluated in Chapter 8 of this appendix.

The skid tie down brackets are shown in Figure E4.7-5. The brackets are designed to withstand the design basis loads for the skid described in Chapter 8 of this appendix.

The hydraulic jacks are designed to support the loaded cask, skid, and trailer and the loads applied to them during HSM loading and unloading. They are utilized at two locations: at the TAN Facility during cask downending, and at the ISFSI during cask alignment and DSC transfer. At both locations, their purpose is to provide a solid support for the trailer frame and skid. Three measures are taken to avoid accidental lowering of the trailer payload: the hydraulic pump is de-energized after the skid has been aligned (the jacks are also hydraulically locked out during operation of the horizontal cylinders); there are mechanical locking collars on the cylinders; and pilot-operated check valves are located on each jack assembly to prevent fluid loss in the event of a broken hydraulic line.

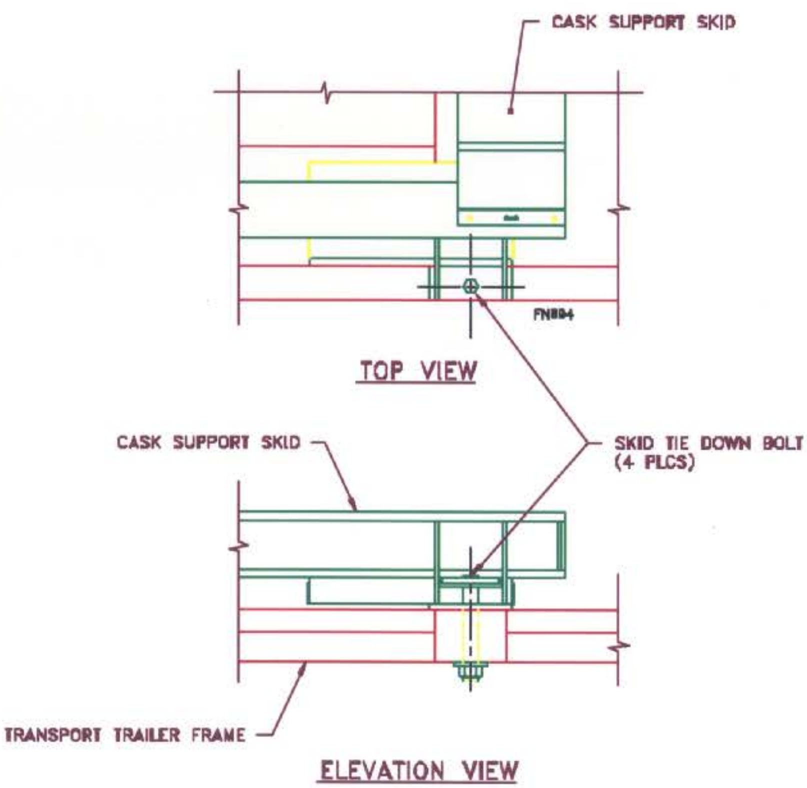


Figure E4.7-9
NUHOMS OS-197 Cask Support Skid Tiedown Bracket.

Three hydraulic positioning modules provide the motive force to horizontally align the skid and cask with the HSM prior to insertion of the DSC. The positioning module controls are manually operated and hydraulically powered.

Anti-friction pads constructed from woven teflon pads and steel are used to reduce the force required to align the cask. These pads are commonly used as bearings for bridges, tank supports, and hydro/electric gates. Four pads are mounted to the trailer frame. Polished steel bearing plates mounted on the underside of the skid longitudinal beams slide on the teflon surfaces and protect them from the weather. The travel of the skid is restricted by the stroke of the hydraulic positioning cylinders. In the event of cylinder failure, travel stops surrounding the bearing plates prevent the skid from excessive travel.

The hydraulic power supply and controls for the SPS are included as a part of the transfer trailer hydraulics. Directional metering valves are used to allow precise control of cylinder motions. The SPS is manually operated and has three operational modes: simultaneous actuation of the four vertical jacks or any pair of jacks, actuation of any single vertical jack, or actuation of any one of the three horizontal actuators. Simultaneous operation of the vertical jacks and the horizontal actuators is not possible.

4.7.3.6 Hydraulic Ram System

The Hydraulic Ram System (HRS) provides the motive force for transferring the DSC between the HSM and the transfer cask. Since operation of the HRS cannot result in damage to the TMI-2 canisters inside the DSC, it is considered not important to safety. The HRS is illustrated in Figure E1.3-3. The codes and standards used in design of the HRS are listed in Section 4.7.4 of this appendix.

The HRS includes the following main subcomponents: one double-acting hydraulic cylinder; one grapple assembly; one hydraulic power unit; hydraulic hoses and fittings; one hose reel; and all necessary appurtenances, pressure limiting devices and controls for the system operation.

The HRS is designed to grapple, push or pull the DSC at any point in the extent of its horizontal travel between the cask and the HSM. The HRS and all other components of the transfer system are conservatively designed for and can apply pushing and pulling forces of up to 80,000 lb, if necessary to complete the transfer. For use at INEEL, the HRS push/pull capability will be limited to 70,000 lbf.

The ram hydraulic cylinder is provided with a support and alignment system which provides for the range of vertical and lateral motion necessary for alignment with the DSC, cask, and HSM. The ram hydraulic power unit and controls are designed to provide the range of flows and pressures required to push or pull the DSC under normal to maximum load conditions at safe design speeds. All controls are mounted in one control panel. Features are included in the control system to prevent the inadvertent operation of the HRS, limit the speed and force of the ram cylinder, as well as to provide an emergency means of stopping the ram motion.

Equipment safety concerns are addressed using a relatively simple control system and comprehensive operational procedure. All controls are manually operated. Pre-set pressure and flow control devices ensure that the maximum design forces and speeds of the hydraulic ram are not exceeded. System pressure gauges are provided to monitor the insertion operation and to verify that design force limits are not exceeded.

4.7.3.7 Ram Support Assembly

The ram hydraulic cylinder is permanently mounted on the cask transfer trailer using a steel support assembly as shown in Figure E1.3-3. The hydraulic ram push/pull loads are transmitted through the support assembly to the transfer cask, through the cask to the cask restraints and into the HSM front wall embedments.

4.7.3.8 Cask Support Skid

The cask support skid is a structural steel frame fabricated from standard wide flange members, built up box beam cross members and trunnion support towers. The cask support skid, shown in Figure E1.3-3, is designed according to the AISC code for its operating loads. During cask loading and trailer towing operations, the cask support skid is rigidly attached to the transfer trailer by four bolted brackets. During cask alignment, the bolts are removed, and the alignment system is used to move the cask support skid into position. For this operation, the skid is supported by the skid positioning system bearing pads located on the trailer frame cross members. The transfer cask is supported on the front and rear trunnion support tower pillow blocks. For cask downending, the lower trunnions are engaged into the front pillow blocks, and the top section of the blocks installed. The cask lifting yoke or sling and TAN Facility crane are then used to lower the upper trunnions into the rear trunnion supports. The yoke/sling is removed and the upper trunnion capture plates are installed.

4.7.4 Transfer Equipment Design Codes and Standards

The following codes and standards are specified for the design, construction, and testing of the NUHOMS® ISFSI transfer equipment components.

4.7.4.1 Transfer Cask and Lifting Yoke

A. ASME Boiler Pressure Vessel Code, Section III, Division 1, Subsection NC, "Class 2 Components," 1983 Edition through Winter 1985 Addenda, used as a guide for design and fabrication.

B. ASME Boiler and Pressure Vessel Code, Section III, Division 1, Appendices.

C. ANSI N14.6 - 1986, "Special Lifting Devices for Shipping Containers Weighing 10,000 lbs or more."

D. ANSI Y14.5 – 1982,"Dimensioning and Tolerancing."

E. ANSI 57.9 – 1984, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)."

F. ANSI N45.2 – 1977, "Quality Assurance Requirements for Nuclear Power Plants."

G. AWS D1.1-88, "Structural Welding Code – Steel."

H. Steel Structures Painting Council (Standards).

I. EPRI NP-4830, "Comparison of Pad Hardness Study with Drop Test Results."

J. Crane Manufacturers' Association of America (CMAA) Specification No. 70-1983, "Specifications for Electric Overhead Traveling Cranes."

4.7.4.2 Transfer System Equipment

A. American Institute of Steel Construction, "Manual of Steel Construction."

B. National Electrical Code.

C. National Fluid Power Association (Standards).

D. National Electrical Manufacturer's Association (Standards).

E. American Society for Testing and Materials (Standards).

F. Steel Structures Painting Council (Standards).

G. American National Standards Institute (Standards).

H. American Welding Society, AWS D1.1, "Structural Welding Code-Steel."

4.8 References

4.1 The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation, Docket No. 72-20, Rev. 1, March 1999.

4.2 "American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials," ANSI N-14.6-1986, American National Standards Institute, Inc., New York, New York.

Intentionally Blank.

CONTENTS

5. Operation Systems 1
5.1 Operation Description........ 1
5.1.1 Narrative Description of Operations at the TAN Hot Shop........ 1
5.1.2 Operations Conducted at the ISFSI........ 9
5.1.3 Flowsheets........ 16
5.1.4 Identification of Subjects for Safety Analysis 16
5.2 Fuel Handling System........ 16
5.3 Other Operating Systems 16
5.4 Operation Support System........ 16
5.5 Control Room and/or Control Areas........ 16
5.6 Analytical Sampling........ 16
5.7 References 16

Intentionally Blank

5. OPERATION SYSTEMS

Since the OS-197 is a 10 CFR 72 approved transfer cask, all operations between the TAN facility and the ISFSI are performed under the purview of 10 CFR 72.

5.1 Operation Description

The majority of the general procedures in the operation description of Section 5.1 of the INEEL TMI-2 ISFSI SAR [5.1] apply to the use of the OS-197 transfer cask. Only the steps that require revisions to address the OS-197 cask are included in this appendix. Procedures are delineated in outline form to describe how these operations are to be performed and are not intended to be limiting.

5.1.1 Narrative Description of Operations at the TAN Hot Shop

The following steps describe the recommended operating procedures for the NUHOMS®–12T and OS-197 cask system. Figure 5.1-1 provides a series of pictorial views of key loading and transfer operations. Even though many of the steps for preparing the OS-197 cask and DSC are similar to the MP-187, all steps are included in the figure for completeness.

5.1.1.1 Preparation of the Cask and DSC

1. Prior to placement in dry storage, the TMI-2 canisters are to be dewatered and vacuum dried to ensure that no free water is contained in the canisters. A verified record of final TMI-2 canister drying will be maintained for each canister.

2. Place the OS-197 Cask in the vertical position in the TAN Hot Shop using the cask handling crane and the cask rigging.

3. Place the cask into the work platform so that the top cover plate and surface of the cask are easily accessible to personnel.

4. Remove the cask top cover plate, including the top spacer. Examine the cask cavity for any physical damage and ready the cask for service. If not already in place, install the bottom spacer.

5. Examine the DSC for any physical damage which might have occurred since the receipt inspection was performed. The DSC is to be cleaned and any loose debris removed. Cleaning methods shall not introduce any chemical residues. (This may be performed prior to bringing the OS-197 cask into the TAN Hot Shop.)

6. Verify the unique identification of the DSC and using a crane, lower the DSC into the cask cavity by the internal lifting lugs and rotate the DSC to match the cask and DSC alignment marks and keyway.

7. Install temporary covers in the cask/DSC annulus to prevent contamination or debris from entering the annulus.

8. Place both the top shield plug and cover onto the DSC. Examine the top shield plug to ensure a proper fit.

9. Remove the top shield plug.

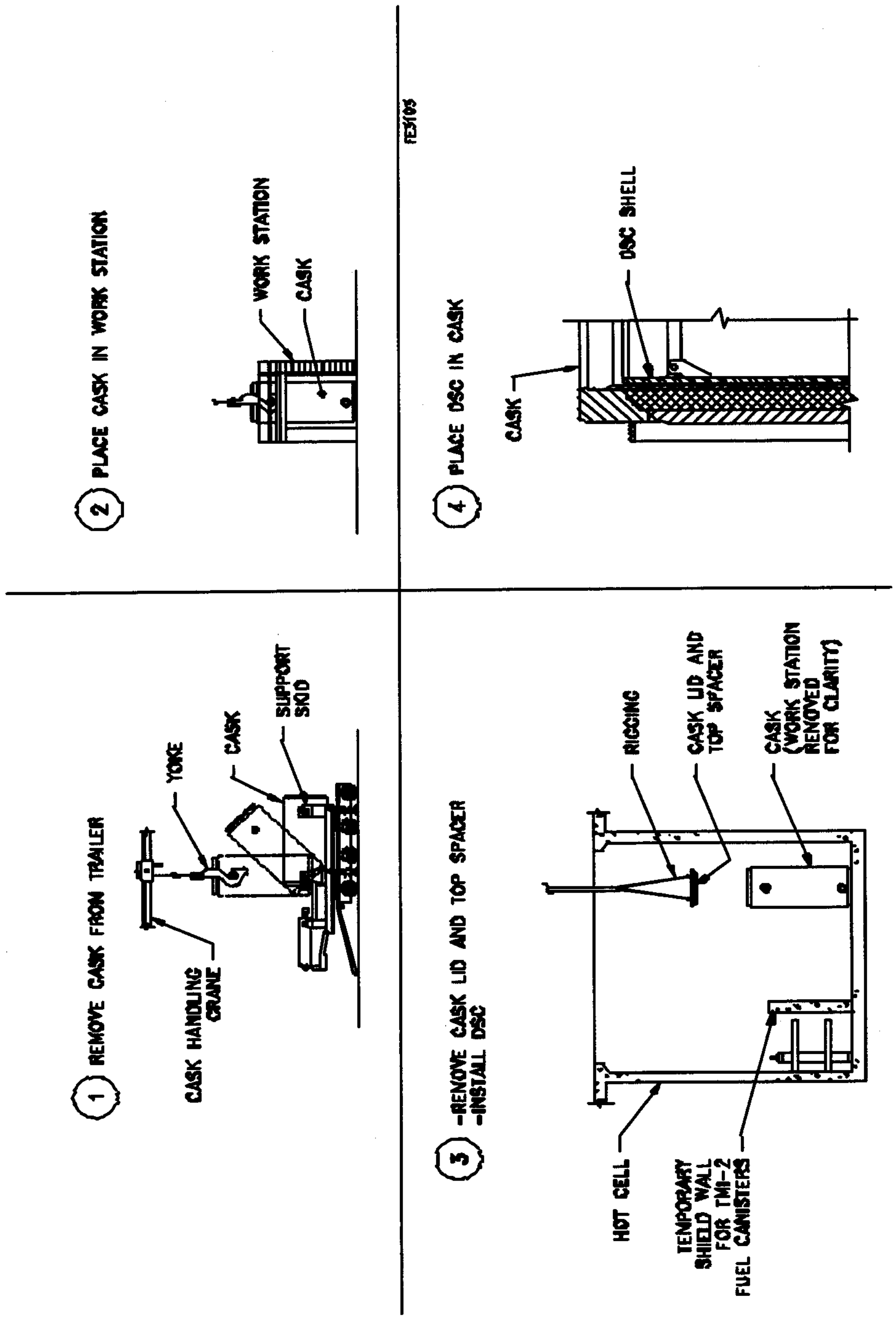


Figure 5.1-10

Primary Operations for the NUHOMS®-12T System

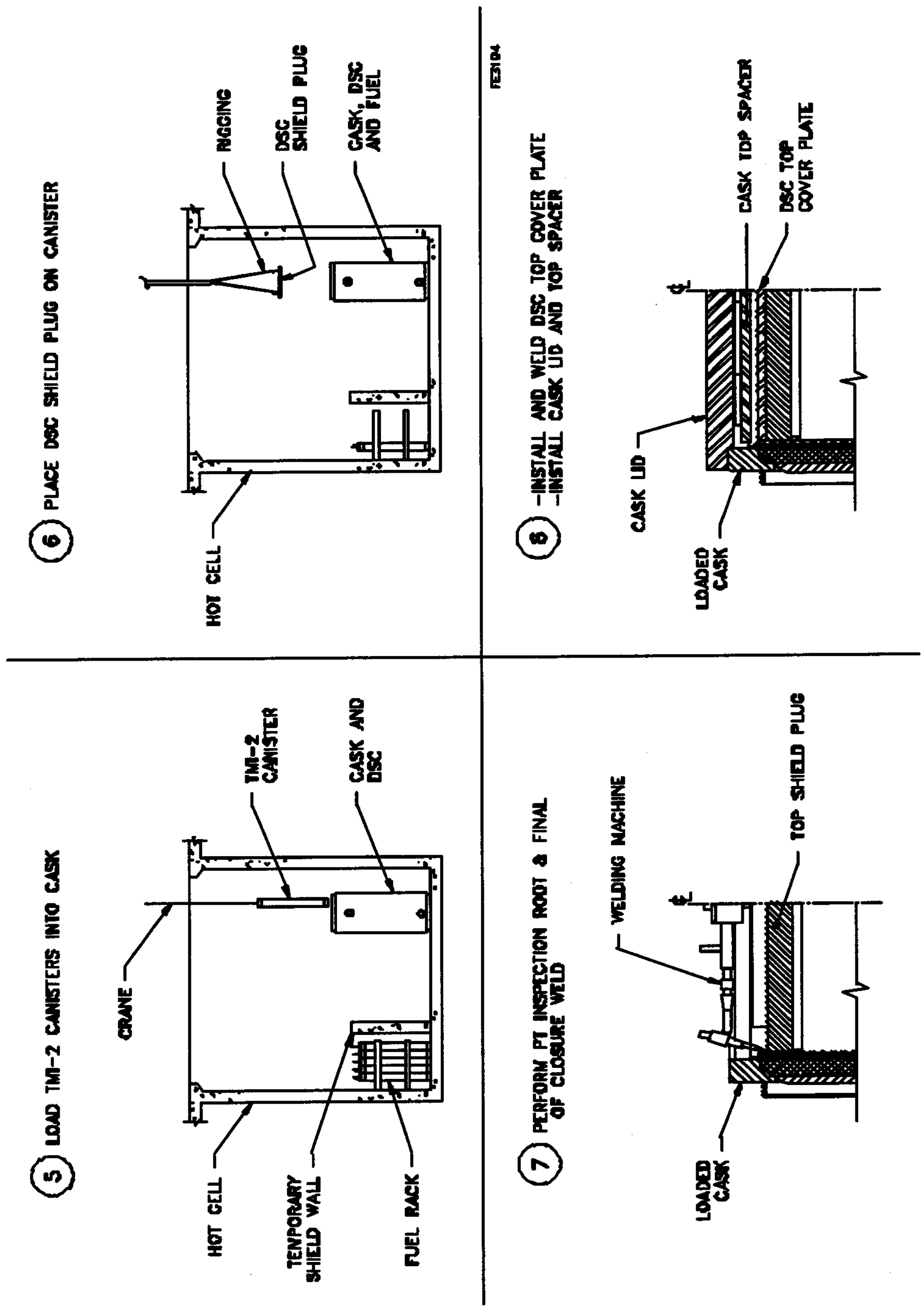


Figure 5.1-1
Primary Operations for the NUHOMS-12T System (continued)

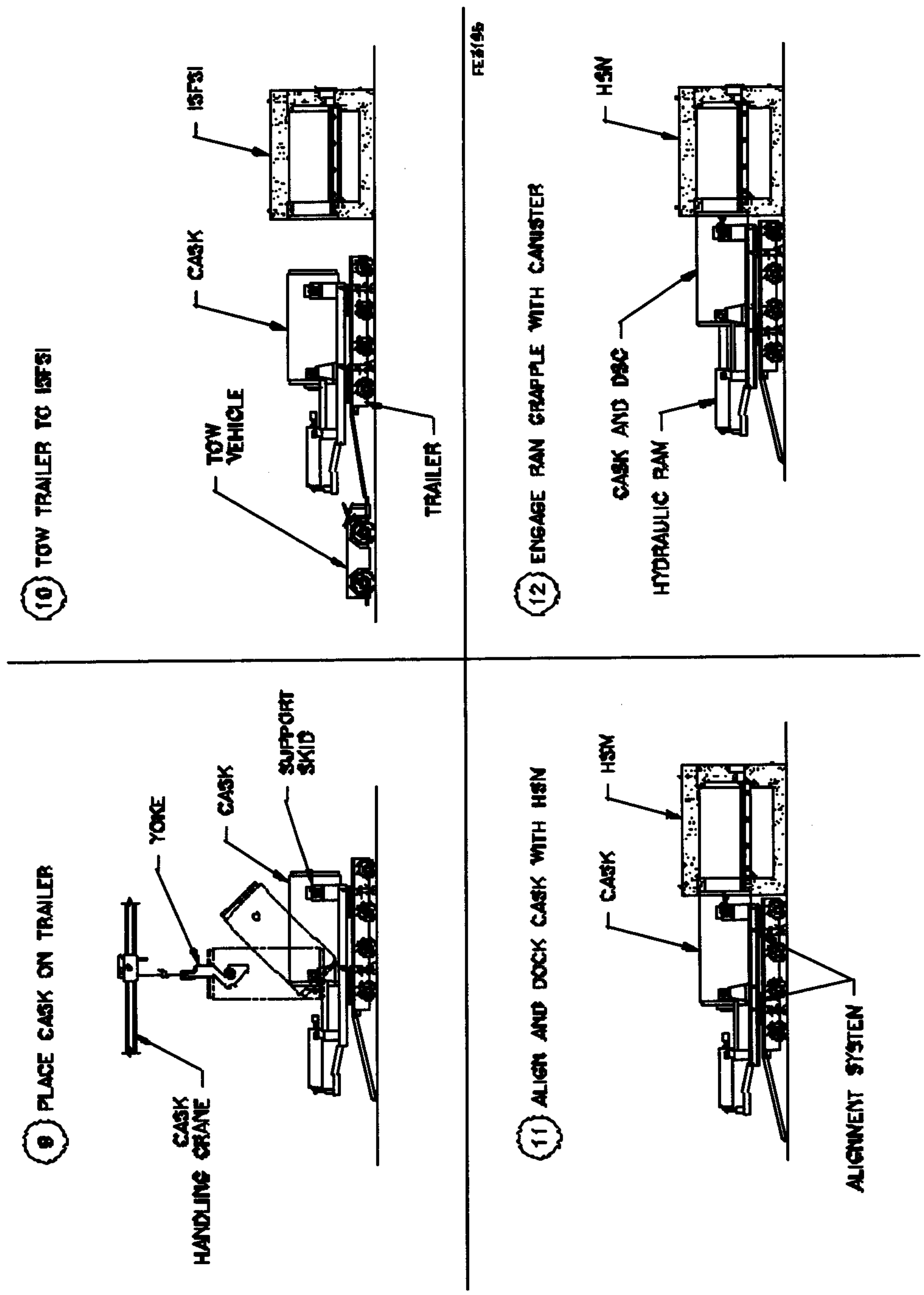


Figure 5.1-1
Primary Operations for the NUHOMS-12T System (continued)

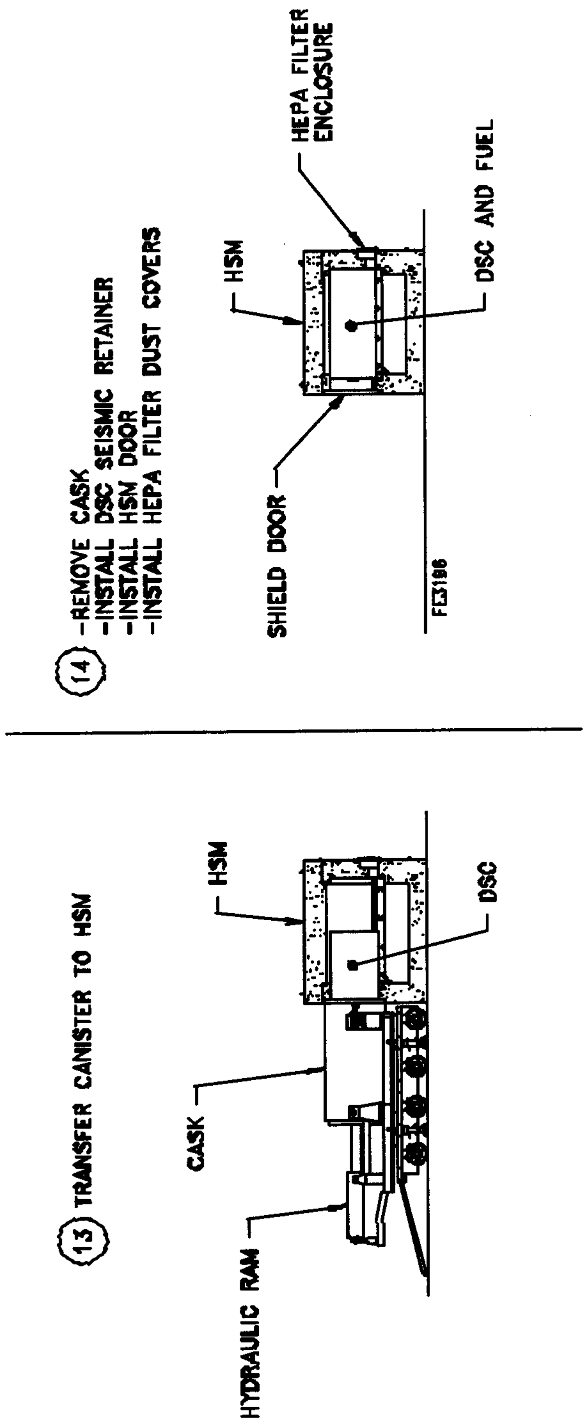


Figure 5.1-1
Primary Operations for the NUHOMS-12T System (continued)

5.1.1.2 TMI Canister Loading into the DSC

Remotely load the dry TMI-2 canisters from the canister staging area into the DSC in accordance with the TAN procedures

1. During the DSC loading process, check, record, and independently verify the identity and location of each TMI-2 canister in the DSC.

2. After all the TMI-2 canisters have been placed into the DSC and their identities verified and recorded in accordance with Technical Specification requirements of the INEEL TMI-2 ISFSI SAR [5.1], position the cask rigging and the top shield plug and lower the shield plug into the DSC.

3. Check radiation levels along the surface of the shield plug.

4. Visually verify that the top shield plug is properly seated onto the DSC.

5.1.1.3 DSC Shield Plug Sealing

1. Install temporary shielding to minimize personnel exposure throughout the subsequent welding operations as required.

2. Mount the automated welding machine on the Cask/DSC, if used for DSC shield plug closure weld.

3. Verify that the cask/DSC annulus cover is in place to prevent debris from entering the annulus.

4. Take appropriate measures to assure that concentrations of flammable gases are below the flammable limit, or sample the environment in the DSC for flammable gases before welding.

5. Either ready the automated welding machine or use manual welds to tack weld the shield plug to the DSC shell. Complete the 360° continuous shield plug weldment and remove the automated welding machine, if used.

6. Perform surface examination of the shield plug weld. ina ccordance with the Technical Specifications[5.1].

5.1.1.4 DSC Top Cover Installation

1. Place the top cover plate onto the DSC. Verify proper fit up of the top cover plate with the DSC shell.

2. If used, mount the automated welding machine on the Cask/DSC.

3. Tack weld the top cover plate to the DSC shell. Install the top cover plate weld root pass. Perform surface examination of the root pass weld. Weld the top cover plate to the DSC shell and perform surface examination on the weld surface in accordance with the Technical Specifications [5.1].

4. Remove vent port test cover (if not already removed) and seal weld the top cover to the shield plug around the vent and purge penetrations (It is optional to remove the automated welding maching prior to this step and then make this weld manually). Perform surface examination of the seal welds in accordance with Technical Specifications [5.1].

5. Remove the automated welding machine from the Cask/DSC if not already removed. Remove any temporary shielding from the vent port and purge port penetrations.

6. Install the vent and purge filter assemblies with the double mechanical seals onto the DSC penetrations(these are installed with filters, but withoutthe transportation covers).

7. Remove the temporary cask/DSC annulus cover.

8. Rig the cask top cover plate with top internal spacer attached and lower the cover plate onto the transfer cask. Bolt the cask cover plate into place.

<u>5.1.1.5 Transfer Cask Downending and Preparation forTransfer to ISFSI</u>

1. Decontaminate the cask exterior surface if required. Temporary shielding may be installed as necessary to minimize personnel exposure.

2. If the neutron shield is to be used during transfer (optional), verify that the OS-197 transfer cask neutron shield is filled with water. Re-attach the transfer cask lifting yoke to the crane hook, as necessary. Ready the transfer trailer and cask support skid for service.

3. The transfer trailer should be positioned so that cask support skid is accessible to the crane with the trailer supported on the vertical jacks.

4. Remove the cask from the work platform eEngaging the lifting yoke and lift the cask over the cask support skid on the transfer trailer.

5. Prior to transfer activities, verify that DSC temperatures and outside temperatures are within the control limits of the Technical Specifications [5.1].

   Using a suitable heavy haul tractor, transfer the cask from the TAN facility to the ISFSI along the designated transfer route. The operating controls and limits for the transfer are covered in Section 10.2.3 of this appendix.Position the cask lower trunnions onto the cask support skid pillow blocks.

6. Move the crane while simultaneously lowering the cask until the cask is just above the support skid upper trunnion pillow blocks.

7. Inspect the positioning of the cask to insure that the cask and trunnion pillow blocks are properly aligned.

8. Lower the cask onto the skid until the weight of the cask is distributed to the trunnion pillow blocks.

9. Inspect the trunnions to insure that they are properly seated onto the skid and install the top halves of the pillow blocks.

5.1.2 Operations Conducted at the ISFSI

5.1.2.1 DSC Transfer to the HSM

1. Once at INTEC, complete the receipt records verification and move the transfer trailer to the HSM.

2. HSM Preparation to Receive DSC: Remove the HSM door using a porta-crane, inspect the cavity of the HSM, removing any debris and ready the HSM to receive a DSC. The doors on adjacent HSMs should remain in place.

3. 4. Check the position of the trailer to ensure the centerline of the HSM and cask approximately coincide. If the trailer is not properly oriented, reposition the trailer, as necessary.

5. Set the trailer brakes and disengage the tractor. Drive the tractor clear of the trailer.

6. Remove the skid tie-down bracket fasteners and use the skid positioning system to bring the cask into approximate vertical and horizontal alignment with the HSM. Using optical survey equipment and the alignment marks on the cask and the HSM, adjust the position of the cask until it is properly aligned with the HSM.

7. Unbolt and remove the cask top cover plate and top internal spacer.

8. Using the skid positioning system, fully insert the cask into the HSM access opening.

9. Secure the cask restraints to the front wall embedments of the HSM.

10. After the cask is docked with the HSM, verify the alignment of the cask using the optical survey equipment.

11. Position the hydraulic ram behind the cask in approximate horizontal alignment with the cask and level the ram. Remove the ram access cover on the cask. Power up the ram hydraulic power supply and extend the ram through the bottom cask opening into the DSC grapple ring. Recording the unique number of the DSC and HSM location may be performed here.

12. Activate the hydraulic cylinder on the ram grapple and engage the grapple arms with the DSC grapple ring.

13. If necessary, recheck all alignment marks and ready all systems for DSC transfer.

14. Activate the hydraulic ram to initiate insertion of the DSC into the HSM. Stop the ram when the DSC is fully inserted or if there are indications that the DSC is jammed.

15. Disengage the ram grapple mechanism so that the grapple is retracted away from the DSC grapple ring.

16. Retract and disengage the hydraulic ram system from the cask and move it clear of the cask. Remove the cask restraints from the HSM.

17. Using the skid positioning system, disengage the cask from the HSM access opening.

18. Install the DSC seismic restraint and record the unique identification number of the DSC and its HSM location.

19. Install the HSM door using a portable crane and secure it in place. Door may be welded for security.

20. Open rear wall access door. Install dust covers on the vent and purge assemblies.

21. Close and lock the rear wall access door.

22. Replace the cask top cover plate and internal spacer. Secure the skid to the trailer, retract the vertical jacks and disconnect the skid positioning system.

23. Reconnect the tractor and tow the trailer and cask to the designated location. Return the remaining transfer equipment to the designated location.

24. Close and lock the ISFSI access gate and activate the ISFSI security measures.

5.1.2.2 HSM Monitoring Operations

Covered in the INEEL TMI-2 ISFSI SAR [5.1].

5.1.2.3 DSC Retrieval from the HSM

1. Ready the cask, transfer trailer, and cask support skid for service and tow the trailer to the HSM.

2. Prior to retrieval activities, verify that DSC temperatures and outside temperatures are within the control limits of Chapter 10 of the INEEL TMI-2 ISFSI SAR [5.1].

3. Open the rear wall access door. Remove the vent system dust covers from the vent and purge filter assemblies.

4. Back the trailer up to the HSM, remove the cask top cover plate and top internal spacer.

5. Connect the skid positioning system hydraulic power unit to the positioning system via the hose connector panel on the trailer, and power it up. Remove the skid tie-down bracket fasteners and use the skid positioning system to bring the cask into approximate vertical and horizontal alignment with the HSM. Using optical survey equipment and the alignment marks on the cask and the HSM, adjust the position of the cask until it is properly aligned with the HSM.

6. Remove the HSM door using a porta-crane. Remove the seismic restraint.

7. Using the skid positioning system, fully insert the cask into the HSM access opening.

8. Secure the cask restraints to the front wall embedments of the HSM.

9. After the cask is docked with the HSM, verify the alignment of the cask using the optical survey equipment.

10. Install and align the hydraulic ram with the cask.

11. Extend the ram through the cask into the HSM until it is inserted in the DSC grapple ring.

12. Activate the arms on the ram grapple mechanism with the DSC grapple ring.

13. Retract ram and pull the DSC into the cask.

14. Retract the ram grapple arms.

15. Disengage the ram from the cask.

16. Remove the cask restraints.

17. Using the skid positioning system, disengage the cask from the HSM.

18. Install the internal spacer and cask top cover plate and ready the trailer for transfer.

19. Replace the door on the HSM.

5.1.2.4 Removal of TMI-2 Canisters from the DSC

If retrieval of the TMI-2 canisters is required, there are two basic options available at the INEEL. The TMI-2 canisters could be removed from the DSC and reloaded into a cask at a dry transfer facility or at the TAN Hot Shop if available. Procedures for unloading of the TMI-2 canisters into a fuel pool or another cask are presented here. Dry unloading procedures are essentially identical to those of DSC loading through the DSC weld removal. Prior to opening the DSC, the following operations are to be performed.

1. Transfer the cask to the cask handling area inside the TAN Hot Shop or other facility.

2. Position and ready the trailer for access by the crane.

3. Place the cask in the vertical position in the designated unloading station.

4. Clean the cask to remove any dirt which may have accumulated during the loading and transfer operations.

5. Place a work platform around the cask so that any point on the surface of the cask is easily accessible to handling personnel.

6. Unbolt the cask top cover plate.

7. Connect the rigging cables to the cask top cover plate and lift the cover plate and internal spacer from the cask. Set the cask cover plate and internal spacer aside and disconnect the lid lifting cables.

8. Install temporary shielding to reduce personnel exposure as required.

DSC opening operations described below are to be carefully controlled in accordance with DSC unloading procedures. This operation is to be performed under the INEEL safety and radiological control procedures for welding, grinding, and handling of potentially highly contaminated equipment. Following opening of the DSC, TMI-2 canisters will be removed using unloading procedures governed by the TAN or other facility operating procedures.
The general sequence for these operations are as follows:

1. Place an exhaust hood or tent over the DSC, if necessary. The exhaust should be filtered or routed to the site radwaste system.

2. Remove the DSC vent and purge assemblies and install the vent test penetration and purge port quick disconnect to prevent the spread of contamination.

3. Place welding blankets around the cask and scaffolding.

4. Using plasma arc-gouging, a mechanical cutting system, or other suitable means, remove the seal welds from between the top cover and the shield plug at the vent and purge penetrations. Then remove the weld between the top cover plate and DSC shell. A fire watch should be placed on the work platform, as appropriate. The exhaust system should be operating at all times.

5. The material or waste from the cutting or grinding process should be treated and handled in accordance with the plant's low level waste procedures unless determined otherwise.

6. Remove the top of the tent, if necessary.

7. Remove the exhaust hood, if necessary.

8. Remove the DSC top cover plate.

9. Reinstall tent and temporary shielding, as required. Remove the shield plug to DSC weld. Remove any remaining excess material on the inside shell surface by grinding.

10. Clean the cask surface of dirt and any debris which may be on the cask surface as a result of the weld removal operation.

11. Lift the top shield plug from the DSC.

12. Remove the TMI-2 canisters from the DSC and place the TMI-2 canisters into an authorized location or other cask.

5.1.2.5 DSC Transfer to the DSC Overpack

The need to transfer a DSC to the HSM with an integral overpack could arise as a result of damage or deterioration that occurs unexpectedly or due to loading difficulties. The following procedural steps accommodate this condition with the initial condition of the DSC already in the transfer cask.

1. Prior to positioning the cask close to the DSC overpack, remove the HSM door using a porta-crane. Inspect the cavity of the DSC overpack, removing any debris, and ready the DSC overpack to receive a DSC. The doors on adjacent HSMs, if any, must remain in place. Verify that the overpack vent and purge filters are in place and the filter housing seals have been leak tested.

2. Prior to transfer operations verify that DSC temperatures and outside temperatures are within the control limits of Chapter 10 of the INEEL TMI-2 ISFSI SAR [5.1].

3. Using a suitable heavy haul tractor, move the cask to the ISFSI overpack HSM location.

4. Check the position of the trailer to ensure the centerline of the DSC overpack and cask approximately coincide. If the trailer is not properly oriented, reposition the trailer as necessary.

5. Set the trailer brakes and disengage the tractor. Drive the tractor clear of the trailer.

6. Unbolt and remove the cask top cover plate and top internal spacer.

7. Using the skid positioning system, fully insert the cask into the DSC overpack access opening.

8. Connect the skid positioning system hydraulic power unit to the positioning system via the hose connector panel on the trailer, and power it up. Remove the skid tie-down bracket fasteners and use the skid positioning system to bring the cask into approximate vertical and horizontal alignment with the DSC overpack. Using optical survey equipment and the alignment marks on the cask and the DSC overpack, adjust the position of the cask until it is properly aligned with the DSC overpack. Just prior to inserting the DSC into the overpack, pull a vacuum on the DSC, release the vacuum and remove the filters.

9. After the cask is docked with the DSC overpack, verify the alignment of the cask using the optical survey equipment.

10. Secure the cask trunnions to the front wall embedments of the DSC overpack using the cask restraints.

11. Install ram front support on the base of the cask and position the hydraulic ram behind the cask in approximate horizontal alignment with the cask and level the ram. Power up the ram hydraulic power supply and extend the ram through the bottom cask opening into the DSC grapple ring.

12. Activate the hydraulic cylinder on the ram grapple and engage the grapple arms with the DSC grapple ring.

13. Recheck all alignment marks used in the Step 11 operation and ready all systems for DSC transfer.

14. Activate the hydraulic ram to initiate insertion of the DSC into the DSC overpack. Stop the ram when the DSC reaches the support rail stops at the back of the DSC overpack.

15. Disengage the ram grapple mechanism so that the grapple is retracted away from the DSC grapple ring.

16. Retract and disengage the hydraulic ram system from the cask and move it clear of the cask. Remove the ram support and cask restraints.

17. Using the skid positioning system, disengage the cask from the DSC overpack access opening.

18. Install and weld the DSC overpack cover and perform surface examination of the root and final pass of the weld in accordance with the DSC closure weld requirements in Chapter 10 of the INEEL TMI-2 ISFSI SAR [5.1].

19. Install the DSC seismic restraint.

20. Install the HSM door using a portable crane and secure it in place. Door may be welded for security.

21. Replace the cask top cover plate. Secure the skid to the trailer, retract the vertical jacks and disconnect the skid positioning system.

22. Tow the trailer and cask to the designated location. Return the remaining transfer equipment to the designated location.

23. Close and lock the ISFSI access gate and activate the ISFSI security measures.

5.1.2.6 DSC Overpack Monitoring Operations

1. Perform routine security surveillance in accordance with the INEEL TMI-2 ISFSI security plan.

2. Perform surveillance of the DSC overpack vent system in accordance with the Chapter 10 requirements for a standard HSM/DSC vent system.

5.1.2.7 DSC Retrieval from the Overpack

1. Ready the cask, transfer trailer, and support skid for service and tow the trailer to the DSC overpack.
2. Evacuate and backfill the overpack and DSC with fresh air or an inert gas.
3. Cut any welds from the door and remove the HSM door using a porta-crane. Remove the DSC seismic restraint.
4. Place scaffolding, a containment tent with exhaust system, and welding blankets around appropriate end of the overpack.
5. Using plasma arc-gouging, a mechanical cutting system, or other suitable means, remove the seal weld from the DSC overpack. A fire watch should be present, as appropriate. The exhaust system should be operating, as necessary.
6. The material or waste from the cutting or grinding process should be treated and handled in accordance with the facilities low level waste procedures unless determined otherwise.
7. Remove the tent and exhaust system.
8. Remove the DSC overpack cover plate.
9. Prior to retrieval activities, verify that DSC temperatures and outside temperatures are within the control limits of Chapter 10 of the SAR [5.1].
10. Back the trailer to within a few inches of the DSC overpack.
11. Using the skid positioning system, align the cask with the HSM and position the skid until the cask is docked with the HSM access opening.
12. Using optical survey equipment, verify alignment of the cask with respect to the DSC overpack. Install the cask restraints.
13. Install rear cask ram support and align the hydraulic ram with the cask, as necessary.
14. Extend the ram through the cask into the DSC overpack until it is inserted in the DSC grapple ring.
15. Activate the arms on the ram grapple mechanism with the DSC grapple ring.
16. Retract ram and pull the DSC into the cask.
17. Retract the ram grapple arms.
18. Disengage the ram from the cask.
19. Remove the cask restraints.
20. Using the skid positioning system, disengage the cask from the DSC overpack.

21. Install the cask internal spacer and top cover plate.

22. Replace the door on the overpack.

5.1.3 Flowsheets

The NUHOMS®–12T is a passive storage system and requires no operating system other than those systems/operations used in loading and transfer. A description and sequence of operations is provided in Section 5.1 of this appendix. A series of pictorial views of operations is also shown in Figure 5.1-1.

5.1.4 Identification of Subjects for Safety Analysis

Covered in the INEEL TMI-2 ISFSI SAR.

5.2 Fuel Handling System

The OS-197 transfer cask and associated equipment are described in Chapter 4 of this Appendix.

5..3 Other Operating Systems

Covered in the INEEL TMI-2 ISFSI SAR.

5.4 Operation Support System

Covered in the INEEL TMI-2 ISFSI SAR.

5.5 Control Room and/or Control Areas

Covered in the INEEL TMI-2 ISFSI SAR.

5.6 Analytical Sampling

Covered in the INEEL TMI-2 ISFSI SAR.

5.7 References

5.1 The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation, Docket No. 72-20, Rev. 1, March 1999.

CONTENTS

6. Site-Generated Waste Confinement and Management 1

Intentionally Blank

6. Site-Generated Waste Confinement and Management

The transfer of the TMI-2 DSCs in the OS-197 Cask will not create any waste. Therefore, the text presented in Chapter 6 of the INEEL TMI-2 ISFSI SAR [6.1] covers the use of the OS-197 Cask.

6.1 References

6.1 The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation, Docket No. 72-20, Rev. 1, March 1999

Intentionally Blank

CONTENTS

7. Radiation Protection 1
7.1 Ensuring That Occupational Radiation Exposures are As-Low-As-Reasonably-Achievable 1
7.2 Radiation Sources 1
7.3 Design Features 1
7.3.1 Installation Design Features 1
7.3.2 Shielding 1
7.3.3 Ventilation 8
7.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation.... 8
7.4 Estimate On-Site Collective Dose Assessment 8
7.4.1 Operational Dose Assessment 8
7.4.2 Site Dose Assessment 9
7.5 Health Physics Program 9
7.6 Estimated Off-Site Collective Dose Assessment 9
7.7 References 10

Intentionally Blank

7. RADIATION PROTECTION

7.1 Ensuring That Occupational Radiation Exposures are As-Low-As-Reasonably-Achievable

Covered in the INEEL TMI-2 ISFSI SAR [7.1].

7.2 Radiation Sources

The OS-197 Transfer System will operate in a vented mode. The DSCs will be vented through HEPA filters to the atmosphere during the transfer. The radiation sources are the same as described in the INEEL TMI-2 ISFSI SAR [7.1].

7.3 Design Features

7.3.1 Installation Design Features

Covered in the INEEL TMI-2 ISFSI SAR [7.1].

7.3.2 Shielding

Shielding of the HSMs is covered in the INEEL TMI-2 ISFSI SAR [7.1].

7.3.2.1 Radiation Shielding Design Features

The OS-197 Transfer Cask is a cylindrical shielded vessel constructed from steel and various shielding materials. Radial gamma shielding is principally provided by a stainless steel inner liner, a lead shield, and carbon or stainless steel structural shell. Neutron shielding in the radial direction is provided by an outer metal jacket that forms an annulus with the cask structural shell. The annulus is typically filled with a neutron-absorbing material (water) to provide neutron dose attenuation. In the case of the TMI-2 fuel transfer, the dose rates are low, and the neutron shield annulus may be either empty or full. The steel transfer cask top and bottom cover plates with integral solid neutron shielding material provide shielding in the axial direction in addition to that of the DSC shield plugs. Figure E1.3-1 shows the physical arrangement of the OS-197 Transfer Cask. Figure E7.3-1 shows the DSC and OS-197 Cask shielding geometry and dimensions.

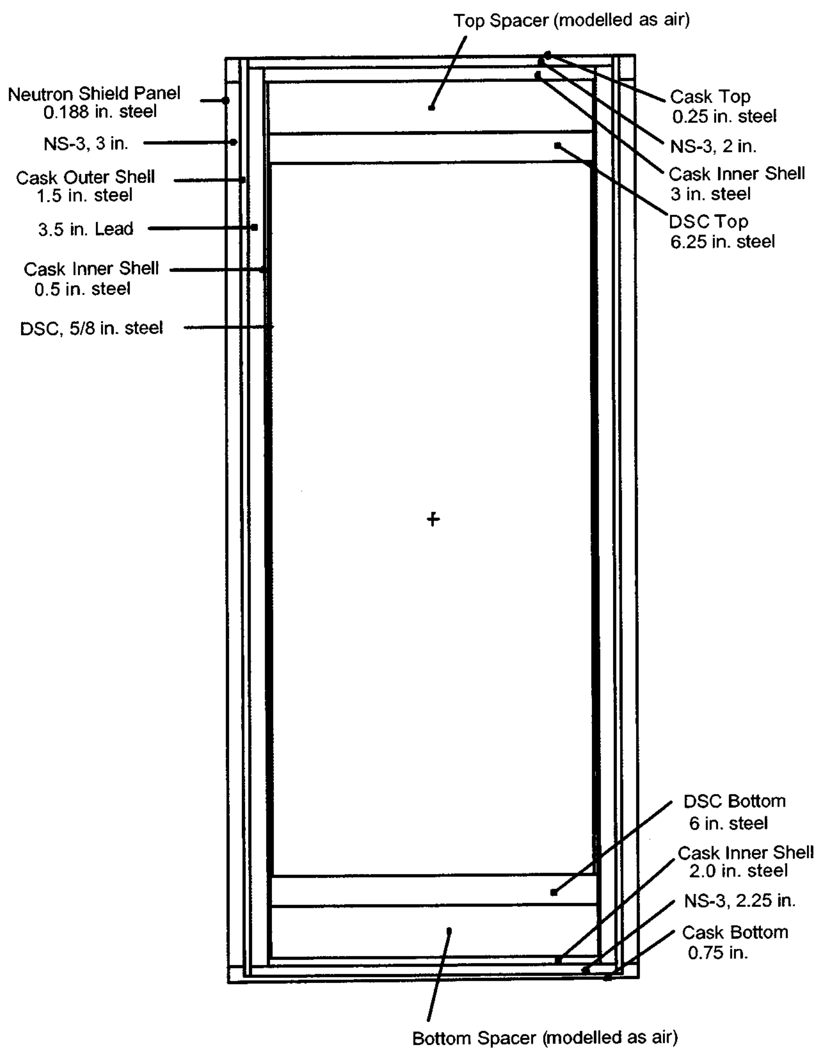


Figure E7.3-11
Simplified Model of the OS-197 Cask (Including DSC).

7.3.2.2 Shielding Analysis

This section contains an evaluation of the OS-197 Cask shielding relative to the shielding provided by the MP-187 Cask. Table 7.3-1 of the INEEL TMI-2 ISFSI SAR lists the results of the shielding analysis for the MP-187 Cask. The dose rates from Table 7.3-1 are summarized in Table E7.3.2-1 below. Table E7.3.2-2 compares the shielding for the two casks. Because the OS-197 Cask has less overall shielding than the MP-187 Cask, an evaluation of the dose rates around the cask has been performed. Because the predicted dose rates of the MP-187 Cask are low, a simplified shielding evaluation was performed to demonstrate the acceptability of the

OS-197 Cask shielding. Note that the OS-197 Cask side neutron shield is normally filled with water, but the cask may be used with the neutron shield dry. Therefore, the shielding analysis will address the dose rates outside the OS-197 Cask for two conditions: (1) the neutron shield filled with water and (2) the neutron shield empty.

Table E7.3.2-1
Shielding Analysis Results for the MP-187 Cask [7.1].

Location	Peak Dose Rate (mrem/h)		Average Dose Rate (mrem/h)	
	Neutron	Gamma	Neutron	Gamma
Cask Side	1.35	1.85	0.16	0.66
Cask Top	0.33	0.30	0.24	0.21
Cask Bottom	0.31	0.16	0.22	0.11

Table E7.3.2-2
Summary of Shielding for the Casks.

Location	Material	Thickness (in.)	
		MP-187	OS-197
Top[b]	Steel	6.5	3.25
	Neutron Absorber (NS-3)	0	2
Bottom[b]	Steel	8	2.75[a]
	Neutron Absorber (NS-3)	0	2.25
Side	Steel	3.94	2.125
	Lead	4	3.5
	Neutron Absorber	4.31 (NS-3)	3 (Water)[c]

[a]Includes 1.75 in. and 1 in. steel plates in the bottom of the cask.
[b] The top and bottom spacers are not included in the cask models.
[c] The OS-197 side neutron shield is normally filled with water, but may be transferred empty.

A. Computer Code: The MCNP Version 4B2 computer code [7.3, 7.4] was used to assess the effect of differences in the OS-197 and MP-187 Casks' shielding on the gamma and neutron dose rates.

The MCNP computer code [7.2] is a general-purpose Monte Carlo code with powerful geometry routines. It uses Evaluated Nuclear Data Files (ENDF/B) for cross sections [7.5]. The state-of-the-art ENDF/B system is maintained by the National Nuclear Data Center at Brookhaven National Laboratory under contract from DOE. Gamma fluence-to-dose conversion factors are based on the anterior-to-posterior irradiation pattern in ANSI/ANS 1991 [7.4]. Neutron flux-to-dose rate conversion factors are based on ANSI/ANS 1977 [7.6].

B. Cask Gamma Dose Rates: The side of the OS-197 Cask has 4.62 cm (1.82 in.) less steel, 1.27 cm (0.5 in.) less lead, and 3.33 cm (1.31 in.) less neutron absorber than the MP-187 Cask.

The OS-197 Cask has 13.3 cm (5.25 in.) less steel in the bottom of the cask and 8.25 cm (3.25 in.) less steel in the top of the cask relative to the MP-187 Cask. Therefore, the gamma dose rates on the top, bottom, and sides of the cask are evaluated. The side neutron shield for the OS-197 Cask was modeled for both wet and dry conditions since the cask may be transferred dry.

Gamma Shielding Models for the OS-197 and MP-187 Casks

Simplified shielding models are used to assess the impact on the gamma dose rates due to differences in the shielding of the OS-197 and MP-187 Casks. The gamma energy spectrum from Table 7.2-2 of the INEEL TMI-2 ISFSI SAR was used in the MCNP models. The source was modeled as a cylinder with a 168 cm (66-in.) diameter and a 384 cm (151-in.) height. These are the approximate inside dimensions of a Dry Shielded Canister (DSC). For simplicity, the source was modeled as air. Tables E7.3.2-3 and E7.3.2-4 describe the geometry and materials used in the simplified MCNP shielding models for the MP-187 and OS-197 Casks. Note that the top and bottom spacers are not included in the models.

Table E7.3.2-3
Description of Simplified MCNP Models for the Cask Top and Bottom

Region	Material	Density g/cc	Thickness (in.)	
Cask Top	Steel	8	MP-187	OS-197
Cask Top	Steel	8	6.5	3.25[a]
Neutron Shield[b]	NS-3	1.968	NA	2
Top Spacer[c]	Air	0.00122	11.75	6
DSC Top	Steel	8	6.25	6.25
Source	Air	0.00122	151	151
DSC Bottom	Steel	8	6	6
Bottom Spacer[c]	Air	0.00122	11.75	23.5
Neutron Shield[b]	NS-3	1.968	NA	2.25
Cask Bottom	Steel	8	8	2.75[d]

[a]Includes 0.25 in. and 3 in. steel plates in the top of the cask.
[b]The MP-187 Cask neutron shield densities include an assumed 10% hydrogen loss and a 50% reduction in boron. Neutron shield material densities include the stainless steel and aluminum stiffeners present in the neutron shield annulus. The following densities for the neutron shield were taken from Table 5.3-1 of the MP-187 SAR [7.7]: hydrogen (0.07 g/cc), boron (0.013 g/cc), carbon (0.157 g/cc), oxygen (0.915 g/cc) aluminum (0.382 g/cc), silicon (0.054 g/cc), calcium (0.09 g/cc), chromium (0.053 g/cc), iron (0.208 g/cc), nickel (0.026 g/cc).
[c]The top and bottom spacers were modeled as air.
[d]Includes 1.75-in. and 1-in. steel plates in the bottom of the cask.

Table E7.3.2-4
Description of Simplified MCNP Models for the Side of the Casks.

Region	Material	Density g/cc	Zone Radius (in)		Zone Thickness (in)	
			MP-187	OS-197	MP-187	OS-197
Source	Air	0.00122	33	33	33	33
DSC Side	Steel	8	33.625	33.625	0.625	0.625
Inner Shell	Steel	8	34.875	34.125	1.25	0.5
Lead Shield	Lead	11.34	38.875	37.625	4	3.5
Outer Shell	Steel	8	41.375	39.125	2.5	1.5
Neutron Shield	B_4C	1.968[a]	45.685	NA	4.31	NA
Neutron Shield[b]	Water/ Air	1.0/ 0.00122	NA	42.125	NA	3
Neutron Shield Panel	Steel	8	45.875	42.25	0.19	0.125

[a]The MP-187 Cask neutron shield densities include an assumed 10% hydrogen loss and a 50% reduction in boron. Neutron shield material densities include the stainless steel and aluminum stiffeners present in the neutron shield annulus. The following densities for the neutron shield were taken from Table 5.3-1 of the MP-187 SAR [7.7]: hydrogen (0.07 g/cc), boron (0.013 g/cc), carbon (0.157 g/cc), oxygen (0.915 g/cc) aluminum (0.382 g/cc), silicon (0.054 g/cc), calcium (0.09 g/cc), chromium (0.053 g/cc), iron (0.208 g/cc), nickel (0.026 g/cc).
[b]The OS-197 Cask neutron shield was modeled both as water and air (i.e., dry).

Gamma Dose Rates for the OS-197 Cask With the Neutron Shield Filled With Water

The dose rates on the top of the cask were found to be 7.9 mrem/h for the MP-187 Cask and 132 mrem/h for the OS-197 Cask. The dose rates on the cask bottom were found to be 1.9 mrem/h for the MP-187 Cask and 219 mrem/h for the OS-197 Cask. Note that due to the simplicity of the MCNP models (e.g., not accounting for self-shielding from the source), the absolute dose rates from the MCNP models do not represent the actual predicted dose rates. However, the ratio of the dose rates for the two casks can be used in conjunction with the dose rates originally calculated for the top and bottom of the MP-187 Cask to estimate the dose rate on the top and bottom of the OS-197 Cask. Using the ratio of the OS-197 Cask top dose rate to that for the MP-187 Cask (16.7 = 132 mrem/h /7.9 mrem/h) and the original peak dose rate of 0.30 mrem/h for the top of the MP-187 Cask, the dose rate on the top of the OS-197 Cask is estimated to be 5.0 mrem/h (16.7 x 0.30 mrem/h), which is approximately the same as the dose rate in the approved Standardized NUHOMS system [7.8]. Using the ratio of the OS-197 Cask bottom dose rate to that for the MP-187 (115 = 219 mrem/h /1.9 mrem/h), and the original peak dose rate of 0.16 mrem/h for the bottom of the MP-187 Cask, the dose rate on the bottom of the OS-197 Cask is estimated to be 18.4 mrem/h (115 x 0.16 mrem/h), which is below the dose rate in the approved Standardized NUHOMS system [7.8].

The dose rates on the side of the cask were found to be 9.5 mrem/h for the MP-187 Cask and 239 mrem/h for the OS-197 Cask (with the neutron shield filled with water). Using the ratio of 25.2 (239 mrem/9.5 mrem) and the original peak dose rate of 1.85 mrem/h for the side of the MP-187 Cask, the dose rate on the side of the OS-197 Cask is estimated to be 46.6 mrem/h (25.2 x 1.85 mrem/h), which is far below the dose rate in the approved Standardized NUHOMS system [7.8].

Gamma Dose Rates for the OS-197 Cask With the Neutron Shield Dry

The dose rate on the top of the OS-197 Cask was found to be 132 mrem/h with the neutron shield dry. The dose rate on the bottom of the OS-197 Cask was found to be 219 mrem/h, and the dose rate on the side of the OS-197 Cask was 342 mrem/h. Note that the presence of water in the OS-197 Cask neutron shield has no impact on the top and bottom gamma dose rates. As was done above, using the ratio of the OS-197 Cask top dose rate to that for the MP-187 Cask (16.7 = 132 mrem/h /7.9 mrem/h) and the original peak dose rate of 0.30 mrem/h for the top of the MP-187 Cask, the dose rate on the top of the OS-197 Cask is estimated to be 5.0 mrem/h (16.7 x 0.30 mrem/h). Using the ratio of the OS-197 Cask bottom dose rate to that for the MP-187 (115 = 219 mrem/h/1.9 mrem/h), and the original peak dose rate of 0.16 mrem/h for the bottom of the MP-187 Cask, the dose rate on the bottom of the OS-197 Cask is estimated to be 18.4 mrem/h (115 x 0.16 mrem/h). Using the ratio of 36 (342 mrem/9.5 mrem) and the original peak dose rate of 1.85 mrem/h for the side of the MP-187 Cask, the dose rate on the side of the OS-197 Cask is estimated to be 66.6 mrem/h (36 x 1.85 mrem/h). These gamma dose rates are below those in the approved Standardized NUHOMS system [7.8].

Note that modeling the source as air produces a gamma energy spectrum for gamma rays leaving the DSC that is different than that for the actual configuration where the canisters and other materials alter (harden) the energy spectrum. However, this has a minimal impact on the ratio of the dose rates from the OS-197 and MP-187 Casks and does not impact the conclusions of this evaluation.

C. Cask Neutron Dose Rates: The OS-197 Cask has top and bottom neutron shields made of a solid neutron absorbing material. The side of the OS-197 Cask has a 7.6 cm (3-in.) water neutron shield, which will be modeled as both water and air for this evaluation. The MP-187 Cask has a 10.9 cm (4.31 in.) neutron shield made of a solid neutron absorbing material. The neutron dose rates on the top, bottom, and side of the cask are evaluated to assess the impact on the neutron dose rates that result from differences in the shielding.

Neutron Shielding Models

The simplified MCNP cask models developed for the gamma dose rate estimates were used for the neutron dose rate estimates with a few modifications. The neutron energy spectrum from Table 7.2-1 of the existing INEEL TMI-2 ISFSI SAR was used in the MCNP models instead of the gamma energy spectrum. The neutron cross sections contained in the MCNP library were used instead of the gamma cross sections, and the ANSI 1977 [7.6] neutron fluence-to-dose factors were used instead of the ANSI 1991 [7.4] gamma-ray flux-to-dose rate factors. Tables E7.3.2-3 and E7.3.2-4 summarize the material and geometry properties used in the simplified model for the OS-97 and MP-187 Casks. Figure 7.3-2 of the INEEL TMI-2 ISFSI SAR illustrates the DSC and MP-187 Cask configuration. Figure E7.3-1 of this appendix illustrates the DSC and OS-197 Cask configuration.

Neutron Dose Rates With the OS-197 Cask Neutron Shield Filled With Water

The peak neutron dose rates on the cask bottom were found to be 0.73 mrem/h for the MP-187 Cask and 0.21 mrem/h for the OS-197 Cask (with the neutron shield filled with water). The peak neutron dose rates on the top of the cask were found to be 0.81 mrem/h for the MP-187 Cask and 0.27 mrem/h for the OS-197 Cask. Note that due to the simplicity of the MCNP models (e.g., not accounting for self-shielding from the source), the absolute dose rates from MCNP models do not represent the actual predicted dose rates. However, the ratio of the MCNP does rates for the two casks can be used in conjunction with the neutron dose rates originally calculated for the MP-187 Cask to estimate the dose rates for the OS-197 Cask. Using the ratio of the OS-197 Cask bottom dose rate to that for the MP-187 (0.29 = 0.21 mrem/h /0.73 mrem/h) and the original peak dose rate of 0.31 mrem/h for the bottom of the MP-187 Cask, the dose rate on the bottom of the OS-197 Cask is estimated to be 0.09 mrem/h (0.29 x 0.31 mrem/h). Applying the ratio of the OS-197 Cask to MP-187 Cask top dose rates (0.33 = 0.27 mrem/h /0.81 mrem/h) to the peak dose rate for the MP-187 Cask (0.33 mrem/h) results in an estimate of 0.11 mrem/h (0.33 x 0.33 mrem/h) for the top of the OS-197 Cask.

The maximum neutron dose rates on the side of the cask were found to be 0.1 mrem/h for the MP-187 Cask and 0.32 mrem/h for the OS-197 Cask. Using the ratio of 3.2 (0.32 mrem/h /0.1 mrem/h) and the original peak dose rate of 1.35 mrem/h for the side of the MP-187 cask, the dose rate on the side of the OS-197 cask is estimated to be 4.3 mrem/h (3.2 x 1.35 mrem/h). These neutron dose rates are below those in the approved Standardized NUHOMS system [7.8].

Neutron Dose Rates With the OS-197 Cask Neutron Shield Dry

The peak neutron dose rate on the bottom of the OS-197 Cask was found to be 0.20 mrem/h with the neutron shield dry. The neutron dose rate on the top of the OS-197 Cask was found to be 0.27 mrem/h, and the dose rate on the side of the cask was 3.3 mrem/h. Using the ratio of the OS-197 Cask bottom dose rate to that for the MP-187 (0.27 = 0.20 mrem/h /0.73 mrem/h), and the original peak dose rate of 0.31 mrem/h for the bottom of the MP-187 Cask, the dose rate on the bottom of the OS-197 Cask is estimated to be 0.08 mrem/h (0.27 x 0.31 mrem/h). Applying the ratio of the OS-197 Cask to MP-187 Cask top dose rates (0.33 = 0.27 mrem/h /0.81 mrem/h) to the peak dose rate for the MP-187 Cask (0.33 mrem/h) results in an estimate of 0.11 mrem/h (0.33 x 0.33 mrem/h) for the top of the OS-197 Cask. Applying the ratio of 33 (3.3 mrem/h /0.1 mrem/h) and the original peak dose rate of 1.35 mrem/h for the side of the MP-187 Cask, the dose rate on the side of the OS-197 Cask is estimated to be 44.6 mrem/h (33 x 1.35 mrem/h). These neutron dose rates are below those in the approved Standardized NUHOMS system [7.8].

Note that modeling the source as air produces a neutron energy spectrum for neutrons, leaving the DSC that is different than that for the actual configuration where the canisters and other materials alter the energy spectrum. However, this has a minimal impact on the ratio of the dose rates from the OS-197 and MP-187 Casks and does not impact the conclusions of this evaluation.

D. Summary of Cask Dose Rates Table E7.3.2-5 provides conservative estimates of the peak neutron and gamma dose rates for the OS-197 Cask based on the results of the simplified shielding models described above. However, since the discovery of AmBeCm startup source material contained in two Dry Storage Canisters, Table E7.3.2-5 has been updated to reflect additional neutron shielding analyses for the OS-197 cask when the neutron shield is dry [7.9]. These results demonstrate that the shielding afforded by the OS-197 Cask is more than adequate to meet all required dose rate limits, and the dose rates are well below those approved in the Standardized NUHOMS system [7.8] both with the neutron shield filled with water and with the neutron shield dry.

Table E7.3.2-5
Shielding Analysis Results for the OS-197 Cask.

Location	Peak Dose Rate (mrem/h)		
	Neutron	Gamma	Total
Neutron Shield Filled with Water			
Cask Side	4.3	46.6	51
Cask Top	0.11	5.0	5.1
Cask Bottom	0.09	18.4	19
Neutron Shield Dry			
Cask Side	60*	66.6	127*
Cask Top	0.11	5.0	5.1
Cask Bottom	0.08	18.4	19

* Includes additional neutron dose equivalent rate attributed to AmBeCm startup source material.[7.9]

7.3.3 Ventilation

Covered in the INEEL TMI-2 ISFSI SAR [7.1].

7.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

Covered in the INEEL TMI-2 ISFSI SAR [7.1].

7.4 Estimated On-Site Collective Dose Assessment

7.4.1 Operational Dose Assessment

Table E7.4-1 contains the estimated dose rates around the OS-197 Cask loaded with TMI-2 core debris both with the neutron shield filled with water and with the neutron shield dry. The table also lists the dose rates from the standard NUHOMS® system which consists of the OS-197 Cask loaded with PWR fuel with the neutron shield filled with water.

Table E7.4-1
Dose Rates for the OS-197 Cask with TMI-2 Core Debris Versus the OS-197 Cask with PWR Fuel.

Location	Dose Rate (mrem/h)		
	OS-197 w/ 12T DSC (neutron shield filled with water)	OS-197 w/ 12T DSC (neutron shield dry)	OS-197 Standard NUHOMS[a]
Cask Side	51	127[b]	592
Cask Top	5.1	5.1	21.2
Cask Bottom	19	19	67.4

[a] Dose rates from Table 7.3-2 of Reference 7.9. The OS-197 neutron shield is filled with water.
[b] Includes additional neutron dose equivalent rate attributed to AmBeCm startup source material.[7.9]

Because the predicted dose rates for the OS-197 Cask with TMI-2 core debris are much lower than those predicted for the previous standard NUHOMS® system, occupational exposures for the TMI-2 ISFSI will be bounded by those observed at other installations. Based on experience from operating NUHOMS® systems at Oconee, Calvert Cliffs, and Davis-Besse, the total occupational dose for placing a DSC with TMI-2 core debris into dry storage will be much less than one person-rem. With the use of effective procedures and experienced ISFSI personnel, the total accumulated dose can be reduced below 500 person-mrem per DSC.

7.4.2 Site Dose Assessment

Covered in the INEEL TMI-2 ISFSI SAR [7.1].

7.5 Health Physics Program

Covered in the INEEL TMI-2 ISFSI SAR [7.1].

7.6 Estimated Off-Site Collective Dose Assessment

Covered in the INEEL TMI-2 ISFSI SAR [7.1].

Use of the OS-197 Cask will not increase the off-site dose for normal operations. The effects of accidental release during the transfer between TAN and INTEC is presented in Section 8.2.4 of this appendix.

7.7 References

7.1 *The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation*, Docket No. *72-20*, Rev. 1, March 1999.

7.2 Breismeister, J. F., Editor, 1997, *MCNP--A General Monte Carlo Code N-Particle Transport Code, Version 4B*, LA-12625-M, Los Alamos National Laboratory, Los Alamos, New Mexico.

7.3 McCoy, J. C., 1998, *WMNW Computer Program Verification for MCNP4B,* EBU-SQA-002, Rev. 1, Waste Management Federal Services, Inc., Northwest Operations, Richland, Washington.

74 ANS, 1991, *Neutron and Gamma-Ray Fluence-to-Dose Factors,* ANSI/ANS-6.1.1 1991, American Nuclear Society, La Grange Park, Illinois

7.5 BNL 1991, ENDF/B-VI Summary Documentation, BNL-NCS-17541, 4th Edition, Brookhaven National Laboratory, Upton, New York

7.6 ANS, 1977, *Neutron and Gamma-Ray Flux-to-Dose Rate Factors,* ANSI/ANS-6.1.1-1977, American Nuclear Society, La Grange Park, Illinois.

7.7 *Safety Analysis Report for the NUHOMS® - MP-187 Multi-Purpose Cask*, NUH-005, Revision 9, Transnuclear-West, Inc., NRC Docket Number 71-9255, September 1998.

7.8 *Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel*, NUH-003, Rev. 4A, VECTRA Technologies, Inc., June 1996.

7.9 Hall, G. G., *Impact of AmBeCm Sources on the TMI-2 ISFSI Design Basis*, Engineering Design File No. 1793, Revision 4, March 15, 2001.

CONTENTS

8. Analysis of Design Events ii
8.1 Normal and Off-Normal Operations 1
8.1.1 Normal Load Structural Analysis 1
8.1.2 Off-Normal Load Structural Analysis 3
8.1.3 Thermal Hydraulic Analysis 4
8.2 Accident Analysis For The ISFSI and OS-197 5
8.2.1 Earthquake 6
8.2.2 Flood 7
8.2.3 Loss of Neutron Shielding 7
8.2.4 DSC Leakage 7
8.3 Load Combination Evaluation 8
8.3.1 DSC Confinement Boundary Load Combination Evaluation 8
8.3.2 DSC Confinement Boundary Fatigue Evaluation 8
8.3.3 OS-197 Cask Load Combination Evaluation 8
8.3.4 OS-197 Cask Fatigue Evaluation 8
8.3.5 HSM Load Combination Evaluation 8
8.3.6 Thermal Cycling of the HSM 10
8.3.7 DSC Support Structure Load Combination Evaluation 10
8.4 Site Characteristics Affecting Safety Analysis 10
8.5 References 10

Intentionally Blank

8. ANALYSIS OF DESIGN EVENTS

The design basis for the OS-197 Transfer Cask, as provided in the Safety Analysis Report for the Standardized NUHOMS® System [8.1], is generally more severe than the design basis associated with its use for transfer of the NUHOMS®-12T DSCs. As such, the OS-197 Transfer Cask is readily shown to be an appropriate transfer cask for transferring the DSCs from TAN to INTEC.

When transporting the -12T DSCs, gross package weight (77,111 kg [170,000 lb]) and internal heat loads (0.86 kW) are well below the design basis of the OS-197 Transfer Cask (86,183 kg [190,000 lb] and 24 kW, respectively). In addition, tornado wind and missile loadings applicable at INEEL (Region III) are much less severe than the Region I design basis used for the OS-197 Cask. For drops up to 203 cm (80 in.) onto an under-reinforced concrete ISFSI pad, impact accelerations for both the design basis case and when transferring the -12T DSCs remain the same (i.e., 75*gs* for end and side drops, 25*gs* for corner drop). The only design basis event that is more severe at Idaho than considered in Reference 8.1 is seismic. At INEEL, the free field accelerations are 0.36*g* horizontal and 0.24*g* vertical as opposed to the respective OS-197 Cask design basis values of 0.25 and 0.17*gs*.

It is also noted that the minimum temperature extreme to be considered for the INEEL Site is
-45.6 °C (-50 °F), whereas the OS-197 design basis is -40 °C (-40 °F). Conversely, at the high-temperature end, a 39.4 °C (103 °F) temperature applies at INEEL as compared to a more extreme 51.7 °C (125 °F) temperature considered for the OS-197 in Reference 8.1.

The significance of the above noted differences is addressed in the remainder of this section.

8.1 Normal and Off-Normal Operations

8.1.1 Normal Load Structural Analysis

8.1.1.1 On-Site Transfer Cask Analysis

The OS-197 On-Site Transfer Cask is evaluated for normal operating condition loads in the safety analysis report for the standardized NUHOMS® System [8.1]. The normal operating conditions include:

1. Dead Weight Load

2 Handling Loads

3. Thermal Loads

The NUHOMS® OS-197 Transfer Cask is shown in Figure 1.3-1 and on the drawings contained at the end of this Appendix.

A. Transfer Cask Dead Weight Analysis

The effects of dead weight for a loaded OS-197 Transfer Cask were evaluated for two cases as described in Section 8.1.1.9 in Reference 8.1. The first case evaluated is for the transfer cask hanging vertically by the two lifting trunnions, and loaded with a maximum payload of 40,823 kg (90,000 lb). Including the self weight of the transfer cask, this gives a total dead weight of 86,183 kg (190,000 lb). This load is the same as the normal handling loads evaluated in Paragraph B below.

The second dead weight load case evaluated for the transfer cask includes the loaded transfer cask resting in a horizontal position on the support skid transfer trailer. In this orientation, the weight of the cask is shared between the lower support trunnions and the upper lifting trunnions resting in the pillow block supports of the support skid.

The maximum payload weight of the TMI-2 DSC is 31,750 kg (70,000 lb), and the associated total weight of the loaded OS-197 Cask will be 77,100 kg (170,000 lb). Both of these weights are less than, and therefore enveloped by, the analyses in the Reference 8.1 document.

B. Transfer Cask Normal Handling Loads Analysis

The major components of the transfer cask affected by the normal handling loads are the structural shell including the top and bottom cover plates, the upper and lower trunnions, the upper trunnion assembly insert plates, and the structural shell local to the trunnions. As described for the dead weight analysis, there are two normal operating cask handling cases which form the design basis for the transfer cask. These cases are illustrated in Figure 8.1-1. As stated in paragraph A above, the analyses performed in Section 8.1.1.9 of Reference 8.1 envelop the normal handling loads at INEEL.

C. Transfer Cask Normal Operating Thermal Stress Analysis

The heat transfer analyses of the OS-197 Transfer Cask are addressed in Section 8.1.3 of the standardized NUHOMS® SAR [8.1].

The design basis heat load for the OS-197 Cask is 24 kW, which is significantly greater than the INEEL TMI-2 DSC design basis heat load of 0.86 kW. Therefore, the thermal stress analysis for the NUHOMS®-12T DSC in the OS-197 Cask is bounded by the analyses presented in Section 8.1.1.9 of Reference 8.1.

D. Transfer Cask Analysis Results Comparisons

The results of the transfer cask analyses for normal operating loads are combined to obtain stresses for the associated load combinations which are compared to the appropriate allowable stresses, as discussed in Section 8.3 of this appendix.

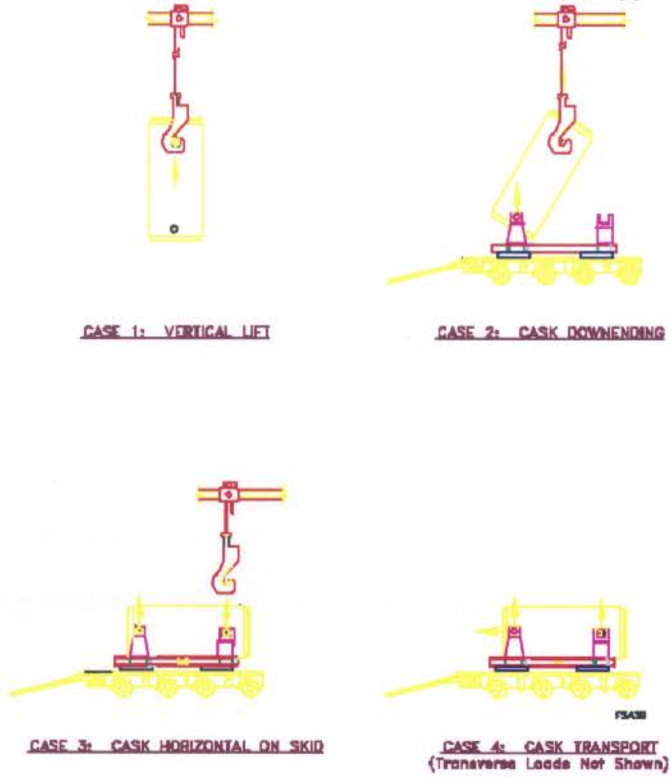


Figure 8.1-12
OS-197 Transfer Cask Handling Loads
(hydraulic ram not shown)

8.1.2 Off-Normal Load Structural Analysis

8.1.2.1 Jammed DSC During Transfer

A 36,287 kg (80,000-lb) maximum hydraulic ram load is covered in both the NUHOMS® SAR [8.1] and the INEEL TMI-2 ISFSI SAR [8.2]. With a maximum –12T DSC weight of 31,752 kg (70,000 lb), the hydraulic ram force will be limited to 31,752 kg (70,000 lb), thus increasing margins of safety over those previously determined.

8.1.2.2 Off-Normal Thermal Analysis

As described in Chapter 8 of the standardized NUHOMS® SAR [8.1], the maximum temperatures and associated through wall thermal gradients are calculated for a loaded on-site transfer cask for a maximum ambient temperature range of –40 °C (–40 °F) to 51.7 °C (125 °F). The temperature gradient for the 125°F ambient temperature case includes a sun screen that allows no solar heat flux on the cask. The bounding 37.8 °C (100 °F) case with solar insolation and the OS-197 Cask design basis heat load of 24 kW results in a maximum calculated temperature of 113 °C (235 °F) on the exterior of the transfer cask and a maximum through-wall temperature gradient of 34 °C (61 °F) for the bounding postulated off-normal cases. This resultant temperature and temperature gradient will also clearly bound a 39.4 °C (103 °F) ambient (extreme temperature for INEEL), full-solar, 0.86-kW, internal heat-load case. As such, a solar shield will never be required when using the OS-197 Cask to transfer the -12T DSCs.

Although the -45.6 °C (-50 °F) minimum extreme temperature at INEEL is 5.6 °C (10 °F) below that previously considered for the OS-197 Cask, this case need not be addressed because no DSC handling or transportation operations will be performed when the DSC temperature is less than 20°F or the ambient temperature is below -17.8 °C (0 °F)

The results of the bounding off-normal thermal analysis are combined with the appropriate results from other analyses for the associated load combinations. The resulting stresses and comparisons with allowable stresses are discussed in Section 8.2 of this appendix.

8.1.3 Thermal Hydraulic Analysis

8.1.3.1 Thermal Hydraulics of the HSM

Covered in INEEL TMI-2 ISFSI SAR [8.2].

8.1.3.2 Thermal Hydraulics of the DSC inside the HSM

Covered in INEEL TMI-2 ISFSI SAR [8.2].

8.1.3.3 Thermal Analysis of the DSC Inside the Transfer Cask

A. NUHOMS®-12T DSC in OS-197 Cask During Transfer Operation

The design basis heat load for the OS-197 Cask is 24 kW [8.1]. The design basis heat load in the NUHOMS®-12T DSC is 0.86 kW. Therefore, the thermal analysis for the NUHOMS®-12T DSC in the OS-197 Cask is bounded by the results presented in the standardized NUHOMS® SAR [8.1].

8.2 Accident Analysis For The ISFSI and OS-197

The design basis accident events for the INEEL TMI-2 ISFSI are addressed in Section 8.2 of the INEEL SAR [8.2]. The design basis accident events for the 10 CFR 72 [8.3]-approved OS-197 Transfer Cask are presented in Section 8.2 of the standardized NUHOMS SAR [8.1]. The postulated accidents considered for the OS-197 Transfer Cask are summarized in Table E8.2-1. Normal and Accident Load combination results for the OS-197 Transfer Cask and the evaluation for fatigue effects are presented in Section 8.3 of this appendix.

Table E8.2-2
Postulated Accident Loading Identification.

Accident Load Type	Section Reference[(a)]	NUHOMS® Component Affected				
		DSC Shell Assembly	DSC Internal Ba	DSC Support Structure	HSM	On-Site Trans Cask
Loss of Adjacent HSM Shielding Effects	8.2.1	(radiological consequence only)				
Tornado Wind	8.2.2				X	X
Tornado Missiles	8.2.2				X	X
Earthquake	8.2.3	X	X	X	X	X
Flood	8.2.4	X			X	
Accident Cask Drop	8.2.5	X	X			X
Loss of Cask Neutron Shield	8.2.5					X
Lightning	8.2.6				X	
Blockage of HSM Air In and Outlets	8.2.7	X	X	X	X	
DSC Leakage	8.2.8	(radiological consequence only)				
DSC Accident Internal Pressure	NA	Vented				Not sealed
Load Combinations	8.2.10	X	X	X	X	X

(a) See Standardized NUHOMS SAR [8.1].

The design basis for each of the INEEL Site postulated accidents for the OS-197 Cask are addressed in Chapter 3 of this Appendix. As shown in the standardized NUHOMS® SAR, the OS-197 Cask successfully meets all of the design basis requirements for a 10 CFR 72 [8.3] transfer cask. A comparison of the INEEL TMI-2 ISFSI SAR requirements and the OS-197 Cask capabilities is shown in Table E8.2-2. In summary, with the exception of the seismic event, the OS-197 Transfer Cask meets or exceeds the postulated accident load requirements. The following subsections address seismic loads and provide additional discussions relative to flooding, loss of neutron shielding, and DSC leakage.

Table E8.2-3
INEEL TMI-2 ISFSI SAR Requirements Versus the OS-197 Cask Capabilities for the Postulated Accident Events.

Accident Load Type	INEEL SAR Requirements	OS-197 Cask Capability
Tornado Winds	Maximum wind pressure: 123 psf Maximum wind speed: 200 mph	Maximum wind pressure: 397 psf Maximum wind speed: 360 mph
Tornado Missiles	Region III	Region I
Earthquake*	Horizontal Ground Acceleration: 0.36*g* Vertical Ground Acceleration: 0.24*g*	Horizontal Ground Acceleration: 0.25*g* Vertical Ground Acceleration: 0.17*g*
Accident Cask Drop	Equivalent static deceleration of 75*g* for vertical end drops and horizontal side drops, and 25*g* for oblique corner drop	Equivalent static deceleration of 75*g* for vertical end drops and horizontal side drops, and 25*g* for oblique corner drop

*Addressed in Section 8.2.1 of this appendix.

8.2.1 Earthquake

Per Section 8.2.3.2.D of the standardized NUHOMS® SAR [8.1], a factor of safety against overturning of the cask/trailer assembly of at least 2 exists for the case of a 0.25*g* horizontal and 0.17*g* vertical seismic ground acceleration. As such, the effective aspect ratio associated with overturning is less than 1.66 as shown below.

a = elevation of the combined trailer/cask center of gravity
b = ½ of the trailer width at ground level
a/b = aspect ratio associated with overturning
W = trailer/cask system combined weight
x = horizontal seismic acceleration
y = vertical seismic acceleration
M_r = restoring moment from dead weight less vertical seismic = W(1 – y)b
M_a = applied moment from horizontal seismic = Wxa
FS = factor of safety against overturning = M_r/M_a = (1 – y)b/(xa)

Solving for the case of x = 0.25, y = 0.17 and FS = 2 results in a/b = 1.66

At INEEL, the seismic accelerations to be considered are x = 0.36*g* and y = 0.24*g*. The corresponding factor of safety for this case becomes:

$$FS = (1 - y)b/(xa) = (1 - 0.24)/(1.66(0.36)) = 1.27$$

Overturning of the OS-197 Cask/trailer assembly will not occur due to earthquake.

As discussed in Section 8.2.3.2.D of Reference 8.1, the normal transport loading case of 0.5*g* acting simultaneously in the vertical, axial, and transverse directions envelopes the seismic case. Stresses associated with this normal transport case conservatively bound the seismic case and are used in the load combination assessments provided in Section 8.3 of this appendix.

8.2.2 Flood

Per Section 3.2.2 of this appendix, the OS-197 Transfer Cask is not to be used for transfers of the –12T DSCs during flood conditions. As such, no accident condition evaluation for flooding is required.

8.2.3 Loss of Neutron Shielding

The OS-197 Cask may be shipped without water in the neutron shield as a normal operating condition. As such, the significance of no neutron shielding in the sides of the transfer cask is addressed as a normal condition (see Sections 7.3.2 and 7.4.1).

8.2.4 DSC Leakage

In Section 8.2.7 of the INEEL TMI-2 SAR, the accidental release of 40.2 Ci of fission product gases and other radioactive materials from one DSC is assumed to occur at the ISFSI located at INTEC. Because the OS-197 Cask will be used to transfer the DSCs from TAN to INTEC, the radiological consequences of this postulated release from the DSC is evaluated along the entire transfer route.

8.2.4.1 Accident Dose Calculations

The postulated accident assumes that the HEPA filter trains from one DSC are ruptured and that all 12 of the TMI-2 canisters fail simultaneously such that 40.2 Ci of the fission product gasses and other radioactive materials in the TMI-2 canisters are released to the atmosphere over a one month period. This is conservative, since the on-site transfer will take less than eight hours. The nuclide composition of the postulated release is provided in Chapter 7 of the INEEL TMI-2 SAR. The closest distance from the transfer route to the INEEL site boundary was determined to be 8.5 km (5.3 miles). The total effective dose equivalent received by an individual at the INEEL controlled area boundary under worst meteorological conditions was calculated using the RSAC-5 code in the same manner as done in the INEEL TMI-2 SAR. The resultant accident dose increased from 0.28 to 0.51 mrem, which is still well within the 10 CFR 72.106 [8.3] limits (less than 5 rem for the maximum whole body or organ dose). The critical organ dose of 0.15 mrem (an increase from 0.08 mrem) was calculated for the thyroid.

8.2.4.2 Recovery

Covered in Section 8.2.7.4 of the INEEL TMI-2 ISFSI SAR [8.2].

8.3 Load Combination Evaluation

8.3.1 DSC Confinement Boundary Load Combination Evaluation

Covered in INEEL TMI-2 ISFSI SAR [8.2].

8.3.2 DSC Confinement Boundary Fatigue Evaluation

Covered in INEEL TMI-2 ISFSI SAR [8.2].

8.3.3 OS-197 Cask Load Combination Evaluation

The OS-197 Cask load combination evaluations are addressed in Section 8.2.10 of the Standardized NUHOMS® SAR [8.1]. The transfer cask calculated stresses due to normal operating loads are combined with the appropriate calculated stresses from postulated accident conditions at critical stress locations. It is assumed that only one postulated accident can occur at a time. Also, since the postulated drop accidents produce the highest calculated stresses, the load combination of dead load plus drop accident envelopes the stresses induced by other postulated accident scenarios. For convenience, the maximum calculated stress intensities for the transfer cask normal operation, off-normal, and accident load combinations are taken from Reference 8.1 and tabulated in Table E8.2-3 through Table E8.2-5, with the corresponding ASME Code allowables for comparison.

8.3.4 OS-197 Cask Fatigue Evaluation

Fatigue effects on the transfer cask were addressed using the criteria provided in NC-3219.2 of the ASME Code. As described in Appendix C.4.2 of Reference 8.1, the code specified criteria were evaluated relative to the transfer cask to demonstrate that fatigue requirements are satisfied.

8.3.5 HSM Load Combination Evaluation

Covered in INEEL TMI-2 ISFSI SAR [8.2].

Table E8.2-4
Transfer Cask Enveloping Load Combination Results for Normal and Off-Normal Loads (ASME Service Levels A and B).

Transfer Cask Component	Stress Type	Controlling Load Combination[a]	Stress (ksi)	
			Calculated	Allowable[b]
Cylindrical Shell	Primary Membrane	A4	1.2	21.7
	Membrane + Bending	A4	1.4	32.6
	Primary + Secondary	A4	61.9	65.1
Top Cover Plate	Primary Membrane	A1	0.2	21.7
	Membrane + Bending	A4	6.9	32.6
	Primary + Secondary	A4	19.6	65.1
Bottom End Plate	Primary Membrane	A1	0.2	21.7
	Membrane + Bending	A2	9.9	32.6
	Primary + Secondary	A4	29.1	65.1

[a]See Table E3.2-2 for load combination nomenclature
[b]See Table E3.2-3 for allowable stress criteria. Material properties were obtained from Table 8.1-3 (Reference 8.1) at a design temperature of 400°F.

Table E8.2-5
Transfer Cask Enveloping Load Combination Results for Accident Loads (ASME Service Level C).

Transfer Cask Component	Stress Type	Controlling Load Combination[a]	Stress (ksi)	
			Calculated	Allowable[b]
Cylindrical Shell	Primary Membrane	C1	1.7	26.0
	Membrane + Bending	C1	5.4	39.1
Top Cover Plate	Primary Membrane	C1	0.2	26.0
	Membrane + Bending	C1	13.2	39.1
Bottom End Plate	Primary Membrane	C1	0.1	26.0
	Membrane + Bending	C1	28.6	39.1

[a]See Table E3.2-2 for load combination nomenclature.
[b]See Table E3.2-3 for allowable stress criteria. Material properties were obtained from Table 8.1-3 (Reference 8.1) at a design temperature of 400°F.

Table E8.2-6
Transfer Cask Enveloping Load Combination Results for Accident Loads (ASME Service Level D).

Transfer Cask Component	Stress Type	Controlling Load Combination[a]	Stress (ksi)	
			Calculated	Allowable[b]
Cylindrical Shell	Primary Membrane	D1	9.7	49.0
	Membrane + Bending	D3	15.6	70.0
Top Cover Plate	Primary Membrane	D1	24.4	49.0
	Membrane + Bending	D1	24.4	70.0
Bottom End Plate	Primary Membrane	D1	23.1	49.0
	Membrane + Bending	D2	34.3	70.0

[a]See Table E3.2-2 for load combination nomenclature.
[b]See Table E3.2-3 for allowable stress criteria. Material properties were obtained from Table 8.1-3 (Reference 8.1) at a design temperature of 400°F.

8.3.6 Thermal Cycling of the HSM

Covered in INEEL TMI-2 ISFSI SAR [8.2].

8.3.7 DSC Support Structure Load Combination Evaluation

Covered in INEEL TMI-2 ISFSI SAR.

8.4 Site Characteristics Affecting Safety Analysis

Covered in INEEL TMI-2 ISFSI SAR.

8.5 References

8.1 Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, NUH-003, Rev. 4A, VECTRA Technologies, Inc., June 1996.

8.2 The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation, Docket No. 72-20, Rev. 0, October 1996.

8.3 Title 10, *Code of Federal Regulations*, Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste," U.S. Nuclear Regulatory Commission, January 1, 1997

CONTENTS

9. Conduct of Operations 1
9.1 Reference 1

Intentionally Blank

9. CONDUCT OF OPERATIONS

Use of the OS-197 Cask will little effect on the Conduct of Operations presented in Chapter 9 of the INEEL TMI-2 ISFSI SAR [9.1]. However, the route between TAN and INTEC will be required to be closed to the public as described in Chapter 10 of this Appendix.

9.1 Reference

9.1 The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation, Docket No. 72-20, Rev. 1, March 1999.

Intentionally Blank

CONTENTS

10. Operating Controls and Limits ii
10.1 Proposed Operating Controls and Limits 1
10.2 References 1

Intentionally Blank

10. OPERATING CONTROLS AND LIMITS

10.1 Proposed Operating Controls and Limits

The NUHOMS®-12T System is essentially passive and requires minimal operating controls during canister loading, closure and transfer operations. Originally it was planned to transfer the TMI-2 DSCs from TAN to INTEC using the 10 CFR 71 [10.1]-approved MP-187 Cask. Since this cask may not be available for the entire shipping campaign, the 10 CFR 72 [10.2]-approved OS-197 On-Site Transfer Cask will also be used. To accomplish this, several controls and limits will be placed on the transfer operations between TAN and INTEC and are specified in Technical Specifications for the Three Mile Island - Unit 2 Independent Spent Fuel Storage Installation, Amendment 0 [10.2]. The bases and justifications for these controls and limits are provided in the Technical Specification Bases for the Three Mile Island - Unit 2 Independent Spent Fuel Installation, Amendment 0 [10.3].

10.2 References

10.1 The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation, Docket No. 72-20, March 1999.

10.2 Technical Specifications for the Three Mile Island - Unit 2 Independent Spent Fuel Storage Installation, Amendment 0.

10.3 Technical Specification Bases for the Three Mile Island - Unit 2 Independent Spent Fuel Storage Installation, Amendment 0.

Intentionally Blank

CONTENTS

11. Quality Assurance 1
11.1 References 1

Intentionally Blank

11. QUALITY ASSURANCE

This Chapter is covered in the INEEL TMI-2 ISFSI SAR [11.1].

11.1 References

11.1 The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation, Docket No. 72-20, Rev. 1, March 1999.

Intentionally Blank

CONTENTS

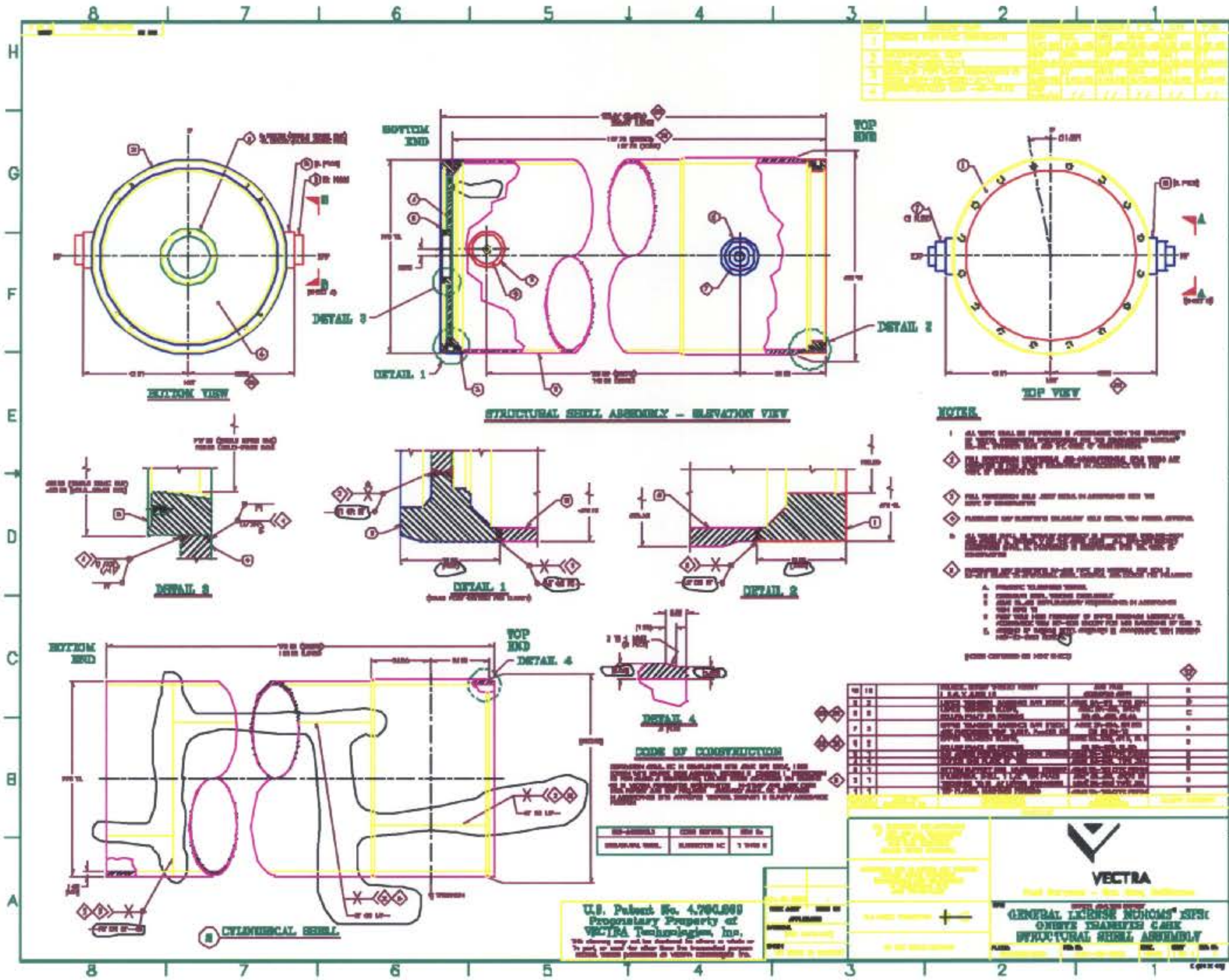
12.0 OS-197 CASK DRAWINGS

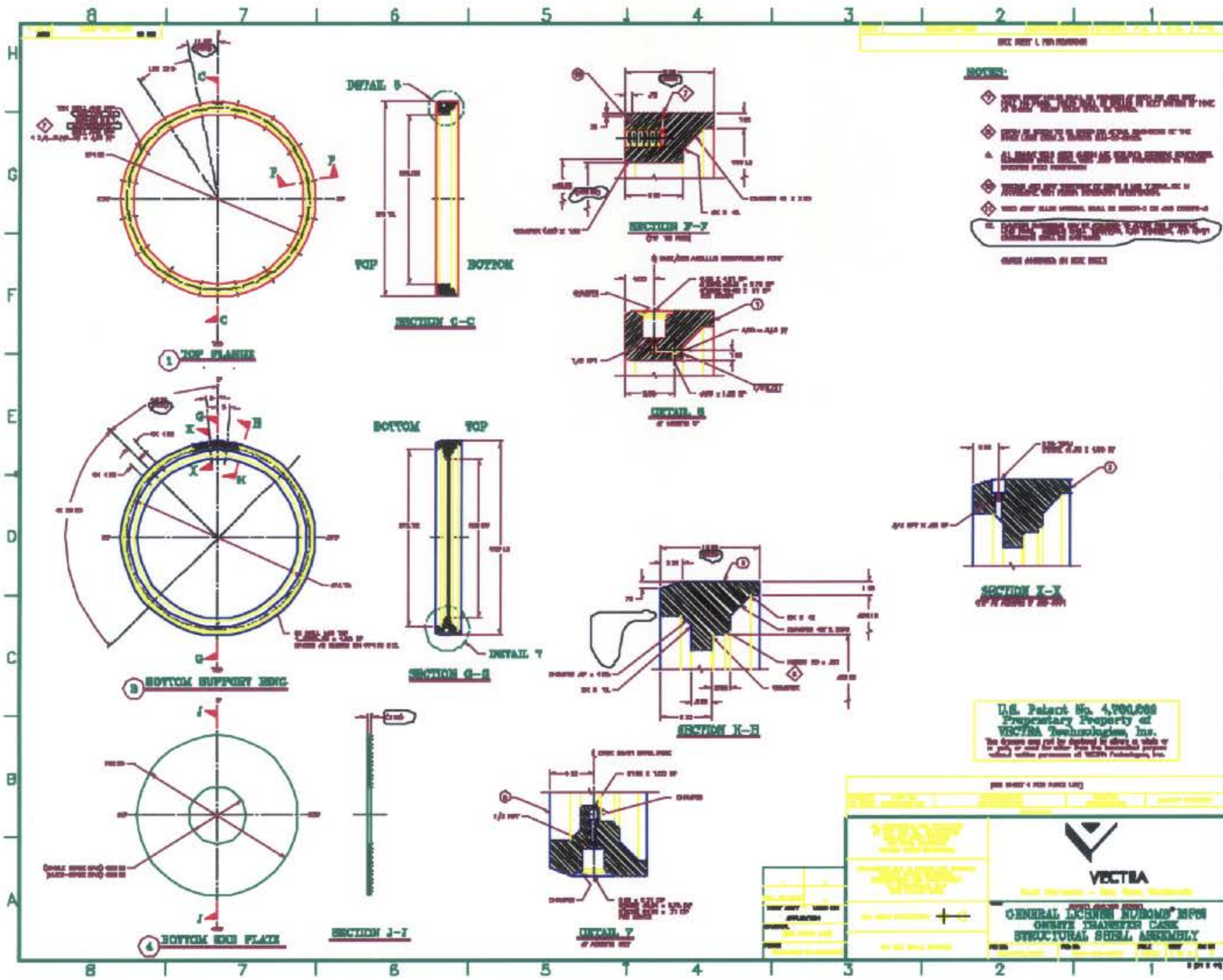
Drawing Number	Revision Number	Number of Sheets
NUM 03-8001	4	4
NUM 03-8002	4	3
NUM 03-8003	4	3

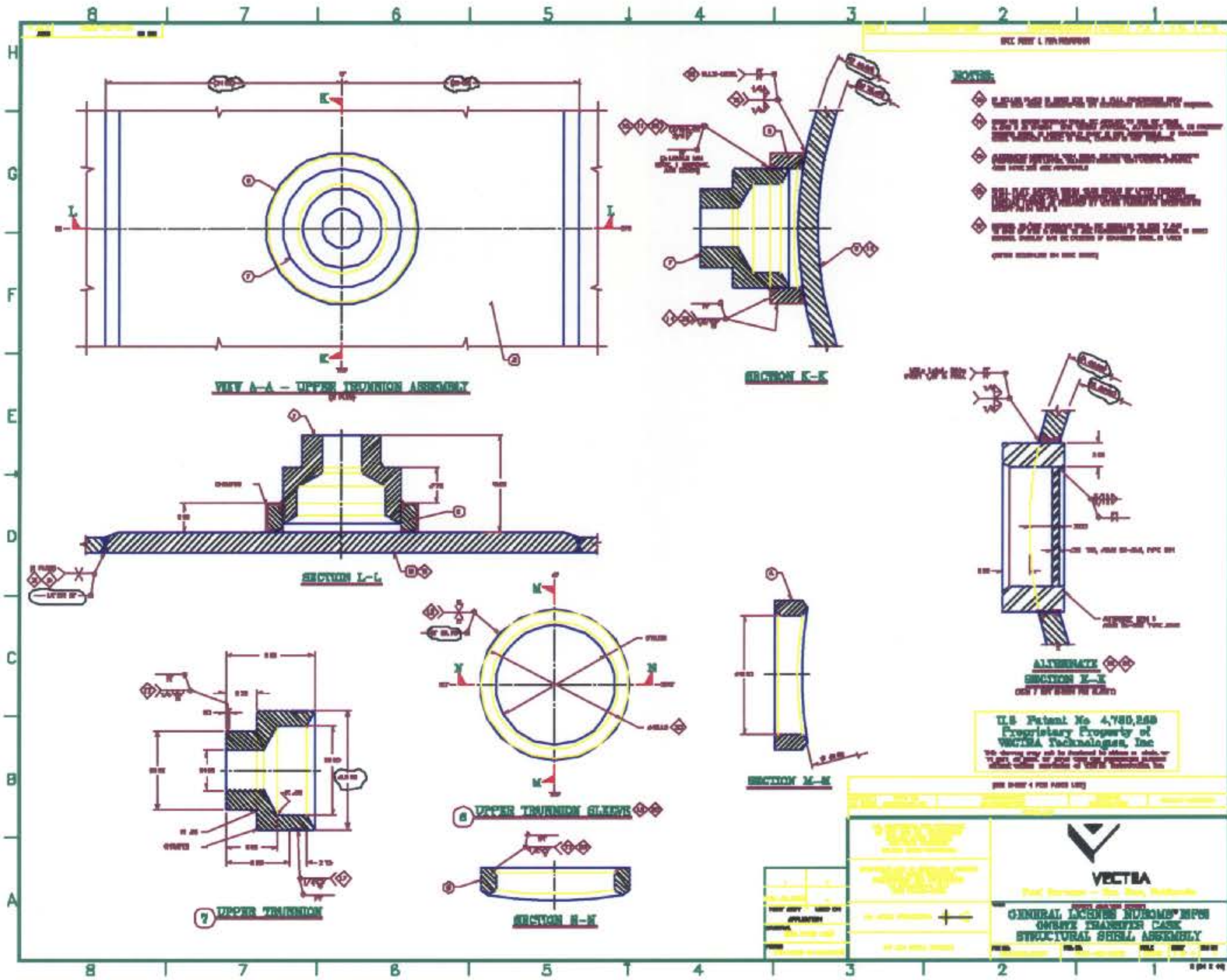
Intentionally Blank

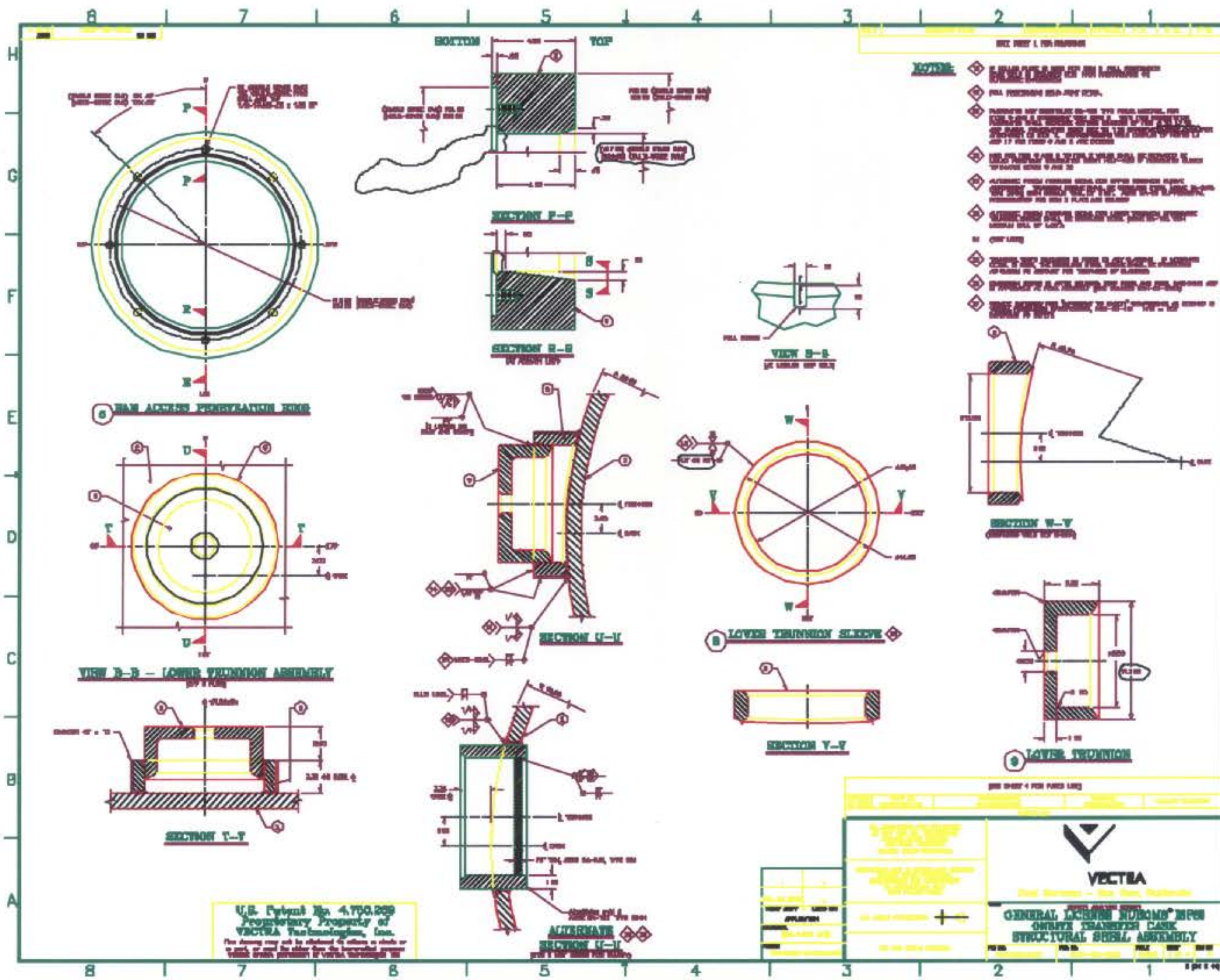
12.0 OS-197 Cask drawings

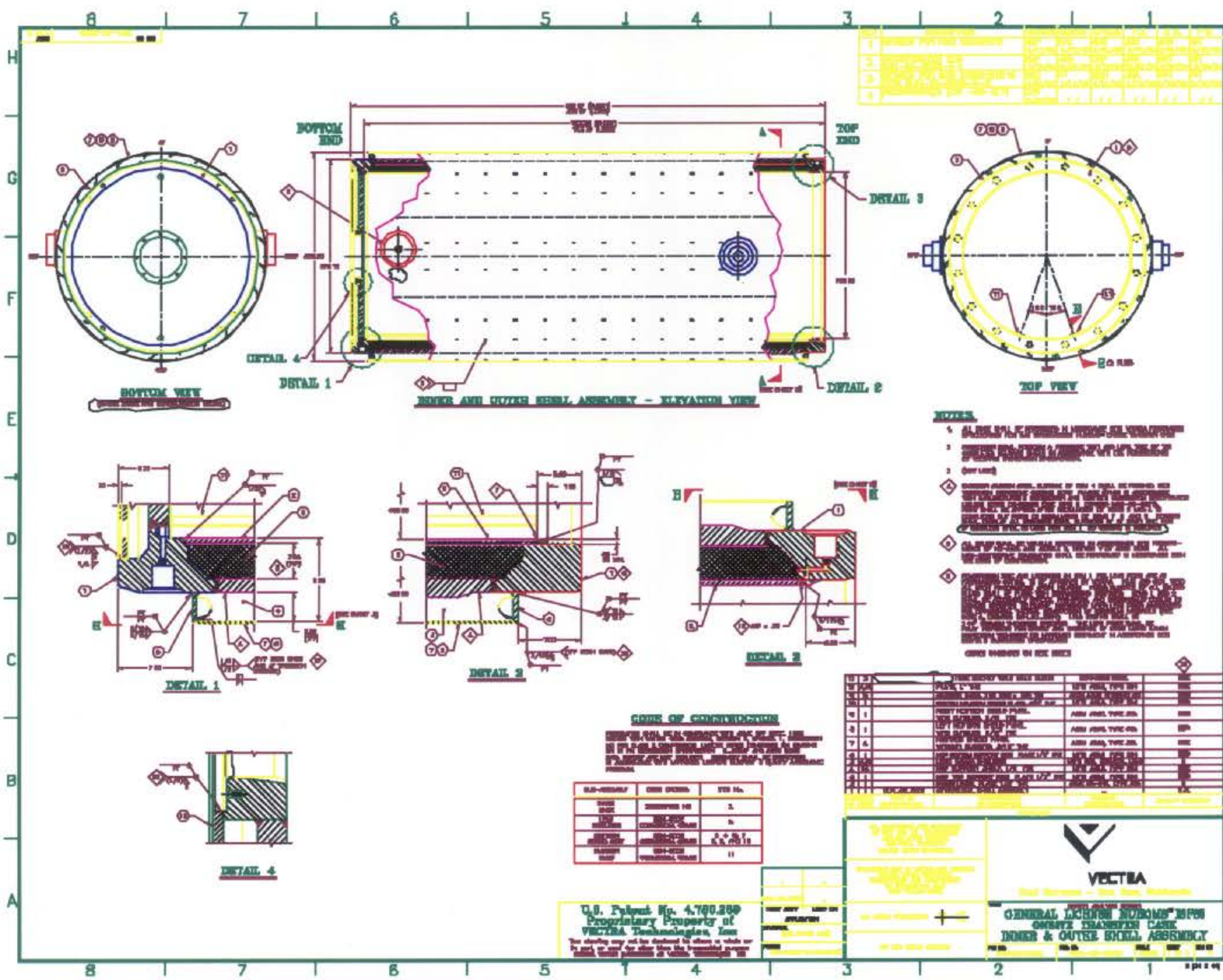
These drawings are provided for information only. The controlled copies of the licensed drawings are included in the standardized NUHOMS® SAR.

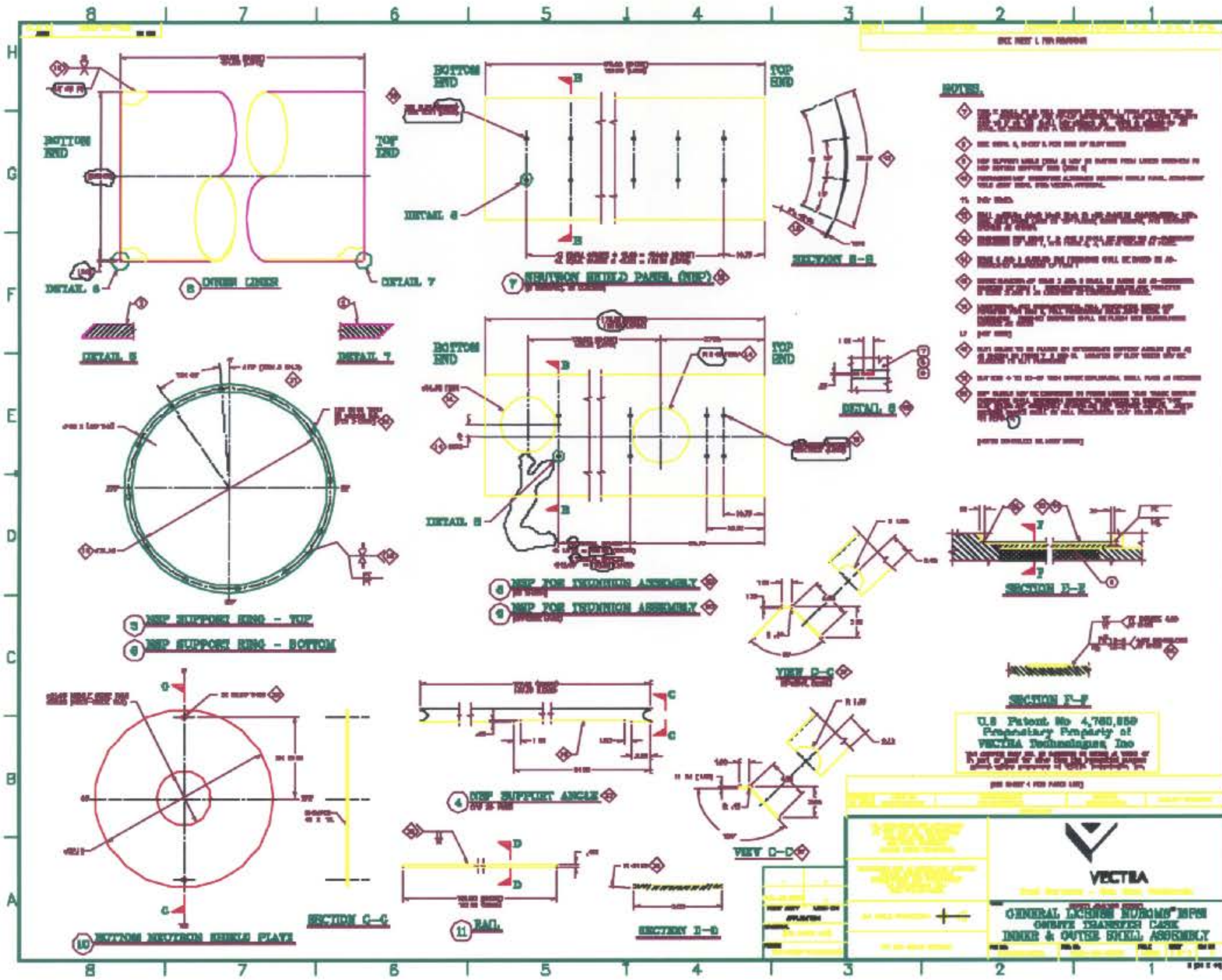

BOTTOM VIEW
STRUCTURAL SHELL ASSEMBLY - ELEVATION VIEW
TOP VIEW
NOTES:
DETAIL 1
DETAIL 2
DETAIL 3
DETAIL 4
BOTTOM END
TOP END
CYLINDRICAL SHELL
CODE OF CONSTRUCTION
U.S. Patent No. 4,780,269
Proprietary Property of
VECTRA Technologies, Inc.
VECTRA
GENERAL LICENSE NUHOMS® ISFSI
ONSITE TRANSFER CASK
STRUCTURAL SHELL ASSEMBLY


NOTES:
DETAIL 5
SECTION C-C
TOP
BOTTOM
SECTION F-F
DETAIL 6
TOP FLANGE
BOTTOM
TOP
SECTION G-G
DETAIL 7
BOTTOM SUPPORT RING
SECTION K-K
SECTION X-X
SECTION H-H
SECTION J-J
BOTTOM END PLATE
DETAIL 7
U.S. Patent No. 4,780,269
Proprietary Property of
VECTRA Technologies, Inc.
VECTRA
GENERAL LICENSE NUHOMS ISFSI
ONSITE TRANSFER CASK
STRUCTURAL SHELL ASSEMBLY

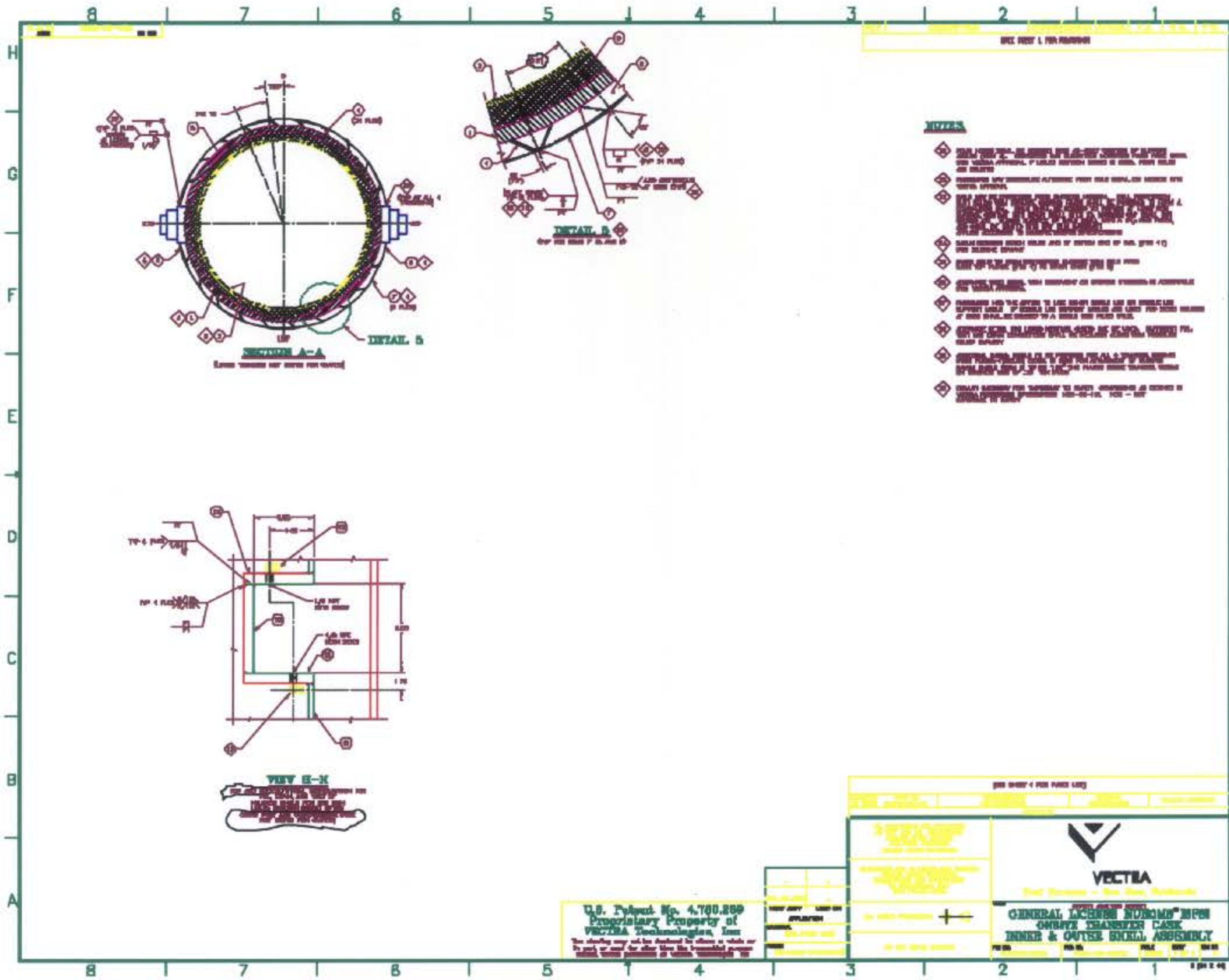

VIEW A-A – UPPER TRUNNION ASSEMBLY
SECTION K-K
NOTES:
SECTION L-L
ALTERNATE
SECTION K-K
U.S. Patent No. 4,780,269
Proprietary Property of
VECTRA Technologies, Inc
SECTION M-M
UPPER TRUNNION SLEEVE
UPPER TRUNNION
SECTION N-N
VECTRA
GENERAL LICENSE NUHOMS® MP88
ONSITE TRANSFER CASK
STRUCTURAL SHELL ASSEMBLY


NOTES:
BOTTOM
TOP
SECTION P-P
SECTION S-S
VIEW B-B
SECTION W-W
RAM ACCESS PENETRATION RING
SECTION U-U
LOWER TRUNNION SLEEVE
VIEW D-D - LOWER TRUNNION ASSEMBLY
SECTION V-V
LOWER TRUNNION
SECTION T-T
ALTERNATE SECTION U-U
U.S. Patent No. 4,780,269
Proprietary Property of
VECTRA Technologies, Inc.
VECTRA
GENERAL LICENSE NUHOMS® MP98
ONSITE TRANSFER CASK
STRUCTURAL SHELL ASSEMBLY

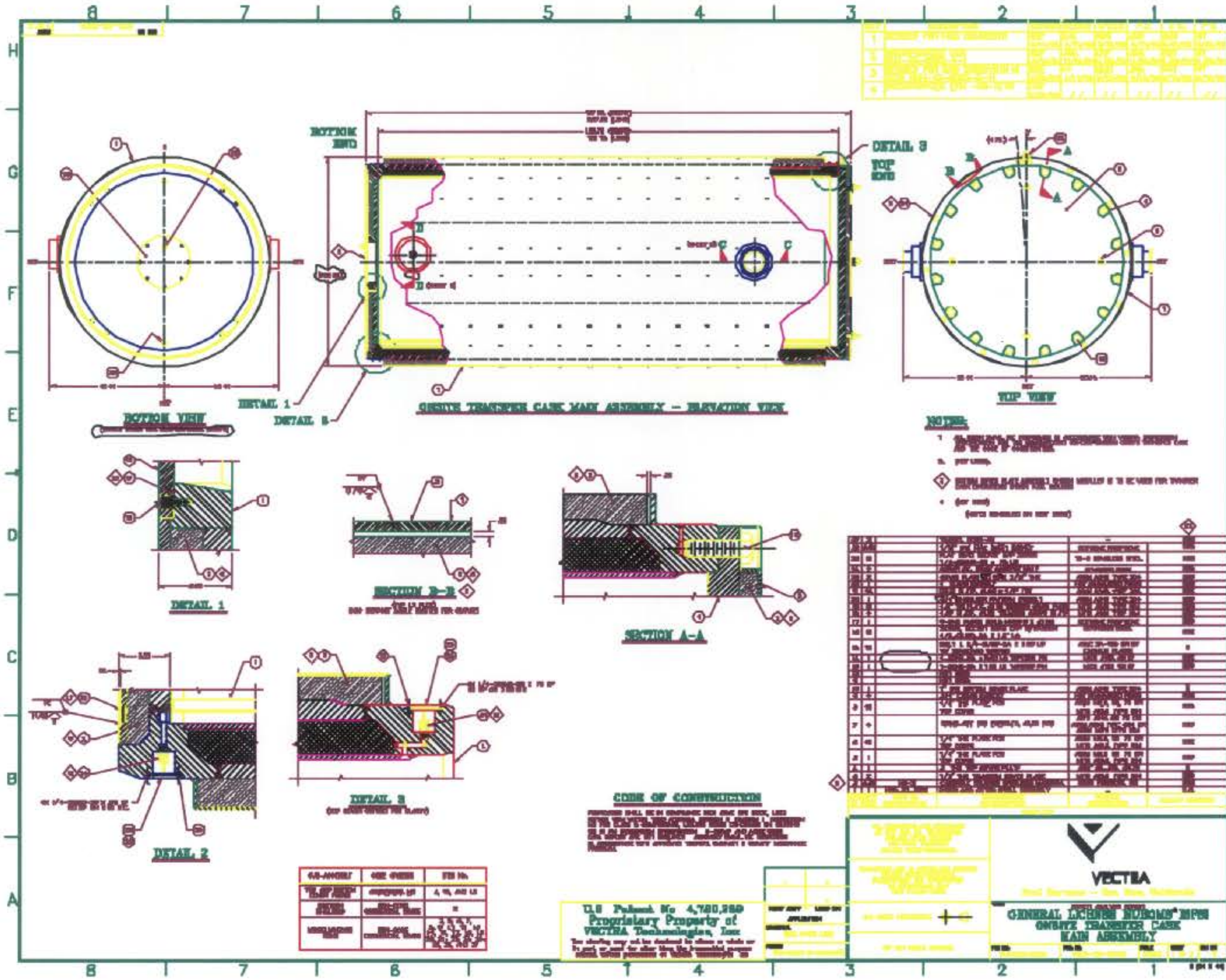

BOTTOM END
TOP END
DETAIL 1
DETAIL 2
DETAIL 3
DETAIL 4
BOTTOM VIEW
TOP VIEW
INNER AND OUTER SHELL ASSEMBLY - ELEVATION VIEW
NOTES
CODE OF CONSTRUCTION
U.S. Patent No. 4,780,269
Proprietary Property of
VECTRA Technologies, Inc.
VECTRA
GENERAL LICENSE NUHOMS-MP187
ONSITE TRANSFER CASK
INNER & OUTER SHELL ASSEMBLY

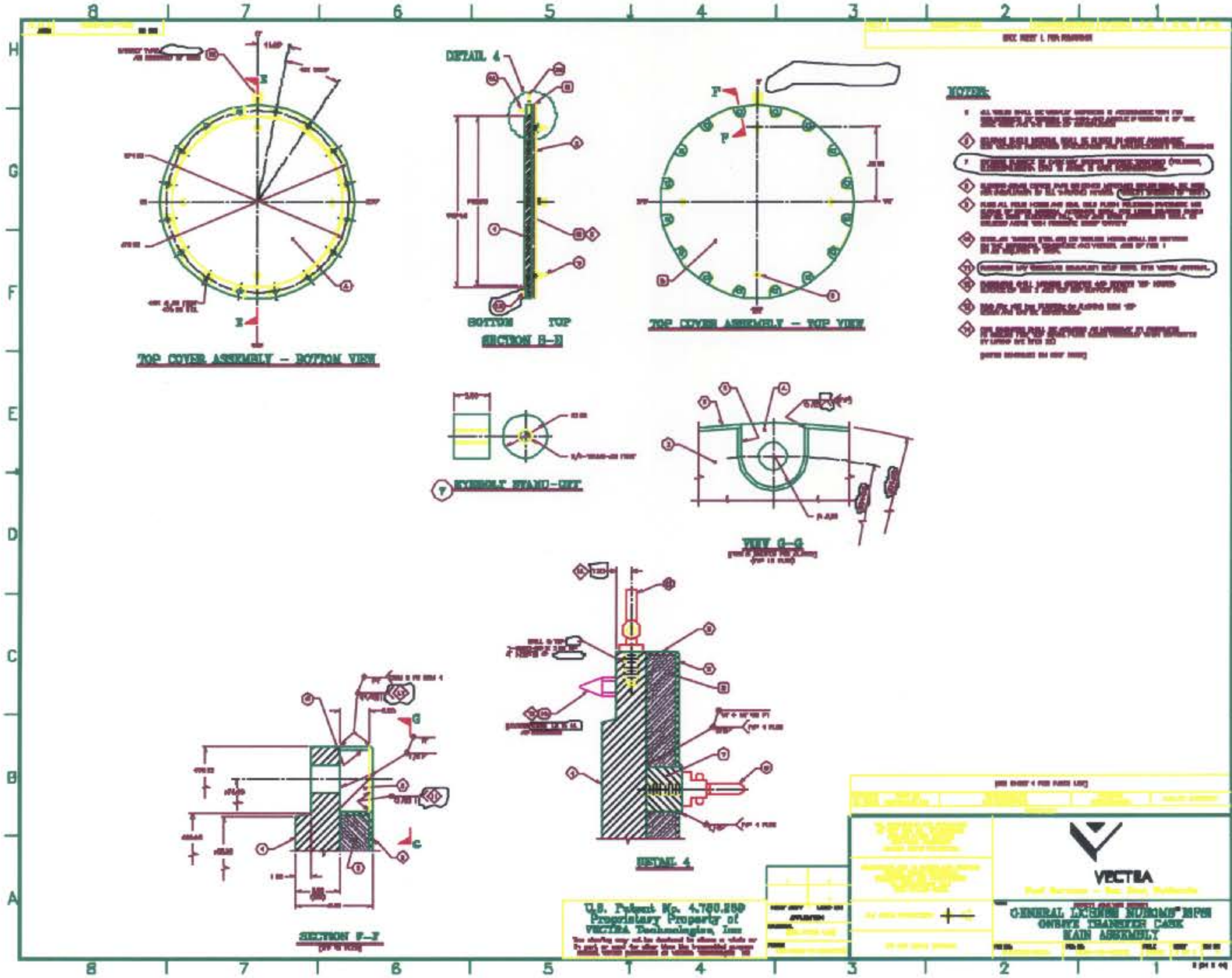


BOTTOM END
TOP END
OUTER LINER
DETAIL 6
DETAIL 7
NOTES
SECTION B-B
DETAIL 8
SECTION E-E
SECTION F-F
VIEW D-D
VIEW C-C
SECTION C-C
SECTION D-D
RAIL
BOTTOM NEUTRON SHIELD PLATE
NSP SUPPORT RING - TOP
NSP SUPPORT RING - BOTTOM
NSP SUPPORT ANGLE
NSP FOR TRUNNION ASSEMBLY
U.S. Patent No 4,780,269
Proprietary Property of
VECTRA Technologies Inc
VECTRA
GENERAL LICENSE NUHOMS® ISFSI
ONSITE TRANSFER CASK
INNER & OUTER SHELL ASSEMBLY

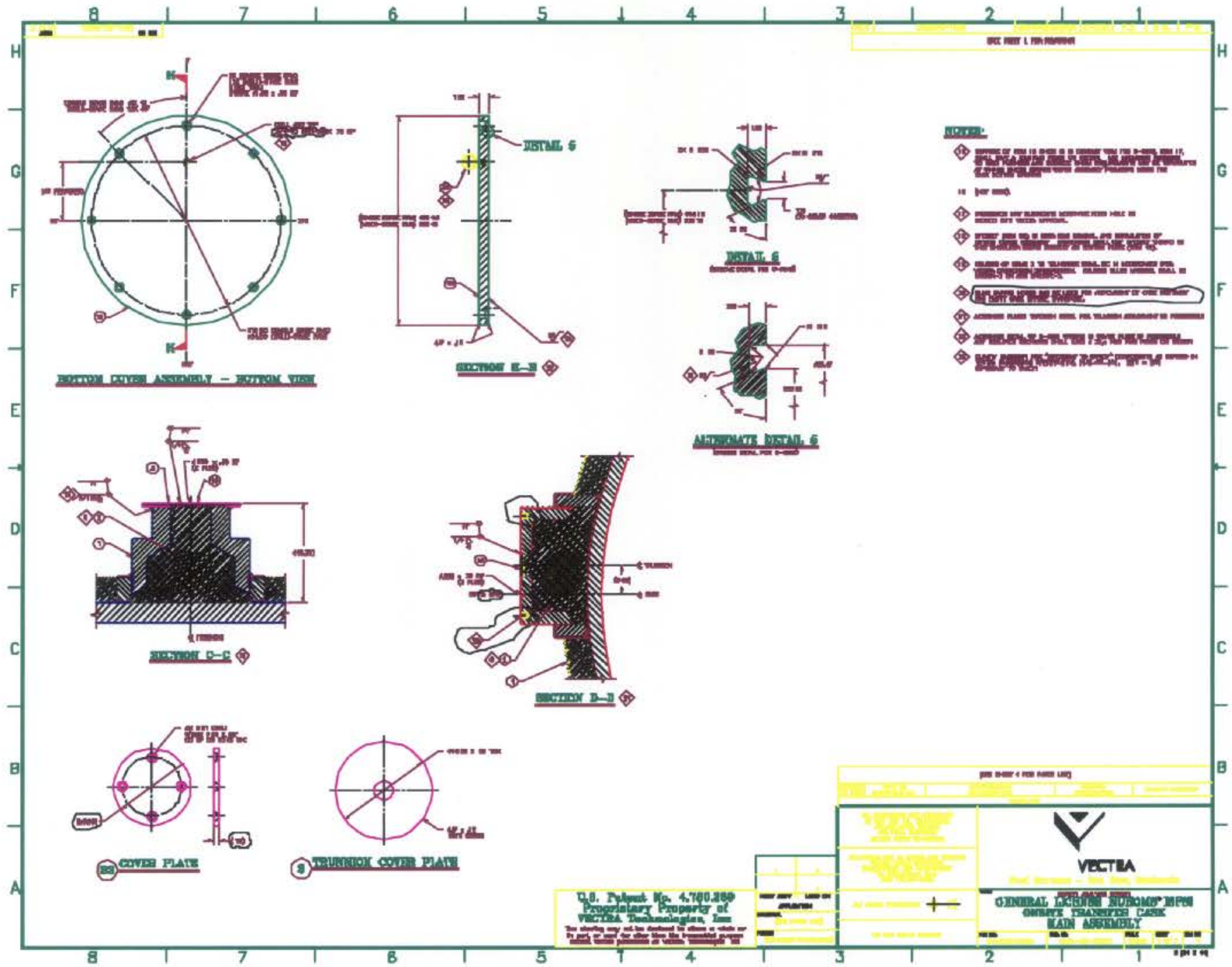


SECTION A-A
DETAIL 5
DETAIL 8
VIEW H-H
NOTES
U.S. Patent No. 4,780,269
Proprietary Property of
VECTRA Technologies, Inc
VECTRA
GENERAL LICENSE NUHOMS®-MP18
ONSITE TRANSFER CASK
INNER & OUTER SHELL ASSEMBLY


BOTTOM VIEW
BOTTOM END
DETAIL 1
DETAIL 2
DETAIL 3
TOP END
TOP VIEW
ONSITE TRANSFER CASK MAIN ASSEMBLY – ELEVATION VIEW
NOTES:
SECTION A-A
SECTION B-B
DETAIL B
CODE OF CONSTRUCTION
U.S. Patent No. 4,780,269
Proprietary Property of
VECTRA Technologies, Inc.
VECTRA
GENERAL LICENSE NUHOMS® ISFSI
ONSITE TRANSFER CASK
MAIN ASSEMBLY



DETAIL 4
TOP COVER ASSEMBLY – BOTTOM VIEW
BOTTOM
TOP
SECTION B-B
TOP COVER ASSEMBLY – TOP VIEW
NOTES:
EYEBOLT STAND-OFF
VIEW G-G
DETAIL 4
SECTION F-F
U.S. Patent No. 4,780,269
Proprietary Property of
VECTRA Technologies, Inc.
VECTRA
GENERAL LICENSE NUHOMS MPC
ONSITE TRANSFER CASK
MAIN ASSEMBLY


DETAIL 6
ALTERNATE DETAIL 6
NOTES:
BOTTOM COVER ASSEMBLY – BOTTOM VIEW
SECTION E–E
SECTION C–C
SECTION D–D
COVER PLATE
TRUNNION COVER PLATE
U.S. Patent No. 4,780,269
Proprietary Property of
VECTRA Technologies, Inc
VECTRA
GENERAL LICENSE NUHOMS ISFSI
ONSITE TRANSFER CASK
MAIN ASSEMBLY

Intentionally Blank