Department of Energy

Idaho Operations Office
850 Energy Drive
Idaho Falls, Idaho 83401-1563

March 16, 2001

United States Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Submittal Of TMI-2 ISFSI Update Reports (Docket 72-20) (INTEC-NRC-01-012)

Dear Sir or Madam:

DOE-ID was issued Materials License SNM-2508 on March 19, 1999 for the Three Mile Island Unit 2 Independent Spent Fuel Storage Installation (TMI-2 ISFSI). Since the date of License issuance, DOE-ID has made changes to the SAR, and essential programs under the provisions of 10 CFR 72.48, and TS 5.5.2. DOE-ID hereby submits the following information, which accurately presents changes made to the SAR and essential programs between license issuance through February 1, 2001:

- Update reporting of changes made to the SAR pursuant to10 CFR 72.70 (b) and a copy of the updated TMI-2 ISFSI SAR pages,
- Update of changes made to the facility and its procedures pursuant to 10 CFR 72.48,
- Update of changes made to the Technical Specification Bases pursuant to TS 5.5.1, and
- Update of changes made to the Radiological Environmental Monitoring Program, the Training Program, and the Quality Assurance Program pursuant to TS 5.5.2.

If you have any questions concerning this submittal, please contact Jan Hagers at (208) 526-0758, Charles Maggart at (208) 526-5560, or myself at (208) 526-5655.

Sincerely,

Mark D. Gardner
FSV/TMI Facility Director

Enclosure

cc: NRC Region IV
Public Reading Room

NMSS01Public

Update Report 72-20/2001-01

TMI-2 ISFSI SAR Update
TMI-2 ISFSI 72.48 Evaluations
TMI-2 ISFSI TS 5.5.1 Evaluations
TMI-2 ISFSI TS 5.5.2 Evaluations

Introduction

The Department of Energy's Idaho Operations Office (DOE-ID) was issued license SNM-2508 to operate the Three Mile Island Unit 2 (TMI-2) Independent Spent Fuel Storage Installation (ISFSI). The date of issuance was March 19, 1999. This update report provides the following:

- The biennial SAR update pursuant to 10 CFR 72.70, Safety Analysis Report Updating. The SAR update is provided in the section titled "Description of Changes to the Safety Analysis Report" and in the attachment providing the SAR replacement pages.
- The annual 72.48 evaluations report pursuant to 10 CFR 72.48. This report, comprised of summaries of evaluations of changes made pursuant to 10 CFR 72.48, is provided in the section titled "Changes, Tests, and Experiments."
- The annual Technical Specifications Bases evaluations report pursuant to TS 5.5.1. This report is provided in the section titled "Changes to the Technical Specification Bases."
- The biennial essential program evaluations report pursuant to TS 5.5.2. This report covers changes made to three of DOE's essential programs and is provided in the sections titled "Radiological Environmental Monitoring Program Changes," "Training Program Changes," and "Quality Assurance Program Changes." (Note: The changes to the Physical Protection Program and the Emergency Response Program are provided separately because of the reporting time frames required by 10 CFR 72.44 (e) and (f), respectively.)

This report is provided in a combined format because many of the changes described in the SAR Update are also covered by evaluations of changes made without NRC approval pursuant to 10 CFR 72.48, TS 5.5.1, and TS 5.5.2. TS 5.5.1 requires 72.48 evaluations to be performed for any change to the Technical Specification Bases. TS 5.5.2 requires an evaluation of the change in program effectiveness (similar to the requirements of 10 CFR 72.44(e) and (f)) for changes to the ISFSI Radiological Environmental Monitoring Program, Training Program, and Quality Assurance Program. These three programs are contained in the ISFSI SAR.

Attachments

TMI-2 ISFSI SAR Chapters 1, 3, 4, 5, 6, 7, 9, and 11; and Appendices C, D, and E.

Update Report 72-20/2001-01

Description of Changes to the Safety Analysis Report

This is the first update of the TMI-2 ISFSI SAR since license SNM-2508 was issued on March 19, 1999.

A. Changes were made to Chapter 7, Radiation Protection, to delete the description of rope used to designate radiological control areas and to update the ISFSI Radiological Environmental Monitoring Program. Those changes affecting Section 7.6.1, Effluent and Environmental Monitoring Program, were evaluated pursuant to TS 5.5.2. This evaluation is described in the section titled Radiological Environmental Monitoring Program Changes.

B. Changes were made to Chapter 9, Conduct of Operations, to update the Training Program in Section 9.3. The training program is one of DOE-ID's essential programs covered by TS 5.5.2; therefore the changes were evaluated pursuant to TS 5.5.2. This evaluation is described in the section titled Training Program Changes.

C. Changes were made to Chapter 9, Conduct of Operations, to reflect organizational changes described in Section 9.1 and to reflect commitments made by DOE-ID to NRC regarding the scope of activities at Test Area North (TAN) subject to review under 10 CFR 72.48. These changes to the SAR did not require an evaluation.

D. Changes were made to Chapter 11, Quality Assurance, to reflect DOE-ID organizational changes that affected the description of the Quality Assurance Program in the SAR. The Quality Assurance Program is one of DOE-ID's essential programs covered by TS 5.5.2; therefore the changes were evaluated pursuant to TS 5.5.2. This evaluation is described in the section titled Quality Assurance Program Changes.

E. Changes were made to Chapter 1, Introduction and General Description of Installation; Chapter 4, Installation Design; and Chapter 5, Operating Systems. These changes were made to conform to the changes described in item (C) above and did not require an evaluation.

F. Additional safety analysis was performed to demonstrate that the TMI-2 ISFSI would remain subcritical with the recognition of potential additional hydrogenous moderator. The additional analysis was reflected in changes to Chapter 3, Principal Design Criteria; Chapter 4, Installation Design; Chapter 5, Operating Systems; Chapter 6, Site-Generated Waste Confinement and Management; Appendix C, Radiolysis; and Appendix D, Criticality Model Input Decks. This change was determined to be a change to the facility as described in the SAR and was evaluated pursuant to 10 CFR 72.48. This evaluation is described in the section titled Changes, Tests, and Experiments.

G. Changes were made to Appendix E, On Site Fuel Transportation, to describe a minor rerouting of the spent fuel transfer cask within TAN. These changes did not require an evaluation.

H. Changes were made to Chapter 9, Conduct of Operations, to update the description of staff level reviews overseen by the ISFSI Safety Review Committee. Because these changes did not affect the ISFSI Safety Review Committee technical specification, these changes did not require an evaluation.

I. Changes were made to Chapter 3, Principal Design Criteria, to better describe the closure devices on the three types of TMI-2 Canisters and to describe a condition that could exist with some of the closure devices. This change was determined to be a change to the facility as described in the SAR and was evaluated pursuant to 10 CFR 72.48. This evaluation is described in the section titled Changes, Tests, and Experiments.

J. A change was made to Chapter 11, Quality Assurance, to remove reference to NUREG-1567. The Quality Assurance Program is one of DOE-ID's essential programs covered by TS 5.5.2; therefore the change was evaluated pursuant to TS 5.5.2. This evaluation is described in the section titled Quality Assurance Program Changes.

Attached to this report are the replacement pages for the SAR, as required by 10 CFR 72.70.

Changes, Tests, and Experiments

The previous report of changes made pursuant to 10 CFR 72.48 was provided in March, 2000.

1. Explanation of Bound Water and Readsorbed Atmospheric Water in the TMI-2 Debris

Description of Change. Additional safety analysis was performed to demonstrate that the TMI-2 ISFSI would remain subcritical with the recognition of potential additional hydrogenous moderator. Bounding quantities of additional water were calculated from (1) readsorption through the HEPA-filtered vents throughout a 40 year storage life and (2) chemically and physically adsorbed water remaining in the TMI-2 Canisters after the aggressive heated vacuum drying process. These bounding water quantities were compared to a new criticality analysis developed to determine the maximum amount of water permissible while remaining safely subcritical. The computer code for the criticality model was an earlier version of the code used in the original safety analysis. The additional analyses were reflected in changes to the SAR described above in the Description of Changes to the Safety Analysis Report.

Summary of Evaluation. The identification of additional sources of water for the criticality model did not affect the probability or consequence of accidents or malfunctions nor were any new accidents or malfunctions created by this change. No Technical Specification Bases margins were affected. In addition, the new regulatory question (new method of evaluation) was determined not to require a license amendment even though the 10 CFR 72.48 rule change has not yet taken effect.

2. TMI-2 Canister Closure Requirements for DSC-02

Description of Change. Changes were made to fittings on two of the three types of TMI-2 Canister to address degradation of elastomeric parts during the heated vacuum drying process (used to dry the core debris contained in the TMI-2 Canisters before the TMI-2 Canisters are stored in the ISFSI). These changes were not evaluated pursuant to 10 CFR 72.48 because they were determined to restore the intended design functions of the TMI-2 Canister fittings.

However, one shipment of TMI-2 Canisters was made to the TMI-2 ISFSI before the degradation of elastomeric parts was recognized. The TMI-2 Canisters in the first shipment were identified as nonconforming and the condition was reported to the NRC pursuant to 10 CFR 72.75(b)(3). It was determined that nuclear safety would not be degraded by leaving the affected TMI-2 Canisters in the ISFSI. A 72.48 evaluation was performed on the condition as a change to the facility (to resolve the nonconformance Use-As-Is) to avoid the personnel exposure to radiation associated with correcting the condition.

Summary of Evaluation. The resolution of the nonconforming condition on the TMI-2 Canisters in the first shipment was determined not to require a license amendment because the relevant accidents and malfunctions (DSC leakage and TMI-2 Canister structural failure) were still considered improbable. The accident of a new type (criticality due to degradation of confinement) remained not credible because of the low fissile material content in the first shipment.

3. Remove Interference from HSM-20 Vent and Purge Port Access Openings

Description of Change. The Horizontal Storage Module (HSM) rear wall is designed with a hole to permit access to the vent and purge ports on the DSC. During the insertion of DSC-04 into HSM-20, the DSC ports interfered with the HSM hole, due to misalignment of the DSC within the HSM. To complete insertion of DSC-04 into HSM-20, the HSM hole was enlarged slightly (less than 1" wider).

Summary of Evaluation. The amount of concrete removal was reviewed to determine the impact to design functions (shielding and structural integrity). The amount of concrete removed did not exceed the amount described in the applicable design code for protection of the reinforcement bars in the HSM walls. Ordinarily an activity with no impact on a design function or a Technical Specification Basis would screen out in the initial 72.48 review. The evaluation was performed to demonstrate that there was no additional nuclear safety risk. As expected for an activity that did not adversely affect a design function, none of the nuclear safety risk criteria of the 72.48 evaluation were adversely affected.

4. Raised or Missing TMI-2 Canister Head Bolts

Description Change. Three engineering calculations were performed to determine the impact on the design functions of the TMI-2 Canisters due to canister head bolts that were not fully seated. Although the TMI-2 Canisters were not part of the TMI-2 ISFSI design, they are credited with performing the function normally attributed to spent fuel cladding. Therefore, the original TMI-2 Canister design documentation was considered in the calculations. Some head bolts were observed to be loose. Based on bounding assumptions, bolts unseated by more the 3/8" were considered to be missing, although no bolts were literally missing. The three engineering calculations, reviewed together, were used to conclude that TMI-2 Canisters with one head bolt disengaged by more than 3/8" and the other seven head bolts disengaged by no more than 3/8" would continue to satisfy its design functions for the TMI-2 ISFSI (retrievability, confinement of radioactive material, and structural integrity).

Summary of Evaluation. Two evaluations considered the effects on TMI-2 Canister design functions and changes affecting design methods and changes affecting a fission product barrier. TMI-2 Canisters were originally designed for a drop accident of 33 feet. This design function was considered to be adversely affected during the initial design review. The TMI-2 Canisters affected by loose head bolts are now considered to be acceptable for a drop accident of 28 feet. Such a drop accident is not considered credible for the TMI-2 ISFSI, either during transfer or storage. Because the new drop height is acceptable for the loading of TMI-2 Canisters into the DSC, it is also considered acceptable for future retrievability of the TMI-2 Canisters from the DSC. The canisters heads are designed to be inset into the canister shell and, therefore, some looseness of the head bolts and a bounding amount of bolt stretch during accident conditions is not enough to cause the canister head to disengage enough to allow release of radioactive material. The new design calculations were considered to be suitably conservative and, therefore they were not considered to be new methods of evaluation affecting a design basis limit.

Changes to the Technical Specification Bases

Description of Changes

There were no changes made to the Technical Specification Bases since the last update report provided to the NRC on March 16, 2000.

Summary of Evaluations

Because there were no changes to the TMI-2 Technical Specification Bases, there are no safety evaluations to report.

Update Report 72-20/2001-01

Radiological Environmental Monitoring Program Changes

This is the first update of the Radiological Environmental Monitoring Program since license SNM-2508 was issued on March 19, 1999.

Description of Changes

The Radiological Environmental Monitoring Program (REMP) is provided in Section 7.6.1 of the TMI-2 ISFSI SAR. Changes were made to this section of the SAR to more clearly differentiate between the environmental monitoring program of the entire Idaho National Engineering and Environmental Laboratory (INEEL) and the monitoring program specific for the ISFSI. The INEEL annual report is replaced in SAR Section 7.6.1 with an ISFSI-specific report for purposes of annual REMP reporting pursuant to 10 CFR 72.44(d).

The replacement pages for the changes to the REMP (SAR Section 7.6.1) are provided as an attachment to this report pursuant to the SAR update requirements.

Summary of Evaluations

These changes were determined to increase the program effectiveness because of the proximity of the ISFSI-specific monitoring to the licensed activities. The removal of the INEEL-wide monitoring and reporting from the TMI-2 ISFSI REMP is not considered a decrease in program effectiveness because the monitoring distances from the TMI-2 ISFSI were too great to be able to separate ISFSI radiation sources from other INEEL radiological activities.

Training Program Changes

This is the first update of the Training Program since license SNM-2508 was issued on March 19, 1999.

Description of Changes

The Training Program is provided in Section 9.3 of the TMI-2 ISFSI SAR. This section of the SAR was updated to change the title of the certified personnel, clarify the applicability and retraining requirements of General Employee Training (GET), removal from the ISFSI Training Program of activities at Test Area North (TAN), change "fuel handling operations" to "during transport and HSM loading and unloading operations", and various editorial changes.

The replacement pages for the changes to the Training Program (SAR Section 9.3) are provided as an attachment to this report pursuant to the SAR update requirements.

Summary of Evaluations

The change of title for certified personnel removes DOE Order training requirements associated with the title of "certified fuel handler"; such training requirements are not applicable to the range of NRC-licensed activities described in the SAR.

The applicability of the ISFSI GET training could have been interpreted to apply to the entire INEEL population; such interpretation far exceeded the intent of the training commitment in the Training Program and was clarified.

Certain GET subjects apply only during ISFSI loading; the retraining requirements of GET were revised to allow these subjects to be dropped from the retraining requirements.

The TAN operations were removed from the scope of the ISFSI Training Program because these personnel are covered by DOE Order-regulated training programs. ISFSI Operators do not require training on TMI-2 Canister drying, DSC loading, and DSC sealing. Adequacy of DSC preparation at TAN is provided by the ISFSI Quality Assurance Program.

The phrase "fuel handling operations" was revised to avoid over-applying the training requirements (for example, certifying truck drivers) and to avoid under-applying the training requirements (for example, during HSM loading and unloading).

Update Report 72-20/2001-01

Quality Assurance Program Changes

This is the first update of the Quality Assurance Program since license SNM-2508 was issued on March 19, 1999.

Description of Changes

The Quality Assurance (QA) Program is provided in Chapter 11 of the TMI-2 ISFSI SAR. The following changes were made.

1. The DOE-ID management structure was reorganized which affected the reporting relationships of the QA manager responsible for the TMI-2 ISFSI QA Program.

2. The commitment to develop the QA Program to meet the Standard Review Plan (NUREG-1567) was deleted from the SAR.

Summary of Evaluations

1. The QA Program requirements for the QA Manager from SAR Section 11.1 were reviewed and the new management structure was determined to be fully in compliance with the QA Program requirements and does not decrease program effectiveness.

2. The QA Program has been developed in accordance with the Standard Review Plan and is now approved by the NRC. Therefore, the original commitment has been satisfied and is removed without affecting program effectiveness.

Instruction for updating the TMI-2 SAR for the March 2001 submittal

Remove the Revision 1 Cover Sheet and replace with the Revision 2 Cover Sheet

Remove the Revision 1 Table of Contents and replace with the Revision 2 Table of Contents and Revision

Remove the Revision 1 Chapter 1 and replace with the Revision 2 Chapter 1

Remove the Revision 1 Chapter 3 and replace with the Revision 2 Chapter 3

Remove the Revision 1 Chapter 4 and replace with the Revision 2 Chapter 4

Remove the Revision 1 Chapter 5 and replace with the Revision 2 Chapter 5

Remove the Revision 1 Chapter 6 and replace with the Revision 2 Chapter 6

Remove the Revision 1 Chapter 7 and replace with the Revision 2 Chapter 7

Remove the Revision 1 Chapter 9 and replace with the Revision 2 Chapter 9

Remove the Revision 1 Chapter 11 and replace with the Revision 2 Chapter 11

Remove the Revision 1 Appendix C and replace with the Revision 2 Appendix C

Remove the Revision 1 Appendix D and replace with the Revision 2 Appendix D

Remove the Revision 1 Appendix E and replace with the Revision 2 Appendix E

The Safety Analysis Report for the INEEL TMI-2 Independent Spent Fuel Storage Installation

Docket No. 72-20

Revision 2
March 2001

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1. INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

1.1 Introduction

The U.S. Department of Energy (DOE) has chosen a modified NUHOMS® spent fuel storage system, designated NUHOMS®-12T, which will be used at an independent spent fuel storage installation (ISFSI) to be constructed at the Idaho National Engineering and Environmental Laboratory (INEEL). The INEEL was formerly known as the Idaho National Engineering Laboratory (INEL) and is so noted on some figures and references. This ISFSI will be constructed at the Idaho Nuclear Technology and Engineering Center (INTEC) site within the INEEL for interim storage of Three Mile Island Unit 2 (TMI-2) core and core handling debris. The INTEC was formerly known as the Idaho Chemical Processing Plant (ICPP) and is so noted on some figures and references. The TMI-2 core debris is currently in stainless steel canisters which are stored in a fuel pool at another site, Test Area North (TAN), within the INEEL. Each NUHOMS®-12T module will provide for the horizontal dry storage of up to 12 TMI-2 canisters inside a dry shielded canister (DSC) which is placed inside a concrete horizontal storage module (HSM). This Safety Analysis Report (SAR) describes the design of the INEEL TMI-2 ISFSI and the NUHOMS®-12T system and is submitted by the DOE to fulfill the requirements of 10 CFR 72.24 "Contents of Application: Technical Information."

The INEEL TMI-2 ISFSI design is based on the currently licensed NUHOMS® system. The NUHOMS® system has an extensive licensing and technical basis. The original NUHOMS® Topical Report (NUH-001, Revision 1A, NRC Project No. M-39) was approved by the United States Nuclear Regulatory Commission (NRC) on March 28, 1986 for storage of seven spent pressurized water reactor (PWR) fuel assemblies per DSC and HSM (NUHOMS®-07P) [1.1, 1.2].

The NUHOMS® Topical Report was revised (NUH-002, Revision 0, NRC Docket No. M-49) to provide the generic design criteria and safety analysis for the larger 24 spent PWR fuel assembly design (NUHOMS®-24P) and its associated on-site transfer cask. NRC approval of the NUHOMS®-24P Topical Report was granted on April 26, 1989 [1.3, 1.4]. The standardized NUHOMS® design has since been expanded to include the NUHOMS®-52B for dry storage and on-site transfer of 52 boiling water reactor (BWR) fuel assemblies [1.5]. The NRC has issued Certificate of Compliance 72-1004, dated January 23, 1995, for the standardized NUHOMS® system, addressing both the NUHOMS®-24P and the NUHOMS®-52B systems. The approved NUHOMS®-24P Topical Report forms the basis for the NUHOMS®-12T system presented in SAR. The NUHOMS®-12T system has been adapted for TMI-2 canister use and the system can accommodate the internal baskets designed specifically to hold TMI-2 canisters.

The INEEL TMI-2 ISFSI will be located on a DOE facility operated under DOE Regulations, Orders and Directives. For the INEEL TMI-2 ISFSI, NRC regulations shall apply and have precedence over DOE Orders, Requirements and Guidelines. The INEEL TMI-2 ISFSI is exempted from those DOE Orders that duplicate or overlap NRC requirements.

To facilitate direct referencing, the format, the numbering system, the section headings, and the content follow NRC Regulatory Guide 3.48 [1.6]. Numbers in brackets indicate references which are listed at the end of each chapter. The international system of units [Système International d'Unités (SI)] and commonly used U.S. units are used to the maximum practical extent for general data presented in the SAR. For calculations, the data is presented in the units used by generally accepted practice in the U.S.

The remainder of this chapter provides a general overview of the INEEL TMI-2 ISFSI and summarizes the contents of this SAR.

1.1.1 Principal Function of the Installation

The TMI-2 canisters are currently stored in a fuel pool at the INEEL Test Area North (TAN). Since the TAN Hot Shop is scheduled for decommissioning as part of the overall INEEL plan, dry storage of the TMI-2 canisters has been selected as the interim storage approach. NUHOMS® is a proven system for dry storage which has been in use at reactor sites since March of 1989. The INEEL TMI-2 ISFSI is designed to provide temporary dry storage for 100% of the TMI-2 canisters. The ISFSI design includes an extra HSM with a pre-installed DSC overpack in case a challenged canister needs additional confinement. The INEEL TMI-2 ISFSI and NUHOMS®-12T components are also designed to allow retrieval of the TMI-2 canisters for further processing, alternate storage, or disposal.

As stated, the dry storage for the TMI-2 canisters will utilize an adaptation of the standardized NUHOMS® system. The most notable differences between the TMI-2 canisters and commercial fuel assemblies are:

- TMI-2 core debris is canisterized whereas commercial fuel is clad. The canisters contain TMI-2 core debris and debris from core handling equipment resulting from the 1979 TMI-2 accident. (In the balance of this SAR, these canisters are generally referred to as "TMI-2 canisters" except when detailed discussion dictates otherwise.) The TMI-2 canisters and contents are described in more detail in Chapter 3 of this SAR.

- The TMI-2 canisters provide a much stronger structural element, as compared to commercial fuel assemblies, for support within the DSC basket.

- The heat load for the TMI-2 canister (maximum 60 watts, average 29 watts) is much less than a commercial spent fuel assembly (approximately 1000 watts).

- The TMI-2 canisters have the potential for hydrogen gas generation due to radiolysis. Gas generation due to radiolysis is described in Appendix C of this SAR.

Based on these considerations, the NUHOMS® system is modified to accommodate these conditions. Specifically, the NUHOMS®-12T DSC will be modified to include venting of the DSC through high efficiency particulate air (HEPA) grade filters during storage. The vent system, which is further discussed in Section 4.3.1 of this SAR, will allow for release of the hydrogen gas and will allow for monitoring and/or purging of the system during operation.

DOE's schedule for licensing, construction and operation of the INEEL TMI-2 ISFSI has been established by the Settlement Agreement [1.7] entered into by the State of Idaho, the Department of Energy, and the Department of Navy. The Settlement Agreement was signed in October 1995 and fully resolves all issues in the actions Public Service Co. of Colorado v. Batt, No. CV 91-0035-S-EJL (D. Id.) and United States v. Batt, No. CV-91-0065-S-EJL (D. Id.). Within the Settlement Agreement, paragraph E7 states:

> "DOE shall complete construction of the Three Mile Island dry storage facility by December 31, 1998. DOE shall commence moving fuel into the facility by March 31, 1999, and shall complete moving fuel into the facility by June 1, 2001."

DOE seeks to comply with the following key milestone dates in order to meet the schedule requirements of the Court Order:

October 1996:	DOE-ID submit license application to NRC
April 1997:	NRC Completes EA/FONSI*
April 1997:	Begin Procurement/Construction activities
March 1998:	NRC Issues ISFSI license*
September 1998	Complete ISFSI construction
December 1998	Complete system testing
February 1999	Begin Transport operations
June 2001	Complete transport operations

* Anticipated need dates to meet the Settlement Agreement milestones.

The various components of the NUHOMS®-12T system are briefly described in Sections 1.2 and 1.3. The design and conservative analyses of the system components are described in detail in the remainder of this SAR.

1.1.2 Location of the ISFSI

The TMI-2 ISFSI is located within the INEEL, a DOE-controlled site occupying 571,800 acres within Butte County and surrounding counties in eastern Idaho. The INEEL has nine primary facility areas situated on an expanse of otherwise undeveloped, high-desert terrain. The INEEL TMI-2 ISFSI is sited within the boundaries of the INTEC, a facility with the mission to receive and store nuclear fuels and radioactive wastes. The INTEC occupies about 120 acres of the south-central portion of the INEEL, and is located 42 miles west of Idaho Falls. The INEEL TMI-2 ISFSI is sited in a two acre dedicated area within the INTEC boundaries. Figure 1.1-1 shows the location of the ISFSI within the INTEC. The site characteristics are discussed in Chapter 2.

The TAN facility, which is also located within the INEEL, is approximately 30 miles north of INTEC. Transportation of the cask from TAN to INTEC will include travel over 5 miles (8 km) of Idaho Highway 33 and then over 25 miles (40 km) of restricted access DOE-controlled highway. This transportation will be treated in accordance with 10 CFR Part 71 as an off-site transport operation or in accordance with 10 CFR 72 as an on-site transport operation. This SAR provides the information necessary for the transportation from TAN to INTEC using the NRC 10 CFR 71 certified MP-187 transportation system. Appendix E of this SAR provides detailed information necessary for the transportation from TAN to INTEC using the NRC 10 CFR 72 approved OS-197 Transfer Cask. Movement and transfer of loaded casks within the TAN Hot Shop will be conducted in accordance with INEEL procedures and DOE Orders, whereas, movement and transfer of the cask outside of the TAN Hot Shop and within the INTEC and ISFSI fences will be treated as on-site transfer operations according to 10 CFR Part 72. Both of these fenced areas have restricted public access.

1.1.3 TMI-2 ISFSI Site Characteristics

Chapter 2 of this document provides the site characteristics relating to the Idaho National Engineering and Environmental Laboratory (INEEL), the Idaho Nuclear Technology and Engineering Center (INTEC), and the INEEL TMI-2 ISFSI. It includes the meteorology, hydrology, seismology, geology, and volcanism of the area. It describes the geographical location, the population distribution within and around the INEEL, land and water use, and associated site activities. It also provides an evaluation of the site with respect to plant safety. Following is a summary of TMI-2 ISFSI site conditions:

- Probable Maximum Flood (PMF) Plain Elevation (Feet): 4917.0 above sea level (ASL)
  - Ambient Temperature (Extremes):
    - Highest: 103^{0}F.
    - Lowest: Minus 50^{0}F.
  - Average Monthly Temperature Extremes:
    - Maximum: 87^{0}F (in July).
    - Minimum: 4^{0}F (in January)
  - Annual Precipitation:
    - Average: 8.71 inches
    - Highest: 14.40 inches
    - Lowest: 4.50 inches
    - Average Yearly Snowfall: 26 inches
  - Seismic Zone 2B per the Uniform Building Code
  - Design Basis Tornado:
    - Maximum wind speed: 200 mph
    - Rotational speed: 160 mph
    - Translational Speed: 40 mph
    - Pressure Drop: 1.5 psi
  - Snow Load: 30 pounds per square foot (psf)
  - Frost Depth: 5 feet
  - Existing Ground Level Elevation (Feet): 4915 (ASL).

1.1.4 Activities and Facilities to be Licensed

The activities and facilities to be licensed pursuant to the requirements of 10 CFR Part 72 commence with the movement of loaded shipping cask from the TAN Hot Shop. However, certain steps in TAN procedures (including some activities in the TAN Hot Shop) implement requirements of the licensed system and these procedure steps are subject to change control under 10 CFR 72.48 (see 9.4.1). The licensed activities include the transportation to INTEC, and include all subsequent receipt, handling, storage, surveillance, and maintenance activities within the ISFSI. The licensed facility includes the structures and equipment that comprise the INEEL TMI-2 ISFSI.

1.1.5 Waste Product Generation

Chapter 6 of this document addresses site-generated waste confinement and management. In summary, cask transfer operations and maintenance of the HEPA grade filters in the dry shielded canister (DSC) vent system are the only activities that will generate waste during the operating design life of the system. This waste will be in the form of dry radioactive waste. On the average, the filters could be replaced five times during the 50-year life of the system. It is estimated this would consist of about one cubic foot per DSC over the design life of the TMI-2 ISFSI (a total of less than 30 ft^3). Decommissioning activities at the time of TMI-2 ISFSI closure is estimated to generate less than 10 ft^3 per module (a total of less than 300 ft^3). The horizontal storage module (HSM) and concrete basemat would be disposed of as clean free release material after radiological surveys and any necessary decontamination.

1.1.6 Activities Conducted at INTEC that may affect TMI-2 ISFSI Operations

The TMI-2 ISFSI will be located within the site boundaries of the INTEC with several other DOE owned facilities and DOE managed programs. The INEEL has its own large security police force, a fire department, medical staff, emergency response teams, and full-time INTEC shift plant supervision. Thus, the INEEL infrastructure will be considered to serve equivalent functions as independent local agencies (similar to local city or county) do for typical commercial licensed sites.

Normal INTEC operations will not affect operation of the TMI-2 ISFSI. Emergency situations, unrelated to the TMI-2 ISFSI operations, which would require personnel to evacuate the plant area, or take cover, could cause temporary interruptions to normal TMI-2 ISFSI operations (loading, unloading and surveillance). The interruptions would not compromise safety.

1.1.7 Quality Assurance Program

The QA Program selected for this project satisfies the requirements of 10 CFR Part 72, Subpart G. The QA Program will ensure that essential technical and quality requirements for structures, systems, and components (SSCs) classified as important to safety are achieved and documented throughout all design, fabrication, construction, testing, operations, modifications and decommissioning activities. Chapter 11 of this document provides a detailed description of the QA program.

The basic quality assurance program is the DOE's Office of Civilian Radioactive Waste Management's Quality Assurance Requirements and Description, DOE/RW-0333P, Revision 5 (QARD). All SSCs are analyzed to determine whether their functions or physical characteristics are essential to the safety function. Those items are classified as “important to safety”, and are subject to the applicable requirements of the QARD. The program will be implemented through use of approved, controlled implementing procedures.

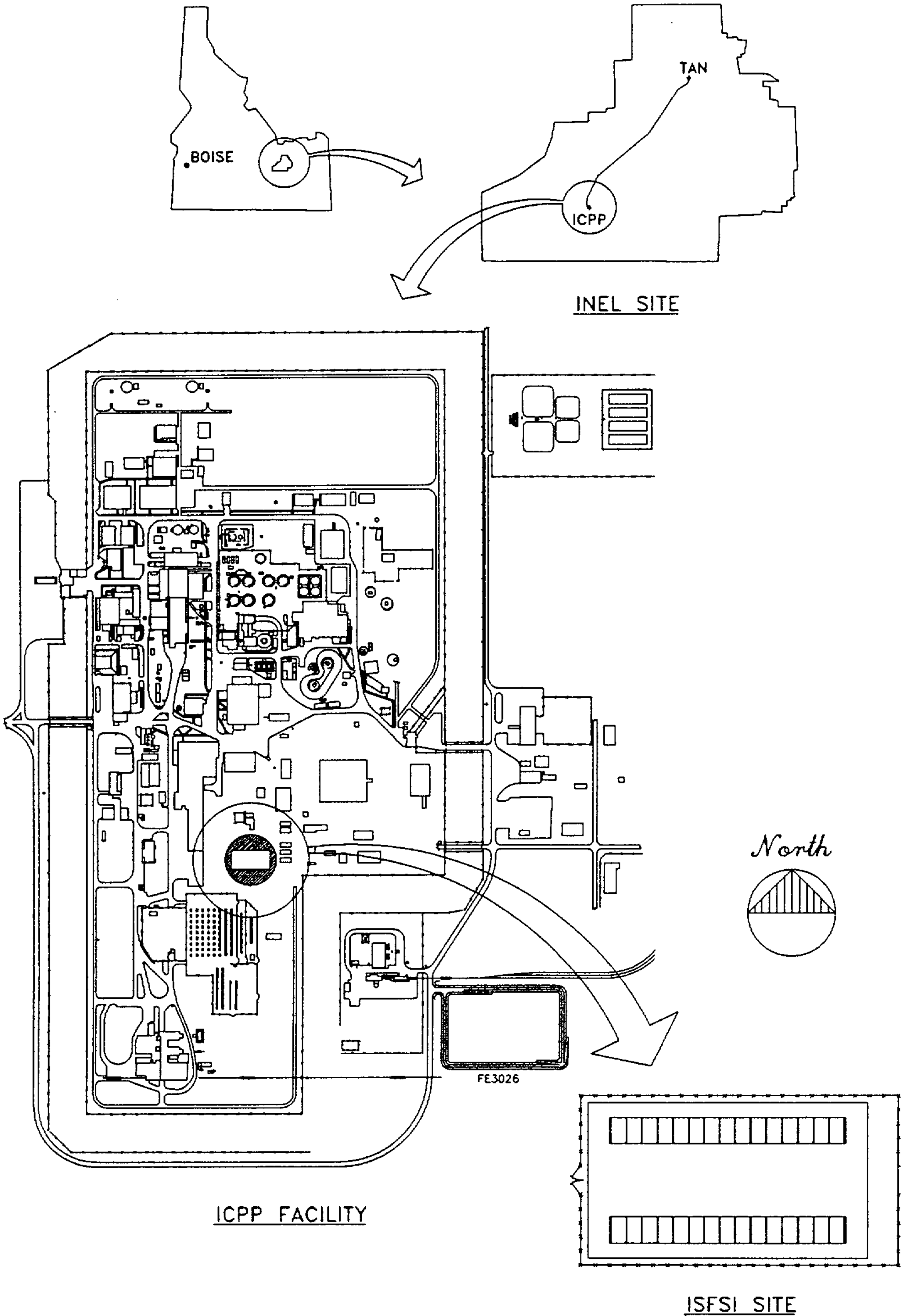


Figure 1.1-1
Location of the INEEL TMI-2 ISFSI

1.2 General Description of Installation

1.2.1 Arrangement of Major Structures and Equipment

The INEEL TMI-2 ISFSI utilizing the NUHOMS®-12T system provides for the horizontal, dry storage of canisterized TMI-2 core debris in a concrete HSM. The storage system components for NUHOMS®-12T consist of a reinforced concrete HSM and a DSC with an internal basket assembly which holds the TMI-2 canisters.

In addition to these storage system components, the NUHOMS®-12T system utilizes transfer equipment to move each DSC from the TAN Facility (where they are loaded with TMI-2 canisters and readied for storage) to the HSMs where they are stored. This transfer system includes the transfer or transportation cask, lifting slings, a hydraulic ram system, a prime mover for towing, a transport trailer, a cask transportation skid, and a skid positioning system. This transfer system interfaces with the existing INEEL TAN Hot Shop cask handling crane. Auxiliary equipment such as a vacuum drying system and an automated welding system are also used to facilitate DSC loading, purging and sealing operations. This SAR primarily addresses the design and analysis of the storage system components, including the DSC and the HSM, which are important to safety in accordance with 10 CFR Part 72. Sufficient information for the transfer system and auxiliary equipment is also included to describe the adequacy of measures that will be taken to ensure safe loading and transfer operations. The NUHOMS®-12T transfer system arrangement is illustrated in Figure 1.2-1.

The INEEL TMI-2 ISFSI layout is based on the use of 30 HSMs, 29 which will be loaded, and one extra. The prefabricated HSM used to form HSM arrays is shown in Figure 1.2-2. Each of 29 HSMs holds a NUHOMS®-12T DSC containing up to 12 TMI-2 canisters. The NUHOMS®-12T DSC assembly is shown in Figure 1.2-3. An extra HSM serves as a backup in case a challenged DSC needs additional confinement. This extra HSM will include a cylindrical overpack so that it can be used to provide an additional barrier for a challenged DSC.

1.2.2 Principal Design Criteria

The principal design criteria are provided in Chapter 3, but are summarized, along with nominal component dimensions, in Table 1.2-1.

Horizontal Storage Module: The HSM is a low profile, reinforced concrete structure designed to withstand all normal condition loads as well as the abnormal condition loads created by earthquakes, tornadoes, and other natural phenomena. The HSM is also designed to withstand abnormal condition loadings postulated to occur during design basis accident conditions.

Dry Shielded Canister: The DSC design addresses the postulated design basis transfer cask drop accident (described in Section 8.2.5). The DSC shell, and the closures on each end, ensure that the intended safety functions of the system are not impaired following a postulated transfer cask drop accident. The limits established for equivalent decelerations due to a postulated drop accident envelop a range of conditions such as the cask handling operations, the type of handling equipment used, the cask on-site transport route, the maximum feasible drop height and orientation, and the conditions of the impacted surface. The structural safety features of the NUHOMS®-12T system are described in Chapters 4 and 8. Nuclear Criticality Safety is also ensured in the design of the DSC as described in Section 3.3.4.

Decay Heat Removal: The decay heat of the TMI-2 core debris is rejected from the DSC shell to the HSM walls by radiant heat transfer. The heat is conducted through the HSM walls and removed from the HSM outer surfaces by natural convection and by radiant heat transfer to the ambient air. Under worst case extreme summer ambient conditions, thermal calculations show that no cooling air vents are required to remove the decay heat generated from the TMI-2 core debris. The thermal performance features of the NUHOMS® system are described in Chapters 4 and 8.

External Atmosphere Criteria: Given the corrosion resistant properties of materials used for construction of the NUHOMS®-12T system components, and the dry environment which exists within the HSM, no limits on the range of acceptable external atmospheric conditions are required. All metal components are steel and are coated with inorganic coatings or galvanized where practicable. Hence, all metallic materials are protected against corrosion wherever possible. However, a corrosion allowance is included in the structural evaluation of the carbon steel components. The interior of the HSM is a concrete surface and is void of any substance which would be conducive to the growth of organic or vegetative matter. Chapter 2 of this SAR provides a detailed discussion of climatic conditions.

DSC Venting: Each DSC will be vented to prevent the accumulation of gases generated due to radiolysis. Although the TMI-2 canisters contain hydrogen recombiners, the vent system design conservatively assumes that the recombiners are not functional relative to reducing hydrogen concentrations. A vent assembly with HEPA grade filters will be installed on each DSC, with access through a small vented door in the rear of the HSM. The design features, operations, surveillance and maintenance plans are developed to assure that the system can be tested and monitored for gas accumulation in the DSCs. Although no significant release of radioactive gases or particulate are anticipated, monitoring of air and gases vented through the HEPA filters is also addressed in the surveillance and maintenance plans.

Table 1.2-1
Key Design Parameters for the NUHOMS®-12T System

Category	Criteria or Parameter (Dimensions are Nominal)	Value
TMI-2 Canister[1] Criteria:	Maximum Canister Weight	1,327 Kg (2926 lbs.)
	Size (Nominal):	
	Length	3.81 m (150 in.)
	Diameter	35.6 cm (14 in.)
	Initial Maximum Enrichment (weight percent (w/o) U-235)	2.98%
	Fuel Burnup (MWD/MTU)	3,175
	Gamma Radiation Source (photons/sec/canister)	6.37 E+14 (19 year cooled)
	Neutron Radiation Source (neutron/ sec./canister)	6.90 E+5 (19 year cooled)
	<u>Thermal Characteristics</u>:	
	Max. Decay Heat Power per TMI-2 Canister	60 W
	Average Decay Heat Power per TMI-2 Canister	15 W
	<u>Thermal Design Basis</u>:	
	Max. Decay Heat Power for one TMI-2 Canister	80 W
	Total Decay Heat Power for DSC with 12 Heaviest Loaded TMI-2 Canisters	860 W
Dry Shielded Canister:	No. of TMI-2 Canisters per DSC	up to 12
	Size (Nominal):	
	Overall Length	4.15 m (163.5 in.)
	Outside Diameter	1.71 m (67.2 in.)
	Shell Thickness	15.9 mm (5/8 in.)
	Heat Rejection	860 W
	Internal Atmosphere	Air

Table 1.2-1
Key Design Parameters for the NUHOMS®-12T System
(continued)

Category	Criteria or Parameter (Dimensions are Nominal)	Value
Dry Shielded Canister: (Concluded)	Design Pressure	15 psig
	Equivalent Cask Drop Deceleration	75g Vertical (End) and Horizontal (Side), 25g Oblique (Corner)
	Materials of Construction	Carbon Steel
	Service Life	50 Years
Cask[2]:	Payload Capacity	37,000 kg (82,000 lbs.)
	Gross Weight	113,000 kg (250,000 lbs.) (handling) 109,000 kg (240,000 lbs.)(transport) 123,000 Kg (271,200 lbs.) (transport with impact limiters)
	Equivalent Cask Drop Deceleration	75g Vertical (End) and Horizontal (Side) 25g Oblique (Corner)

Table 1.2-1
Key Design Parameters for the NUHOMS®-12T System
(concluded)

Category	Criteria or Parameter (Dimensions are Nominal)	Value
Horizontal Storage Module:	Capacity	One DSC per HSM
	Array Size	Two rows of 15 Modules
	HSM Size (Nominal):	
	Length	5.54 m (18'-2")
	Height	4.42 m (14'-6")
	Width	3.12 m (10'-3")
	Surface Dose Rate	ALARA
	Heat Rejection Capacity	860 Watts
	Materials of Construction	Reinforced Concrete and Structural Steel
	Service Life	50 years

(1) Enveloping design basis fuel.

(2) Design Basis of MP187 Cask [1.9, 1.10].

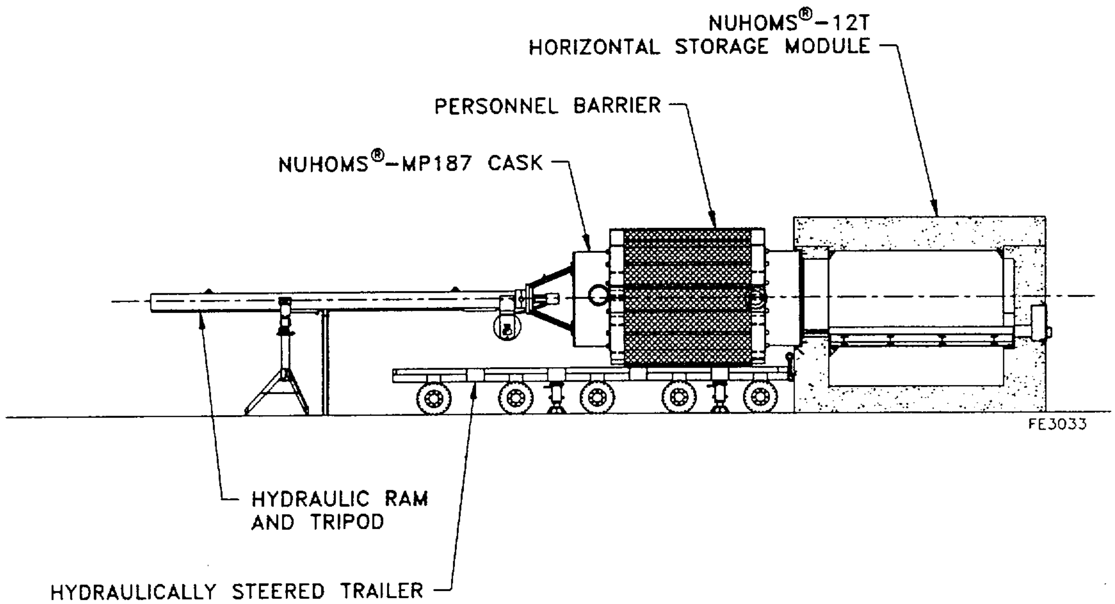
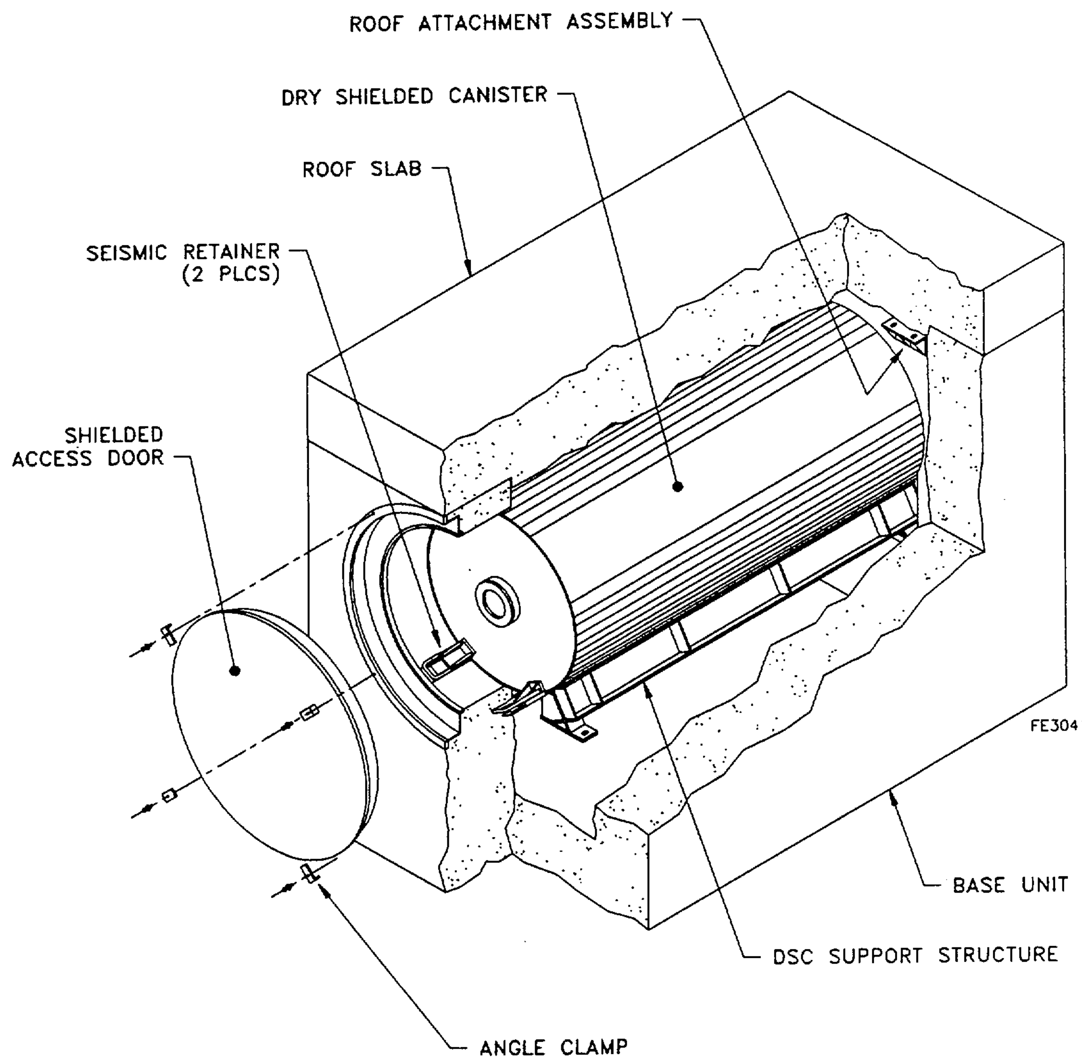


Figure 1.2-1
NUHOMS®-12T System Components, Structures, and Transfer Equipment - Elevation View



NOTE: Nominal Dimensions are shown in Table 1.2-1

Figure 1.2-2
Prefabricated NUHOMS®-12T Horizontal Storage Module
Front View
(Sheet 1 of 2)

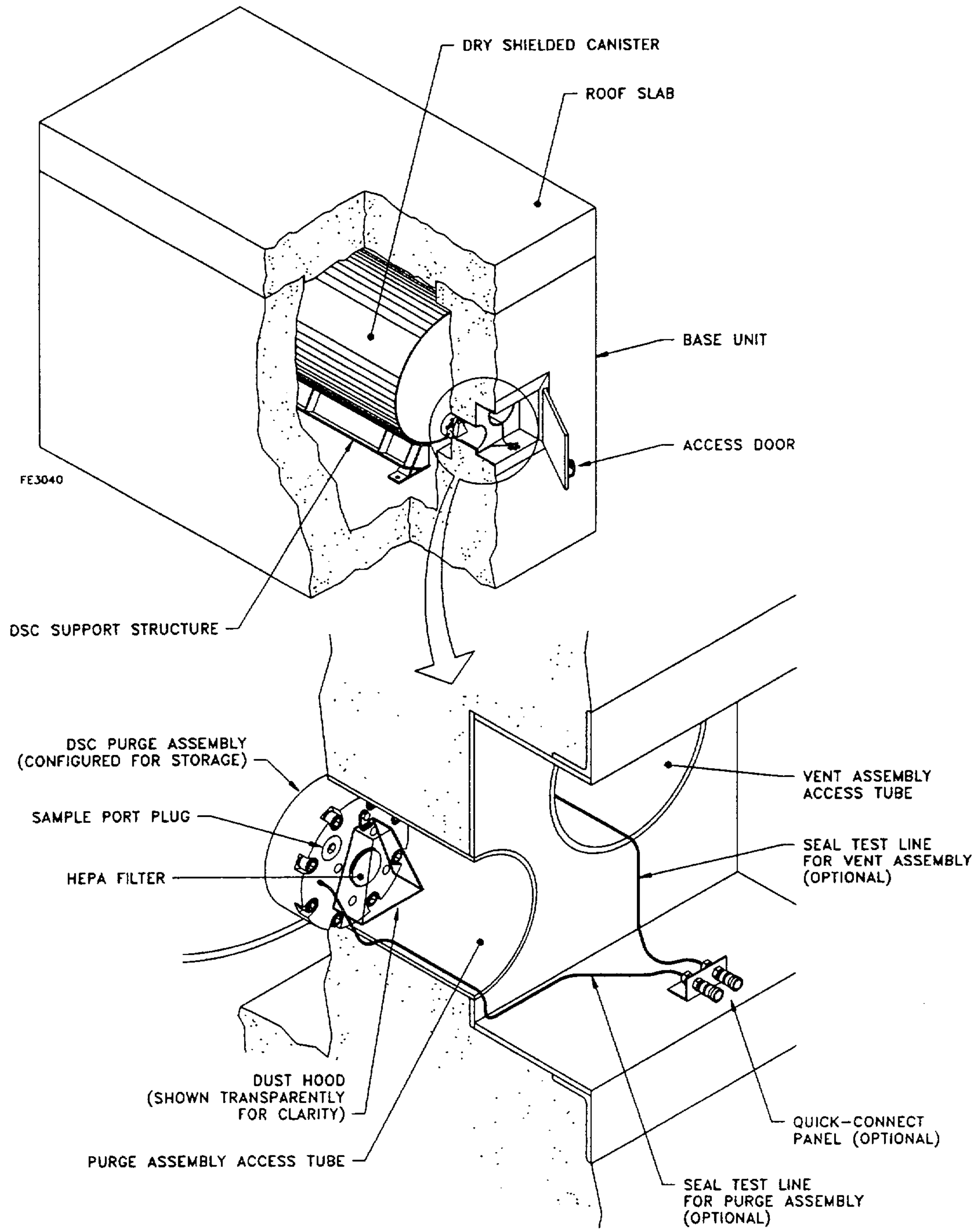


Figure 1.2-3
Prefabricated NUHOMS®-12T Horizontal Storage Module
Rear View
(Sheet 2 of 2)

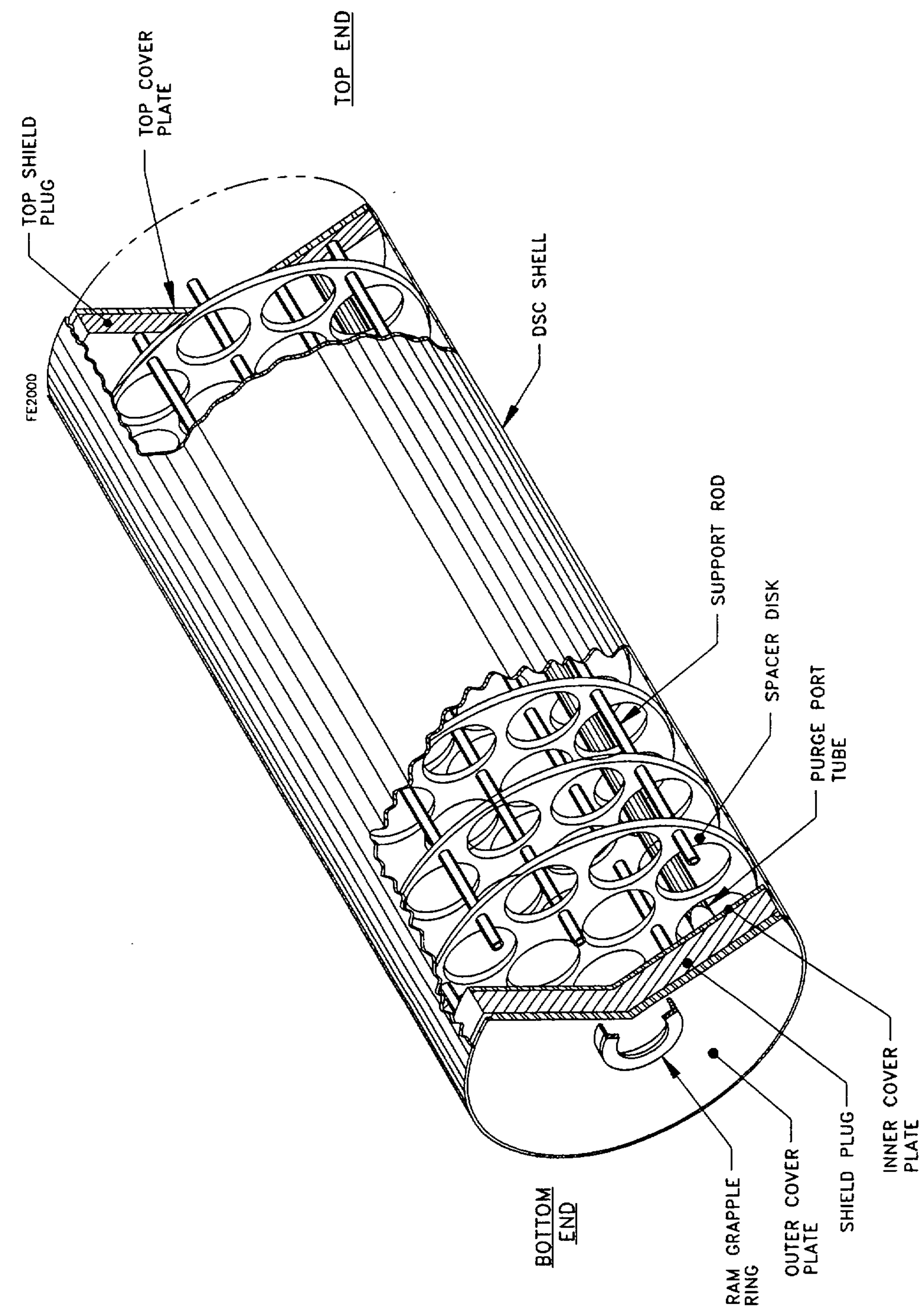


Figure 1.2-3
NUHOMS®-12T Dry Shielded Canister Assembly Components

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1.3 General Systems Description

The following subsections briefly describe the features and operation of the INEEL TMI-2 ISFSI utilizing the NUHOMS®-12T system elements.

1.3.1 Storage Systems

1.3.1.1 Dry Shielded Canister

The DSC assembly is illustrated in Figure 1.2-3. The DSC shell, the top and bottom cover plates, and the top shield plug form the confinement boundary for the spent fuel. The DSC shield plugs at each end are provided to minimize the occupational doses during sealing and handling operations.

The DSC has seal welds which join the shell, the top and bottom cover plates and the top shield plug to form the confinement boundary. The bottom end assembly confinement boundary welds are made during fabrication of the DSC. The top end assembly confinement boundary welds are made after TMI-2 canister loading. Both top plug penetrations (purge and vent ports) are mechanically sealed with a vent/filter housing installed after loading operations are complete. Transportation covers with mechanical seals are used to cover the vent/filter housing during the 10 CFR 71 transport of the DSC from TAN to INTEC and are removed to allow venting of the DSC during the storage mode. As documented in Chapter 8 of this SAR, there are no credible accidents which could breach the confinement boundary of the DSC.

The DSC internal basket consists of circular spacer disks and longitudinal support rods. These combine to provide support for the TMI-2 canisters under normal operating conditions of loading, transport, and storage. However, the internal basket assembly is not required to maintain criticality control as fixed geometric spacing of the TMI-2 canisters is not required for criticality control during transportation or storage.

1.3.1.2 Horizontal Storage Module

Isometric views of a prefabricated HSM utilized to form an array of HSMs are shown in Figure 1.2-2. Each HSM provides a self-contained modular structure for storage of TMI-2 core debris canisterized in a DSC. The HSM is constructed from reinforced concrete and structural steel. The thick concrete roof and walls of the HSM provide substantial neutron and gamma shielding.

The nominal thickness of the HSM roof and exterior walls of an HSM array for biological shielding ranges from two to three feet. Thick concrete side walls provide sufficient shielding between HSMs in an HSM array to prevent scatter in adjacent HSMs during loading and retrieval operations.

TMI-2 core debris decay heat is removed by a combination of radiant, conductive, and convective heat transfer mechanisms. No cooling air vents are required to remove the decay heat generated by the TMI-2 core debris. Decay heat is rejected from the DSC shell to the HSM walls by radiant heat transfer. The heat is conducted through the HSM walls and removed from the HSM outer surfaces by natural convection and by radiant heat transfer to the ambient air. Passive cooling is sufficient to maintain peak core debris temperatures below limits set forth in the design criteria.

The INEEL TMI-2 ISFSI HSMs provide an independent, passive system with substantial structural capacity to ensure the safe dry storage of the TMI-2 canisters. To this end, the HSMs are designed to ensure that normal transfer operations and postulated accidents or natural phenomena do not impair the DSC or pose a hazard to facility personnel, or the public.

The HSMs are placed on, but not physically anchored to, a load bearing reinforced concrete basemat. The HSMs are located in a fenced, secured location with controlled access.

1.3.2 Transfer Systems

1.3.2.1 Transfer/Transport Cask

The NUHOMS®-12T DSCs can be moved using any NRC 10 CFR Part 72-approved transfer cask or a NRC 10 CFR 71 certified transportation system. This SAR provides the information necessary for the transportation from TAN to INTEC using the NRC 10 CFR 71 certified MP-187 transportation system. Appendix E of this SAR provides the detailed information necessary for the transportation from TAN to INTEC using the 10 CFR 72 approved Transfer Cask. The major difference between the two transportation approaches is that the NRC 10 CFR 72 approved OS-197 Transfer Cask does not require impact limiters, evacuation and helium backfill of the DSC, leak testing of the DSC closure weld, or installation of the vent/filter housing transportation covers. The MP187 is being licensed to 10 CFR Part 71 and 10 CFR Part 72 transport/transfer requirements; that is, the MP187 may be used for over-the-road transportation under 10 CFR Part 71 conditions, with impact limiters installed, and also for the on-site transfer of the DSC under 10 CFR Part 72 conditions. A sketch of the MP187 is provided in Figure 1.3-1. The MP187 design is provided in the NUHOMS®-MP187 SAR [1.9]. Drawings of the MP187 are also provided for reference in Appendix B of this SAR.

The MP187 cask is designed to provide sufficient shielding to ensure that dose rates meet regulatory limits and are as low as reasonably achievable (ALARA). Two lifting trunnions are provided for handling the cask at the TAN Hot Shop using a lifting yoke and an overhead crane. Lower support trunnions are provided on the cask for pivoting the cask from/to the vertical and horizontal positions on the support skid/transport trailer.

1.3.2.2 Transfer Equipment

Transport Trailer: The transport trailer consists of a heavy industrial trailer. The trailer transports the cask transportation skid and the loaded cask between the TAN Hot Shop and the ISFSI. The trailer is designed to ride as low to the ground as possible to minimize the cask height during transport and DSC transfer operations. The trailer is equipped with hydraulic leveling jacks to provide 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 DSC transfer to the HSM is such that the cask is elevated less than 1.68m (5'-6") above grade as measured from the lowest point on the cask. This is well below the 2.0m (80 inch) drop height used as the 10 CFR Part 72 accident drop design basis of the cask and DSC.

Cask Transportation Skid: The cask transportation skid is similar in design and operation to other transportation cask skids used for shipment of fuel. The key differences are:

1. There is no ancillary equipment mounted on the skid.

2. The skid is mounted on a surface with sliding support bearings and hydraulic positioners to provide alignment of the cask with the HSM. Brackets with locking bolts are provided to prevent movement during trailer towing.

3. The cask transportation skid is mounted on a heavy haul industrial trailer.

The TAN Hot Shop crane is used to place the cask onto the transportation skid which is secured to the transport trailer. DOE safety requirements apply to the specific details of this operation at the TAN Hot Shop.

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 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 cask, and from the cask to the HSM through the cask restraints.

1.3.3 Auxiliary Systems

Auxiliary systems are used during the DSC sealing and testing operations; they are:

Vacuum Drying System (VDS): The VDS provides a means for evacuating the DSC, and backfilling it with helium if required. The VDS can also be used to backfill the transfer/transport cask with helium if required for 10 CFR Part 71 leak testing. The vacuum drying system may be used during DSC storage if it is determined that purging of the DSCs is required to control the accumulation of gases generated from radiolysis. The VDS is described in Chapter 4 of this SAR.

Welding System: DSCs are seal welded using an automated or manual welding system. The welding system is described in Chapter 4 of this SAR.

Waste Processing Systems: There are no waste processing systems required for the ISFSI. VDS exhaust and general cask decontamination waste are generated during DSC evacuation and sealing operations as well as during the normal storage mode where periodic purging of the DSC may be required. Both waste streams will be managed in accordance with established waste processing practices at INEEL. These wastes are discussed in Chapter 6.

1.3.4 System Operation

The operations for the NUHOMS®-12T system are described in Chapter 5 of this SAR. The following overview of operations is provided for general introduction and description of the INEEL TMI-2 ISFSI.

Cask Preparation: Cask preparation includes exterior washdown and interior decontamination. These operations are performed on an as-needed basis. The operations are performed by INEEL facility personnel using INEEL procedures.

DSC Preparation: The internals and externals of the DSC are thoroughly washed or wiped down on an as-needed basis. This ensures that the newly fabricated DSC will meet existing facility cleanliness requirements.

Cask Movement from Transportation Skid to an Upright Position: The cask is moved into the TAN Hot Shop, unloaded from the trailer, and placed on the turning skid. The cask is lifted to an upright position using the TAN Hot Shop crane and transferred to a work stand.

Placement of DSC in Cask: An empty DSC is inserted into the cask. Proper alignment is assured by a matching key and slot on the DSC and cask and also by visual inspection of the alignment match marks on the DSC and cask.

TMI-2 Canister Loading into DSC: Previously dewatered and dried TMI-2 canisters are placed into the DSC basket.

Removing TMI-2 Canister Fittings: The canister fittings are removed to allow for venting of the TMI-2 canisters during the storage mode.

DSC Top Shield Plug Placement: The DSC top shield plug is placed onto the DSC using the TAN Hot Shop crane.

DSC Sealing, Welding, and Testing: The DSC top shield plug and top cover plate are each installed and welded in place, with examination of each weld.

Install DSC Vent Housing Assemblies: The vent housings are installed and leak tested, and if a 10 CFR 71 transport is to be performed, the vent transportation covers are installed.

Cask Cover Plate Placement: The top internal spacer and cask top cover plate are put in place using the TAN Hot Shop crane. The cask lid is bolted closed for subsequent handling operations.

Placement of Cask on Transport Trailer Skid: The TAN Hot Shop crane is used to remove the transport cask from the work stand, move it to the turning skid, and downend the cask from the vertical to a horizontal position. The cask is then placed on the transportation skid on the transport trailer and readied for subsequent transport operations. If a 10 CFR Part 71 transport is to be performed, leak testing and installation of impact limiters is performed.

Transport of Loaded Cask to HSM: Once loaded and secured, the transport trailer is towed to the ISFSI along a predetermined route. Upon entering the ISFSI secured area, the impact limiters are removed and the transport cask is positioned and aligned with the particular HSM in which a DSC is to be transferred.

Cask/HSM Preparation: At the ISFSI, with the transport cask positioned in front of the HSM, the cask top cover plate and the HSM door are removed. The skid positioning system is then used for the final alignment and docking of the cask with the HSM.

Loading DSC into HSM: After final alignment of the transport cask, HSM, and hydraulic ram, the DSC is pushed by the hydraulic ram into the HSM.

Storage: After the DSC is inside the HSM, the hydraulic ram is disengaged from the DSC and withdrawn through the cask. The transfer trailer is pulled away, the DSC seismic restraint is installed, and the HSM shielded access door installed.

Vent System Connection: The access door in the rear wall of the HSM is opened, the transportation covers if installed are removed from the vent assemblies, and the access door is closed and locked. The DSC is now in safe storage within the HSM.

Retrieval of the DSC: If retrieval from the HSM is required for any reason, transfer operations can be performed in the reverse manner as previously described. The system is designed to allow the hydraulic ram to pull the DSC out of the HSM back into a transfer/transport cask. Once inside the transfer/transport cask, the DSC can be transferred to the DSC overpack for storage, or transferred to another suitable facility for further processing, alternate storage, or disposal.

1.3.5 Arrangement of Storage Structures

The DSC containing the TMI-2 canisters is transferred to, and stored in, the HSM in the horizontal position. HSMs are arranged within the ISFSI site on a concrete pad with the entire area enclosed by a security fence. Individual HSMs are not anchored to the pad but arranged adjacent to each other, with a nominal six inch gap between modules. Figure 1.3-2 shows the layout for the INEEL TMI-2 ISFSI. In planning the installation layout, the parameters of interest are: the configuration of the HSM array, an area in front of each HSM to provide adequate space for backing and aligning the transport trailer, and an area for access to the HSM rear walls to access the vent system and to perform periodic monitoring of the DSC and vent system.

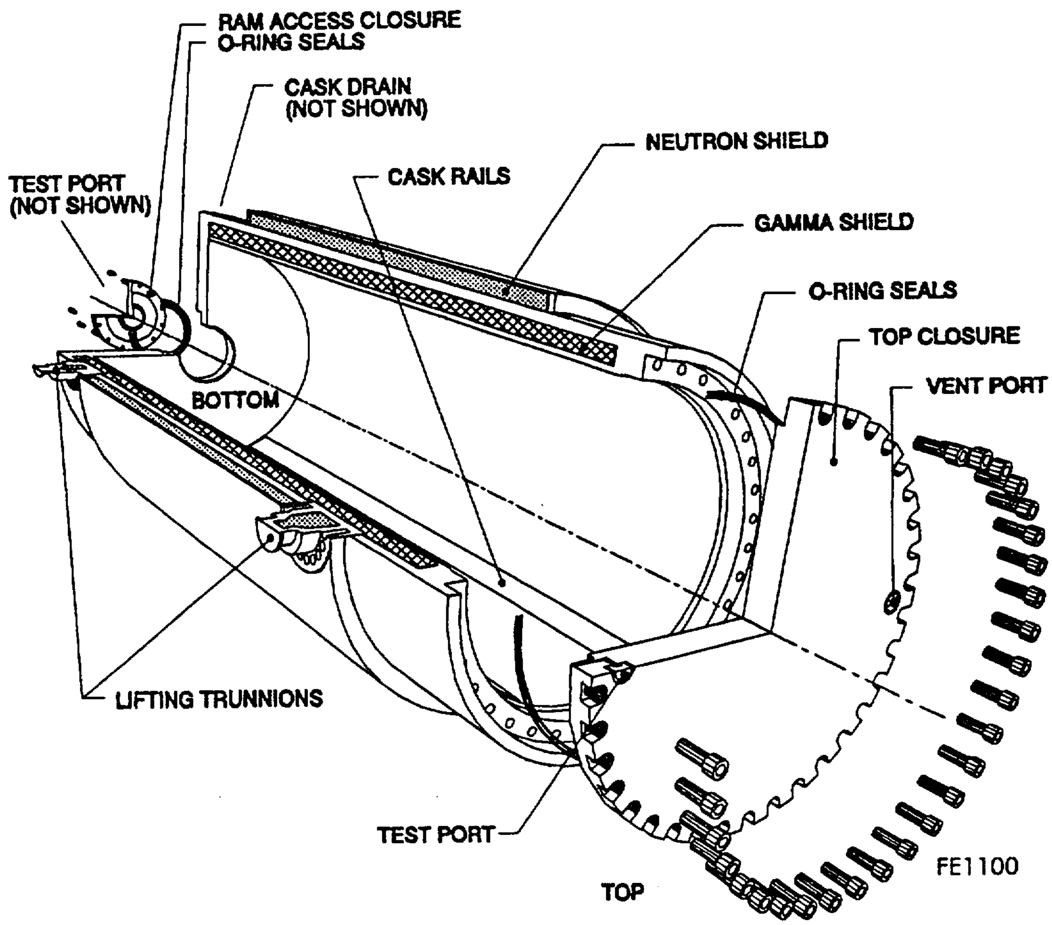

Figure 1.3-1
NUHOMS®-12T MP187 Cask

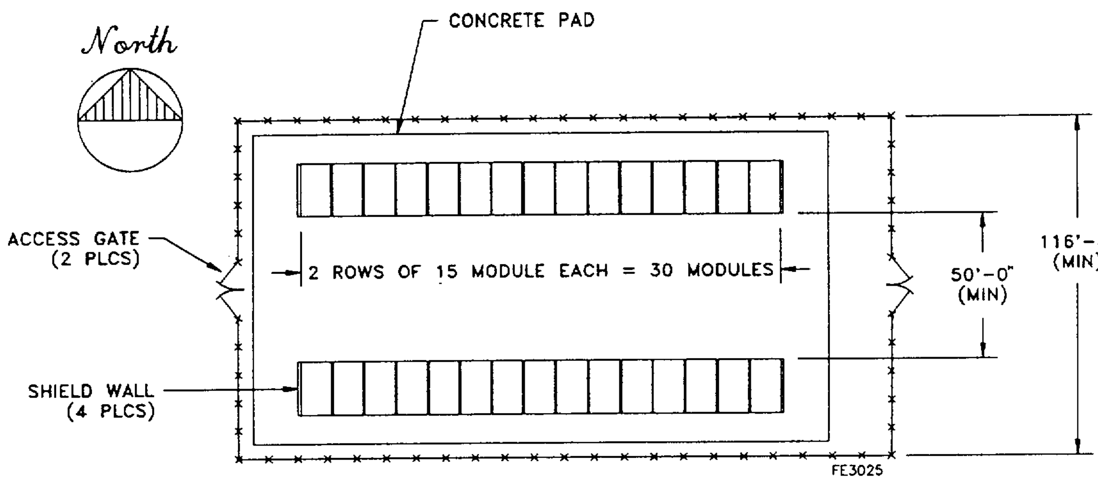

Figure 1.3-2
Module Layout for INEEL TMI-2 ISFSI

1.4 Identification of Agents and Contractors

The Department of Energy, Idaho Operations Office (DOE-ID), under authorization by DOE Headquarters (HQ), has overall responsibility for the engineering, design, licensing, construction, operation and decommissioning of the INEEL TMI-2 ISFSI. The DOE utilizes its Management & Operating (M&O) contractor for the operation, maintenance and support of activities at the DOE Idaho National Engineering Laboratory (INEEL), including the TMI-2 ISFSI. The M&O contractor at the INEEL is currently Bechtel BWXT Idaho, LLC.

The lead contractor for the design, safety analysis, and construction of the INEEL TMI-2 ISFSI is Newport News Shipbuilding (NNS) of Newport News, Virginia. NNS has subcontracted with Transnuclear West (TNW) of Fremont, California, and SCIENTECH, Inc. of Idaho Falls, Idaho, for design, safety analysis, and licensing support. TNW is the subcontractor for design and safety analysis of the NUHOMS® system components. SCIENTECH is the subcontractor responsible for design review and licensing support activities.

NNS and TNW will subcontract selected portions of the fabrication and on-site construction to qualified firms later in the construction phase of the project.

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1.5 Material Incorporated by Reference

Efforts have been made to make this SAR a self-contained document with reference to other documents such as the standardized NUHOMS®-24P SAR [1.5] as a minimum. Several other documents related to the licensing of the INEEL TMI-2 ISFSI are being submitted with the 10 CFR Part 72 license application and are referenced throughout this SAR.

The Sacramento Municipal Utility District (SMUD) Rancho Seco ISFSI SAR [1.10], presents the bounding operating loading conditions for the MP187 cask and contents when operated as an on-site transfer cask. The NUHOMS®-MP187 Transportation Cask Safety Analysis Report is referenced in this SAR in instances where transportation requirements bound those imposed by 10 CFR Part 72.

An amendment to the NUHOMS®-MP187 Transportation Cask Safety Analysis Report [1.9] will be submitted to the NRC Transportation Branch in conjunction with this application. It will contain descriptions and analyses of the cask for transportation conditions specific to the INEEL TMI-2 ISFSI and will be submitted for review under 10 CFR, Part 71.

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1.6 References

1.1 VECTRA Technologies, Inc., "Topical Report for the Nutech Horizontal Modular Storage System for Irradiated Nuclear Fuel," NUH-001, Revision 2A, San Jose, California, NRC Docket No. M-39.

1.2 U. S. Nuclear Regulatory Commission, Office of Nuclear Materials Safety and Safeguards, "Safety Evaluation Report for Nutech Horizontal Modular System for Irradiated Fuel Topical Report," NRC Docket No. M-39, March 28, 1986.

1.3 VECTRA Technologies, Inc., "Topical Report Amendment 2 for the NUTECH Horizontal Modular Storage System for Irradiated Nuclear Fuel - NUHOMS® -24P," Revision 2A, File No. NUH002.0103, NRC Docket No. M-49.

1.4 U. S. Nuclear Regulatory Commission, Office of Nuclear Materials Safety and Safeguards, "Safety Evaluation Report Related to the Topical Report for the Nutech Horizontal Modular Storage System for Irradiated Nuclear Fuel NUHOMS®-24P Submitted by Nutech Engineers, Inc.," NUH-002, Revision 1A, NRC Docket No. M-49, April 1989.

1.5 "Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," NUH-003, Revision 4A, VECTRA Technologies, Inc., File No. NUH003.0103, NRC Docket No. 72-1004, June 1996.

1.6 U.S. Nuclear Regulatory Commission, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation (Dry Storage)," Regulatory Guide 3.48, U.S. NRC, 1989.

1.7 DOE 1995b, *"Settlement Agreement"* between the State of Idaho, Department of the Navy, and the Department of Energy." October 16, 1995.

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

1.9 "Safety Analysis Report for the NUHOMS®-MP187 Multi-Purpose Cask," NUH-005, Revision 2, VECTRA Technologies, Inc., NRC Docket Number 71-9255, February 1996.

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

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3 PRINCIPAL DESIGN CRITERIA

3.1 Purpose of Installation

The INEEL TMI-2 ISFSI provides for horizontal, dry storage of the TMI Unit 2 (TMI-2) core debris canisters in a high integrity steel DSC which is placed inside a massive reinforced concrete HSM. The DSC will be vented through a HEPA grade filter once it is placed inside the HSM to prevent build-up of combustible levels of hydrogen gas inside the DSC. The function of the DSCs and HSMs is to provide for the safe, controlled, interim storage of the TMI-2 canisters. The standardized NUHOMS® dry spent fuel storage system has been adapted for storing TMI-2 canisters and has been designated NUHOMS®-12T.

The ISFSI layout is based on the use of 30 HSMs. Each HSM holds one NUHOMS®-12T DSC containing up to 12 TMI-2 canisters. Therefore, 29 HSMs will contain all (344) TMI-2 canisters plus provide four additional TMI-2 canister spaces. An extra HSM serves as a backup in case temporary storage of a DSC is required or in case a challenged canister needs additional confinement. This spare HSM will include a cylindrical overpack so that it can be used as an additional confinement barrier. The INEEL TMI-2 ISFSI layout is shown in Figure 1.3-2. Those systems, structures and components considered to be important to safety are identified in Table 3.4-1. The design life of the DSC and HSMs is intended to be 50 years.

3.1.1 Material to be Stored

The material to be stored inside the DSC consists of canisters containing core debris removed from the damaged TMI Unit 2 during defueling operations. TMI-2 was a Babcock & Wilcox (B&W) pressurized water reactor. The material contained in the TMI-2 canisters is the remains of the TMI-2 core [3.1, 3.2]. Records of the contents of each canister were kept and define the materials to be stored [3.3]. Retrieved materials from the TMI-2 core include:

- Rubble bed debris.

- Partially intact fuel assemblies.

- Debris bed stratified material.

- Miscellaneous core component pieces (e.g., fuel rod segments, spacer grids, end fittings, control rod assembly spiders, springs, fuel pellets, etc.).

- In-core instrument assemblies.

There are three types of TMI-2 canisters that will be stored inside the DSC:

- TMI-2 *Fuel* canisters (large pieces of core debris).

- TMI-2 *Knockout* canisters (fines generated from the use of the debris vacuum system).

- TMI-2 *Filter* canisters (fines generated from the use of the debris vacuum system and defueling water cleanup system).

In this SAR, the TMI-2 *fuel* canisters, *knockout* canisters, and *filter* canisters are generically referred to as TMI-2 canisters and are shown in Figure 3.1-1, Figure 3.1-2, Figure 3.1-3, and the Appendix A drawings.

The *fuel* canister was a receptacle for pieces of core debris large enough to be picked up by mechanical devices. The *knockout* canister was part of the fines/debris vacuum system. It was designed to separate debris ranging in size from 140 μm up to the size of whole fuel pellets [0.95 cm (0.375 in) diameter by 1.5 cm (0.6 in) long] and larger pieces of resolidified, once-molten fuel. The inlet flow came directly from the defueling vacuum system inside the reactor, while the outlet flow went to a *filter* canister for further treatment. As part of either the defueling water cleanup system or the fines/debris vacuum system, the *filter* canister was designed to remove very small debris particles from the water. The *filter* assembly module fitting inside the canister shell was designed to remove particulates in the range of 0.5 to 800 μm. Details of the design and original function of the three types of canisters are provided in Reference 3.4.

Table 3.1-1 lists the principal design parameters determined for the TMI-2 canisters to be used as the design basis for the NUHOMS®-12T system documented in this SAR.

3.1.1.1 Physical Characteristics

The physical characteristics of the TMI-2 canisters and their contents are described in detail in the Safety Analysis Report for the transportation of TMI-2 Core Debris to INEEL [3.5], the design specification for the TMI-2 canisters [3.4], and are summarized in Table 3.1-1, Table 3.1-2 and table 3.1-3. The key physical parameters of interest are the canister weight, canister length, cross-sectional dimensions, canister contents, internal poisons, debris density, and debris weight. The values of these parameters form the basis for the criticality, mechanical, and structural design of the DSC and its internals.

3.1.1.2 Thermal Characteristics

The key parameter utilized to determine the heat removal requirements for the NUHOMS®-12T system design is the TMI-2 fuel decay heat power. The total decay heat power per TMI-2 canister is dependent on the total burnup and the cooling time of the fuel debris. To a lesser extent, total decay heat power is dependent on the initial enrichment, specific power (MW/MTU), and neutron flux energy spectrum.

The maximum heat load for any TMI-2 canister is 60 watts with an average heat load for all of the TMI-2 canisters of 29 watts/canister [3.6]. The thermal analysis of the TMI-2 DSC and HSM is conservatively based on a total decay heat of 860 watts. The thermal analysis of the DSC internals which include TMI-2 canisters with core debris is conservatively based on 80 watts/canister decay heat load.

This heat load is sufficiently low that the DSC and HSM are fully capable of dissipating the heat and keeping all temperatures within the recommended material temperature limits without the need for HSM cooling air vents.

3.1.1.3 Radiological Characteristics

The maximum initial enrichment of the TMI-2 fuel was 2.98 weight percent (w/o) U-235. The TMI-2 core has a fuel burnup of 3,175 MWD/MTU and a cooling time of 19 years. A summary of the TMI-2 canister radiological characteristics is provided in Table 3.1-3.

3.1.2 General Operating Functions

The general operating functions described below are applicable for the NRC 10 CFR 71 certified MP-187 transportation system. Appendix E provides the general operating functions for the 10 CFR 72 approved OS-197 Transfer Cask. The major difference between the two transportation approaches is that the NRC 10 CFR 72 approved OS-197 Transfer Cask does not require impact limiters, evacuation and helium backfill of the DSC, leak testing of the DSC closure weld, or installation of the vent/filter housing transportation covers.

The INEEL TMI-2 ISFSI is designed to maximize the use of existing INEEL facilities and equipment at INTEC and TAN, and to minimize the need to add or modify equipment. The ISFSI will be located within the existing INEEL security boundary. Services such as security, maintenance, training and emergency response will be performed by the M&O Contractor. The power provided for the ISFSI security system and lighting is obtained from the INTEC electrical grid. Other support services from INEEL are necessary only during DSC transfer and retrieval operations.

A brief description of the general operation of the system begins with an empty DSC and cask which have been prepared for loading and TMI-2 canisters which have been drained and dried and prepared for insertion into the DSC. During loading of the TMI-2 canisters into the DSC, the DSC rests in the cavity of the cask inside the TAN Hot Shop. The DSC will be sealed and then purged and backfilled with helium for leak testing. After purging, the DSC (still inside the cask) will be moved to the cask skid/trailer and transported to the ISFSI. The DSC will be pushed from the cask into the HSM by a hydraulic ram. The HSM rests on, but is not anchored to, a concrete ISFSI basemat.

The DSC is sealed to ensure that any flow of gases in or out of the DSC, during storage, is through a HEPA filter. This is accomplished by welding the closure plates in place and leak testing the welds. The inner cover is welded and inspected to the same criteria as the outer cover plate. The plates are welded to the shell and seal welded together at the purge and vent ports to provide redundant closures. Both the purge and vent ports are covered with vent housings that are sealed to the outer cover plate with dual metallic seals. During leak testing and transfer/transport activities the filters are closed by installing cover plates which are sealed to the vent housings with dual metallic seals. Acceptance leak testing is done with the DSC inside the cask by pulling a vacuum in the DSC, back filling with helium, sealing the cask, then pulling a vacuum in the annulus between the cask and the DSC with the discharge routed through a helium leak detector. When the DSC is placed in the HSM the test/transport covers are removed to allow the DSC to vent to atmosphere, thereby, removing radiolytically generated hydrogen from any residual moisture contained inside the DSC. The HEPA filters are screwed into the filter housing using a single elastomeric gasket under the flange of the filters. Filters are sintered stainless steel encased in stainless steel bodies originally developed for long term hydrogen gas venting of radiological waste containers. There are four, two-inch diameter filters located in the vent cover housing and one, two inch diameter filter located in the purge port vent cover housing. The vent port accesses the DSC in the headspace immediately above the top of the TMI canisters. This allows for direct removal of any gases emitted by the canisters. The purge port connects to a mechanical tube that goes to the bottom of the DSC to allow for gas circulation in the system. This also allows for complete purging of the DSC if, as discussed in section 4.3, any abnormally high gas build-ups are noted. Both the purge port filter and vent port filter housings allow for sampling of gases within the DSC. Additionally, the test/transport covers can be installed over the filters to allow equalization of gases within the DSC so representative gas samples can be obtained. The filter housings also have leak test ports for remotely testing the filter housing to DSC seals. The vent and purge ports can be accessed through the rear of the HSM during DSC storage. The HSM filter access ports exit the HSM rear wall through a vented steel door. The internal location of the filters and the heavy steel door that protects the access to the filters ensures safe operation of the filters.

The filters are constructed entirely from stainless steel. The filter media is sintered stainless steel that is certified by the supplier to have an efficiency of greater than 99.97% for particulate down to 0.3 microns. This material is welded into the threaded stainless steel filter body which in turn is threaded into the filter housings. The filter assembly before installation into the housing is also checked for filtration efficiency. This filter is completely passive and is constructed of stainless steel making in unaffected by the environment it will see at INEEL.

Once inside the HSM, the DSC and its payload of TMI-2 canisters will be in passive dry storage. Safe storage in the HSM is assured by passive heat transfer and massive concrete walls and slabs which act as biological radiation shields. The storage operation of the HSMs and DSCs is passive except for monitoring, surveillance, and/or purging of the DSC, and vent system HEPA grade filter change out if hydrogen gas build-up is detected. Chapter 5 addresses the operating steps in more detail.

3.1.2.1 Handling and Transfer Equipment

The handling and transfer equipment required for the NUHOMS®-12T system includes the cask rigging, cask turning skid, transfer cask, cask transportation skid and positioning system, a heavy haul transport trailer, a tractor, 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. Performance criteria for the cask, skids, trailer, and ram are shown in Table 3.1-4 and described in the following sections. The NUHOMS®-12T system and MP187 cask are compatible with the TAN Hot Shop crane.

All equipment will be functionally tested, including load tests as appropriate, to demonstrate that each item meets its operational requirements. The cask and DSC are designed, tested and documented as Important to Safety equipment to ensure that they will meet all design conditions. The non-safety related support equipment is designed and built to meet commercial codes and standards and functionally tested. This equipment is not required to meet accident-related criteria as its failure cannot result in an unanalyzed safety condition. For example the lifting yoke will be load tested to ANSI 14.6 and dimensionally checked by fit up to the MP-187 trunnions, the trailer will be load tested, the hydraulic ram and the skid positioning systems will be functionally tested to the design limits of the systems. Following the individual functional and load tests, a dry run(s) will be performed for the complete transportation and transfer parts of the system using dummy DSC loads simulating the TMI-2 fuel debris canisters. The test(s) will ensure that all parts of the system meet their functional requirements and correctly interface with the other components.

Cask: The loaded DSCs can be moved with any 10 CFR Part 72 approved transfer cask for on-site moves, or a 10 CFR Part 71 approved transportation cask. It is planned to transport the loaded DSCs from the TAN facility to the ISFSI using the MP187 cask with impact limiters in place. However, the MP187 cask is also designed for use in the on-site transfer mode without impact limiters. The internal cavity of the cask (nominal length of 187 inches) is longer than the NUHOMS®-12T DSC (nominal length 163.5 inches without filter assemblies). The additional cask length will be filled with two equal length spacers, one on each end.

Cask Transportation Skid and Positioning System Criteria: As with previously licensed NUHOMS® systems, the transportation skid and skid positioning systems provide for longitudinal and transverse movement to facilitate cask/DSC alignment with the HSM. The amount of transverse motion required is a few inches. The system has positive locks which prevent any possibility of movement or load shifting during transport.

Cask Turning Skid: Due to the design of the cask transportation skid, the cask turning skid is used at the TAN Hot Shop to allow for rotating the cask between horizontal and vertical positions.

Trailer Criteria: The heavy-haul trailer used to transport the cask, skid, and DSC from the TAN Hot Shop to the HSM at the ISFSI is a tractor-towed, multi-axle trailer. The principal criteria for the transport trailer are: 1) the capacity to bear the weight of the fully loaded cask with impact limiters and the transportation skid, plus the additional inertia forces associated with transport operations; and 2) the ability to adjust the height of the cask in order to achieve precise alignment with the HSM. This latter requirement is accomplished with the skid positioning system.

The trailer deck, jacks, and transportation skid assembly provide a rigid support structure for the cask on the ISFSI approach slab. That is, any springing, such as may result from tires, coil springs or other flexible members, is eliminated from the support system to prevent cask movement while the DSC is being transferred into the HSM.

Hydraulic Ram System Criteria: The hydraulic ram system consists of a double acting hydraulic cylinder mounted on a firm base, with a grapple affixed to the piston. It is used to apply a push or pull force to transfer the DSC to/from the cask/HSM. The hydraulic ram is capable of exerting sufficient force during the entire insertion and retrieval strokes to effect the transfer. The ram has the capacity to move the DSC assuming a coefficient of friction of one for the DSC sliding in the cask or in the HSM. The ram cannot exert a force greater than 11.5 kN (70,000 pounds), which is somewhat greater than the loaded weight of the DSC, but less than or equal to the allowable force for which the DSC is designed. The stroke of the ram is sufficient to complete the transfer. During DSC transfer operations, the ram is firmly attached to the rear surface of the cask to transfer the reaction load during insertion and retrieval.

3.1.2.2 Waste Processing, Packaging, and Storage Areas

The gases evacuated from the DSC during purging and sealing at the TAN Hot Shop will be handled in accordance with TAN operating procedures.

A limited amount of dry active waste is generated from temporary protective clothing and material used during fuel loading, DSC purging, and sealing operations. These wastes will also be handled within the TAN Hot Shop according to TAN operating procedures.

The only other waste generated by the NUHOMS®-12T system is the storage components themselves at the end of their service life. These will be treated and disposed of during ISFSI decommissioning.

Table 3.1-1
Principal Parameters for the Bounding TMI-2 Canister to be Stored in NUHOMS®-12T DSC

Parameter	Value
Physical Parameters	
Maximum loaded Canister Weight	≤ 1327 Kg (2926 lb.)
Average of 12 Heaviest	1318 Kg (2905 lb.)
No. of Canisters per DSC	≤ 12 Canisters
Thermal Characteristics	
Maximum Decay Heat Power per Canister	≤60 W
Average Decay Heat Power per Canister	29 W*
Thermal Design Basis	
Maximum Decay Heat Power for one TMI-2 Canister	≤80 W
Total Decay Heat Power for DSC Loaded with 12 TMI-2 Canisters	860 W
Radiological Characteristics	
Maximum Initial Enrichment	2.98 w/o U-235
Burnup	3175 MWD/MTU
Post-Irradiation Cooling Time	≥ 19 years

* 29 watts/canister was obtained by multiplying the average canister decay heat of 15 watts/canister by the hot channel peaking factor of 1.879.

Table 3.1-2
TMI-2 Canister Data *

Parameters	Fuel	*Filter*	*Knockout*
	Type of Canister		
Overall length (maximum) (cm)	381.0	381.0	381.0
(in)	150.0	150.0	150.0
Outer diameter (nominal) (cm)	35.56	35.56	35.56
(in)	14.00	14.00	14.00
Canister contents	Up to partial fuel assemblies	Small fines, 0.5 to 800 μm	140 μm to gravel size
Criticality control	Boral sheets	B_4C rods	B_4C rods
Fittings			
- inlet (cm)		6.35	5.08
- inlet (in)		2.5	2
- outlet (cm)		6.35	5.08
- outlet (in)		2.5	2.0
- drain (cm)	0.95	0.95	0.95
- drain (in)	0.375	0.375	0.375
- vent(cm)	0.635	0.635	0.635
- vent (in)	0.25	0.25	0.25
Empty canister weight (nominal)			
- in air (kg)	559	655	475
(lb)	1230	1440	1046
Bottom head design	Reversed dish	Reversed dish	Reversed dish
Top head design	Flat plate with skirt (bolted closure)	Flat plate with skirt (welded closure)	Flat plate with skirt (welded closure)

(*) From Reference 3.4

Table 3.1-3
TMI-2 Summary of Bounding Canister Source Term Characteristics

Gamma Source (γ/sec/canister)	6.37E+14
Gamma Power (MeV/sec/canister)	1.88E+14
Neutron Source (n/sec/canister)	6.90E+05
Activity (Curie/canister)	3.17E+04
Specific Power (MW/MTU)	27.14*

* This specific power is consistent with the average TMI-2 burnup. The above listed source terms were calculated using this specific power multiplied by the hot channel peaking factor of 1.879 as discussed in Chapter 7 (page 7.2-1).

Table 3.1-4
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 Transportation Skid	Weight Capacity	Cask + DSC + Impact Limiters
	Cask Positioning	Horizontal Translation and Rotation
Cask Turning Skid	Weight Capacity	Cask + DSC
	Cask Rotation Orientation	Allows Vertical to Horizontal to Vertical Rotation
Transport Trailer	Payload Capacity	330,000 lb Payload
	Cask Positioning	Vertical Translation at Each Corner
	Rigidity	Cask is Solidly Supported During DSC Transfer Operation
	Turning Radius	Turn 90° in 48 ft wide lane
Hydraulic Ram	Capacity	11.5 kN (70,000 lbf) Push and Pull
	Load Limit	Maximum Force is Limitable
	Base Mounting	Immobile During DSC Transfer

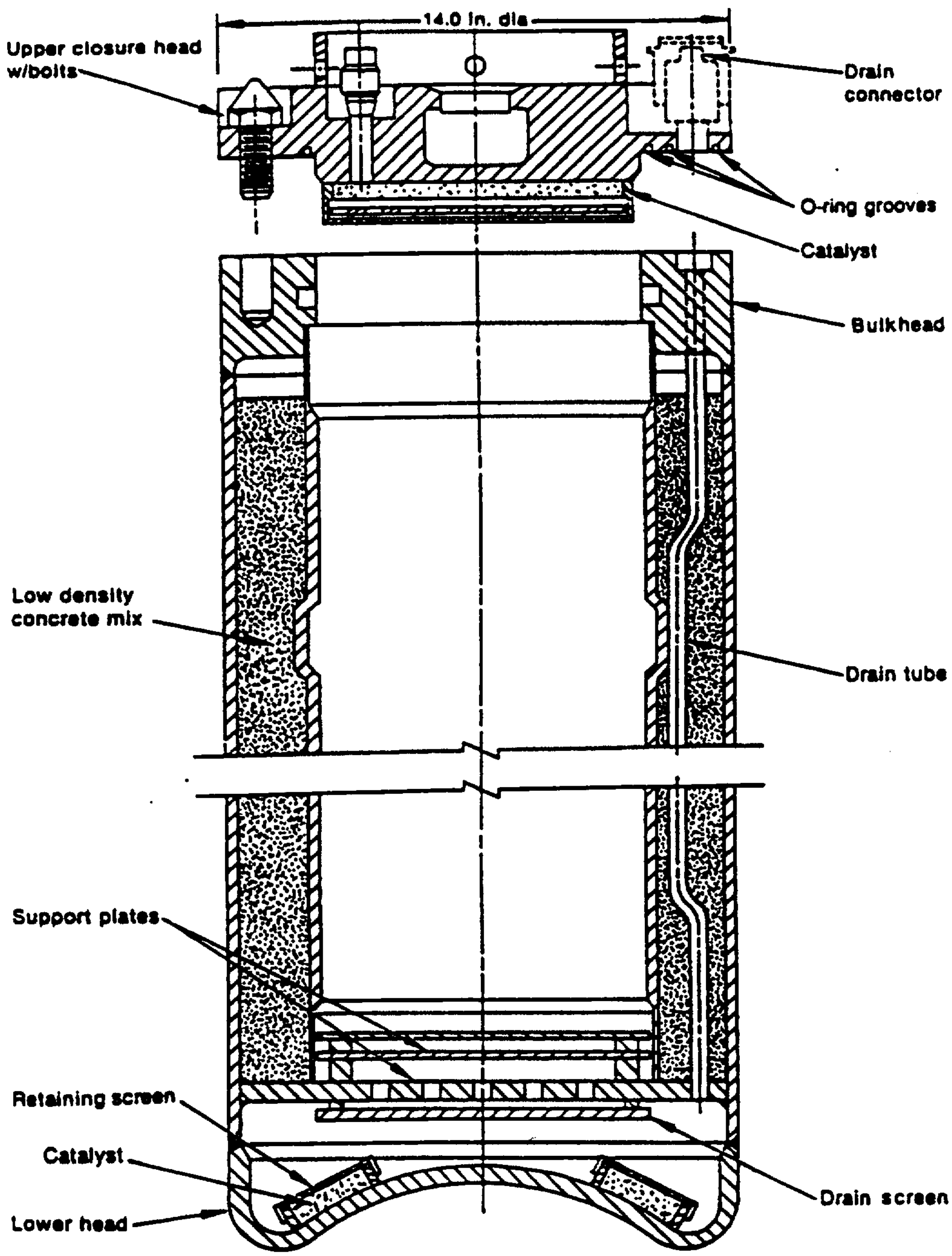

Figure 3.1-1
TMI-2 *Fuel* Canister
[Reference 3.1]

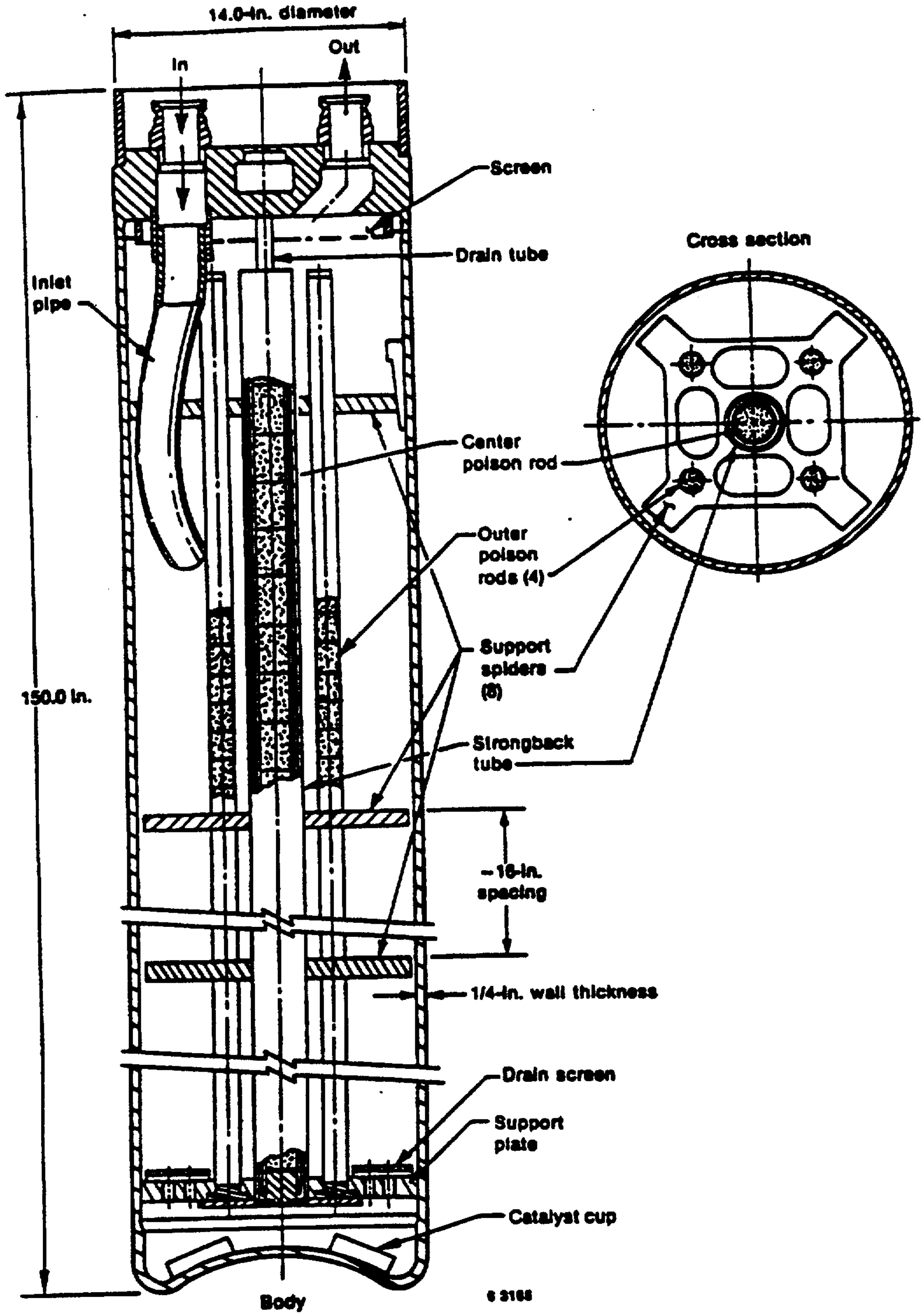

Figure 3.1-2
TMI-2 *Knockout* Canister
[Reference 3.1]

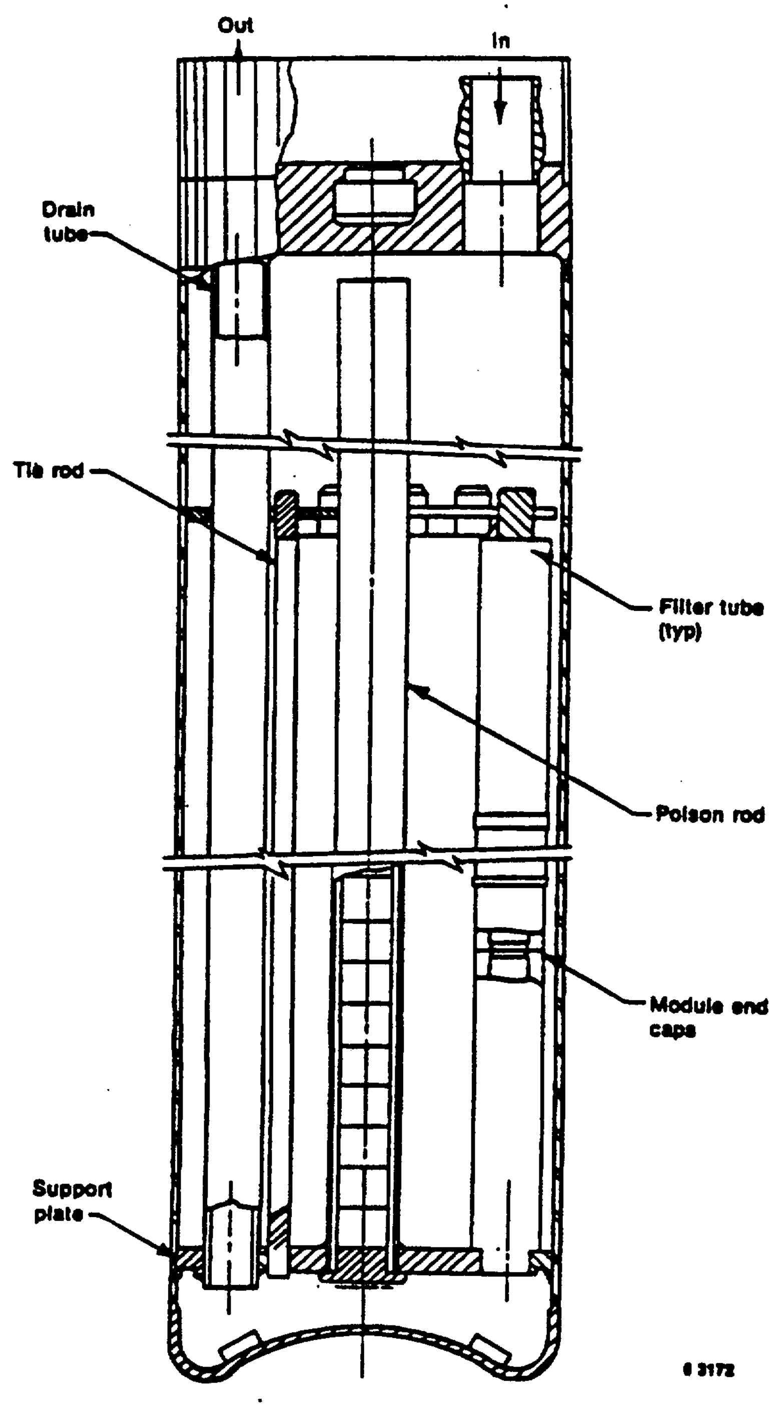

Figure 3.1-3
TMI-2 *Filter* Canister
[Reference 3.1]

3.2 Structural and Mechanical Safety Criteria

The reinforced concrete HSM and the DSC are the NUHOMS®-12T system ISFSI components which are important to safety. Consequently, they are designed and analyzed to perform their intended functions under the extreme environmental and natural phenomena specified in 10 CFR 72.122 [3.7] and ANSI-57.9 [3.8]. As stated previously, the cask must be designed and constructed to meet 10 CFR Part 71 requirements for a transportation cask and 10 CFR Part 72 requirements for an on-site transfer cask. As such, the cask shall meet all regulatory requirements to protect the DSC and TMI-2 canisters during transfer from the TAN facility to the INTEC ISFSI.

Table 3.2-1 summarizes the design criteria for the principal NUHOMS® system components. This table also summarizes the applicable codes and standards utilized for design. The extreme environmental and natural phenomena design criteria discussed below comply with the requirements of 10 CFR 72.122 and ANSI-57.9. A description of the structural and mechanical safety criteria for the other design loadings listed in Table 3.2-1, such as thermal loads and cask drop loads, are provided in Chapter 8.

3.2.1 Tornado and Wind Loadings

The TMI-2 ISFSI is located at the INEEL INTEC site. For this site, the design basis wind load is 100 mph at 30 feet above grade and the design basis tornado wind loads are specified by NRC Regulatory Guide 1.76 [3.9] and NUREG-0800, Section 3.5.1.4, Region III [3.10] and modified by NUREG/CR-4461 [3.11] and Reference 3.12. The design basis wind effects are much less severe than the specified tornado wind and missile loads or seismic effects and, therefore, are not evaluated in detail for the HSM. The Region I design basis tornado wind loads for the MP187 cask envelope the Region III criteria.

3.2.1.1 Applicable Design Parameters

The design basis tornado (DBT) intensities used for the HSM are obtained from Reference 3.11 for Region III. For Region III, the maximum rotational plus translational wind speed is 61 m/sec (200 miles per hour), the radius of the maximum rotational speed is 45.7 m (150 feet), the pressure drop across the tornado is 10.3 kN/m^2 (1.5 psi), and the rate of pressure drop is 4.1 kN/m^2 (0.6 psi) per second. The maximum transit time based on the 2.2 m/sec (5 miles per hour) minimum translational speed is not used since an infinite transit time is conservatively assumed.

3.2.1.2 Determination of Forces on Structures

The effects of a DBT are evaluated for the HSM. Tornado loads are generated for two separate loading phenomena: First, pressure forces created by drag, as air impinges and flows past the HSM; and second, impact, penetration, and spalling forces created by tornado-generated missiles impinging on the HSM. The atmospheric pressure change induced forces are considered. In the following paragraphs, the determination of these forces is described.

The determination of the DBT velocity pressure is based on the following equation as specified in ANSI 58.1-1982 [3.13].

$$q = 0.00256\ K_z(IV)^2$$

Table 5 of ANSI A58.1 [3.13] defines the Importance Factor (I) to be 1.07 and the velocity pressure exposure coefficient (K_z) to be 0.8 applied to the full HSM height of 4.4 m (14.5 feet). Since the generic design basis HSM dimensions are relatively small compared to the 45.7 m (150 ft) rotational radius of the DBT, the velocity value of combined rotational and translational wind velocity of 61 m/sec (200 miles per hour) is conservatively used in the above equation as follows:

$$q = 0.00256 \times 0.8 \times [1.07 \times 200]^2 = 94 \text{ psf}$$

The calculated DBT velocity pressure is converted to a design wind pressure by multiplying this value by the appropriate pressure and gust response coefficients specified in Figure 2 and Table 8 of ANSI A58.1-1982. With a gust response coefficient of 1.31 as used in Table 3.2-2, the wind pressure used in this analysis bounds that obtained using the basic wind pressure formula $q = 0.00256 \times V^2$. The magnitude and direction of the design pressures for various HSM surfaces and the corresponding pressure coefficients are tabulated in Table 3.2-2. The effects of overturning and sliding of the HSM under these design pressures are evaluated and reported with the stress analysis results in Section 8.2.

3.2.1.3 Ability of Structures to Perform Despite Failure of Structures Not Designed for Tornado Loads

The HSM protects the DSC from adverse environmental effects and is the principal NUHOMS® structure exposed to tornado wind and missile loads. Furthermore, all components of the HSM (regardless of their safety classification) are designed to withstand tornadoes and tornado-based missiles. The cask protects the DSC from adverse environmental effects such as tornado winds during transit to the ISFSI. The analyses of the HSM for tornado effects are contained in Section 8.2.2.

Since the HSMs are located outdoors in a large open area, there is no possibility of an adjacent building collapsing on an HSM. HSM air vents are not required for cooling because the heat loads from the TMI-2 canisters stored in the DSCs are very low. This eliminates the possibility of HSM vent blockage as an accident condition. Also, the design assumes that the gaps between modules are filled with debris to determine the worst case thermal loads. The effect of blockage of the gaps between modules is presented in Section 8.2.10.

3.2.1.4 Tornado Missiles

The determination of impact forces created by the DBT generated missiles for the HSM is based on the criteria provided by NUREG-0800, Section 3.5.1.4, III.4 for Region III [3.10].

For the overall effects of a DBT missile impact, overturning, and sliding on the HSM, the force due to the 1800 Kg deformable massive missile impact at 70 mph is applied to the structure at the most adverse location. Conservation of momentum is assumed to demonstrate that sliding and/or tipping of a single stand-alone module will not result in an unacceptable condition for the module. The coefficient of restitution is assumed to be zero and the missile energy is transferred to the module to be dissipated as sliding friction, or an increase in potential energy due to raising the center of gravity. The force is evenly distributed over the impact area. The magnitude of the impact force for design of the local reinforcing is calculated in accordance with Bechtel Topical Report "Design of Structures for Missile Impact" [3.14].

For the local damage analysis of the HSM for DBT missiles, 125 Kg armor piercing artillery shell impacting at 70 mph is used for the evaluation of concrete penetration, spalling, scabbing and perforation thickness. The 1" solid sphere is not evaluated as there are no small openings in the HSM which lead directly to the DSC. The modified National Defense Research Committee (NDRC) empirical formula is used for this evaluation as recommended in NUREG-0800, Section 3.5.3 [3.15]. The results of these evaluations are reported in Section 8.2.

3.2.2 Water Level (Flood) Design

As described in Section 2.4, the maximum postulated flood for the INTEC ISFSI site is elevation 4917' ASL. To avoid all flood related loads on the HSM, the lowest elevation for the ISFSI base slab will be 4917'. This will assure that HSMs are not subjected to any flood loading throughout their lifetime.

3.2.3 Seismic Design Criteria

3.2.3.1 Input Criteria

The design basis response spectra of NRC Regulatory Guide (R.G.) 1.60 [3.16] is used for the INEEL TMI-2 ISFSI design earthquake as defined in 10 CFR 72.102 (a)(2). Since the DSC can be considered to act as a large diameter pipe for the purpose of evaluating seismic effects, the "Equipment and Large Diameter Piping System" category in NRC Regulatory Guide 1.61, Table 1 [3.17]. Hence, a value of three percent of critical damping for the design basis earthquake is used. Similarly, from the same R.G. table, a value of seven percent of critical damping is used for the reinforced concrete HSM. The horizontal and vertical components of the design response spectra (Figures 1 and 2, respectively, of NRC Regulatory Guide 1.60) correspond to a maximum horizontal and vertical ground acceleration of 1.0g. The maximum ground displacement is proportional to the maximum ground acceleration, and is set at 36 inches for a ground acceleration of 1.0g.

NRC Regulatory Guide 1.60 also states that for sites with different acceleration values specified for the design basis earthquake, the response spectra used for design should be linearly scaled from R.G. 1.61 Figures 1 and 2 in proportion to the maximum specified horizontal ground acceleration. Per Section 2.6 of this SAR the horizontal ground acceleration component specified for design of the TMI-2 ISFSI is 0.36g. The vertical acceleration component is two-thirds of the horizontal component which is 0.24g.

3.2.3.2 Seismic-System Analyses

To establish the amplification factors associated with the design basis response spectra, frequency analyses are performed as described in Section 8.2.3 for the NUHOMS® system components. The results of these analyses show that the dominant lateral frequency for the reinforced concrete HSM is 36.3 Hertz. The DSC is supported by the front and back HSM concrete walls and has a calculated dominant lateral frequency of 23.8 Hertz along the support structure. The corresponding horizontal seismic acceleration used for design of the HSM is 0.36g. The dominant DSC and HSM vertical frequency is 67.9 Hertz, which results in a vertical seismic design acceleration of 0.24g. The resulting seismic design accelerations used for the DSC are .49g horizontally and 0.24g vertically.

3.2.4 Snow and Ice Loads

The maximum 100 year roof snow load, specified for the INEEL TMI-2 ISFSI location for an unheated structure, is 1.4 kN/m^2 (30 psf). This value is conservative as compared to 18.1 psf calculated using the formula $P_f = 0.7C_eC_tIP_g = 0.7x0.9x1.2x1.2x20 = 18.1$ psf from ANSI A58.1-1982, Tables 18 through 20. For the purpose of this SAR, a total live load of 6.24 kN/m^2 (130 psf) is used in the HSM analysis to envelope all postulated live loadings, including snow and ice.

3.2.5 Load Combination Criteria

3.2.5.1 Horizontal Storage Module

The INEEL TMI-2 ISFSI reinforced concrete HSM is designed to meet the requirements of ACI 349 [3.18] and is constructed to ACI 318 [3.19]. The ultimate strength method of analysis is utilized with the appropriate strength reduction factors as described in Table

3.2-2. The load combinations specified in Section 6.17.3.1 of ANSI 57.9-1984 are used for combining normal operating, off-normal, and accident loads for the HSM. All seven load combinations specified are considered and the governing combinations are selected for detailed design and analysis. The HSM design load combinations and the appropriate load factors are presented in Table 3.2-3. The effects of duty cycle on the HSM are considered and found to have negligible effect on the design. The corresponding structural design criteria and load combination methodology for the DSC support structure are summarized in Table 3.2-5 and Table 3.2-7 [3.21]. The HSM load combination results are presented in Section 8.3.5.

3.2.5.2 Dry Shielded Canister

The DSC shell and closure plates are designed by analysis to meet the allowables of the ASME Boiler and Pressure Vessel Code [3.20] Section III, Division l, Subsection NB. The DSC shell and closure plates are conservatively designed utilizing linear elastic or non-linear elastic-plastic analysis methods. The load combinations considered for the DSC shell and closure plates normal, off-normal and postulated accident loadings are shown in Table 3.2-4. ASME Code Service Level A and B allowables are conservatively used for normal and off-normal operating conditions. Service Level C and D allowables are used for accident conditions such as a postulated cask drop accident. Using this acceptance criteria ensures that, in the event of a design basis drop accident, the confinement boundary will not be breached. The maximum shear stress theory is used to calculate principal stresses. Normal operational stresses are combined with the appropriate off-normal and accident stresses. It is assumed that only one postulated accident condition occurs at any one time. The accident analyses are documented in Section 8.2. The structural design criteria for the DSC shell and closure plates are summarized in Table 3.2-6. The effects of fatigue on the DSC shell and closure plates due to thermal and pressure cycling are addressed in Section 8.3.

The internal support structure is designed to maintain its geometric arrangement for normal operating events. There are no design requirements for the internal structure for postulated accident events. The DSC internal support structure is not required to maintain criticality control of the TMI-2 canisters.

Table 3.2-1

Summary of INEEL TMI-2 ISFSI Storage Component Design Loadings

Component	Design Load Type	SAR Section Reference	Design Parameters	Applicable Codes
Horizontal Storage Module:	---	---	---	ACI 349-85 and ACI 349R-85 (design) ACI 318-95 (construction only)
	Design Basis Tornado	3.2.1	Max. wind pressure : 123 psf Max. speed: 200 mph	NRC Reg. Guide 1.76, Region III and ANSI A58.1 1982
	DBT Missile	3.2.1	Max. speed: 70 mph Types: 1800 Kg automobile 276 lbs artillery shell	NUREG-0800, Section 3.5.1.4
	Flood	3.2.2	There are no flood loads since HSMs are above flood plain	10 CFR 72.122(b)
	Seismic	3.2.3	Horizontal free field zpa: 0.36g (both directions) Vertical free field zpa:0.24g	NRC Reg. Guides 1.60 and 1.61
	Snow and Ice	3.2.4	Maximum load: 30 psf (included in live loads)	ANSI A58.1-1982
	Dead Loads	8.1.1.5	Dead weight including loaded DSC (concrete density of 150 pcf assumed)	ANSI 57.9-1984
	Normal and Off-normal Operating Temperatures	8.1.1.5	DSC with spent fuel rejecting 860 W of decay heat. Normal ambient temperatures: -20°F to 87°F; 67 Btu/hr-ft^2 solar insolation. Off-normal ambient temperatures: -50°F to 103°F; 105 Btu/hr-ft^2 solar insolation.	ANSI 57.9-1984

Table 3.2-1
Summary of INEEL TMI-2 ISFSI Storage Component Design Loadings
(continued)

Component	Design Load Type	SAR Section Reference	Design Parameters	Applicable Codes
	Accident Condition Temperatures	8.2.7.2	Same as off-normal conditions	ANSI 57.9-1984
	Normal Handling Loads	8.1.1.1	Hydraulic ram load of 70,000 lb. (35,000 lb./rail)	ANSI 57.9-1984
	Off-normal Handling Loads	8.1.1.4	Hydraulic ram load of 70,000 lb. (70,000 applied to one rail)	ANSI 57.9-1984
	Live Loads	8.1.1.5	Design load: 130 psf (includes snow and ice loads)	ANSI 57.9-1984
	Fire and Explosions	3.3.6 8.2.9	Enveloped by other design basis events	10 CFR 72.122(c)
Dry Shielded Canister: [confinement boundary only]	---	---	---	ASME Code, Section III, Subsection NB, Class 1 Component
	Flood	3.2.2	There are no flood loads since HSMs are above flood plain	10 CFR 72.122(b)
	Seismic	3.2.2	Horizontal free field zpa: 0.36g Vertical free field zpa: 0.24g	NRC Reg. Guides 1.60 & 1.61
	Dead Loads	8.1.1.2	Weight of loaded DSC: 30,000-60,000 lb. enveloping	ANSI 57.9-1984
	Normal and Off-Normal Pressure	8.1.1.2	Enveloping internal pressure of > -14.7 psig, ≤15 psig	10 CFR 72.122(h)
	Test Pressure	8.1.1.2	Enveloping internal pressure of 22.5 psig.	10 CFR 72.122(h) and 10 CFR Part 71

Table 3.2-1
Summary of INEEL TMI-2 ISFSI Storage Component Design Loadings
(continued)

Component	Design Load Type	SAR Section Reference	Design Parameters	Applicable Codes
	Normal and Off-normal Operating Temperature	8.1.1.2, 8.1.2.2	DSC with spent fuel rejecting 860 W of decay heat. Normal ambient temperatures: -20°F to 87°F; 67 Btu/hr-ft^2 solar insolation. Off-normal ambient temperatures: -50°F to 103°F; 105 Btu/hr-ft^2 solar insolation.	ANSI 57.9-1984
	Normal Handling Loads	8.1.1.2	Hydraulic ram load of 70,000 lb.	ANSI 57.9-1984
	Off-normal Handling Loads	8.1.2.1	Hydraulic ram load of 70,000 lb.	ANSI-57.9-1984
	Accidental Cask Drop Loads	8.2.5	Equivalent static deceleration of 75g for vertical end drop and horizontal side drops, and 25g oblique corner drop	10 CFR 72.122(b)
	Accident Internal Pressure	8.2.7 8.2.9	Enveloping internal pressure of 15 psig	10 CFR 72.122(h)
Dry Shielded Canister Support Structure:	---	---	---	AISC Specification for Structural Steel Buildings
	Dead Weight	8.1.1.4	Loaded DSC plus self weight	ANSI-57.9-1984
	Seismic	3.2.3	DSC reaction loads with horizontal free field zpa of 0.36g and vertical free field zpa of 0.24g	NRC Reg. Guides 1.60 & 1.61

Table 3.2-1
Summary of INEEL TMI-2 ISFSI Storage Component Design Loadings
(continued)

Component	Design Load Type	SAR Section Reference	Design Parameters	Applicable Codes
	Normal Handling Loads	8.1.1.4	DSC reaction loads with hydraulic ram load of 70,000 lb. (35,000 lb./rail)	ANSI-57.9-1984
	Off-normal Handling Loads	8.1.1.4	DSC reaction loads with hydraulic ram load of 70,000 lb. (70,000 lb. in one rail)	ANSI-57.9-1984

Table 3.2-2

Design Pressures for Tornado Wind Loading

Wall ① Orientation	Velocity Pressure (psf)	Gust Response Factor	Max/Min Pressure Coefficient	Max/Min ② Design Pressure (psf)
North	94	1.32	+0.1.06	99
East	94	1.32	-0.92	-87
South	94	1.32	-0.66	-62
West	94	1.32	-0.92	-87
Roof	94	1.32	-0.92	-87

Notes:

1. Wind direction assumed to be from North. Wind loads for other directions may be found by rotating table values to desired wind direction. For example, if the wind was from the east, the design pressure would be 99 psf on the east wall, -62 psf on the west wall, and -87 psf on the roof, north, and south walls.
2. Negative values indicate suction pressure.

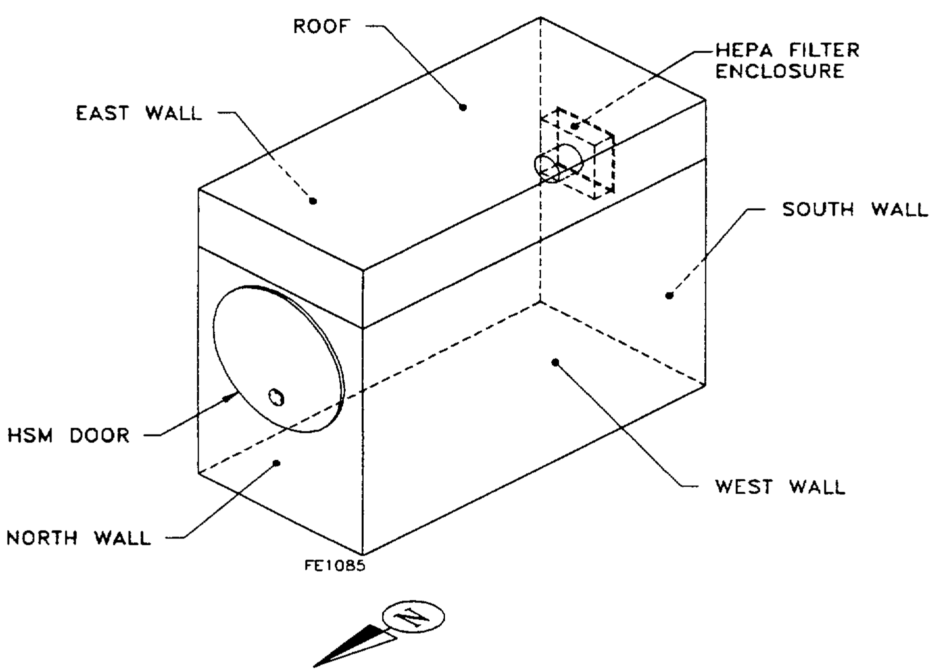

Table 3.2-2
HSM Ultimate Strength Reduction Factors

Type of Stress	Reduction Factor
Flexure	0.9
Axial Tension	0.9
Axial Compression	0.7
Shear	0.85
Torsion	0.85
Bearing	0.7

Table 3.2-3
HSM Load Combination Methodology

Case No.	Load Combination[1]	Loading Notation
1	$1.4D + 1.7L$	D = Dead Weight[2]
2	$1.4D + 1.7L + 1.7R_o$	E = Earthquake Load
3	$0.75\ (1.4D + 1.7L + 1.7T + 1.7W)$	R_o and R_a = Normal and Off-normal Handling Loads.
4	$0.75\ (1.4D + 1.7L + 1.7T)$	
5	$D + L + T_o + E$	L = Live Load[3]
6	$D + L + T_o + W_t$	T_o and T_a = Normal, Off-normal or Accident Condition Thermal Load
7	$D + L + R_a + T_a$	Wt = Tornado Generated Wind Load[4] W = Wind Load

---

(1) The HSM load combinations are in accordance with ANSI-57.9-1984. The effect of creep and shrinkage are included in dead weight load for Cases 2 through 7.

(2) Dead loads (D) are evaluated for ±5% to simulate most adverse loading.

(3) Live loads (L) are varied between 0 and 100% of design load to simulate most adverse conditions for the HSM.

(4) Design Basis Tornado loads include wind pressure, differential pressure, and missile loads. Missile loads are additive to wind pressure and other loads. Local damage is permitted at the point of impact if there is no loss of intended function on any structure important to safety.

Table 3.2-4
DSC Shell and Closure Plates Load Combinations and Service Levels

Load Case		Test Condi-tions (3)	Normal Operating Conditions				Off-Normal Conditions				Accident Conditions							
			A1	A2	A3	A4	B1	B2	B3	B4	D1	D2	C1	C2	C3	C4	C5	C6
Dead Weight	Vertical, DSC Empty		X															
	Vertical, DSC w/Fuel			X														
	Horizontal, DSC w/Fuel	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Thermal	Inside HSM: -20° to 87°F					X							X	X	X		X	
	Inside Cask: -20° to 87°F			X	X		X		X			X						X
	Inside HSM: -50° to 103°°F	X						X		X						X		
	Inside Cask: -50°F to 103°°F										X							
Internal Pressure	Normal Pressure			X	X		X							X				
	Off-Normal Pressure					X		X	X	X								
	Accident Pressure										X	X	X(2)		X(2)	X(3)	X(2)	X(2)
	Test Pressure	X																
Handling Loads	Normal DSC Transfer				X	X									X			
	Jammed DSC Loads						X	X	X								X	X
Cask Drop (end, side, or corner drop)												X						
Seismic													X					
Flooding														X				
ASME Code Service Level		(1)	A	A	A	A	B	B	B	B	D	D	C	C	C	C	C	C

NOTES:

1. The stress limits of NB-3226 apply.
2. Accident pressure for Service Level C condition is applied to inner closure plates. Accident pressures on the outer closure plates are evaluated for Service Level D allowables.
3. Test conditions include pressure during ASME Code hydrostatic test.

Table 3.2-5
DSC Support Structure Load Combination Methodology

Allowable Stress (S)[4]	
Case No.	Load Combination[1]
1	$S > D$[2] $+ L$[3]
2	$S > D + L + R_o$
3	$1.33S > D + L + W$
4	$1.5S > D + L + T + W$
5	$1.33S > D + L + T + R_a$
6	$1.6S > D + L + T_o + E$
7	$1.33S > D + L + R_a + T_a$

---

(1) Load combinations are per ANSI 57.. For definitions of loads see Table 3.2-4.

(2) Dead load (D) includes weight of loaded DSC and is increased +5% to simulate most adverse loading.

(3) Live load is varied 0 - 100% to obtain critical section.

(4) Maximum shear stress allowable is limited to 1.4 S.

Table 3.2-6
Structural Design Criteria for DSC

	Stress Type	Stress Values[1]		
		Service Levels A & B	Service Level C	Service Level D
DSC[2] Shell & Closure Plates	Primary Membrane	S_m	Greater of 1.2 S_m or S_y	Smaller of 2.4 S_m or 0.7 S_u
	Primary Membrane + Bending	1.5 S_m	Smaller of 1.8 S_m or 1.5 S_y	Smaller of 3.6 S_m or S_u
	Primary + Secondary	3.0 S_m	N/A	N/A
DSC Fillet Welds	Primary	0.50 S_m	Greater of 0.65 S_m or 0.50 S_y	Smaller of 1.2 S_m or 0.35 S_u
	Primary + Secondary	0.75 S_m	Smaller of 0.9 S_m or 0.75 S_y	N/A

(1) Values of S_y, S_m, and S_u versus temperature are given in Table 8.1-3.

(2) Includes full penetration volumetrically inspected welds.

Table 3.2-7
Structural Design Criteria for DSC Support Structure

Allowable Stress (S)	
Stress Type	Stress Value[1]
Tensile	0.60 S_y[2]
Compressive	(See Note 2)
Bending	0.60 S_y[3]
Shear	0.40 S_y[4]
Interaction	(See Note 5)

(1) Values of S_y versus temperature are given in Table 8.1-3.

(2) Equations E2-1 or E2-2 of the AISC Specification [3.13] are used as appropriate.

(3) If the requirements of Paragraph F1.1 are met, an allowable bending stress of 0.6 S_y is used.

(4) Maximum allowable shear stress for Cases 4 to 7 is limited to 1.4S (0.56 S_y)

(5) Interaction equations per the AISC Specification are used as appropriate [3.21].

3.3 Safety Protection System

3.3.1 General

The NUHOMS®-12T system is designed for safe and secure, long-term confinement and dry storage of the TMI-2 canisters. The storage components, structures, and equipment which are designed to assure that this safety objective is met are shown in Table 3.3-1. The key elements of the NUHOMS®-12T system and its operations which require special design consideration are:

A. Double closure seal welds on the DSC shell form a confinement boundary.

B. Personnel radiation exposure minimized during DSC loading, closure, and transfer operations.

C. Design of the DSC for postulated accidents.

D. Design of the HSM passive heat removal system for effective decay heat removal to prevent further degradation of the TMI-2 core debris.

E. Passive vent system to remove hydrogen and oxygen gases that are generated as a result of radiolysis.

These items are addressed in the following subsections.

3.3.2 Protection by Multiple Confinement Barriers and Systems

3.3.2.1 Confinement Barriers and Systems

The radioactive material which the INEEL TMI-2 ISFSI confines is TMI-2 core debris and the associated contaminated materials. These radioactive materials are confined by the multiple barriers listed in Table 3.3-1.

During fuel loading operations at the TAN Hot Shop, the transportation cask is lifted from the transport skid, transferred to the turning skid, and then uprighted. The cask is then transferred to the work stand, the DSC is installed into the cask, and the previously dried TMI-2 canisters are placed into the cask/DSC. This operation assures that the exterior DSC surface loose contamination levels are within those required for shipping cask externals (see Section 3.3.7.1.2). Compliance with these contamination limits is assured by taking surface swipes of the upper (outside) end of the DSC while resting in the cask prior to cask closure.

Once inside the sealed DSC, the TMI-2 canisters are confined by the DSC shell and by multiple barriers at each end of the DSC. The cladding of TMI-2 fuel was severely damaged during the TMI-2 accident and thus, radioactive materials are not confined by fuel cladding. The TMI-2 canisters provide the first barrier for confinement of radioactive materials. The TMI-2 canisters have two small penetrations, a purge port and a fill port, which are left open during storage. The path that fuel debris must travel to get out of the canisters is not direct and the penetrations are such that the open penetrations do not compromise the canister confinement function. Additionally, the vent penetrations in the *fuel, knockout* and *filter* canisters are screened to various extents which helps prevent fuel particles from escaping the canisters. The DSC has a series of barriers to ensure the confinement of radioactive materials. The DSC cylindrical shell is fabricated from rolled steel plate which is joined with full penetration 100% radiographed welds. All top and bottom end closure welds are multiple-pass welds. This effectively eliminates pinhole leaks which might occur in a single pass weld, since the chance of pinholes being in alignment on successive weld passes is not credible. Furthermore, the DSC cover plates are sealed by separate, redundant closure welds. The DSC confinement boundary welds are examined as required by the Appendix A drawings using the acceptance criteria of the ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NB [3.20].

The *knockout* and *filter* canisters also have two larger ports (2" and 2-1/2" nominal) that were closed with expandable mechanical plugs. The plugs are designed to seal an opening by expanding a four-piece grip section and an elastomeric seal over a tapered mandrel by screwing a nut down the bolt stem of the mandrel. To secure the plugs against potential internal canister pressure, the nuts were tightened to a specified torque. The *debris* canisters have an elastomeric gasket between the canister body and the bolted head which allowed the water-tight seal necessary for the dewatering operation at TMI.

The elastomeric parts of the TMI-2 canisters that would form a part of the confinement barrier are rendered ineffective in the heated vacuum drying system. The loss of elastomeric parts in the *debris* canisters does not affect the confinement function because the lid remains in place and the path that fuel debris must travel to get out of the *debris* canisters is very small and still not direct. The loss of elastomeric parts in the *filter* and *knockout* canisters could cause the loss of the expandable mechanical plugs. Therefore, the confinement function of the expandable mechanical plugs will be supplemented by a mechanical closure (in other words, not welded) designed to be secured over the top of the larger ports (2" and 2-1/2" nominal).

DSC-02 was loaded with eight *filter* canisters before the functional effect on the expandable mechanical plugs due to the loss of the elastomeric parts was recognized. Because of the low radioactive material inventory in DSC-02, the remaining effectiveness of DSC-02 as a confinement barrier, and the lack of a credible driving force for the movement of radioactive material, the expandable mechanical plugs are not needed in TMI-2 canisters contained in DSC-02.

3.3.2.2 Ventilation - Offgas

No HSM cooling air vents are required to remove the decay heat since the decay heat generated by the TMI-2 fuel debris inside the DSC is low.

The DSC is vented to reduce the accumulation of gases generated due to radiolysis. A venting system is provided inside the HSM with access through the rear wall. The venting systems are depicted in Chapter 4 figures and the Appendix A drawings. The DSC cavity gases will vent through the HEPA filters into the HSM cavity which is in turn vented through holes provided in the rear access door. The ability to close off the vents and sample ahead of and behind the HEPA filters provides the capability to periodically monitor gas composition and rate of change. Although not anticipated, pressure build-up in the DSC and radioactive material release from the HSM can be checked. The design features and operation and maintenance procedures will assure that the system can be monitored, tested and purged (if necessary) during system operation.

3.3.3 Protection by Equipment and Instrumentation Selection

3.3.3.1 Equipment

The HSM and the DSC are the storage equipment which are important to safety. Other equipment associated with the INEEL TMI-2 ISFSI is required for handling operations at TAN, and utilized for transfer and transportation operations.

3.3.3.2 Instrumentation

The NUHOMS®-12T is a passive system, and no safety-related instrumentation is necessary. The maximum temperatures and pressures are conservatively bounded by analyses (see Section 8.1.3). Therefore, there is no need to monitor the internal cavity of the DSC for pressure or temperature during normal operations. The DSC is conservatively designed to perform its confinement function during all worst case normal, off-normal, and postulated accident conditions. The HSM is designed with no cooling vents and the concrete temperatures are conservatively enveloped by calculation. No temperature monitoring system is required to detect a blocked vent accident event or the presence of debris between adjacent HSMs.

3.3.4 Nuclear Criticality Safety

The NUHOMS®-12T system is designed to be subcritical under all credible conditions. Regulations specific to nuclear criticality safety of the cask system are contained in 10 CFR 72.124 and 72.236(c). Other pertinent regulations include 10 CFR 72.24(c)(3), and 72.236(g). Aside from DSC flooding, at least two unlikely, independent, and concurrent or sequential changes to the conditions essential to criticality safety must occur before an accidental criticality is possible. Criticality safety of the design is based on permanent fixed neutron-absorbing materials inside the TMI-2 canisters, drying the TMI-2 canisters before loading them into the DSCs and the prevention of water intrusion into the DSC. Criticality safety of the NUHOMS®-12T system does not rely on the use of burnup credit, the use of burnable neutron absorbers, or more than 75 percent credit for fixed neutron absorbers. Loading operations are done after all free liquid water has been removed from the individual TMI-2 canisters and with a dry DSC. Unloading operations would be performed in a dry environment without submerging the DSC in water.

The DSC and TMI-2 canisters are designed to ensure nuclear criticality safety during worst case dry loading operations. Design measures are taken to exclude the possibility of flooding the DSC cavity during the transfer operations and storage period. Prior to the loading operations, the TMI-2 canisters are vacuum dried. The DSCs are located in the HSMs above the level of the design basis flood. Multiple barriers prevent direct impingement of externally applied water on the vent system openings. The thermal reservoir of the massive concrete HSM and steel DSC is not readily affected by daily temperature variations. Changes can occur in the water content inside the DSC and the TMI-2 canisters due to atmospheric moisture. An evaluation [3.29] shows, however, that over a 40 year storage period, using very conservative assumptions, a small amount of water can be acquired from the atmosphere in each TMI-2 canister. This amount was taken into account in canister drying acceptance criteria so that criticality safety would not be compromised over time in storage. The cask and HSM are designed to provide adequate drop and/or missile protection for the DSC and the TMI-2 canisters are designed to maintain the fuel configuration after a drop accident. There is no credible accident scenario which would result in the possibility of water intrusion into the DSC. Chapter 2 addresses the ISFSI flood level and demonstrates that flood water intrusion during vented storage is not credible.

Control methods for the prevention of criticality for the DSC consist of the material properties of the fuel, the geometric confinement of the fuel within the TMI-2 canisters, and the inherent neutron absorption in the steel components of the TMI-2 canister structures.

3.3.4.1 Original Criticality Evaluation

The original criticality safety analysis for the system is presented in sections 3.3.4.1 and 3.3.4.2. A second criticality safety evaluation [3.30] is presented in section 3.3.4.3. The second criticality evaluation was performed to account for readsorbed atmospheric water and bound water.

The key factors and assumptions to be used in the original criticality safety analysis are as follows:

1. Moderator is water at a density of 8.8E-5 grams/cc (corresponding to saturated air at 120°F at 14.7 psia) and an additional amount of hydrogen equivalent to 100% volume fraction hydrogen gas at standard temperature and pressure.

2. The geometry of the TMI-2 canister shells is maintained and the fuel is confined within the TMI-2 canisters.

3. The TMI-2 canisters contain fixed poisons.

Because of the administrative controls placed on transportation of the DSC from TAN to INTEC (Appendix E), there is no credible event that could lead to a cask drop accident during the 10 CFR 72 transport and transfer operations. In addition, there is no credible event whereby the DSC could be accidentally flooded with water during transport and transfer operations. Since moderator intrusion due to precipitation or flooding during storage is prevented and not considered credible, subcriticality of the DSC is assured during storage at the ISFSI.

3.3.4.1.1 Reactivity Equivalence and Criticality Analysis Methods

A. Computer Code Description

The Criticality Safety Analysis Sequence No. 2X (CSAS2X) included in the SCALE-4.3 [3.22] package of codes was used for the criticality evaluation.

B. Computer Code Application

The SCALE-4.3 package is an extensive computer package which has many applications, including cross-section processing, criticality studies, and heat transfer analyses. The package is comprised of many functional modules which can be run independently of each other. Control Modules were created to combine certain function modules in order to make the input requirements less complex and shorter. For this evaluation, only four functional modules and one control module were used. This included the Control Module CSAS2X which utilizes the criticality code KENO-V.a and the preprocessing codes BONAMI-S, NITAWL-II, and XSDRNPM-S. The 44 group ENDF/B-V cross-section library was used for this evaluation. KENO V.a, in conjunction with the 44 group ENDF/B-V cross-section library of nuclear cross-section data, was used to calculate the multiplication factor, k_{eff}, of the NUHOMS®-12T ISFSI. KENO V.a utilizes a three-dimensional Monte-Carlo computation scheme. The preprocessing codes used for this evaluation are the functional modules BONAMI-S, NITAWL-II, and XSDRNPM-S. They are consolidated into the control module CSAS2X. BONAMI-S has the function of performing Bondarenko calculations for resonance self-shielding. The cross-sections and Bondarenko factor data are pulled from an AMPX master library. The output is placed into a master library as well. Dancoff approximations allow for different fuel lattice cell geometries. The main function of NITAWL-II is to change the format of the master cross-section libraries to one which the criticality code can access. It also provides the Nordheim Integral Treatment for resonance self-shielding. XSDRNPM-S is a discrete-ordinates code which solves the one-dimensional Boltzmann equation. XSDRNPM-S is also used to collapse cross-sections, do shielding analysis, and produce bias factors for

Monte-Carlo shielding calculations. The main function of XSDRNPM-S in this evaluation is to weight the fuel lattice cells in order to be able to smear the fuel region over a large area in a complex geometry.

3.3.4.2 Criticality Evaluation

This section presents the analyses which demonstrate the acceptability of storing TMI-2 canisters in the DSC under normal fuel loading, handling, and storage conditions. A nominal case model is described and a neutron multiplication factor, k_{eff}, presented. Uncertainties are addressed and applied to the nominal calculated k_{eff} value. The final k_{eff} value produced represents a maximum with a 95 percent probability at a 95 percent confidence level.

A. Basic Assumptions

The methodology and assumptions used for this evaluation are extremely conservative and bounding. While no credit can be taken for the magnitude of conservatism, it should be noted that bounding methods and assumptions are used when definitive data is not available for the payload. The most reactive TMI-2 canister is present in 12 locations in the models. This was done to avoid administrative controls on the loading of the DSCs and to simplify the computer models. This evaluation is done once for normal, off-normal, and accident conditions using the accident conditions. During accident conditions the DSC basket is assumed to fail, that is, it completely disappears from the model. The poison structures in the *knockout* canisters are displaced the maximum credible amount, one inch. The poison tube and internals of the *filter* canister are compressed and pushed to one side of the canister shell. The filter elements are assumed to disappear from the model. The *fuel* canister does not experience any deformation or displacement of the poison shroud during accident conditions. The following assumptions are used in the DSC criticality evaluation:

1. Batch 3 fresh fuel only (2.98w/o uranium-235).

2. Enrichment: batch 3 average + 2σ.

3. No cladding or core structural material.

4. No soluble poison or control materials from the core.

5. Fuel lump is whole fuel pellets for *knockout* and *fuel* canisters.

6. Fuel lump is 850 microns for *filter* canister.

7. Fuel is UO_2 and no credit is taken for degradation to less dense oxides.

8. Moderator is water at a density of 8.8E-5 grams/cc (corresponding to saturated air at 120°F at 14.7 psia) and additional hydrogen equivalent to 100% volume fraction hydrogen gas at standard temperature and pressure.

9. Fuel pitch is minimized for triangular pitch columns of cylindrical fuel pellets.

10. Canister fuel regions are filled to theoretical maximum capacity without weight restrictions.

11. Fuel is smeared to fill all volume available in the fuel regions.

12. Fixed poison concentrations are 75% of minimum specified during original fabrication of poison components.

B. Fuel Modeling Techniques

As discussed previously, there are three types of TMI-2 canisters: *fuel*, *knockout*, and *filter*. For criticality calculations, each canister type was assumed to carry its most reactive possible payload; close packed whole fuel pellets when moderatored with 8.8E-5 gram/cc of water. The entire region inside the TMI-2 canisters which could contain fuel is modeled as pure fuel moderator mix without any non-fissile material. As such, the mass of fuel exceeds the maximum payload measured in any of the TMI-2 canisters. Maximum fuel particle size in the *fuel* and *knockout* canisters is limited to whole pellets, [0.375 inches in diameter and 0.50 inches long]. The *filter* canisters were designed and used such that particle size in the canister is limited to the range of 0.5 to 800 microns [3.19]. As such, the maximum particle size modeled in the *filter* canisters is 850 microns [3.4]. Fuel is assumed to be of the maximum enrichment in the TMI-2 core, 2.98w/o uranium-235. The 2.98w/o uranium-235 includes a factor of 2-sigma added to the batch 3 (highest) average enrichment. No credit is taken for irradiation of the fuel. The material is assumed to consist of pure uranium-dioxide at a density of 10.0 grams/cc. Fuel has been modeled as cylindrical stacks of pellets in a triangular pitch. The triangular pitch generally provides a slightly more reactive fuel region than a square pitch. The fuel region moderator in the HSM and cask models includes the addition of hydrogen equivalent to 100% hydrogen gas at standard temperature and pressure to the 8.8E-5 gram/cc water.

C. TMI-2 Canisters and DSC Models Input

The *fuel* canister is a receptacle for large pieces of core debris that were picked up by the grapple and placed in the canister. An internal shroud controls the size of the internal cavity and provides a means of encapsulating the neutron absorbing material used for criticality control. As part of the debris vacuum system, the *knockout* canister separates the medium size debris from the water by reducing the flow velocities, thereby allowing the particles to settle out. An internal screen helps retain all but the very small fines in the canister. An array of four rods around a central rod, all containing boron carbide (B_4C) pellets is included for criticality control. To remove very small fines, the *filter* canister utilizes filter elements fabricated from a stainless steel media. These elements are joined together to form a filter bundle permitting a flow rate up to 125 gpm while filtering out particles as small as 0.5 microns. A center rod containing B_4C pellets ensures that the canister contents remain subcritical. The drawings provided in Appendix A give detailed dimensions of the canisters.

The canister models used for the criticality evaluation are very simple and use nominal dimensions. No attempt has been made to address the many simplifications contained in the canister models since the results of the evaluation are well below the accepted regulatory margin. The bounding normal and/or accident conditions have been used in the evaluation such that only a single geometry for each canister is used.

The *fuel* canister model has constant cross-sectional configuration throughout the length of the 150 inch canister. The *fuel* canister is made up of six concentrically arranged regions. The center region is the fuel region modeled as a cuboid. Seventy-five percent of the minimum concentration of boron originally specified in the poison material is used in the model.

The *knockout* canister model has constant cross-sectional configuration throughout the length of the 150 inch canister. The poison tubes have been displaced one inch to bound the drop testing results [3.18]. Seventy-five percent of the minimum concentration of boron originally specified is used in the canister model. There is no change in the TMI-2 canister shell diameter due to a drop accident.

The *filter* canister model has a constant cross-section. The canister internals were slumped to one side since drop testing was not performed on the *filter* canister. Again, no increase in shell diameter was modeled. The DSC model is simplified as a cylinder with shield plugs and end covers. The basket and vent and purge assemblies are not modeled. The 12 TMI-2 canisters are triangular pitch, close packed. The cask model is relatively complete, except for impact limiters which are not modeled. No changes were made to the DSC model or the HSM model. The HSM is simplified to include only the significant features of the structure: a cylindrical, two foot thick shell of concrete and two foot thick end slabs.

The input decks for the three types of TMI-2 canister, a DSC loaded with 12 *knockout* canisters in the MP187, and a DSC loaded with 12 *knockout* canisters in an HSM have been provided in Appendix D of this SAR.

D. <u>Atom Number Densities</u>

Most atom number densities were calculated by the material information processor (MIP) contained in SCALE-4.3. The data for the preprocessing is controlled entirely by the

MIP. It requires data to specify the cross-section library, the composition of each mixture, and the geometry of the fuel unit cell. For the purpose of this calculation, the compositions of the mixtures are specified by either volume percentage of a mixture (such as the concrete in the *fuel* canister) or by atomic density (a/b-cm) based on the values reported in the 125-B SAR [3.20]. Where the number densities were calculated by the MIP, they are taken from a typical CSAS2X output and repeated in Table 3.3-2 for completeness.

The minimum B-10 surface density in the borated aluminum contained in the *fuel* canisters was specified such that the mean of the test samples from the production run would be a minimum of 0.040gm/cm^2 at a 95/95% confidence level giving at least a 2σ margin [3.18]. A minimum B_4C density equivalent to 1.45 gm/cc at 73w/o boron having 18.34w/o Boron-10 was specified for the poison tubes in the *knockout* canister [3.18]. The atomic number densities for the Boron-10 in the borated aluminum and B_4C were conservatively taken to be 75% of the values used in Reference 3.20. The atomic number densities for the low density concrete (LDC) contained in the *fuel* canisters is based on the fabrication data provided on the Reference 3.21 drawing. The mist moderator density is calculated based on the water content of 100% humid air at 120° Fahrenheit at 1 atmosphere pressure and the atom density for hydrogen gas was taken from Reference 3.25. The fuel atomic number densities are calculated by the MIP based on actual UO_2 density of 10.0 grams/cc [3.21][3.28] and a theoretical density of 10.98 grams/cc [3.23]. The volume fraction of the fuel is simply the ratio of the actual density to the theoretical density. The MIP then calculates atomic number densities based on the weight percentages supplied (2.98w/o Uranium-235). The atomic number densities for the neutron shield material were taken from Reference 3.24. It should be noted that the boron carbide added to the shielding material was conservatively not accounted for in the calculations.

E. Benchmark Comparisons

The bias and uncertainty methodology applied in the calculation of the DSC final k_{eff} result is based on CSAS2X/44 group ENDF/B-V calculated results for the set of 19 critical experiments summarized in Table 3.3-3. A representative number of the benchmark experiments include stainless steel separating materials and are very similar to the DSC conditions. The inclusion of benchmark systems which differ from DSC conditions in some respects, such as separating materials, is justified by inspection of the Table 3.3-3 k_{eff} results which do not indicate any significant trends. The calculated k_{eff} results for the group of experiments analyzed demonstrates the calculational accuracy of the method under a variety of conditions, including those representative of the NUHOMS®-12T system.

The benchmark cases are generally representative of the cask and fuel features and parameters that are important to reactivity. The 44 Group ENDF/B-V and CSAS2X using the same modeling techniques used for the modeling contained in this calculation result in a maximum negative bias ($-\Delta k_b$) of 0.00762, including 2σ. This bias is to be added to the maximum system multiplication factor.

F. Additional Bias and Uncertainties and Determination of Worst-Case Maximum k_{eff}

The results of the three types of TMI-2 canisters indicate that the *knockout* canister is the most reactive. Parametric studies were not performed for fabrication tolerances in the TMI-2 canisters or the DSC. Many rough estimates and assumptions were used in the models, however, the overall models are very conservative and the results indicate a very large safety margin. Uncertainty in the results due to simplifications and use of nominal dimensions is addressed by adding a very large factor of 0.05 to the system reactivity results. The worst case loading of 12 *knockout* canisters was modeled in the MP187 and a simple approximation of an HSM and gave results of 0.54881 ± 0.00062 and 0.54051 ± 0.00082, respectively. With the code bias, 2σ (for the worst case model) and the 0.05 factor for modeling uncertainties, the resulting maximum system multiplication factor is 0.60005.

G. Analysis Results

The multiplication factor (k_{eff}), including all biases and uncertainties at a 95 percent confidence level, does not exceed 0.95 under all credible normal, off-normal, and accident conditions. The NUHOMS®-12T system is designed with the fundamental criterion that the DSC will not be flooded. This is achieved, in part, by locating the bottom of the DSC above the design flood elevation of 4917'. Aside from DSC flooding, at least two unlikely, independent, and concurrent or sequential changes to the conditions essential to criticality safety must occur before an accidental criticality is possible. Criticality safety of the design is based on favorable geometry, permanent fixed neutron-absorbing materials, and the prevention of water ingress into the system. Criticality safety of the system does not rely on the use of burnup credit, the use of burnable neutron absorbers, or more than 75 percent credit for fixed neutron absorbers.

The most reactive canister type for a bounding evaluation of the NUHOMS®-12T ISFSI is the *knockout* canister. The maximum system multiplication factor including all biases and uncertainties at a 95 percent confidence level, is 0.60767 under all credible normal, off-normal, and accident conditions.

3.3.4.3 Second Criticality Safety Evaluation

In an attempt to improve the demonstration that the water parameter in the fuel matrix is bounded, two evaluations were provided to identify conservative values of water from two sources: (1) retention of physically or chemically adsorbed water during the drying process (such water can have a very low equilibrium pertial pressure at elevated temperatures) and (2) readsorption of atmospheric water vapor over the 40 year storage period.

The key factor and assumption used in the secondary criticality safety analysis is that the geometry of the TMI-2 canister shells is maintained and the fuel is confined within the TMI-2 canisters.

3.3.4.3.1 Reactivity Equivalence and Criticality Analysis Methods

A. Computer Code Description

Calculations were performed using the three-dimensional Monte Carlo code KENO V.a which is part of the SCALE-4 modular code system. All calculations were performed on an HP workstation operating under HP-UX with Version 9.05 of the Fortran compiler. Configuration Release 1.10 of the SCALE-4.0 code system and the associated 27-energy-group ENDF/B Version 4 cross-sections were used to evaluate the KENO V.a models. SCALE 4.0 was used in the analysis because of a problem in SCALE 4.3 which doubles the k_{eff} calculation in KENO V.a when using an ICE mixed AMPX format working library. The problem with SCALE 4.3 did not affect the original evaluation. NRC Information Notice 91-26 identifies problems with "working-format" libraries distributed with the SCALE 4.0 package. Since the analysis did not use a working-format library, and since SCALE 4.0 and the 27 energy group cross-sections were benchmarked by comparison to experimental data, the use of SCALE 4.0 is not an issue.

B. Computer Code Application

The fuel models use cell weighting of the cross-sections to describe the fuel region. The SCALE code functional module XSDRNPM was used to create homogeneous cell-weighted cross sections, which have the characteristics of heterogeneous cells. For low-enriched fuels, it is more conservative to model the fuel as heterogeneous rather than homogeneous. The cell-weighted cross sections are calculated from two materials; the fuel and the moderator, and two dimensions; the fuel diameter and pitch. The SCALE functional modules WAX and ICE are used when multiple cell-weighted fuel regions are needed.

3.3.4.4 Criticality Evaluation

This section presents the analyses that demonstrate the acceptability of storing TMI-2 canisters in the DSC under normal fuel loading, handling, and storage conditions. A nominal case model is described and a neutron multiplication factor, k_{eff}, presented. Uncertainties are addressed and applied to the nominal calculated k_{eff} value. The final k_{eff} value produced represents a maximum with a 95 percent probability at a 95 percent confidence level.

A. Basic Assumptions

The methodology and assumptions used for this evaluation are extremely conservative and bounding. Bounding methods and assumptions were used when definitive data was not available for the payload. The most reactive TMI-2 canister is present in 12 locations in the models. This was done to avoid administrative controls on the loading of the DSCs and to simplify the computer models. During accident conditions the DSC basket is assumed to fail. The poison structures in the canisters are modeled in the nominal position, but filled with water instead of boron carbide. The following assumptions are used in the DSC criticality evaluation:

1. Batch 3 fresh fuel only (2.98wt/% uranium-235).
2. Enrichment: batch 3 average + 2σ.
3. No cladding or core structural material.
4. No soluble poison or control materials from the core.
5. Fuel lump is a whole fuel pellet.
6. *Filter* canisters are enveloped by *knockout* canisters.
7. Fuel is UO_2 and no credit is taken for degradation to less dense oxides.
8. Canister fuel regions are filled with 1908 lb of UO2, which is the maximum reported canister payload.
9. Fuel is smeared to fill all volume available in the fuel regions.
10. Water and fuel are modeled at the top of the canisters, rather than at the bottom or sides (the nominal canister configuration), since this produces more conservative results.

B. Fuel Modeling Techniques

As discussed previously, there are three types of TMI-2 canisters: *fuel*, *knockout*, and *filter*. For criticality calculations, a knockout canister containing 1908 lbs of UO_2 was modeled to envelope all canister types. The entire region inside the TMI-2 canisters that could contain fuel is modeled as pure fuel moderator mix without any non-fissile material. Fuel is assumed to be of the maximum enrichment in the TMI-2 core, 2.98wt/% uranium-235. The 2.98wt/% uranium-235 includes a factor of 2-sigma added to the batch

3 (highest) average enrichment. No credit is taken for irradiation of the fuel. The material is assumed to consist of pure uranium-dioxide at a density of 10.1 grams/cc. Fuel has been modeled as cylindrical stacks of pellets in a triangular pitch. The triangular pitch generally provides a slightly more reactive fuel region than a square pitch.

Calculations were performed to find the optimal fuel pellet diameter, optimal fuel pitch, optimal moderation between fuel pellets, and optimal moderation between canisters. The optimal fuel pellet diameter was found to be between 0.939 and 1.878 cm. Thus, the nominal pellet diameter (0.939 cm) was used in the calculations as the most reactive. The optimal fuel pitch was found to be between 1.3 and 1.45 cm. The optimal water density between pellets was found to be full density water. It was found during this process that the most conservative model was one in which all of the water inside the canisters was modeled in the top part of the canister, and the remaining fuel was modeled with no interspersed moderation. Thus, the fuel was modeled in a "wet region" and a "dry region." In the wet region, the fuel was modeled with the optimal pitch and full density water between rods. In the dry region, the fuel was modeled touching, with void between the rods. The optimal moderation between canisters was found to be in the range of 0.4 to 1.0 water volume fraction.

In most cases, the boron columns in the canisters were modeled as full density water. Using this conservatism, a limit of 8.0 liters of water per canister was established. A comparison was also made in which 75% of the boron was modeled in the poison columns of each canister. In this case, the canisters would be limited to containing just over 14.0 liters of water per canister. There was no difference in the reactivity when the canisters were filled entirely with fuel. The water limit applies to bound water (water that cannot migrate in the TMI-2 canisters at worst case storage conditions), unbound (or free) water, and water re-acquired from the atmosphere.

C. TMI-2 Canisters and DSC Models Input

The canister models used for the criticality evaluation are very simple and use nominal dimensions. The *knockout* canister model has constant cross-sectional configuration throughout the length of the 150 inch canister. The poison tubes were modeled in the nominal positions. The boron was replaced with full density water in most calculations. There is no change in the TMI-2 canister shell diameter due to a drop accident.

The HSM and DSC were modeled collapsed to fit tightly around the canister array. The HSM is simplified to be a 2-foot-thick reflector on all sides.

The input decks for a DSC loaded with 12 *knockout* canisters in an HSM have been provided in Appendix D of this SAR.

D. Atom Number Densities

Atom number densities were calculated by hand with the aid of a spreadsheet program. All calculated atom number densities were checked by an independent criticality safety analyst for consistency and correctness.

The fuel atomic number densities are calculated based on UO_2 density of 10.1 grams/cc.

E. Benchmark Comparisons

Benchmark experiments involving arrays of hydrogen moderated, low-enriched UO_2 rods were modeled to validate the SCALE 4.0 code. The TMI fuel modeled in the analysis had an H/X ratio of about 150, while the H/X ratio for the benchmark experiments ranged between 100 and 200. The largest deviation from unity was 0.7%, and therefore a 1% bias (0.01 Δk_{eff}) was conservatively added to all results in the analysis.

F. Additional Bias and Uncertainties and Determination of Worst-Case Maximum k_{eff}

The 1% bias added to the calculations (as discussed above) was judged to be sufficient, and thus no additional bias was added to the calculations. The models are very conservative. As stated above, the optimal fuel pellet diameter, optimal fuel pitch, optimal moderation between fuel pellets, and optimal moderation between canisters were used in the models. The worst case loading of 12 *knockout* canisters each containing 1908 lb of UO2 was modeled in the DSC inside an approximation of the HSM. The analysis calculated the maximum amount of water mixed with fuel inside of each TMI canister that would remain below the 0.95 criterion (including the 1% bias and two standard deviations of the statistical uncertainty (σ) associated with the calculations).

G. Analysis Results

The multiplication factor (k_{eff}), including all biases and uncertainties at a 95 percent confidence level, does not exceed 0.95 under all credible normal, off-normal, and accident conditions. The NUHOMS®-12T system is designed with the fundamental criterion that the DSC will not be flooded. This is achieved, in part, by locating the bottom of the DSC above the design flood elevation of 4917'. Aside from DSC flooding, at least two unlikely, independent, and concurrent or sequential changes to the conditions essential to criticality safety must occur before an accidental criticality is possible. Criticality safety of the design is based on favorable geometry, permanent fixed neutron-absorbing materials, and the prevention of water ingress into the system. Criticality safety of the system does not rely on the use of burnup credit, the use of burnable neutron absorbers, or credit for fixed neutron absorbers.

The most reactive canister type for a bounding evaluation of the NUHOMS®-12T ISFSI is the *knockout* canister. With 8.0 liters of water mixed with the fuel in each TMI canister, the maximum system multiplication factor including all biases and uncertainties at a 95 percent confidence level is 0.9235 under all credible normal, off-normal, and accident conditions. This model includes 1722 liters of water (the optimal amount) between the canisters inside the DSC.

3.3.4.4.1 Safety Criteria Compliance

This second criticality safety evaluation shows that significant amounts of moderator (water) can remain in the TMI-2 canisters without compromising criticality safety. Up to 8.0 L of water can be present in the fuel region of each TMI-2 canister and still have a k_{eff} less than 0.95. More moderator can be present as bound water if the water volume fraction is less than 0.3-0.4. Bound water in this sense is water that can not migrate in the fuel debris at the worst case assumed storage conditions. Christensen [3.31] provides the technical basis which shows that the water content of TMI-2 canisters in storage is less than allowed by this additional criticality safety evaluation, throughout the 40-year life of the ISFSI. This EDF also provides the acceptance criteria to be used to ensure that essentially all free water is removed during the heated vacuum drying process.

3.3.4.4.2 Off-Normal Conditions

Postulated off-normal conditions do not result in a system reactivity which exceeds the k_{eff} value calculated and presented in Section 3.3.4.1 through 3.3.4.4.

Additionally, off-normal conditions potentially resulting in reactivity increases over the normal conditions considered are addressed.

Even though small amounts of condensation could occur in the DSC during storage at INTEC, no mechanism exists which could cause an amount of condensation inside the DSC that would compromise criticality safety or exceed the criteria limiting k_{eff} of 0.95. The analyses presented in this SAR section demonstrate that the criteria limiting k_{eff} to 0.95 is satisfied under all postulated conditions for the system.

3.3.5 Radiological Protection

The TMI-2 ISFSI is designed to maintain on-site and off-site doses ALARA during transfer operations and long-term storage conditions. ISFSI operating procedures, shielding design, and access controls provide the necessary radiological protection to assure radiological exposures to station personnel and the public are ALARA. Further details on design considerations for radiation protection for on-site and off-site doses resulting from the TMI-2 ISFSI operations and the ISFSI ALARA evaluation are provided in Chapter 7.

3.3.5.1 Access Control

The INEEL TMI-2 ISFSI is located within the INEEL controlled area. The INEEL TMI-2 ISFSI Security Plan describes the remote sensing devices which are employed to detect unauthorized access to the ISFSI. In addition to the controlled access, an HSM access door may be tacked or fully welded in place after insertion of a loaded DSC. The HSM access door weighs approximately three tons and requires heavy equipment for removal. This ensures that there is ample time to respond to an unauthorized entry into the ISFSI before access can be gained to any radiological material. The vent system access door in the rear module wall is locked shut.

3.3.5.2 Shielding

For the NUHOMS®-12T system, shielding is provided by the HSM, cask, and shield plugs of the DSC. The HSM is designed to minimize the surface dose to limit occupational exposure and the dose at the ISFSI fence. Experience has confirmed that the dose rates for the HSM are extremely low. The cask and the DSC top shield plug are designed to limit the surface dose rates (gamma and neutron) ALARA. Temporary neutron shielding may be placed on the DSC shield plug and top cover plate during closure operations. Similarly, additional temporary shielding may be used to further reduce surface doses. Radiation zone maps of the HSM, cask, DSC surfaces and the area around these components are provided in Chapter 7.

3.3.5.3 Radiological Alarm Systems

There are no radiological alarms required for the INEEL TMI-2 ISFSI.

3.3.6 Fire and Explosion Protection

The ISFSI contains no permanent flammable material and the concrete and steel used for their fabrication can withstand any credible fire hazard. There is no fixed fire suppression system within the boundaries of the ISFSI. The facility is located such that the plant fire brigade can respond to any fire emergency using portable fire suppression equipment. Flammable materials that may be brought into the ISFSI on a temporary basis include fuel for necessary vehicles and construction materials. Use of non-flammable consumable materials will be emphasized. Administrative controls will be established to control any temporary fire loads within the boundary of the ISFSI.

Due to the positive drainage of the ISFSI approach slab, a fuel spill large enough to cause puddling would also tend to drain toward the east-west edge of the slab and away from the HSMs. This drainage, coupled with the expected rapid detection of any fire by the fuel transfer personnel will tend to limit the spread and severity of any fire. In addition, INEEL fire fighting assistance is available if required. The damage caused by any fire will be negligible given the massive nature of the casks. A spill too small to cause puddling would be very difficult to ignite due to the relatively high flash point of diesel fuel and, in any case, such a small fire would not pose a credible threat to the ISFSI.

ISFSI initiated explosions are not considered credible since no explosive materials are present in the DSCs other than hydrogen generated by radiolysis. Due to the low hydrogen concentrations which are available, only hydrogen deflagration could occur. However, an ignition source must be present to initiate deflagration. The system is designed without any known ignition sources present. Externally initiated explosions are considered to be bounded by the design basis tornado generated missile load analysis presented in Section 8.2.2. Analyses have been performed in compliance with 10 CFR 72.94 to confirm that no conditions exist near the ISFSI that would result in pressures due to off-site explosion or aircraft impact which would exceed those postulated herein for tornado missile or wind effects.

3.3.7 Materials Handling and Storage

3.3.7.1 TMI-2 Canister Handling and Storage

All TMI-2 canister handling, including placement into the DSC is governed by INEEL procedures. Subcriticality during storage is discussed in Section 3.3.4. The criterion for a safe configuration is an effective mean plus two-sigma neutron multiplication factor (k_{eff}) of 0.95. Section 3.3 calculations show that the expected k_{eff} value is below this limit.

3.3.7.1.1 Temperature Limits

The fuel rods stored in the TMI-2 fuel canisters are severely damaged. A majority of the cladding on the fuel rods was either melted during the accident, or was cut during dismantling of the core debris for storage in the TMI-2 canisters. Therefore, cladding temperature limits for this fuel are of little significance during storage. However, to prevent further fuel degradation, the cladding temperature limits in Reference 3.27 are applied to this fuel during storage.

The cladding temperature limits in Reference 3.27 are 724°F (384°C) for long term storage and 1058°F (570°C) for short term conditions. These limits are based on an inert atmosphere dry storage of intact fuel rods. TMI-2 fuel is stored in an air atmosphere, but the fuel temperatures calculated are significantly cooler. Therefore, further cladding degradation is not expected.

3.3.7.1.2 Surface Contamination Limits

DSC exterior contamination is minimized by preventing radioactive material from contacting the DSC exterior. This provides assurance that the DSC exterior surface has less residual contamination than required for shipping cask externals (Table V, 10 CFR 71.87(i)(1)). Surface swipes of the upper (outside) end of the DSC exterior will be taken after DSC closure, but prior to installing the cask lid to assure that the maximum DSC removable contamination does not exceed:

Beta/Gamma Emitters	22,000 dpm/100 cm^2
Alpha Emitters	2,200 dpm/100 cm^2

The cask external contamination is minimized by the use of smooth, easily decontaminated surface finishes to minimize personnel radiation exposures during cask handling operations at the TAN facility. 49 CFR 173.443(d) [3.17], which governs contamination levels for off-site shipment in a closed exclusive use vehicle, is used as a basis for the cask maximum removable contamination limits as:

Beta/Gamma Emitters	22,000 dpm/100 cm^2
Alpha Emitters	2,200 dpm/100 cm^2

Confinement of radioactive material associated with TMI-2 fuel debris is provided by the DSC steel shell, vent system and double seal welded inner and outer closures.

3.3.7.2 Radioactive Waste Treatment

Radioactive waste, such as HEPA grade filters that have been replaced as needed, is generated during the storage period for the DSC. Radioactive wastes generated during DSC loading operations (contaminated water from purging the DSC and potentially contaminated air and helium from the DSC cavity) are treated using existing systems and procedures as described in Chapter 6.

3.3.7.3 Waste Storage Facilities

The requirements for on-site waste storage are satisfied by existing INEEL facilities for handling and storage of radioactive waste and dry active wastes as described in Chapter 6.

3.3.8 Industrial and Chemical Safety

No hazardous chemicals or chemical reactions are involved in the NUHOMS®-12T system loading and storage operations. Industrial safety relating to handling of the cask and DSC are addressed by the INEEL industrial hygiene program which meets the Occupational Safety and Health Administration (OSHA) requirements.

Table 3.3-1

Radioactive Material Confinement Barriers for NUHOMS® System

Confinement Barriers and Systems

1. TMI-2 Canister

2. DSC Confinement Boundary (including vent system HEPA grade filters, DSC shell)

3. Top DSC Shield Plug

4. Top Shield Plug DSC Closure Weld

5. Top Cover Plate

6. Top Cover Plate Weld

7. Inner and Outer Bottom Cover Plates

8. Inner and Outer Bottom Cover Plate Welds

Table 3.3-2
Atomic Number Densities

Material	Density (g/cc)	Component	Atomic Number Density (barn-atoms/cc)
Type 304 Stainless Steel	7.92	Chromium	1.74286E-02
		Manganese	1.73633E-03
		Iron	5.93579E-02
		Nickel	7.72070E-03
Lead	11.344	Lead	3.29690E-02
Boron Carbide	1.35	Boron-10	9.525E-03
		Boron-11	5.08E-02
		Carbon	1.58E-02
Borated Aluminum	2.5	Boron-10	5.265E-03
		Boron-11	2.81E-02
		Aluminum	4.72E-02
Low Density Concrete	1.0	Hydrogen	1.93631E-02
		Oxygen	2.15365E-02
		Sodium	1.43800E-04
		Magnesium	3.58590E-05
		Aluminum	2.83850E-03
		Silicon	8.7196E-04
		Calcium	1.3101E-03
		Iron	1.3576E-05
"Mist" Moderator	8.8E-05	Hydrogen	5.88400E-06
		Oxygen	2.94200E-06
Hydrogen Gas (Radiolysis)	8.9E-05	Hydrogen	5.3E-05
Fuel	10.0	Uranium-235	6.71835E-04
		Uranium-238	2.15967E-02
		Oxygen	9.73434E-02
MP187 Neutron Shield Material	1.76	Oxygen	3.7793E-02
		Aluminum	7.0275E-03
		Carbon	8.2505-03
		Calcium	1.4835E-03
		Hydrogen	5.0996E-02
		Silicon	1.2680-03
		Iron	1.0628E-04
Carbon Steel	7.8212	Iron	8.34982E-02
		Carbon	3.92503E-03
Concrete	2.2994	Oxygen	3.55219E-02
		Hydrogen	8.50102E-03
		Iron	1.93013E-04
		Carbon	2.02171E-02
		Sodium	1.62991E-05
		Magnesium	1.86016E-03
		Aluminum	5.55805E-04
		Silicon	1.70002E-03
		Calcium	1.11006E-02
		Potassium	4.03004E-05

Table 3.3-3
Benchmark Critical Experiments

VECTRA Case. #	Enrich-ment (w/o)	Rod Pitch (mm)	Absorber Material	Absorber Thickness (mm)	Abs. to Cluster Distance (mm)	Reflector Material	Refl. to Cluster Distance (mm)	Critical Cluster Sep. (mm)	Series 3 K_{eff} ± 1 s
3	4.31	25.40	SS304	4.85	2.45	Moderator	N/A	85.8	0.99525 ± 0.00045
4	4.31	25.40	SS304	4.85	32.77	Moderator	N/A	96.5	0.99342 ± 0.00052
5	4.31	25.40	SS304	3.02	4.28	Moderator	N/A	92.2	0.99382 ± 0.00050
6	4.31	25.40	SS304	3.02	32.77	Moderator	N/A	97.6	0.99392 ± 0.00052
11	4.31	25.40	Boral	7.13	32.77	Moderator	N/A	67.2	0.99496 ± 0.00050
60	2.35	16.84	SS304	3.02	N/A	Steel	13.21	82.8	0.99740 ± 0.00046
62	2.35	16.84	Boral	2.92	N/A	Steel	13.21	26.9	0.99671 ± 0.00046
68	4.31	18.92	SS304	3.02	N/A	Steel	19.56	137.5	1.00231 ± 0.00054
70	4.31	18.92	Boral	2.92	N/A	Steel	19.56	83.0	1.00188 ± 0.00054
103	2.35	20.32	SS304	4.85	6.45	Moderator	N/A	68.8	0.99871 ± 0.00045
104	2.35	20.32	SS304	4.85	27.32	Moderator	N/A	76.4	0.99739 ± 0.00045
105	2.35	20.32	SS304	4.85	40.42	Moderator	N/A	75.1	0.99776 ± 0.00046
106	2.35	20.32	SS304	3.02	6.45	Moderator	N/A	74.2	0.99762 ± 0.00045
107	2.35	20.32	SS304	3.02	40.42	Moderator	N/A	77.6	0.99676 ± 0.00045
108	2.35	20.32	SS304	3.02	6.45	Moderator	N/A	104.4	0.99844 ± 0.00047
109	2.35	20.32	SS304	3.02	40.42	Moderator	N/A	114.7	0.99782 ± 0.00047
114	2.35	20.32	Boral	7.13	6.45	Moderator	N/A	63.4	0.99734 ± 0.00046
115	2.35	20.32	Boral	7.13	44.42	Moderator	N/A	90.3	0.99815 ± 0.00047
116	2.35	20.32	Boral	7.13	6.45	Moderator	N/A	50.5	0.99800 ± 0.00046

Intentionally Blank

3.4 Classification of Structures, Components, and Systems

Table 3.4-1 provides a list of major INEEL TMI-2 ISFSI components and their classifications. Components are classified in accordance with the criteria of 10 CFR Part 72 [3.2]. Structures, systems, and components classified as "important to safety" are defined in 10 CFR 72.3 as those features of the ISFSI whose function is:

1. To maintain the conditions required to store spent fuel safely,
2. To prevent damage to the spent fuel container during handling and storage, and
3. To provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

These criteria are applied to the INEEL TMI-2 ISFSI system components in determining their classification in the paragraphs which follow.

3.4.1 Dry Shielded Canister

The DSC provides shielding for and confinement of the radioactive materials. The DSC vent provides a diffusion path for hydrogen generated by radiolysis. Therefore, the DSC confinement boundary, which includes the vent system, is designed to remain intact, with no loss of function, under all accident conditions identified in Chapter 8. The DSC is designed, constructed, and tested in accordance with the quality assurance requirements for components "important to safety" as provided in 10 CFR 72.24(n) and 72.140(b) and described in Chapter 11. The welding materials required to make the closure welds on the DSC top shield plug and top cover plate are specified with the same ASME Code criteria as the DSC shell (Subsection NB, Class 1).

3.4.2 Horizontal Storage Module

The HSM is considered "important to safety" since it provides physical protection and shielding for the DSC during storage. The reinforced concrete HSM is designed in accordance with ACI 349-85. The level of testing, inspection, and documentation provided during construction and maintenance is in accordance with the quality assurance requirements provided in 10 CFR 72.140(b) and as described in Chapter 11.

3.4.3 ISFSI Basemat and Approach Slabs

The INEEL TMI-2 ISFSI basemat is classified as "not important to safety" because the HSMs are not anchored to the pad. Approach slabs are also classified as "not important to safety" and are designed, constructed, maintained, and tested as commercial grade items.

3.4.4 Transfer Equipment

3.4.4.1 Transport Cask and Cask Rigging

The MP-187 transportation cask is "important to safety" since it protects the DSC during handling and is part of the primary load path used while handling the DSC at TAN. The cask is designed, constructed, tested, and will be licensed in accordance with the requirements of 10 CFR Part 71 for a transportation cask. These criteria exceed the requirements of standard 10 CFR 72.140(b) for an "important to safety" transfer cask.

The rigging used for handling of the cask at the TAN facility is designed and will be procured under INEEL procedures and is not a part of the licensed activities addressed by this document.

3.4.4.2 Other Transfer Equipment

The NUHOMS®-12T transfer equipment (i.e., ram, skid, trailer) are necessary for the successful loading of the DSC into the HSM. However, the analyses described in Chapter 8 demonstrate that the performance of these items is not required to provide assurance that DSCs and the TMI-2 canisters can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public. Therefore, these components are classified as "not important to safety." These components are designed, constructed, and tested in accordance with accepted engineering practices.

3.4.5 Auxiliary Equipment

The vacuum drying system and the automated welding system are classified as "not important to safety." Performance of these items is not required to provide reasonable assurance that TMI-2 canisters can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public. Failure of any part of these systems may result in delay of operations, but will not result in a hazard to the public or operating personnel. Therefore, these components need not comply with the requirements of 10 CFR Part 72. These components are designed, constructed, and tested in accordance with accepted engineering practices.

Table 3.4-1
NUHOMS® Major Components and Safety Classification

Component		10 CFR Part 72 Classification
Dry Shielded Canister (DSC)		
	Basket Assembly	Not Important to Safety
	Shield Plugs	Important to Safety(1)
	DSC Shell	Important to Safety(1)
	Cover Plates	Important to Safety(1)
	Weld Filler Metal	Important to Safety(1)
	Vent System (including HEPAs)	Important to Safety(1)
Horizontal Storage Module (HSM)		
	Reinforced Concrete	Important to Safety(1)
	DSC Support Structure	Important to Safety(1)
ISFSI Basemat and Approach Slabs		Not Important to Safety
Transfer Equipment		
	Cask	Important to Safety(1)
	Cask Rigging(2)	Not Important to Safety
	Trailer/Skid	Not Important to Safety
	Uprighting Skid	Not Important to Safety
	Ram Assembly	Not Important to Safety
	Dry Film Lubricant	Not Important to Safety
Auxiliary Equipment		
	Vacuum Drying System	Not Important to Safety
	Automated Welding System	Not Important to Safety

(1) Structures, systems and components "important to safety" are defined in 10 CFR 72.3 as those features of the ISFSI whose function is (1) to maintain the conditions required to store spent fuel safely, (2) to prevent damage to the spent fuel container during handling and storage, or (3) to provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

(2) Rigging is not required for NRC licensed activities.

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3.5 Decommissioning Considerations

Decommissioning of the INEEL TMI-2 ISFSI will be performed in a manner consistent with the decommissioning of the INTEC facilities since all system components are constructed of materials similar to those found in existing INTEC facilities.

The DSC may be minimally contaminated internally by radioactive materials from the TMI-2 canisters and may be slightly activated by spontaneous neutron emissions from the TMI-2 canisters. The DSC internals may be cleaned to remove surface contamination and the DSC disposed of as low-level waste. Alternatively, if the contamination and activation levels of the DSC are small enough (to be determined on a case-by-case basis), it may be possible to decontaminate the DSC and dispose of it as commercial scrap.

The NUHOMS®-12T system can be decommissioned by removing the TMI-2 canisters and transporting the HSMs off-site. Closure removal techniques can allow for reuse of the DSC shell/basket assembly. Economic and technical conditions existing at the time of TMI-2 canister removal would be assessed prior to making a decision to reuse the DSC.

The final decommissioning plan for the TMI-2 ISFSI will be developed and submitted to NRC at a later date prior to commencing decommissioning activities. Because no contamination of the outer surface of the DSC is expected, no contamination is expected on the internal passages of the HSM. It is anticipated that the prefabricated HSMs can be dismantled and disposed of using commercial demolition and disposal techniques. Alternatively, the HSMs may be refurbished and reused for storage at another site.

The decommissioning plans for the INEEL TMI-2 ISFSI are addressed in the Conceptual Decommissioning Plan which will be prepared and submitted in accordance with 10 CFR 72.30.

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4. INSTALLATION DESIGN

4.1 Summary Description

This chapter provides a more detailed description of the NUHOMS®-12T system with the MP-187 transportation cask for use at the INEEL TMI-2 ISFSI, including the HSM and DSC. Appendix E provides a detailed description for the NRC 10 CFR 72 approved OS-197 Transfer Cask. The major differences between the two transportation approaches is that the NRC 10 CFR 72 approved OS-197 Transfer Cask does not require impact limiters, evacuation and helium backfill of the DSC, leak testing the DSC closure weld, or installation of the vent/filter housing transportation covers.

4.1.1 Location and Layout of Installation

As shown in Figure 1.1-1, the INEEL TMI-2 ISFSI is located on the INEEL INTEC site. The prefabricated HSMs are arranged in two rows which allow access for loading of the DSCs and for inspection and monitoring of the vent system. The HSM arrangement is shown in Figure 1.3-2. Adjacent HSMs have a six inch space between them to permit air flow and to allow for independent motion of each HSM during a seismic event. Each HSM holds a DSC containing up to 12 TMI-2 canisters. Therefore, 29 DSCs will contain all existing (344) TMI-2 canisters with four canister open spaces. An extra HSM provides a backup in case additional operations are required, or a challenged canister needs additional confinement. This spare HSM will include a cylindrical overpack so that it can be used to replace a challenged DSC's confinement boundary.

The basemat for the INEEL TMI-2 ISFSI is a reinforced concrete slab with reinforcement on the top and bottom of the slab. The concrete strength for this application is a minimum of 3,000 psi. The soil supporting the slab is excavated and backfilled, as required, to provide adequate bearing pressure for all postulated loads and to ensure adequate drainage. The slab is designed to preclude the effects of frost heave.

4.1.2 Principal Features

The principal features of the INEEL TMI-2 ISFSI installation are described in Sections 1.2 and 1.3. There are no utility systems required during storage conditions within the INEEL TMI-2 ISFSI. Low voltage electrical power is needed to operate hydraulic pumps during DSC insertion and withdrawal operations, and for ISFSI lighting and security systems. The existing INTEC telephone and paging systems may be extended to the ISFSI if deemed advisable There are no water or sewer systems necessary, nor are there any holding ponds, chemical and gas storage systems, or open air tankage utilized for the INEEL TMI-2 ISFSI. Each DSC is vented to the atmosphere through HEPA grade filters as described in Section 4.3.1. The filters are physically protected from environmental hazards by means of heavy steel doors installed on the rear of each module, dust covers installed over each individual filter and a dust cover over the group of filters at the vent penetration and the filter at the purge penetration. The HSMs have no additional air vents for cooling.

4.2 Storage Structures

The INEEL TMI-2 ISFSI utilizes NUHOMS® HSMs for the storage of DSCs. The HSMs are dimensioned and designed to accept the NUHOMS®-12T DSCs.

4.2.1 Design Bases and Safety Assurance

The design bases for the INEEL TMI-2 ISFSI are described in Chapter 3. In accordance with 10 CFR 72.3 [4.1], the only storage components at the INEEL TMI-2 ISFSI that are important to safety are the DSCs, including the vent system, and the HSMs. As described in Chapter 8, the design and operation of the TMI-2 ISFSI ensures that a single failure will not result in the release of significant radioactive material.

4.2.2 Compliance with General Design Criteria

The INEEL TMI-2 ISFSI is designed in accordance with the following general design criteria:

- 10 CFR 72.122 Overall Requirements
- 10 CFR 72.124 Criteria for Nuclear Criticality Safety
- 10 CFR 72.126 Criteria for Radiological Protection
- 10 CFR 72.128 Criteria for Spent Fuel, High-level Radioactive Waste, and Other Radioactive Waste Handling and Storage
- 10 CFR 72.130 Criteria for Decommissioning

4.2.3 Structural Specifications

Fabrication and construction specifications will be utilized in accordance with 10 CFR Part 72 [4.1] and industry codes and standards. The codes and standards used for fabrication and construction of the NUHOMS® components, equipment, and structures are identified throughout the SAR. They are summarized as follows:

Component, Equipment, Structure	Code of Construction
DSC Shell and Closure Plates including Vent Housings	ASME Code, Section III Subsection NB [4.2]
DSC Internal Structure	Non-Code
HSM	ACI-318 [4.3]
DSC Support Structure	AISC Manual [4.4]
Transfer Equipment	AISC, ANSI, AWS and/or other applicable industry standards

The DSC confinement boundary components to which the ASME Code applies are the DSC shell, the inner and outer bottom cover plates, the top shield plug, the top cover plate, and the vent and purge assemblies. Exceptions to the Code are identified in the Technical Specifications.

4.2.4 Installation Layout

The specific layout for the TMI-2 ISFSI is shown in Figure 1.3-2. The functional features of the NUHOMS® storage structures are shown on the Appendix A licensing drawings. Radioactive particulate matter is confined within the DSC as discussed in Sections 1.2, 1.3, and 3.2.2.

4.2.5 Individual Unit Description

4.2.5.1 Horizontal Storage Module (HSM)

The HSM is a prefabricated reinforced concrete vault that is 10'-3" wide by 18'-2" long by 14'-6" high (nominal dimensions). The HSM serves to provide shielding for the DSC to minimize the radiation dose rate from the ISFSI facility. The NUHOMS® HSM provides for horizontal storage of the DSC to remove the heat load from the DSC. The HSM includes a steel lined door which is removed for insertion and retrieval of the DSC. For the INEEL TMI-2 ISFSI, the HSM is modified from the standard NUHOMS® system to provide an access door on the back wall for monitoring and maintenance of the DSC vent and purge HEPA filters. A drain is provided to remove any moisture that may get into the HSM. Sketches of the prefabricated NUHOMS®-12T HSM are provided in

Figure 4.2-1 through Figure 4.2-3. Additional details are provided in the Appendix A drawings.

The design of the prefabricated NUHOMS® HSM has been developed in accordance with the applicable codes and a quality assurance program suitable for design of structures important to safety, as documented in Chapter 3. The HSM design has been performed using techniques similar to those reviewed and approved by the NRC for the NUHOMS®-24P design [4.5]. The prefabricated modules are installed in two pieces: the roof and the body. The body consists of the four walls and floor. All sections are a minimum of two feet thick. These rigid components are rigged into place using standard rigging practices for assembling of prefabricated concrete and steel components. Fabrication, transport, and final assembly shall be in accordance with the requirements of ACI 318 [4.3]

The HSM is a massive reinforced concrete structure that provides protection for the DSC against tornado missiles and other potentially adverse natural phenomena. The HSM also serves as the principal biological shield for the TMI-2 canisters during storage.

The HSM contains no cooling air vents as they are not required to remove the decay heat generated by the TMI-2 canisters. The cooling air flows around the DSC to the top of the HSM. Air warmed by the DSC transfers heat to the HSM walls and roof slab. Adjacent modules are spaced to provide adequate natural convection flow and shielding. This passive system provides an effective means for spent fuel decay heat removal. The HSM gap between modules does not require any special screens or covering as the analysis conservatively assumes the gap has free air flow to produce the maximum thermal gradients or is blocked by debris to produce the maximum reported HSM and DSC temperatures.

The HSM provides protection for the DSC from the external environment. The roof of the HSM is a 2-1/2 foot thick continuous slab that overlaps the walls by a minimum of two feet. The result is at least two feet of horizontal surface which external moisture in the form rain or snow would have to pass to reach the interior of the HSM. By protecting the DSC from the elements, the HSM helps insure that the DSC remains dry in the INEEL environment even if there is minimal decay heat within the DSC.

The DSC is slid into position in the HSM using parallel structural steel beams supported by the front and back HSM concrete walls. Once in its storage location, the weight of the DSC is transmitted directly to the HSM front and rear walls. The DSC support structure is fabricated from structural steel as shown in Figure 4.2-1 and Figure 4.2-2. The DSC support structure member sizes and connection details are shown in the Appendix A drawings. The support structure is shimmed level and connected to the HSM front and rear walls during module assembly. The support rails extend into the HSM access opening, which is slightly larger in diameter than the DSC. The HSM access opening has a stepped flange as shown in Figure 4.2-3 sized to facilitate docking of the transport cask.

This configuration minimizes streaming of radiation through the HSM opening during DSC transfer.

Thermal expansion of the support rails is accommodated in the DSC support system design. The top surfaces of the rails, on which the DSC slides, are coated with a lubricant suitable for a radiation environment.

The DSC is prevented from sliding along the support rails during a postulated seismic event by rail stops attached to the HSM wall at the rear end and a tube steel seismic retainer on the front wall. The DSC seismic retainer design is shown in the Appendix A drawings.

Clearance between the seismic retainer and the DSC is designed for the maximum DSC thermal growth. There is a small gap which may allow movement of the DSC relative to the HSM during a seismic event. This motion could produce a small increase in the DSC axial force if these forces were sufficient to overcome friction between the rails and the DSC. For conservatism, these effects have been included in the design analysis.

The HSM wall and roof thicknesses are primarily dictated by shielding requirements. The massive walls combined with the shield walls on the outer most HSMs adequately protect the DSCs against tornado missiles and other adverse natural phenomena. The tornado generated missile effects are considered to bound any other probable impact-type accident. The HSM wall thicknesses are specified on the Appendix A drawings.

The front and rear wall access openings into the HSM are covered by thick steel doors which provide protection against tornado missiles. The HSM front wall access door is shown in Figure 4.2-3. The door assembly includes a solid concrete core which acts as a combined gamma and neutron shield. The rear wall HEPA filter access opening is covered by a thick steel plate door hinged on one edge and padlocked, for security, on the other.

During DSC insertion/withdrawal operations, the transport cask is mechanically secured to the cask restraint embedments provided in the front wall of the HSM. The embedments are equally spaced on either side of the HSM access opening. The HSM embedments are designed in accordance with the requirements of ACI 349 [4.6]. The cask restraint system is designed for loads which occur during normal DSC transfer operations and during an off-normal jammed DSC event.

A typical reinforcing steel layout for the HSM floor, walls, and roof is shown in Figure 8.1-16. Design licensing details, such as concrete joint and reinforcing bar lap splice requirements, are shown on the Appendix A drawings.

The HSM design documented in this SAR is constructed of 5,000 psi normal weight concrete with Type II Portland cement meeting the requirements of ASTM C150 [4.7]. The concrete aggregate meets the specifications of ASTM C33 [4.7]. The concrete is reinforced by ASTM A615 or A706 Grade 60 [4.8] deformed bar placed vertically and horizontally in each face of the walls, roof, and floor. The maximum HSM concrete temperature for normal, off-normal, and accident conditions is less than 200°F and meets the requirements of ACI 349 [4.6] for normal concrete. Therefore, no special provisions are required for the NUHOMS®-12T HSM concrete aggregates.

4.2.5.2 Dry Shielded Canister

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® system DSC, but is 23.5 inches shorter. During transfer operations this shorter length is made up by installing internal spacers into the MP187 cavity. These internal spacers are bolted to the bottom and lid of the cask. The top spacer has cutouts for the vent and purge housings. These cutouts ensure that the DSC will not rotate out of position during transport. The DSC internal structure is designed to support the TMI-2 canisters. The DSC confinement boundary consists of a 5/8 inch thick cylinder with shield plugs and cover plates at each end. The DSC is shielded along its length by the transport/transfer cask during transport and transfer operations and by the HSM during storage. The shield plugs are used to provide axial shielding during DSC welding operations, transfer operations, and storage. For the INEEL TMI-2 ISFSI, the DSC is fabricated from coated carbon steel.

During storage, the DSC is vented to maintain safe levels of hydrogen and oxygen gases caused by radiolysis within the TMI-2 canisters. The generation of gas by radiolysis occurs at a slow rate, however, any buildup must be accounted for in the design of the DSC. The venting system allows for filtered release of these gases through HEPA filters, and accommodate periodic sampling, monitoring, and purging.

The DSC shell and closure plates form a high integrity steel welded pressure vessel that provides confinement of radioactive materials, encapsulates the TMI-2 canisters, and when placed in the transfer cask, provides biological shielding during DSC closure and transfer operations. The NUHOMS®-12T DSC design is illustrated in Figure 4.2-4 through Figure 4.2-7. Licensing drawings for the DSC are contained in Appendix A.

The DSC shell, and top and bottom end assemblies enclose a non-structural basket assembly which serves to support the TMI-2 canisters during loading and normal operations only. The basket assembly, shown in Figure 4.2-5, is not designed to provide structural support to the TMI-2 canisters during off-normal or accident loading conditions.

The shield plugs at each end of the DSC provide biological shielding when the DSC is in the transfer cask or HSM. The top shield plug rests on the support ring and is welded to the DSC shell to provide the inner confinement boundary. The top cover plate provides a redundant confinement. The bottom shield plug and cover plates, the internal basket assembly, the shell and support ring, and the grapple ring are shop fabricated assemblies.

The top shield plug and top cover plate are installed at the TAN Hot Shop after the TMI-2 canisters have been loaded into the DSC basket. A small diametrical gap is provided between the top shield plug and the DSC shell. The minimum radial gap at any point on the circumference of the top shield plug/DSC shell annulus is controlled during fabrication. This gap is adequate to allow the plug to be freely inserted or removed from the DSC shell assembly, while permitting the seal weld to be completed without the need for additional shims.

All final closure welds are multiple-pass welds. This effectively eliminates pinhole leaks which might occur in a single-pass weld, since the chance of pinholes being in alignment on successive weld passes is negligibly small. In addition, the DSC closure plates are sealed by separate, redundant closure welds. The circumferential and longitudinal shell plate weld seams are fabricated using multipass, full penetration butt welds. The butt weld joints are fully radiographed according to the requirements of Section V [4.9]of the ASME Boiler and Pressure Vessel Code. The remaining confinement welds are examined to the same code, using ultrasonic, dye penetrant, or magnetic particle examination as shown in the Appendix A drawings.

These stringent design and fabrication requirements insure that the confinement and pressure retaining functions of the DSC are maintained. Due to the potential buildup of gases due to radiolysis of the TMI-2 canister contents, the DSCs are vented through HEPA grade filters to the atmosphere. Therefore, for storage conditions, the internal pressure of the DSCs is maintained at atmospheric. Sample port accesses at both the purge and vent penetrations can be used to sample the DSC atmosphere and could be used to determine the rate of gas buildup.

The top shield plug includes vent and purge ports. The vent penetration is terminated at the bottom of the shield plug assembly. The purge port is attached to a tube, which continues to the bottom of the DSC cavity. The vent and purge ports include offsets to prevent radiation streaming. The vent and purge ports terminate in double gasketed sealed heads which contain the HEPA grade filters.

The loading and sealing operations are described in Section 4.7.3.1. Movement of the DSC from the transfer cask to the HSM by the hydraulic ram is done by grappling the ring plate assembly welded to the bottom cover plate of the DSC. This assembly prevents significant deformation and bending stresses in the DSC bottom cover plate and shell during handling.

Three lifting lugs are provided on the interior of the DSC shell to facilitate lifting of the empty DSC into the cask prior to fuel loading. The DSC is lowered into the cask cavity using a crane at the TAN facility. Shackles, rope slings, and a spreader beam are used to rig the DSC lifting lugs to the crane hook.

The DSC orientation during insertion into the transfer cask is achieved by alignment of match marks on the DSC and the cask top ends. During transport, the position is assured by the top internal spacer. This spacer is bolted to the lid of the cask and has cutouts for the vent and purge filter housings. In addition, a key is used to key the DSC basket assembly to the shell to ensure that the canister orientation with the DSC shell and transfer cask is maintained. Maintenance of the alignment of the DSC ensures that the vents align with the penetrations in the HSM rear wall.

Following DSC fabrication, leak tests of the DSC shell assembly are performed in accordance with the provisions of ANSI N14.5, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment" [4.10].

The principal material of construction for the NUHOMS®-12T DSC is coated carbon steel. All structural component parts of the DSC are fabricated from this material. Coated carbon steel is used for the DSC internals. The DSC cylindrical shell and the cover plates, which form the DSC confinement boundary, are coated carbon steel.

The coating will be a zinc based material that has demonstrated excellent characteristics in the atmospheric environment that is anticipated for the DSC. The DSC coating of the steel provides corrosion protection for the steel. However, this protection is not considered in the evaluation since a corrosion allowance is built into the design. The DSC will be stored in a dry environment in the cavity of the HSM. It will be protected from the elements. The DSC is loaded in a dry environment and will be unloaded in a similar environment. Since the DSC will be vented, the inside is exposed to the same environment as the exterior. The moisture of the air will react with the coating to produce a zinc oxide and then a zinc carbonate at a very slow rate, effectively protecting the carbon steel. The slow rate is guaranteed by the lack of any strong acidic environments or the significant presence of boron which is known to influence the reaction rate. Any off gassing from the reactions will be dissipated through the vent system. Due to the dry atmospheric environment, there are minimal chemical or galvanic reactions that will affect the DSC.

4.2.5.3 Transfer Cask

The NUHOMS®-12T DSCs can be moved using any NRC Part 72-approved transfer cask or an NRC 10 CFR 71 certified transportation system. This SAR provides the information necessary for the transportation from TAN to INTEC using the NRC 10 CFR 71 certified MP-187 transportation system. Appendix E of this SAR provides the detailed information necessary for the transportation from TAN to INTEC using the NRC 10 CFR 72 approved OS-197 Transfer Cask. The major differences between the two transportation approaches is that the NRC 10 CFR 72 approved OS-197 Transfer Cask does not require impact limiters, evacuation and helium backfill of the DSC, leak testing the DSC closure weld, or installation of the vent/filter housing transportation covers. The MP187 is a dual purpose cask that is being licensed to 10 CFR Part 71 and 10 CFR Part 72. The MP187 can be used for over-the-road transportation under 10 CFR Part 71 conditions, with impact limiters installed, and also for the on-site transfer of the DSC into the HSM. Operations can be reversed to retrieve a DSC. A sketch of the MP187 is provided in Figure 4.2-8. The MP187 design is provided in the NUHOMS®-MP187 SAR [4.11] for 10 CFR Part 71 applications and in the Sacramento Municipal Utility District (SMUD) Rancho Seco ISFSI SAR [4.12] for 10 CFR Part 72 applications.

The MP187 cask is a pressure-retaining cylindrical vessel with a welded bottom assembly and bolted top cover plate. The cask provides the principal biological shielding and heat rejection mechanism for the NUHOMS®-12T DSC and TMI-2 canisters during handling at the TAN facility, DSC closure operations, transport to the ISFSI, and transfer to the HSM. The cask also provides primary protection for the loaded DSC during off-normal and drop accident events postulated to occur during the transport/transfer operations. Copies of the MP187 SAR [4.11] licensing drawings of the cask are contained in Appendix B. The cask bottom ram access cover plate is a leak tight closure used only during cask handling operations at the ISFSI facility.

Two trunnion assemblies are provided in the upper region of the cask for lifting of the cask and DSC at the TAN facility, and for downending the cask. An additional pair of trunnions in the lower region of the cask are used as the rotation axis during down-ending of the cask. When installed on the transportation skid, the cask is supported by the two inch thick end neutron shield rings. The trunnions do not carry any transportation or transfer loads for the INEEL TMI-2 ISFSI.

Alignment of the DSC with the MP187 cask is achieved by the use of permanent alignment marks on the DSC and cask top surfaces. These marks facilitate orienting the DSC to the required azimuthal tolerances for satisfactory insertion of the DSC into the HSM, and assure that the vent and purge ports align with the precast HSM access openings and HEPA filter enclosure. To insure the DSC does not rotate during transport, the top spacer has cutouts that lock the purge and vent filter housings to the lid (Figure 4.2-9).

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 will have sufficient margin for any minor eccentricities in the cask vertical center of gravity which may occur. The yoke and special slings are designed and fabricated to meet the requirements of ANSI N14.6 [4.13]. The test load for the yoke and other lifting devices is 300% of the design load, with annual inspection, to meet ANSI N14.6 requirements.

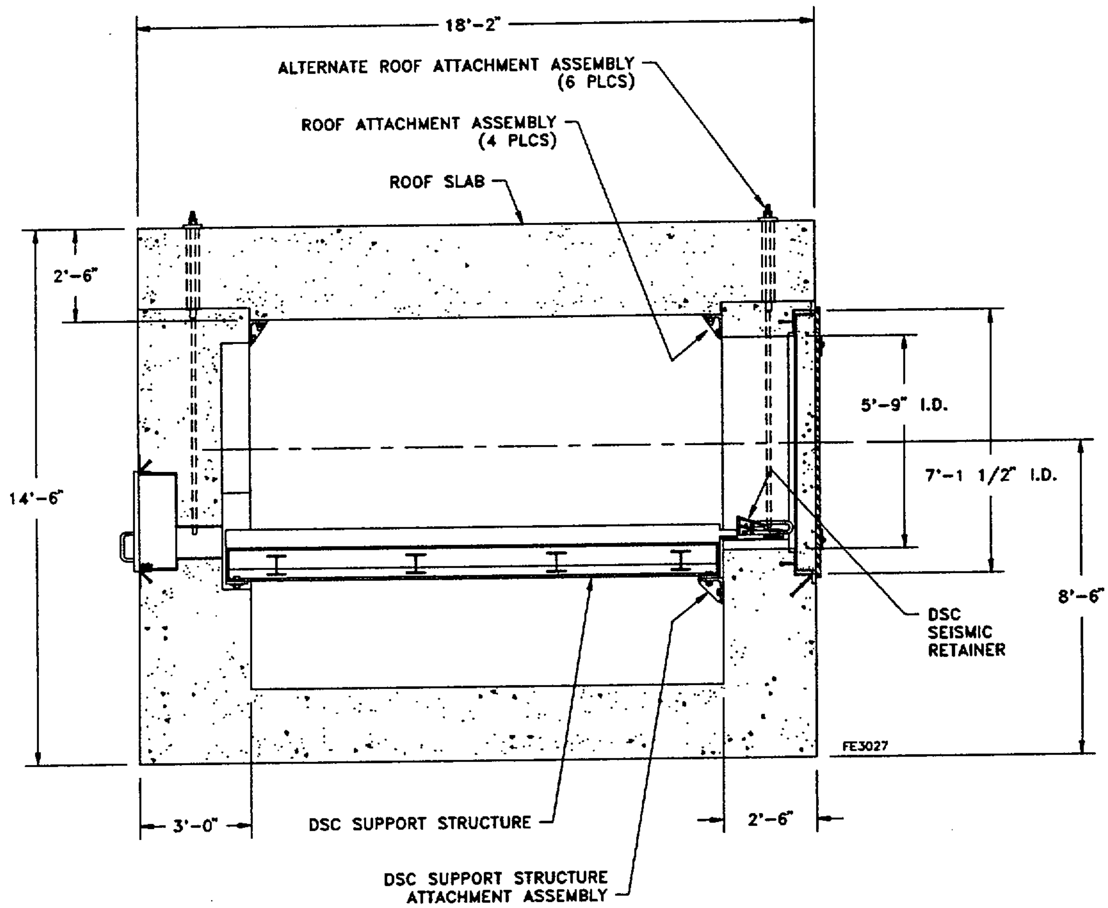

Figure 4.2-1
Prefabricated NUHOMS® 12T Module Longitudinal Section

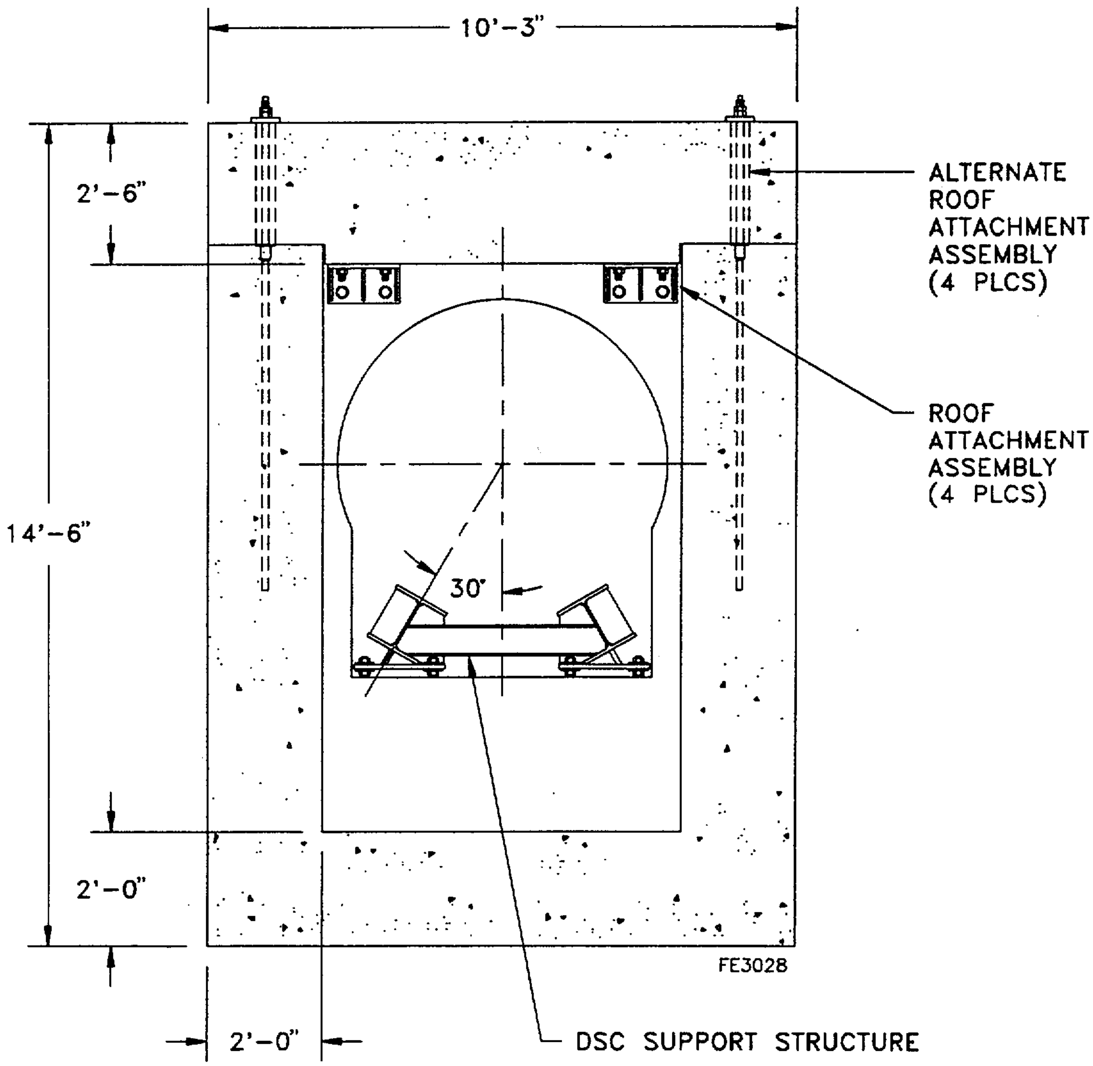

Figure 4.2-2
Prefabricated NUHOMS®-12T Module Cross-Section

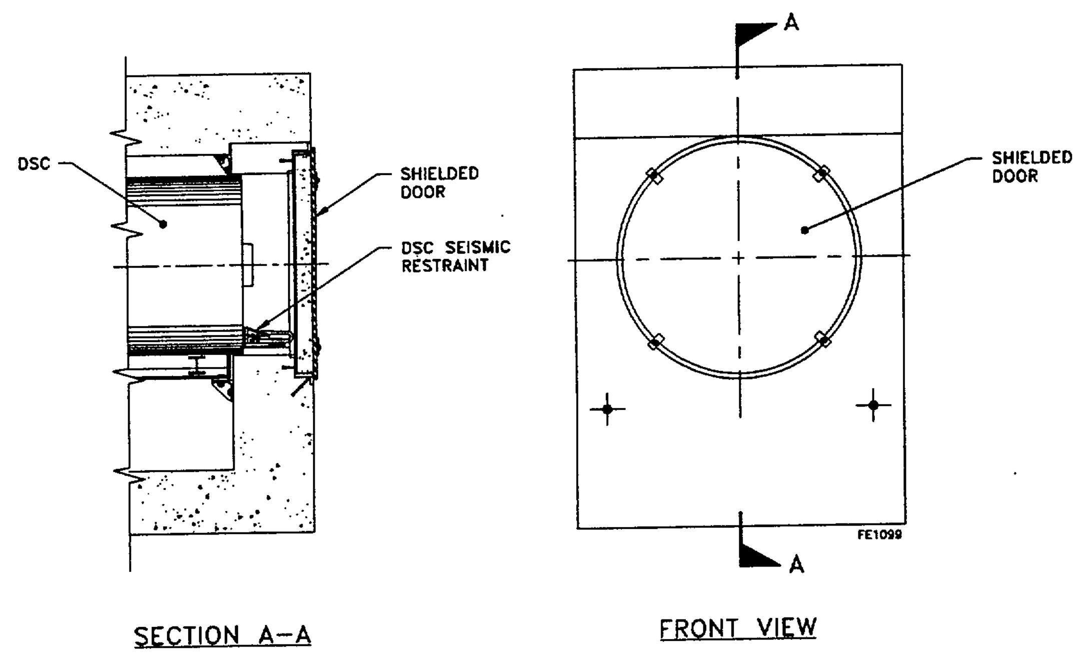

Figure 4.2-3
HSM Front Wall Details

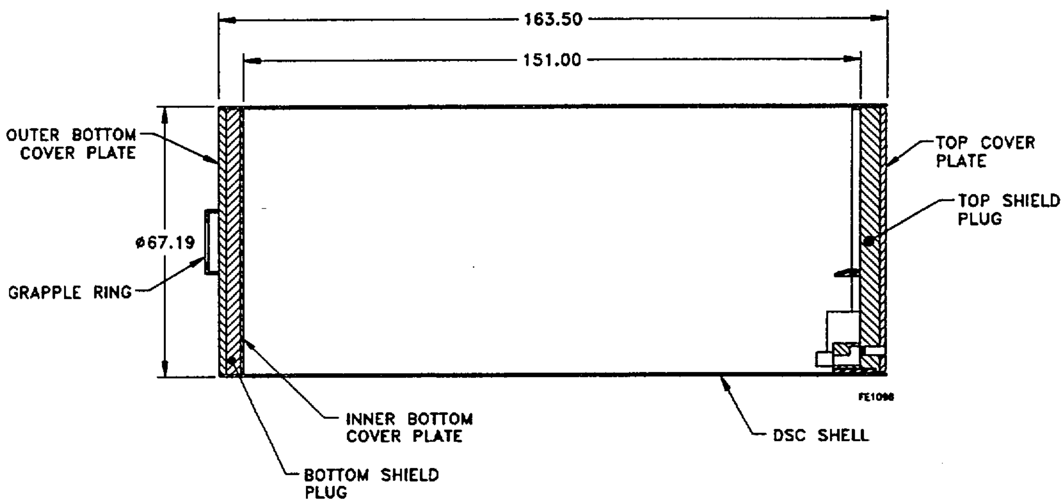

Figure 4.2-4
NUHOMS®-12T Canister Shell Assembly

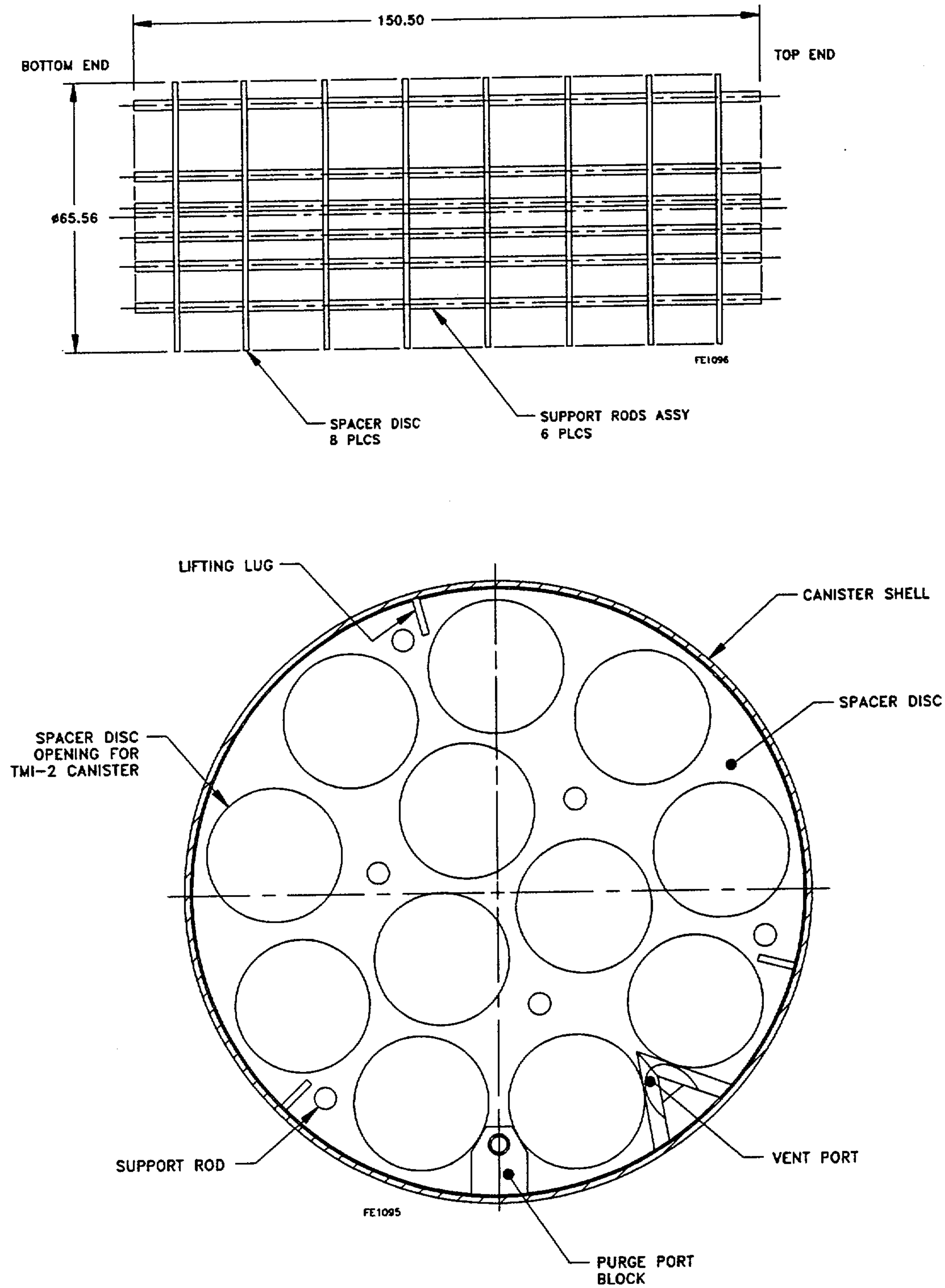

Figure 4.2-5
NUHOMS®-12T Canister Basket

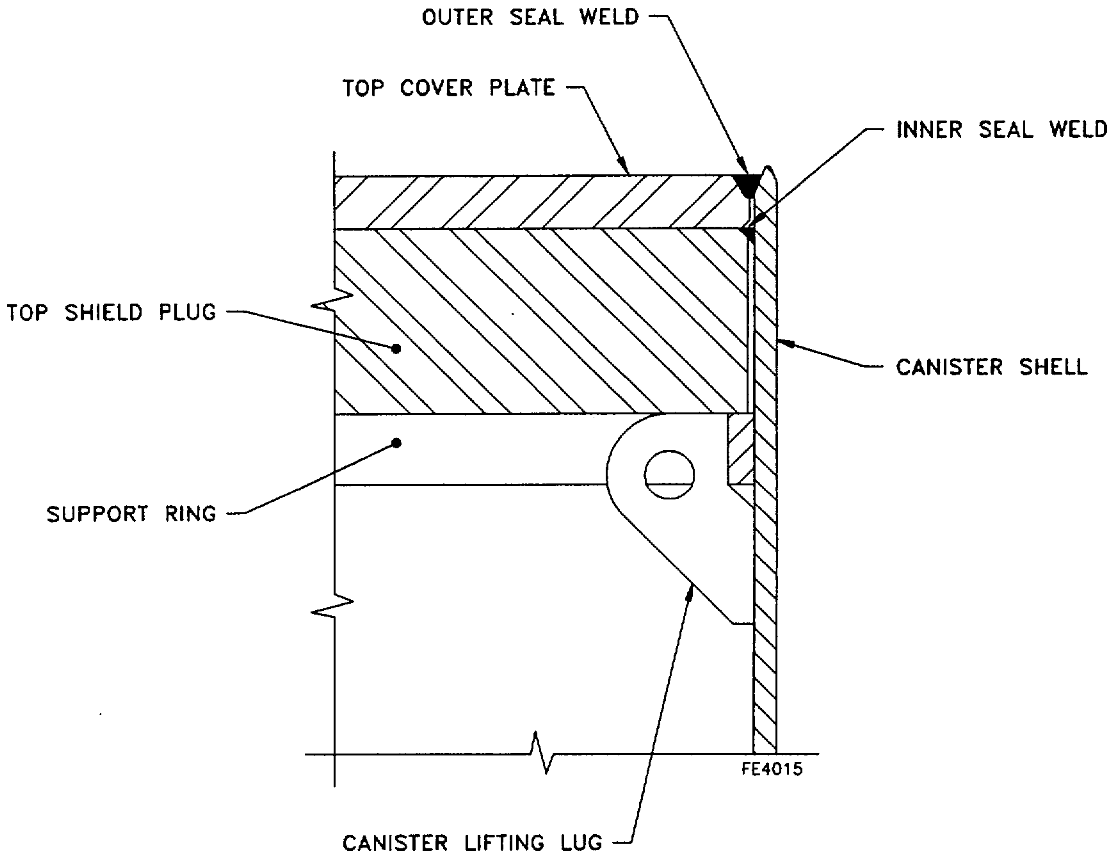

Figure 4.2-6
DSC Top Shield Plug and Cover Plate Closure Welds

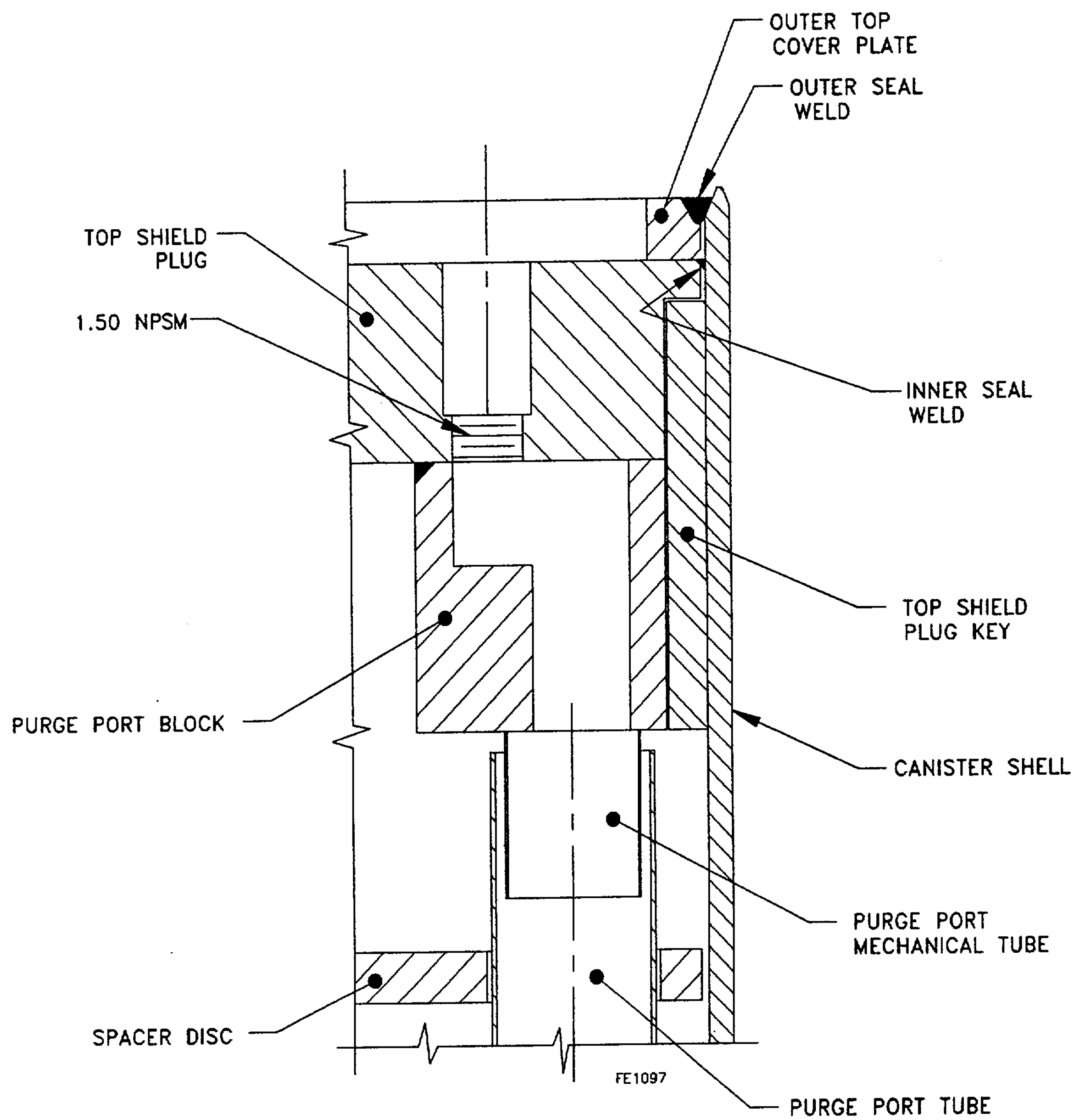

Figure 4.2-7
DSC Purge Port

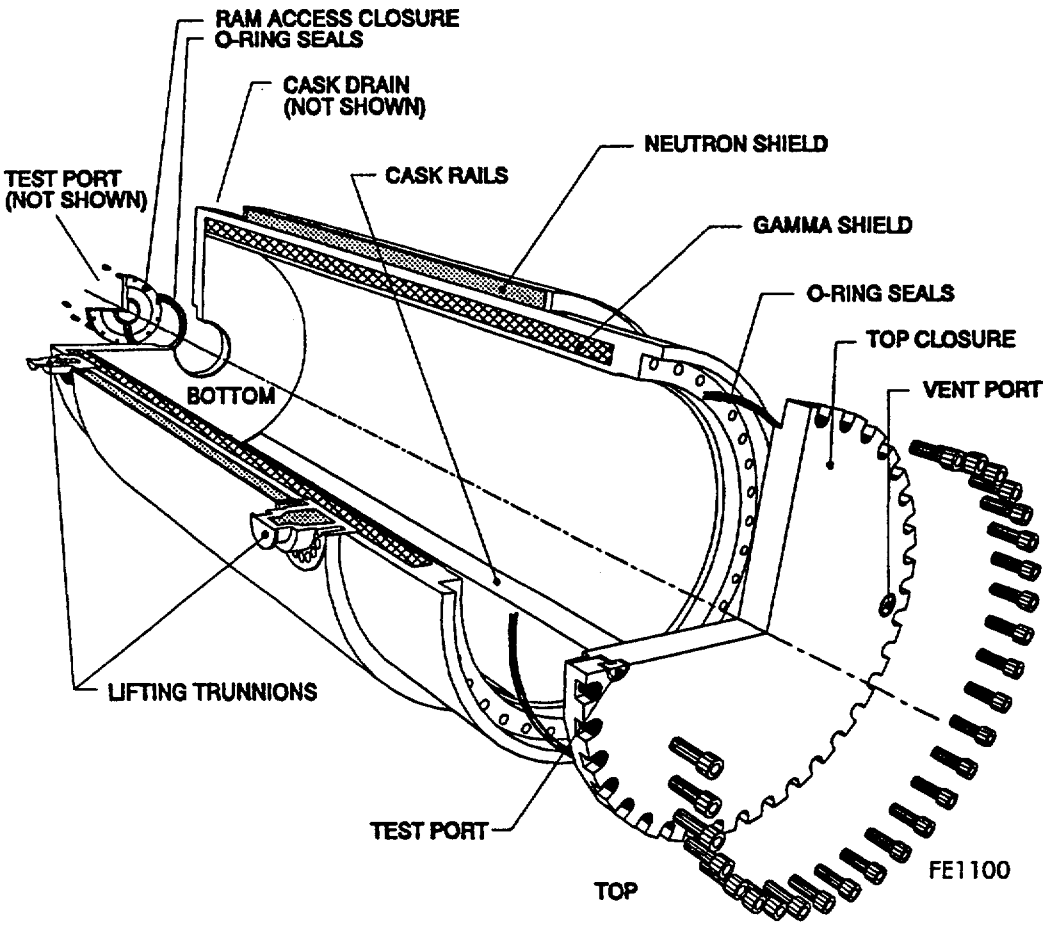

Figure 4.2-8
Composite View of NUHOMS®-MP187 Cask

FIGURE WITHHELD UNDER 10 CFR 2.390

Figure 4.2-9
Cask Spacers

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4.3 Auxiliary Systems

The INEEL TMI-2 ISFSI is a self-contained, passive storage facility which requires no permanently installed auxiliary systems. All auxiliary systems required to support the loading and off-loading of the system, periodic monitoring, and maintenance are designed to be portable systems. These systems such as power for the sampling and loading and off-loading systems will be built into the equipment to support those functions. The security systems are discussed in the security plan.

4.3.1 Ventilation and Offgas Requirements

The ventilation and off gas system for the NUHOMS®-12T storage system is completely passive. The system is designed to maintain hydrogen gas concentration at less than 5% (U.S. NRC office Inspection and Enforcement Notice 84-72, September 1984). The system design is conservatively based on the TMI-2 canister that produces the maximum amount of gas and takes credit only for diffusion for the removal of the gas. See Appendix C for a detailed evaluation of the gas generation and release from the canisters and the DSC.

Additional air flow due to temperature gradients and atmospheric pressure changes will dilute the calculated concentrations further.

4.3.1.1 Major Components

The NUHOMS®-12T DSC vent system, as shown in Figure 4.3-1, is based on a five inch diameter filtered opening in the top cover plate. This opening empties directly into filters which filter the gases prior to release to the atmosphere. The filters are HEPA grade for radionuclides, exhibiting a particle removal efficiency of greater than 99.97%. Since there is no driving mechanism (no forced air flow through the TMI-2 canisters inside the DSC) particle entrainment in the air flow will be minimal. Most of the fission gases associated with the TMI-2 fuel were released during the TMI-2 accident, or subsequently during handling and storage. The remaining fission products are low-volatiles and are entrained within the fuel matrices. Release of the remaining fission products from the fuel debris would require extremely high temperatures or disruption [4.14]. Following receipt at INEEL, the canisters have been stored underwater in a fully flooded condition. During underwater storage, the canisters have been filled with water and individually vented to the atmosphere via tygon tubing attached to the vent port in the top of each canister. The canisters will be dried prior to loading into the DSC. As part of the drying of the TMI-2 canisters, a vacuum will be pulled on the canisters before being loaded into the DSC. This will help insure that all readily releasable gases are removed from the TMI-2 canisters.

The HEPA grade filters are sintered stainless steel type used widely within the DOE system for venting various stored wastes, such as transuranic waste, where there is a potential for gas build-up. The filters have an efficiency of greater than 99.97% for particles down to 0.3 microns. These passive filters are designed to be maintenance free. Although the filter housing has a dust cover, each individual filter comes with a dust cover over the filter exit that prevents any direct access to the filter media. The filters could accumulate some dust that may restrict the air flow. The accumulation of dust, although highly unlikely, would occur over a period of time. Periodic sampling of the gas within the DSC is made to assure the hydrogen gas concentration stays below the Technical Specification limit, which includes a limit which will be used as a decision point for purging the system and replacing the filters. Increased levels of hydrogen within the DSC after the hydrogen level has been stable for a period of time (6-12 months) may be caused by clogged filters. If increased hydrogen levels approach the Technical Specification limits, the filters will be replaced.

The filters have been tested in a variety of environments that bound the environment at INEEL. Testing has not shown any significant change of diffusivity or filtration ability. These tests have included artificially forcing dust into the filter. The consequences of all the filters plugging is addressed in Chapter 8 as an abnormal event. The consequences of a complete confinement failure including the filters is considered in the accident scenario release evaluation. The filters are made out of stainless steel that does not readily absorb water. The seals in this passive filter are all static seals. In this application there is no driving pressure or movement that would require the seals to be resilient throughout the design temperature range. The steel housing attaching the vents to the DSC is machined from a piece of plate and sealed using double metallic sealing rings. The filters have a stainless steel housing around the HEPA filter that threads into the carbon steel housing attaching to the DSC. Each of the filters comes with a single neoprene rubber gasket. These filters can easily be threaded in and out through the access door in the HSM rear wall. The access door also provides access for leak testing the housing-to-DSC seals and sampling of the DSC gases for possible build-up of hydrogen. The filters are normally covered with an open dust cover, but can be sealed off to facilitate sampling and purging if necessary. A similar vent is attached to the purge connection on the DSC. The purge sample port can also be used to purge the system. The purge connection is connected to a tube that runs to the far end of the DSC so that, during a purging operation, all areas within the DSC will be purged.

The HSM rear wall access hole to the DSC vents is covered with a steel door which is secured to the HSM rear wall to protect the vent system and prevent unauthorized access. The holes in the door allow air circulation to prevent build-up of hydrogen in the HSM, yet prevent natural intrusions. The vents are located approximately three feet back from the outer surface of the HSM. None of the holes are directly over the vent opening. The vent housing dust cover and the individual filter stainless steel dust covers insure that no moisture other than the air humidity can gain access to the filter openings. The vent location and the door are designed to prevent any weather damage.

Another system feature is that the sample/purge lines can be used to draw a negative pressure in the DSC to ensure there will be no releases during filter change out. Since the system relies on diffusion, there is no reliable method of field testing the filters. The only meaningful test is whether or not the hydrogen concentration stays at acceptable levels. Any plugging of the filters will increase the filtering efficiency. If, due to low hydrogen generation rate, the increased resistance in the filters does not affect the hydrogen concentration, there is no need to replace the filters. The filters will be changed when the hydrogen concentration approaches the Technical Specification limits. At that time, the DSC will be purged and the filters replaced. From the calculation presented in Appendix C, it can be seen that it takes at least six months for the system to reach equilibrium and approach the maximum actual stable concentration.

4.3.1.2 Safety Considerations and Controls

Due to the passive nature of the system, there are no off-normal conditions or accident conditions which will significantly affect the performance of the vent system. Due to the confinement of the material in the TMI-2 canisters and the design of the vent system, radioactive material can not be easily released from the DSC/HSM even if a vent fails. As stated above, there is no forced air flow through the DSC and no way of forcing air through the canisters that could lead to significant entrainment of the particles. The HSM, with the steel door over the access area, protects the vent system from all natural phenomena as described in Chapter 8.

4.3.2 Electrical System Requirements

Other than lighting and security system power, no electrical systems are required for the HSM or DSC during storage conditions. The required electrical power at the TAN facility is obtained from the existing on-site power supply system. Power at the ISFSI is supplied by the INTEC facility grid which in turn is connected to the commercial power grid serving the site.

4.3.3 Air Supply System

An air supply system is not required for any Important to Safety DSC loading or purging operations. Plant air may be utilized for general loading activities. Any plant air that could gain access to the DSC or TMI-2 canisters is free of oil.

4.3.4 Steam Supply and Distribution System

There are no steam systems utilized.

4.3.5 Water Supply System

Demineralized water may be needed for the MP187 cask washdown operations. If used, this water will be supplied by existing systems at the TAN facility and are not part of this licensing application.

4.3.6 Sewage Treatment System

There are no sewage treatment systems required for the INEEL TMI-2 ISFSI.

4.3.7 Communication and Alarm Systems

No communication systems are required for the safe operation of the INEEL TMI-2 ISFSI. The existing plant paging and telephone system may be extended to the ISFSI during transfer operations. The ISFSI security alarm system is described in the ISFSI Security Plan which is being submitted under separate cover.

4.3.8 Fire Protection System

No fire detection or suppression system is required for the INEEL TMI-2 ISFSI. The HSMs contain no combustible materials. The provisions needed for fire response will be provided consistent with existing INEEL INTEC requirements.

4.3.9 Cold Chemical Systems

There are no cold chemical systems for the INEEL TMI-2 ISFSI.

4.3.10 Air Sampling System

The capability of air sampling ahead of the vent system HEPA filters allows for monitoring the gas generation inside the DSCs. There are two sampling systems used at the ISFSI. One is an air particulate sampling system to periodically check air for activity as it leaves the vents. This system is portable to allow periodic checks. When the DSC is sampled for hydrogen, a cover with double metalic seals is placed over the filters and then a sample pulled through a fitting in the cover. At the completion of the sampling, the cover is replaced with the dust cover. Figure 4.3-2 shows an alternative configuration for the sampling system.

Sampling the air downstream from the filters allows efficient monitoring while ensuring that no significant particles are released. Any airborne activity which may occur during TMI-2 canister loading and DSC closure operations is monitored by the existing TAN Hot Shop ventilation and radiological detection systems.

4.3.11 Maintenance System.

The maintenance system consists of a testing program to verify there is no abnormal radioactive release, sampling of the DSC for hydrogen build-up, and periodic testing of the mechanical seals attaching the vent housings to the DSC. The maintenance program also involves inspection of the vent access doors to ensure they remain operational and that no build-up of debris or snow occurs in the vent areas.

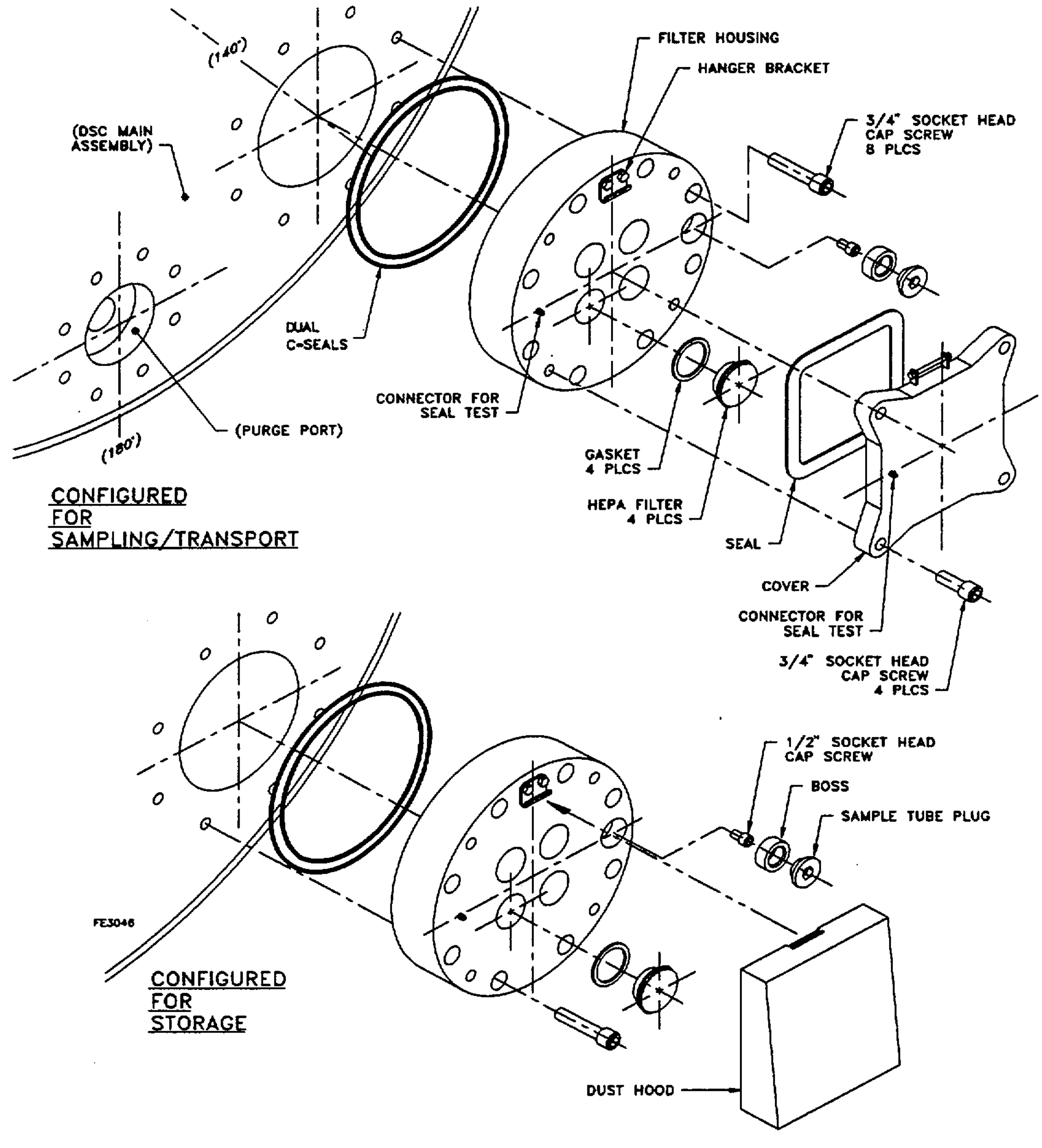

Figure 4.3-1
DSC Vent and Purge Assemblies

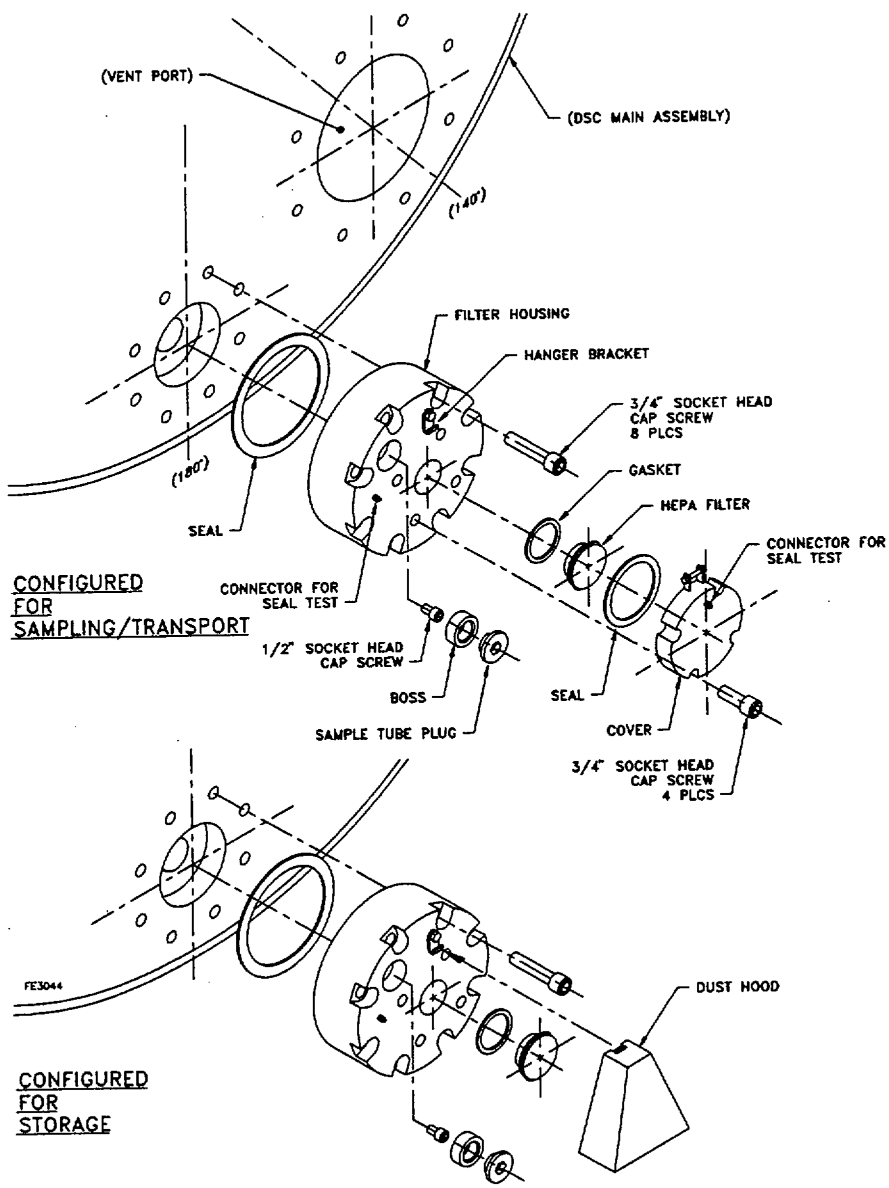

Figure 4.3-1
DSC Vent and Purge Assemblies
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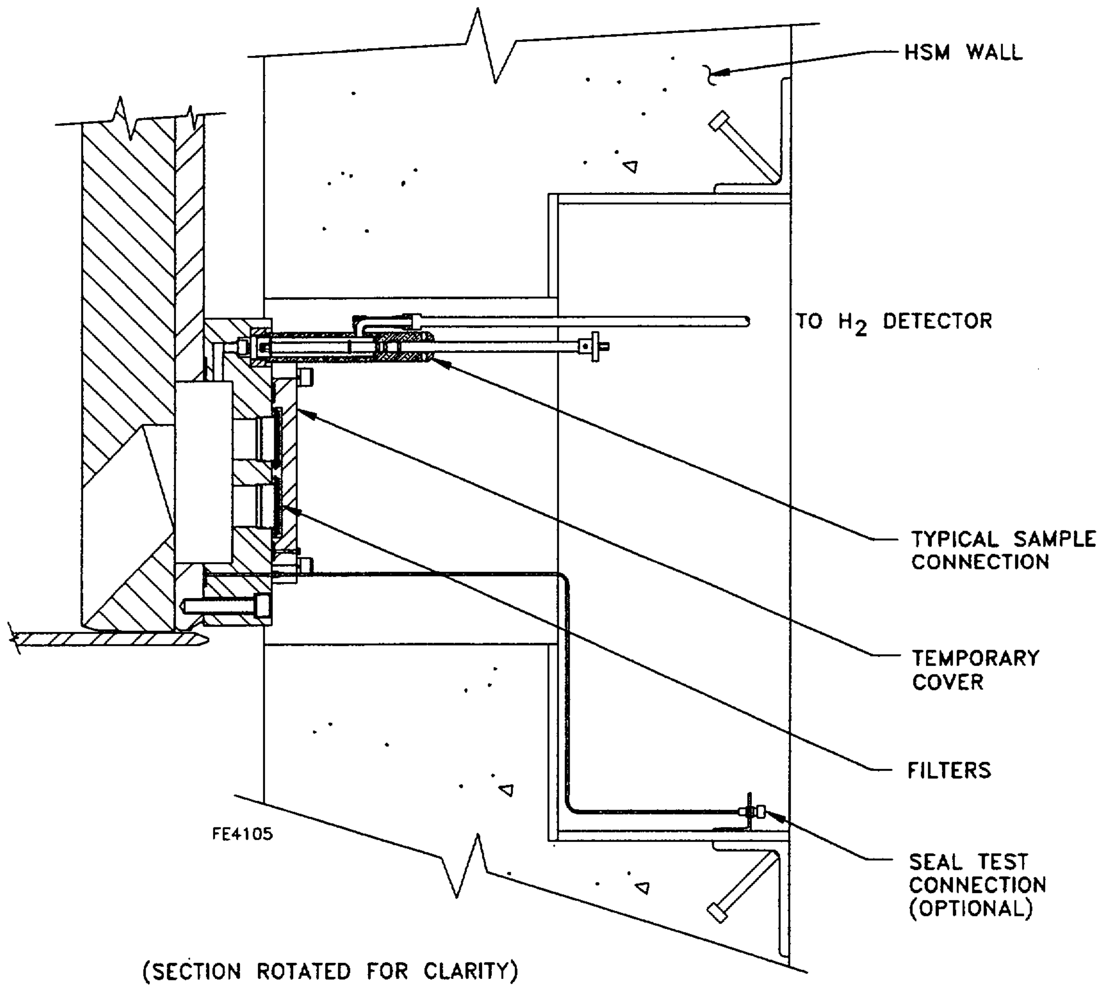

Figure 4.3-2
DSC Sampling System

4.4 Decontamination System

4.4.1 Equipment Decontamination

No decontamination equipment is required at the INEEL TMI-2 ISFSI. In general, decontamination of the cask, lifting devices, and the DSC shell will not be necessary since the cask and the DSC are loaded dry in the TAN hot shop. If required, decontamination operations can be performed in the TAN facility using detergent and wiping cloths. These operations are not part of the license application.

4.4.2 Personnel Decontamination

It is not expected that personnel decontamination facilities will be necessary for the INEEL TMI-2 ISFSI. Any potential contamination due to maintenance operations such as sampling or filter change-out will be controlled. Anti-contamination clothing and localized step-off areas at each HSM may be used as necessary to minimize the spread of contamination, if any, around the facility. Should personnel require additional decontamination, they will be transported to INTEC facilities where existing equipment and procedures are available. Personnel decontamination at TAN, if necessary, will utilize existing equipment and procedures. These operations are not part of the license application.

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4.5 Shipping Cask Repair and Maintenance

The MP187 cask is designed to minimize maintenance and repair requirements. Any maintenance that may be required during INEEL TMI-2 ISFSI transfer operations may be performed at existing INEEL facilities or any other suitable location since cask contamination levels are maintained below transportable limits.

4.5.1 Repair

The MP187 cask and lifting hardware will be inspected prior to each use. 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 that may impair the ability of the cask to function properly will be repaired and/or parts will be replaced. This work may be performed on-site, depending upon the capabilities of the site resources, or at an approved vendor's facility. Repairs will be performed in accordance with the approved 10 CFR Part 71 license condition requirements.

4.5.2 Maintenance

Inspections will be performed prior to each use in accordance with the 10 CFR Part 71 license condition requirements for the MP187 cask. Examples of inspections to be performed include:

A. Visually inspect the cask exterior surfaces for cracks, dents, gouges, tears, or damaged bearing surfaces. Particular attention will 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 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. Visually inspect neutron shield jacket.

The following inspections and tests will be performed on an annual basis when the cask is used for on-site transfer operations controlled by 10 CFR Part 72:

A. Test the cask cavity fittings and seals for leak tightness in accordance with ANSI N14.5.

B. Examine the cask trunnions and cask lifting devices in accordance with ANSI N14.6.

Any parts which fail these tests shall be repaired or replaced as appropriate. Detailed inspections will be performed in accordance with the cask operating manual.

4.6 Cathodic Protection

The INEEL TMI-2 ISFSI is dry and above ground so that cathodic protection in the form of impressed current is not required. The normal operating environment for all metallic components is near or above ambient air temperatures so there is little opportunity for condensation on those surfaces.

The DSC has a zinc based coating and does not require corrosion protection for immersion in water since all activities are performed dry. The DSC support structure in the HSM is coated carbon steel. The carbon steel components are galvanized or coated with a zinc rich coating which will provide protection by zinc's sacrificial nature with respect to iron. Initially, zinc oxide will form by reaction with atmospheric oxygen. If moisture is available, the oxide will then be converted to a hydroxide which then reacts with carbon dioxide in the atmosphere to form zinc carbonate. This film provides excellent barrier protection. This coating protects the basket for the duration between fabrication and fuel loading through the end of the system design life. The inside surface of the cover closure welds is not accessible for coating after installation. As such, the exposed carbon steel may corrode. The rate is low and the expected total thickness loss is accounted for in the corrosion and thinning allowance in the structural evaluation.

The cask is protected from corrosion by suitable coatings or materials such as stainless steel, which is not susceptible to general corrosion.

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4.7 Fuel Handling Operation Systems

INEEL TMI-2 ISFSI fuel handling is performed in two general locations. Individual TMI-2 canisters are loaded into the DSCs at the TAN Hot Shop. Once confined in the DSC, the TMI-2 canisters are transported to the ISFSI and the DSC inserted into the selected HSM. Handling activities inside the TAN Hot Shop are performed under the existing TAN procedures and are not subject to licensing, however certain steps in the TAN procedures implement requirements of the licensed system and these procedure steps are subject to change control under 10 CFR 72.48 (see 9.4.1). Handling operations at the ISFSI are performed under the 10 CFR Part 72 license as described in this SAR.

A. The following TAN Hot Shop handling systems are not subject to licensing:

- TMI-2 canister handling mechanisms.
- Cask handling crane.
- Cask and DSC lifting devices.
- Cask turning skid.

B. The TMI-2 canister handling system equipment required to transport the NUHOMS®-12T DSCs to the ISFSI and insert the DSCs into the selected HSMs are:

- An NRC-licensed transportation/transfer cask.
- Transport trailer and skid.
- Skid positioning system.
- Hydraulic ram system.

C. Applicable sections of the following codes and standards are specified for the design, construction, and testing of the INEEL TMI-2 ISFSI transfer equipment components.

- American Institute of Steel Construction, "Manual of Steel Construction."
- National Electrical Code.

- National Fluid Power Association (Standards).

- National Electrical Manufacturer's Association (Standards).

- American Society for Testing and Materials (Standards).

- Steel Structures Painting Council (Standards).

- American National Standards Institute (Standards).

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

4.7.1 Structural Specifications

The codes and standards for the MP187 cask and the transfer equipment are described in Reference 4.11 and Section 4.7.C above, respectively.

4.7.2 Installation Layout

The layout of the INEEL TMI-2 ISFSI is discussed in Section 4.1.1.

4.7.2.1 Building Plans

There are no buildings required at the INEEL TMI-2 ISFSI located at the INTEC facility. The layout of the ISFSI fences, slabs, and approach roads is shown in Figure 1.1-2. The details of the HSMs are shown in Appendix A drawings and item discussions contained in this SAR.

4.7.3 Individual Unit Descriptions

4.7.3.1 TAN Hot Shop Equipment/Operations Overview

Handling equipment and activities inside the TAN Hot Shop are performed under INEEL procedures and are not subject to NRC licensing, however certain steps in the TAN procedures implement requirements of the licensed system and these procedure steps are subject to change control under 10 CFR 72.48 (see 9.4.1). An overview is provided in the following paragraphs for convenience in understanding the loading process.

The TAN hot shop 110 ton crane is used for all DSC and cask movements within the Hot Shop. The TMI-2 canister handling mechanisms are used to load TMI-2 canisters into the DSC.

To maintain canister accountability, the TMI-2 canister identification number must remain visible and must be recorded prior to placement into a DSC. The TMI-2 canisters are dried prior to placement in the DSC.

The TMI-2 canisters are placed into a NUHOMS®-12T DSC after the DSC is placed in the transfer cask cavity at the TAN Hot Shop.

The top shield plug is rigged and placed over the DSC so that it aligns with the DSC top shield plug keyway. Tag lines may be used to assist in precise positioning. After the shield plug is installed and the DSC is sealed, for the NRC 10 CFR 71 certified transportation the DSC cavity is evacuated and backfilled with helium to perform leak testing of the closure welds. The seal welds are inspected and leak tested for informational purposes. To accomplish this, the suction line of the vacuum drying system (VDS) (Figure 4.7-1) is connected to the DSC purge port. A hose is connected from the discharge outlet of the VDS to the canister dewatering skid. A particle filter is located on the suction side of the VDS. The filter is used to capture any radioactive particles that may be entrained within the gas, thereby preventing contamination of the VDS.

All discharges from the DSC cavity, whether gas or water vapor, are routed to the vacuum system skid which contains HEPA filters and collection tanks. Therefore, all radioactive materials or particles are confined within a closed, controlled system.

Primary closure is formed by welding the top shield plug to the DSC shell using remote or manual welding equipment (Figure 4.7-2). After welding the top shield plug, the top cover plate is lowered onto the DSC. Again, using remote or manual welding equipment, the top cover plate, is welded in place. Both welded joints act as barriers for confining all radioactive material within the DSC throughout the service life of the DSC.

The automated welding system consists of two major components, the welding machine itself as shown in Figure 4.7-2, and the control panel/power supply. The control panel and power supply, along with the purge gas bottle, can be located at any convenient position for the operator within the range of the umbilical cables (usually about 50 feet). The use of an automated welding machine is considered for ALARA during routine operations. Manual welding of any closure weld is permissible, but is typically only used for purposes of weld repair. Manual welding is also used as a recovery procedure if the machine becomes non-operational during the closure process or if the automatic welding system is not functional. Small weldments may be made manually as part of routine operations because of the short stay time required for small weld volumes.

4.7.3.2 MP187 Used as a Transfer Cask

When used as a transportation cask all operations of the MP187 cask are performed in accordance with the requirements of the MP187 SAR [4.11] for Part 71 applications.

When used for on-site transfer operations, under the rules of Part 72, the MP187 transportation cask is used in the same general configuration as described in the Part 71 SAR [4.11] except, there is no requirement to include the metallic seals or specified bolt preloads. The MP187 used in the transfer mode is designated as Important-to-Safety since it provides the biological and structural protection for the DSC from impact loads. The codes and standards used to design and fabricate the MP187 cask are presented in the Part 71 SAR [4.11]. The fuel loading operations at the TAN facility are conducted dry, and the ram access cover plate seals are not required to keep the cask interior clean. Similarly, as the DSC shell provides the Part 72 confinement boundary the bolted top cover plate seals are not required and the bolt preload required by the MP187 Part 71 drawings is not applicable.

Unloading operations at the INTEC are similar to the methods and procedures approved for the standard NUHOMS® SAR [4.15] except that the MP187 cask is supported in the transportation skid by the neutron support rings as shown on drawing NUH-05-4006NP [4.11]. The ISFSI alignment procedures and DSC transfer operations utilize the same proven techniques demonstrated on the approved NUHOMS® system.

4.7.3.3 Transport Trailer

The transport trailer is designed for use with the NUHOMS®-12T transfer equipment. Its function is to move the cask and cask transportation skid from the TAN facility to the ISFSI location. Once there, the trailer is raised and stabilized with jacks so that it will remain stationary during 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 4.7-3. The codes and standards governing the design and construction of the trailer are provided in Section 4.7. Adequate space is provided between the rows of HSMs to allow the trailer to be easily turned and aligned to the HSM.

The down ending sequence for the cask is shown in Figure 4.7-4. The cask is never lifted above the maximum drop height for 10 CFR Part 72 operations (80 inches) after it is loaded onto the cask transportation skid. The configuration of the transport trailer and other transfer equipment at the HSM is shown in Figure 1.2-1. The trailer is configured as a 5 x 2 axle dolly. Ten hydraulic suspensions carry four pneumatic tires each and are located in five axle lines. Hydraulic suspensions enable coupled steering of all axles around a common point, thus minimizing tire scuffing and damage to pavement and tires. The suspensions also offer 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.

4.7.3.4 Skid Positioning System

The functions of the skid positioning system (SPS) are to hold the cask transportation skid stationary (with respect to the transport trailer) during cask transfer operations at the HSM, and to provide alignment between the cask and the HSM prior to insertion or withdrawal of the DSC. It is composed of tie-down or travel lock brackets and bolts, hydraulically powered horizontal positioning modules, mechanical rollers, hydraulic lifting jacks, and a hydraulic supply and control skid. The SPS hardware located on the transport trailer is illustrated in Figure 4.7-5.

The codes and standards governing the design and construction of the SPS are provided in Section 4.7. 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.

The trailer hydraulic jacks are designed to support the loaded cask, the skid, the trailer, and the loads applied to them during HSM loading and unloading. They are utilized at two locations: in the TAN facility during cask loading, 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. Hydraulic jacks are also located between the mechanical rollers and the skid. When pressurized, these jacks support the weight of the loaded cask and transportation skid, and permit movement of the cask using the mechanical rollers. In the unpressurized condition, the weight of the cask and skid are carried directly to the trailer deck. The mechanical rollers are located in pockets in the transportation skid.

Hydraulic positioning modules provide the motive force to horizontally align the skid and cask with the HSM prior to insertion or retrieval of the DSC. The positioning module controls are manually operated and hydraulically powered. The system is designed to provide the capability to align the cask to within the specified alignment tolerance.

Anti-friction pads, constructed from woven Teflon pads and steel, are located between the mechanical rollers and skid for lateral movement of the skid. These pads are commonly used as bearings for bridges, tank supports, and hydro/electric gates. The travel of the skid is restricted by the stroke of the hydraulic positioning cylinders. In the event of loss of hydraulic pressure/pump failure, the jacks would depressurize and the skid would be set down on the trailer deck.

The hydraulic power supply and controls for the SPS may be included as a part of the transfer trailer hydraulics or located on a separate skid. The hydraulic pump is typically powered by an electric motor. 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 each set of four vertical jacks or any pair of jacks; actuation of any single vertical jack; or actuation of any one of the horizontal actuators. Simultaneous operation of the vertical trailer jacks and the horizontal actuators is not possible.

4.7.3.5 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 DSC, it is considered not important to safety. The HRS is illustrated in Figure 4.7-6. The codes and standards used in design of the HRS are listed in Section 4.7.

The HRS includes the following main sub-components: double-acting hydraulic cylinder; 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 and grapple are designed to push or pull the DSC at any point in its horizontal travel between the cask and the HSM. The HRS and all other components of the transfer system are conservatively designed for pushing and pulling forces of up to 70,000 pounds, if necessary to complete the transfer.

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.

4.7.3.6 Ram Support Assembly

The ram hydraulic cylinder is supported at the front (cask) end by a temporary structural steel frame bolted to the base of the cask after the impact limiters are removed. The rear end of the ram is supported by an adjustable tripod as shown in Figure 4.7-6. 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.

4.7.3.7 Cask Skids

The cask transportation skid is a structural steel frame fabricated from plate and standard wide flange members. The cask transportation skid, shown in Figure 4.7-7, is designed according to the AISC code to meet the requirements of 10 CFR Part 71 transportation loads and 10 CFR Part 72 operating loads. During cask loading and trailer towing operations, the cask support skid is rigidly attached to the transfer trailer by bolted brackets. During HSM cask alignment, the bolts are removed, and the alignment system is used to move the cask transportation skid into position. For this operation, the skid is supported by the skid positioning system, mechanical rollers, and bearing pads located on the trailer frame cross members. The MP187 cask is supported on the front and rear neutron shell support rings.

The turning skid is fabricated from standard wide flange members and steel plate. It is shown in Figure 4.7-7. It has two towers for the lower trunnions and a saddle which supports the upper section of the cask structural shell. For cask uprighting, the lower trunnions are installed and the cask transferred horizontally to the turning skid, where the lower trunnions are engaged into the pillow blocks. The cask is set down onto the skid, slings are removed and the upper trunnions are installed. The slings or lifting yoke mounted on the TAN facility crane, are engaged into the top trunnions, and the cask raised to the vertical position. Downending of the cask and loading onto the transportation skid is the reverse of these operations.

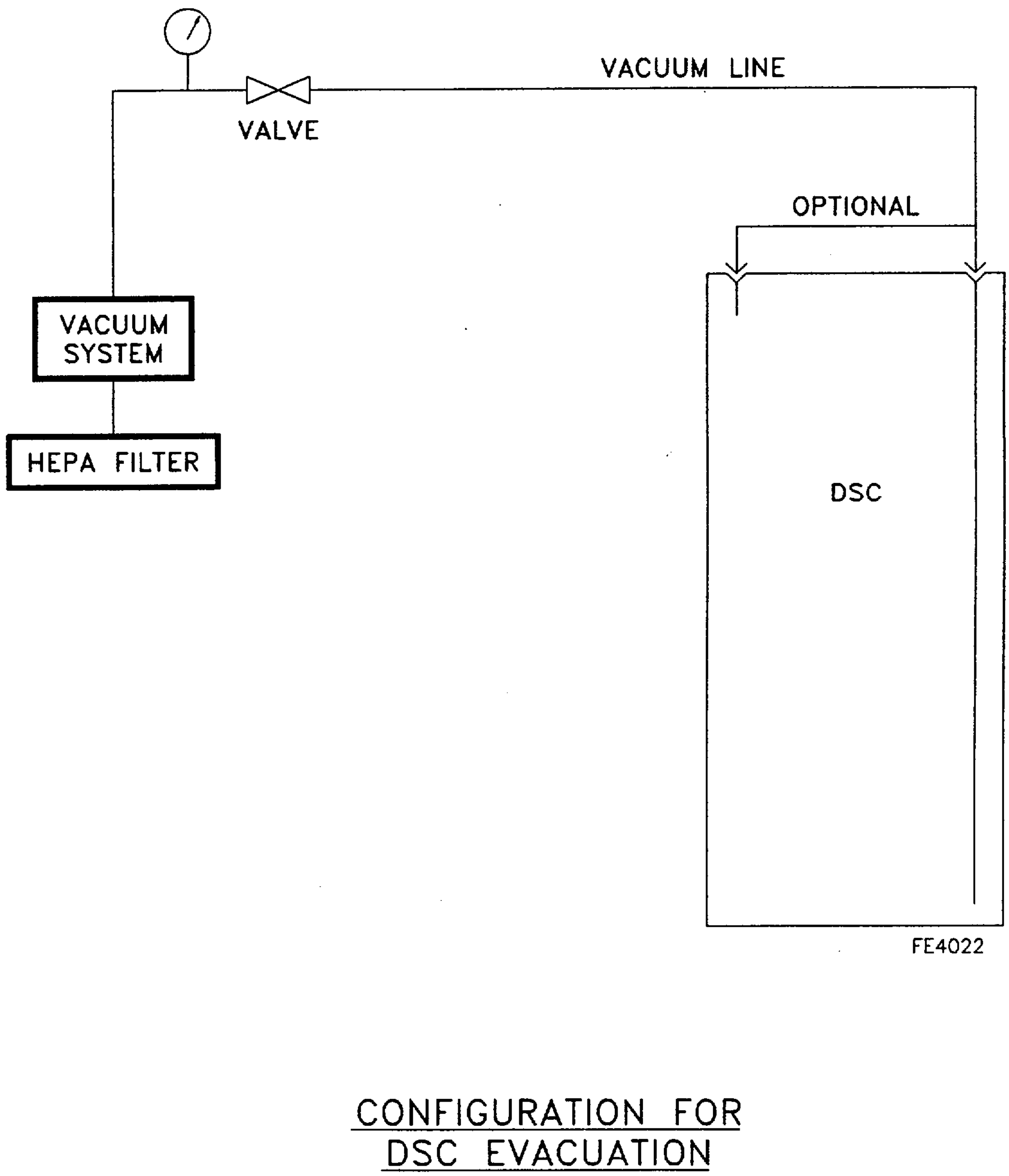


Figure 4.7-1
DSC Evacuation

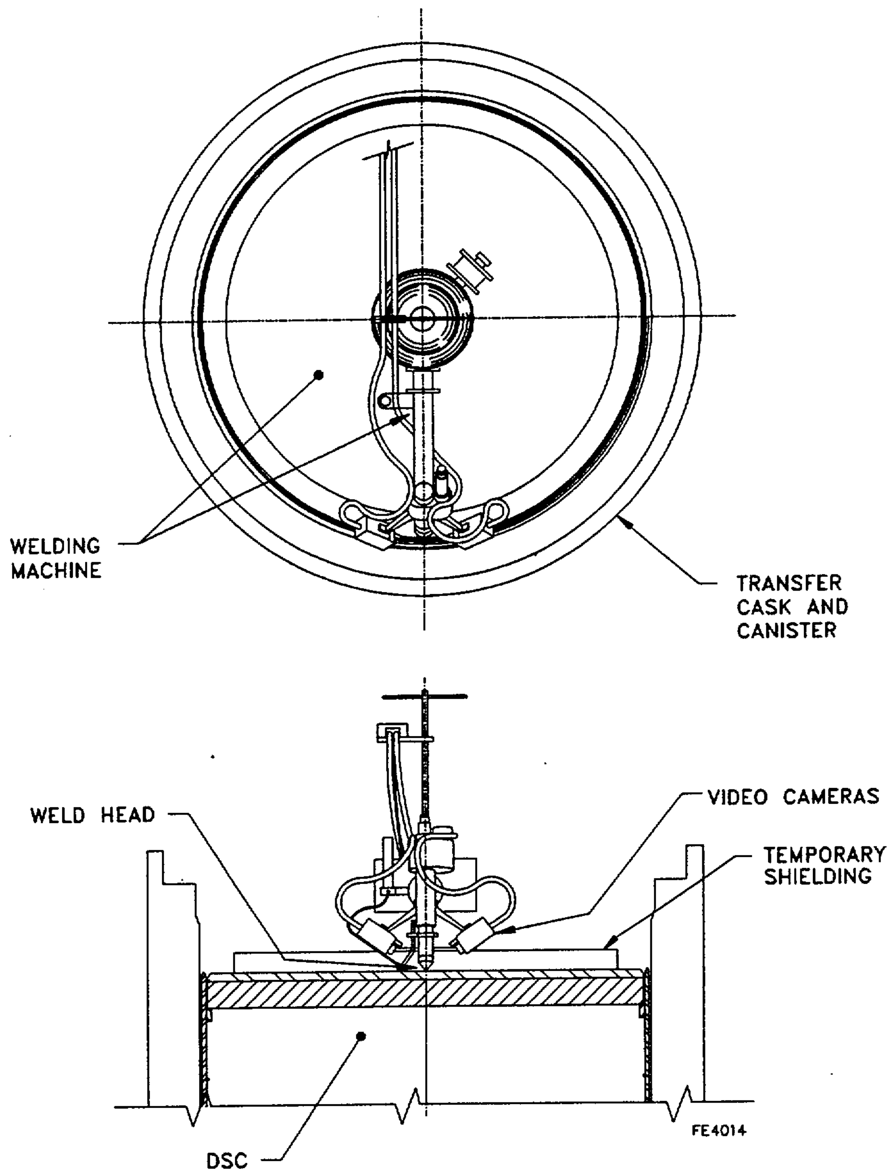


Figure 4.7-2
DSC Automated Welding System

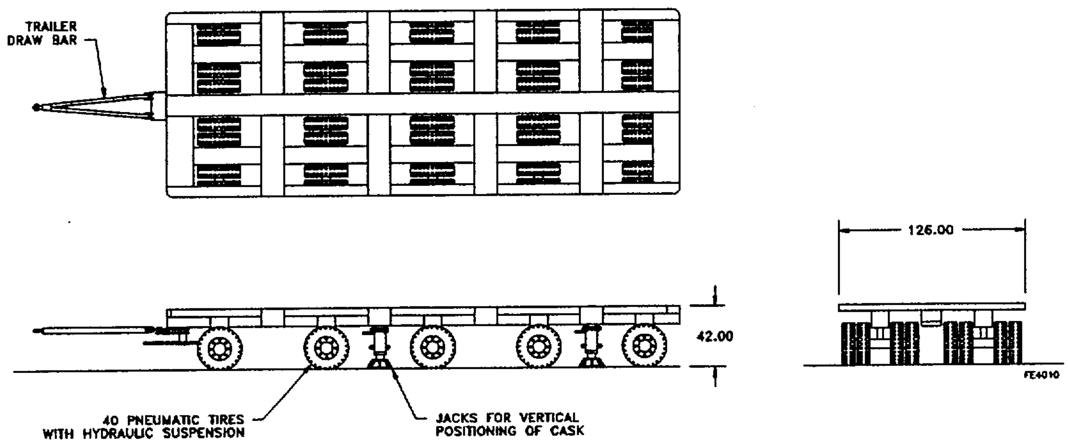
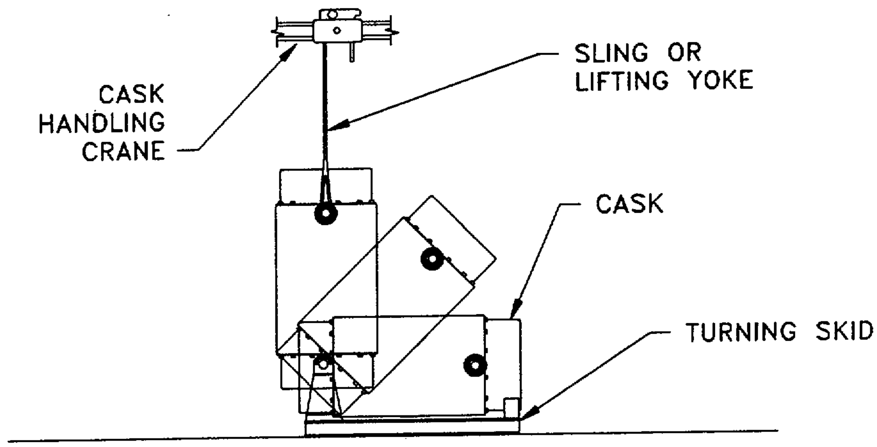


Figure 4.7-3
NUHOMS®-12T Transport Trailer

PLACE CASK ON TURNING SKID



MOVE CASK TO TRANSPORTATION SKID

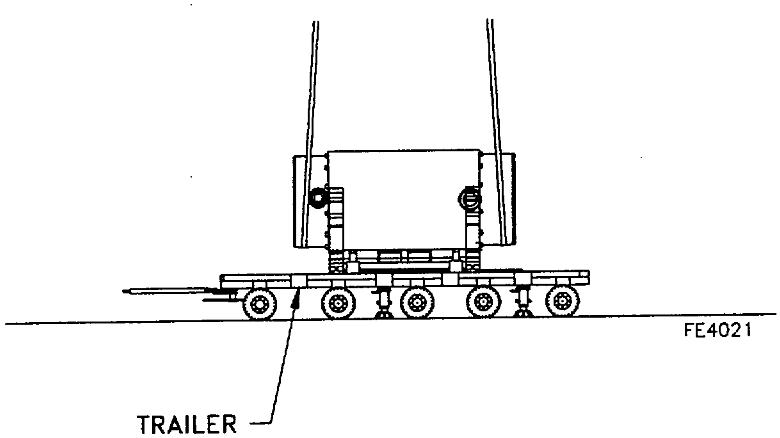


Figure 4.7-4
NUHOMS®-12T Cask Downending Sequence

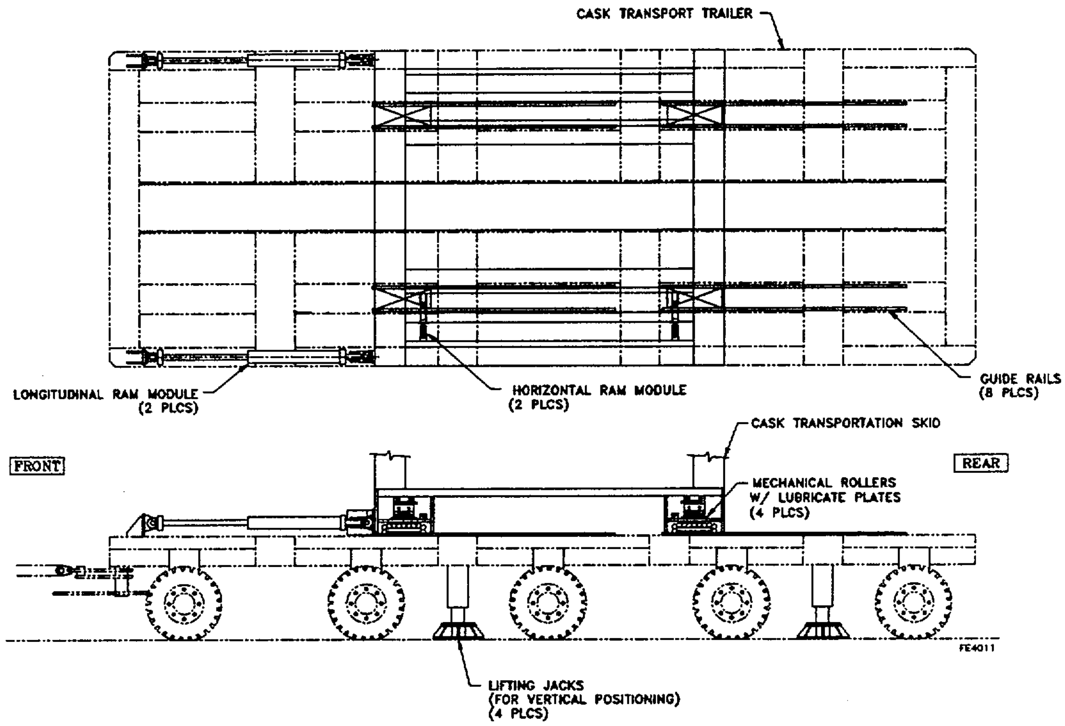


Figure 4.7-5
NUHOMS®-12T Skid Positioning System (SPS)

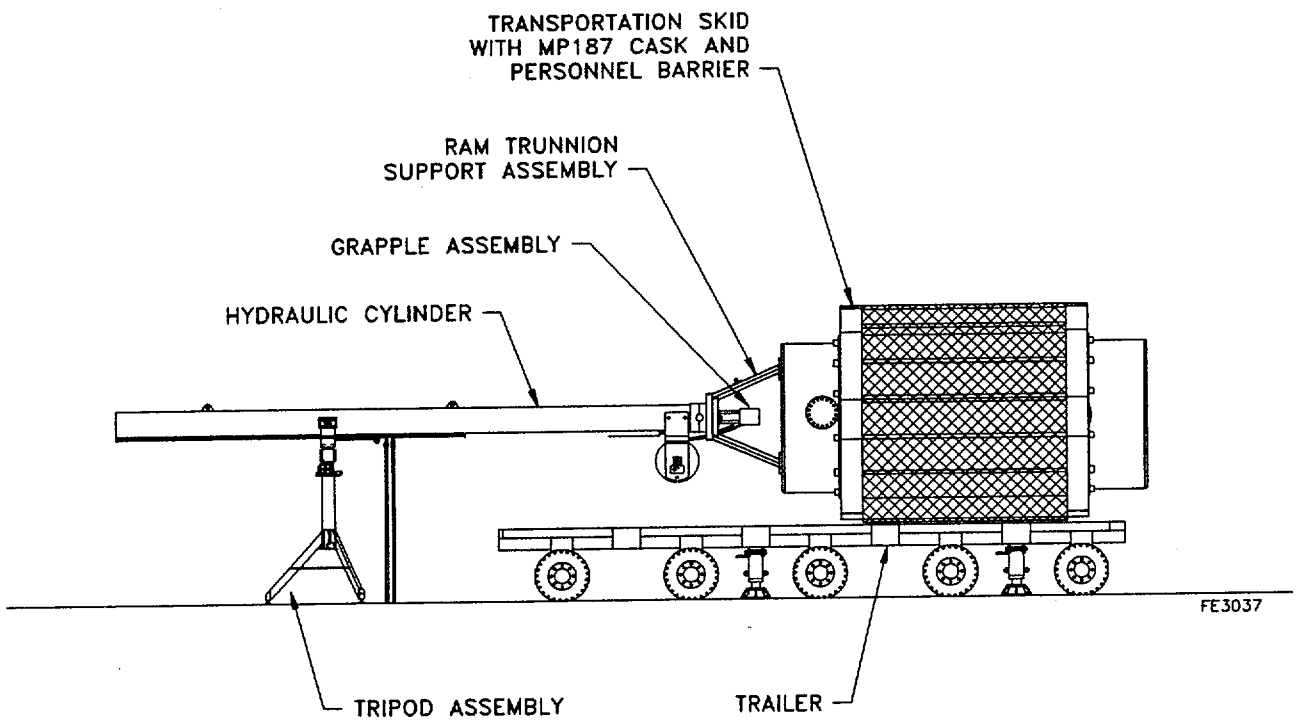
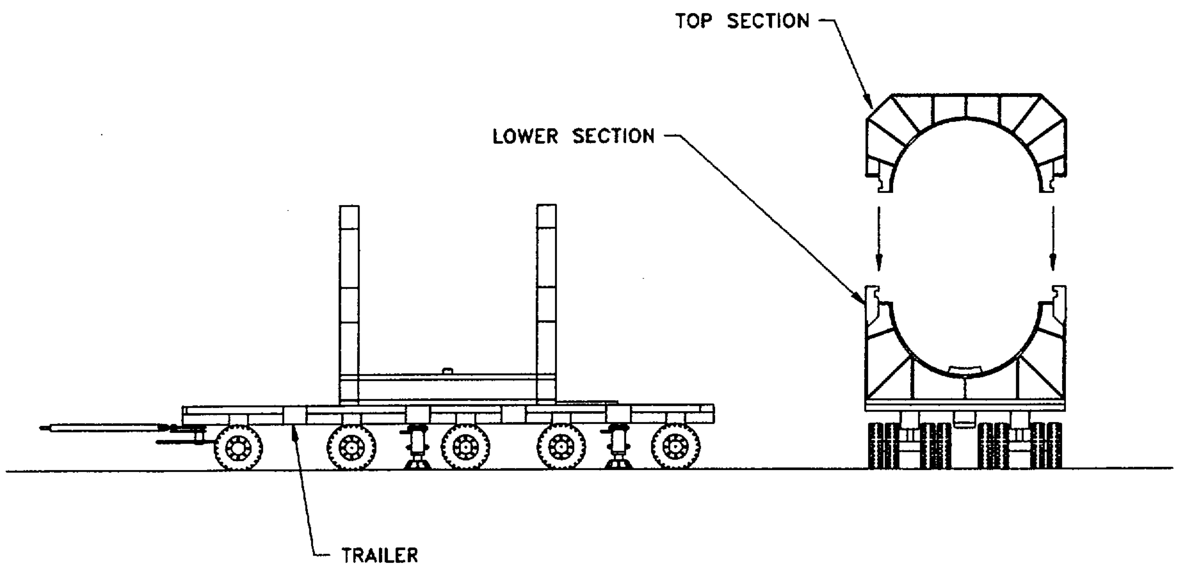
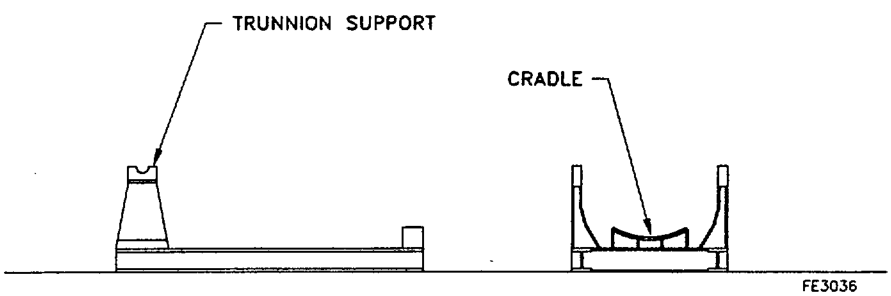


Figure 4.7-6
<u>Hydraulic Ram and Transportation Skid</u>



TRANSPORTATION SKID



TURNING SKID

Figure 4.7-7
Cask Transportation Skid

4.8 References

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5. OPERATION SYSTEMS

This chapter describes the operations to be performed using the NUHOMS®-12T system with the MP-187 transportation cask described in previous chapters and shown on the drawings in Appendix A. Appendix E describes the operations to be performed using the NRC 10 CFR 72 approved OS-197 Transfer Cask. The major difference between the two transportation approached is that the NRC 10 CFR 72 approved OS-197 Transfer Cask does not require impact limiters, evacuation and helium backfill of the DSC, leak testing of the DSC closure weld, or installation of the vent/filter housing transportation covers. The operations include preparation of the DSC and fuel loading, closure of the DSC, transport to the ISFSI, DSC transfer into the HSM, monitoring operations, and DSC retrieval from the HSM. The NUHOMS®-12T transfer equipment, and the existing systems and equipment are used to accomplish these operations.

Operations are performed in two locations: the TAN Hot Shop and the ISFSI. Handling operations at the TAN Hot Shop are described herein but are not subject to licensing, however certain steps in the TAN procedures implement requirements of the licensed system and these procedure steps are subject to change control under 10 CFR 72.48 (see 9.4.1). Operations at the ISFSI are subject to requirements of 10 CFR Part 72. Procedures are delineated in outline form to describe how these operations are to be performed and are not intended to be limiting. TMI-2 canister and cask handling operations performed at TAN under DOE regulated procedures and operations under the purview of 10 CFR Part 71 are described in less detail. Operational procedures at TAN and procedures for transportation under 10 CFR Part 71 may be revised and new ones may be developed according to INEEL requirements, provided that the limiting conditions of operation are not exceeded.

5.1 Operation Description

The following sections outline the general procedures (sequences of steps) that will be followed to prepare and load TMI-2 canisters into the DSCs, transfer the DSCs from TAN to the ISFSI, and place the DSCs into the HSMs at the ISFSI. Operating procedures will be developed for the NUHOMS®-12T system to ensure these sequences are followed to: minimize the amount of time required to complete the subject operations; minimize personnel exposure; and assure that all operations required for DSC loading, closure, transfer, and storage are performed safely. The procedure outlines presented here are provided as a guide for the preparation of the operating procedures and serve to point out how the NUHOMS®-12T system operations are to be accomplished. This outline is not intended to be limiting in that DOE-ID may judge that alternate acceptable means are available to accomplish the same operational and safety objectives.

5.1.1 Narrative Description of Operations at the TAN Hot Shop

The following steps describe the recommended operating procedures for the NUHOMS®-12T system with the MP-187 transportation cask. Figure 5.1-1 provides a series of pictorial views of the key loading and transfer operations to help in the description of the operating activities.

5.1.1.1 Preparation of the Cask and DSC

1. Prior to placement in dry storage, the TMI-2 canisters are to be 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. Install lower trunnions on the cask. Place the cask on the turning skid. Install upper trunnions. Upright the cask using a cask handling crane.

3. Place the cask in the vertical position in the TAN Hot Shop using the cask handling crane and the cask rigging.

4. Place scaffolding around the cask so that the top cover plate and surface of the cask are easily accessible to personnel.

5. Remove the cask top cover plate and top spacer. Examine the cask cavity for any physical damage and ready the cask for service.

6. 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.

7. 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.

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

9. Place the top shield plug onto the DSC. Examine the top shield plug to ensure a proper fit.

10. Remove the top shield plug.

5.1.1.2 TMI-2 Canister Loading into the DSC

1. Remotely load the dry TMI-2 canisters from the canister staging area into the DSC in accordance with the TAN procedures. Remove the TMI-2 canister inlet and drain line caps and remove the quick disconnect fittings, if not already done.

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

3. Install test flanges on vent and purge penetrations on the shield plug.

4. After all the TMI-2 canisters have been placed into the DSC and their identities verified and recorded, position the cask rigging and the top shield plug and lower the shield plug into the DSC.

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

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

5.1.1.3 DSC Shield Plug Sealing

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

2. Place the automated welding machine onto the cask. As an alternative manual welding is permissible.

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

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

5. 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.

6. Obtain authorization to proceed and then ready the automated welding machine, if installed, and tack weld the shield plug to the DSC shell. Complete the 360° continuous shield plug weldment and remove the automated welding machine, if installed.

7. Perform surface examination of the shield plug welds (one continuous 360° shield plug to DSC shell weld, one purge penetration weld) in accordance with the Technical Specification requirements.

8. Connect the vacuum drying system (VDS) to the DSC purge port as shown in Figure 4.7.1.

9. Connect the hose from the purge test port to the intake of the vacuum pump. Connect a hose from the discharge side of the VDS to an off-gas system. Connect the VDS to a helium source.

10. Open the valve on the suction side of the pump, start the VDS and draw a vacuum on the DSC cavity. When the pressure reaches 10 torr or less, the DSC evacuation is complete. This step is performed to provide an evacuated DSC so that when backfilled with helium, the helium is not diluted with air.

11. Open the valve to the purge port and allow the helium to flow into the DSC cavity.

12. Pressurize the DSC with helium to 22 psia.

13. Helium leak test the shield plug to DSC shell weld for leakage. This leak test is performed for informational purposes prior to welding on the top cover plate.

14. If a leak is found, repair the weld, re-pressurize the DSC and repeat the Step 6 surface examination and the helium leak test.

15. If no leak is detected, release the pressure.

5.1.1.4 DSC Top Cover Installation

1. Disconnect the VDS from the DSC.

2. Place the top cover plate onto the DSC. Verify proper fit up of the top cover plate with the DSC shell. Install the automatic welding system on the cask (as an alternative manual welding is permissible).

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 Specification requirements.

4. Remove the automated welding machine from the cask, if installed. Remove vent port test cover and manually seal weld the top cover to the shield plug around the vent and purge penetrations. Perform surface examination of the seal welds in accordance with Technical Specification requirements.

5. Remove temporary shielding from the vent port and purge port penetrations.

6. Install the vent and purge filter assemblies (with transportation covers already installed on the filter assemblies) and the double mechanical seals onto the DSC penetrations.

7. Evacuate and backfill the DSC with helium in accordance with 10 CFR Part 71 requirements. Evacuate and leak test the annulus between the double mechanical seal between the DSC and the vent assembly. Test ports are integral to the filter housings. Testing is done in accordance with 10 CFR Part 71 (10 CFR Part 71 requirements bound), however, only the Technical Specifications requirements are required for the 10 CFR Part 72 license.

8. Remove the temporary cask/DSC annulus cover.

9. Rig the cask top cover plate with top internal spacer attached and lower the cover plate onto the transport cask. Bolt the cask cover plate into place, tightening the bolts to the required torque in a star pattern.

10. Leak test the DSC and cask in accordance with the 10 CFR Part 71 requirements and document on the acceptance form.

5.1.1.5 Cask Downending and Preparation for Transport to ISFSI

1. The transport trailer should be positioned so that the cask support skid is accessible with the trailer supported on the vertical jacks.

2. Re-attach the transport cask rigging to the crane hook. Transfer the cask to the turning skid and then downend the cask. Remove cask upper trunnions. Return the cask to the transport trailer.

3. Remove the cask lower trunnions. Install top half of transport skid frame. Install impact limiters. Install personnel barriers.

4. Complete applicable transfer forms for the spent nuclear fuel (SNF) contained in the DSC and attach to the acceptance form.

5.1.2 Operations Conducted at the ISFSI

5.1.2.1 DSC Transfer to the HSM

1. 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.

2. Prior to transfer activities, verify that DSC temperatures are within the control limits of Technical Specifications of the SAR.

3. Using a suitable heavy haul tractor, transport the cask from the TAN facility to the ISFSI along the designated transfer route.

4. Once at the ISFSI, remove the cask impact limiters and complete the receipt records verification.

5. After removing the impact limiters, move the transport trailer to the HSM.

6. 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.

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

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 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.

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

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

11. Using the skid positioning system, fully insert the cask into the HSM access opening docking collar.

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

13. Install ram front support on base of cask. 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.

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

15. Recheck all alignment marks and ready all systems for DSC transfer.

16. 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.

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

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

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

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

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

22. Open rear wall access door. Remove transportation covers from the vent and purge assemblies and install the dust covers.

23. Close and lock the rear wall access door.

24. 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.

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

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

5.1.2.2 HSM Monitoring Operations

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

2. Perform surveillance of the DSC vent system in accordance with the Technical Specification requirements.

5.1.2.3 DSC Retrieval from the HSM

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

2. Prior to retrieval activities, verify that DSC temperatures are within the control limits of Technical Specifications.

3. Open the rear wall access door. Remove the vent system dust covers and install the transportation covers on the vent and purge filter assemblies. Evacuate and backfill the DSC, with helium (if required for 10 CFR Part 71 transportation testing). Install and leak test (if required for transport) the vent and purge assembly seals and vent and purge assembly transportation cover seals.

4. Back the trailer to within a few inches of the HSM, remove the cask top cover plate and top internal spacer.

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

6. 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.

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

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 transport.

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 shipping 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 or other facility.

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

3. Remove the top half of the transportation skid and install lower trunnions.

4. Move cask to turning skid.

5. Install upper trunnions.

6. Move the crane backward in a horizontal motion while simultaneously raising the crane hook vertically and lift the cask off the turning skid.

7. Lower the cask to stand in a vertical position.

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

9. Place scaffolding around the cask so that any point on the surface of the cask is easily accessible to handling personnel.

10. Unbolt the cask top cover plate.

11. 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.

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

The process of DSC unloading is similar to that used for DSC loading. 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:

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

14. Vent and purge the gas inside the DSC through the vent port to the facility off-gas system and backfill the DSC with an inert gas such as argon.

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

16. Place welding blankets around the cask and scaffolding.

17. 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 scaffolding, as appropriate. The exhaust system should be operating at all times.

18. 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.

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

20. Remove the exhaust hood, if necessary.

21. Remove the DSC top cover plate.

22. 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.

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

24. Lift the top shield plug from the DSC.

25. 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 are within the control limits of Technical Specifications.

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 docking collar.

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 the DSC overpack cover including surface examination of the root and final pass of the weld in accordance with Technical Specification requirements.

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

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

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

22. 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 physical protection plan.

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

5.1.2.7 DSC Retrieval from the Overpack

1. Ready the cask, transport 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 are within the control limits of Technical Specifications.

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 vent and purge port filter/transportation cover assemblies, if required. Install and leak test (if required for transport) the vent assembly transportation covers.

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

23. 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 5.1.1. A series of pictorial views of operations is also shown in Figure 5.1-1.

5.1.4 Identification of Subjects for Safety Analysis

5.1.4.1 Criticality Control

The criticality analyses and controls for the NUHOMS®-12T system are described in Section 3.3.4.

5.1.4.2 Chemical Safety

There are no hazardous chemicals used in the NUHOMS®-12T system that require special precautions. Material control procedures at the TAN facility will ensure that no hazardous chemicals or surface contaminants are introduced.

5.1.4.3 Operation Shutdown Modes

NUHOMS®-12T is a totally passive system, including DSC venting, and has no operational shutdown modes.

5.1.4.4 Instrumentation

Table 5.1-1 shows the typical instruments which might be used to measure conditions or control the operations during the DSC loading, closure, transfer, and storage operations. The instruments are standard industry equipment, which is readily available.

5.1.4.5 Maintenance Techniques

The NUHOMS®-12T system does not require maintenance during storage except when sampling of the DSCs indicates that filter replacement and DSC purging is required. When required by Technical Specification limits, the DSC would be purged and the HEPA grade filters replaced. HEPA grade filter replacement would be performed while a slight negative pressure differential is maintained with the vacuum drying system.

Table 5.1-1
Instrumentation Used for NUHOMS®-12T System Operations

	Instruments	Function
1.	Gross Gamma/Beta/Neutron Detectors	Measure dose rate at DSC top cover plates
2.	Pressure and Vacuum Gauges	Measure helium, air and vacuum pressures inside DSC. Measure the pressure drop across the HEPA filters.
3.	Hydraulic Pressure Gauges and Ram Pressure Relief Valves	Measure and limit hydraulic ram force applied to DSC
4.	Optical Survey Equipment	Align cask and ram with HSM
5.	Gas Sampling Equipment	Measure hydrogen concentration during vent system surveillance activities
6.	Air Particulate Measuring Equipment	Measure air samples outside of filters for airborne activity.

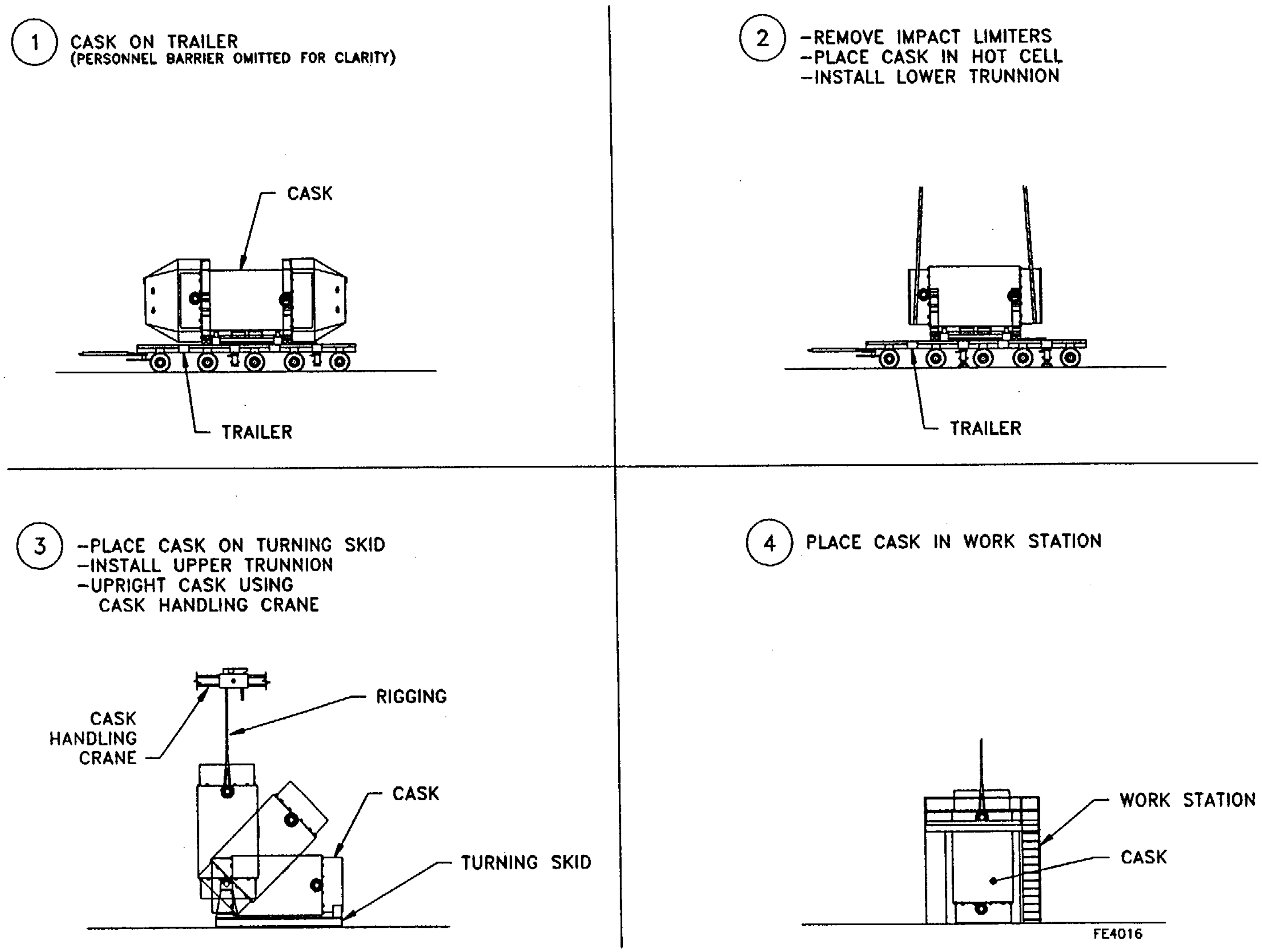

Figure 5.1-1
Primary Operations for the NUHOMS®-12T System

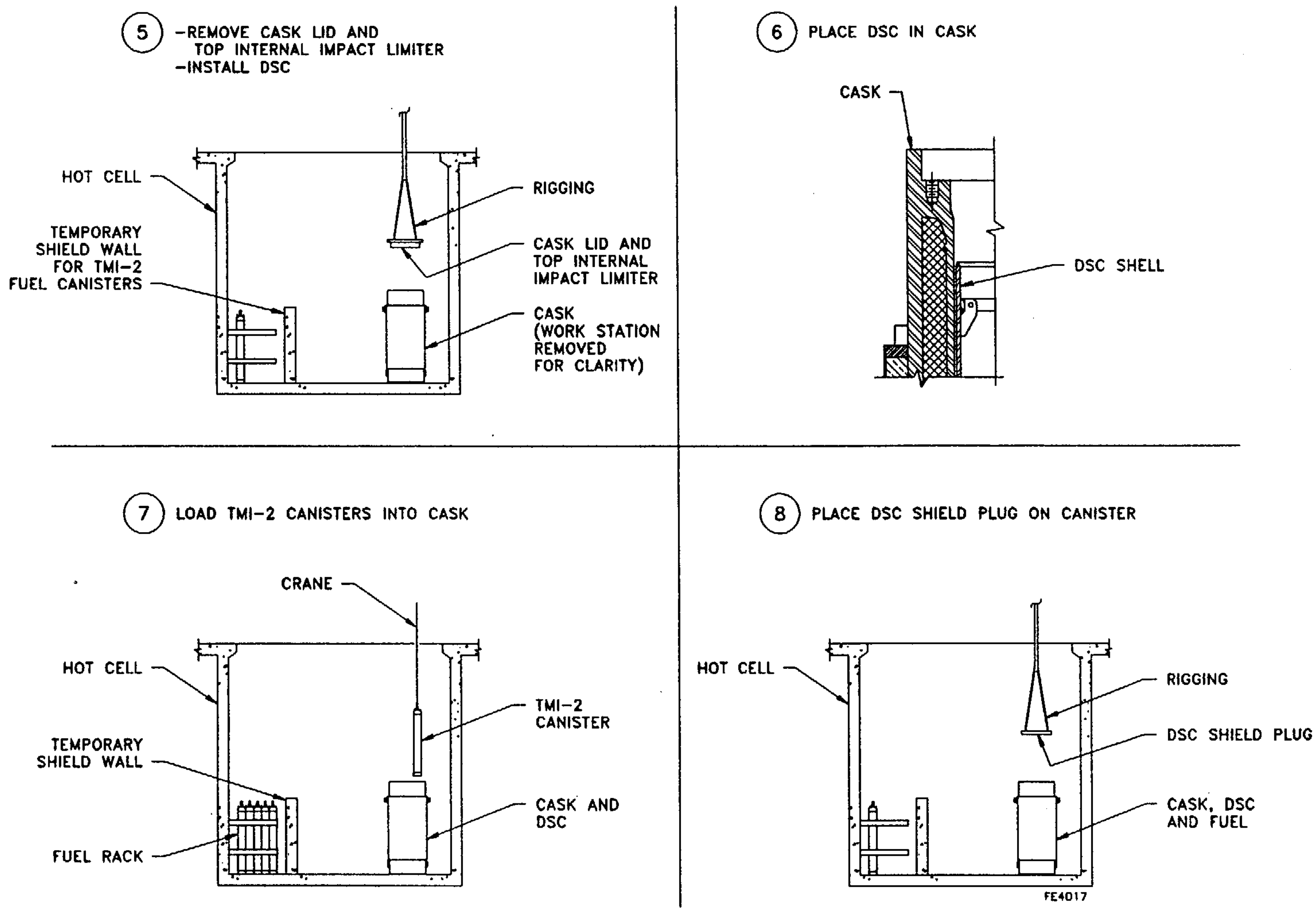

Figure 5.1-1
Primary Operations for the NUHOMS®-12T System
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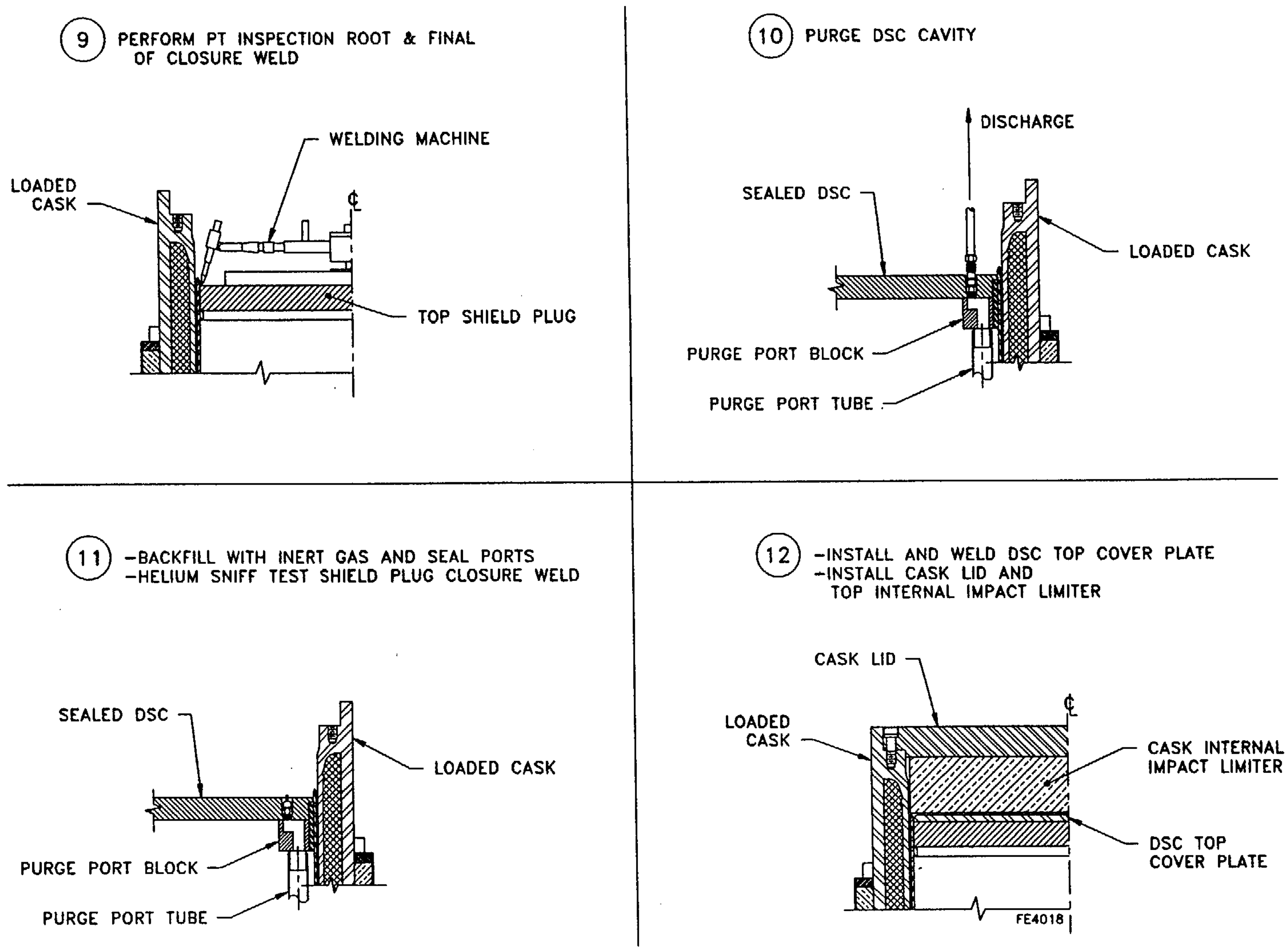

Figure 5.1-1
Primary Operations for the NUHOMS®-12T System
(continued)

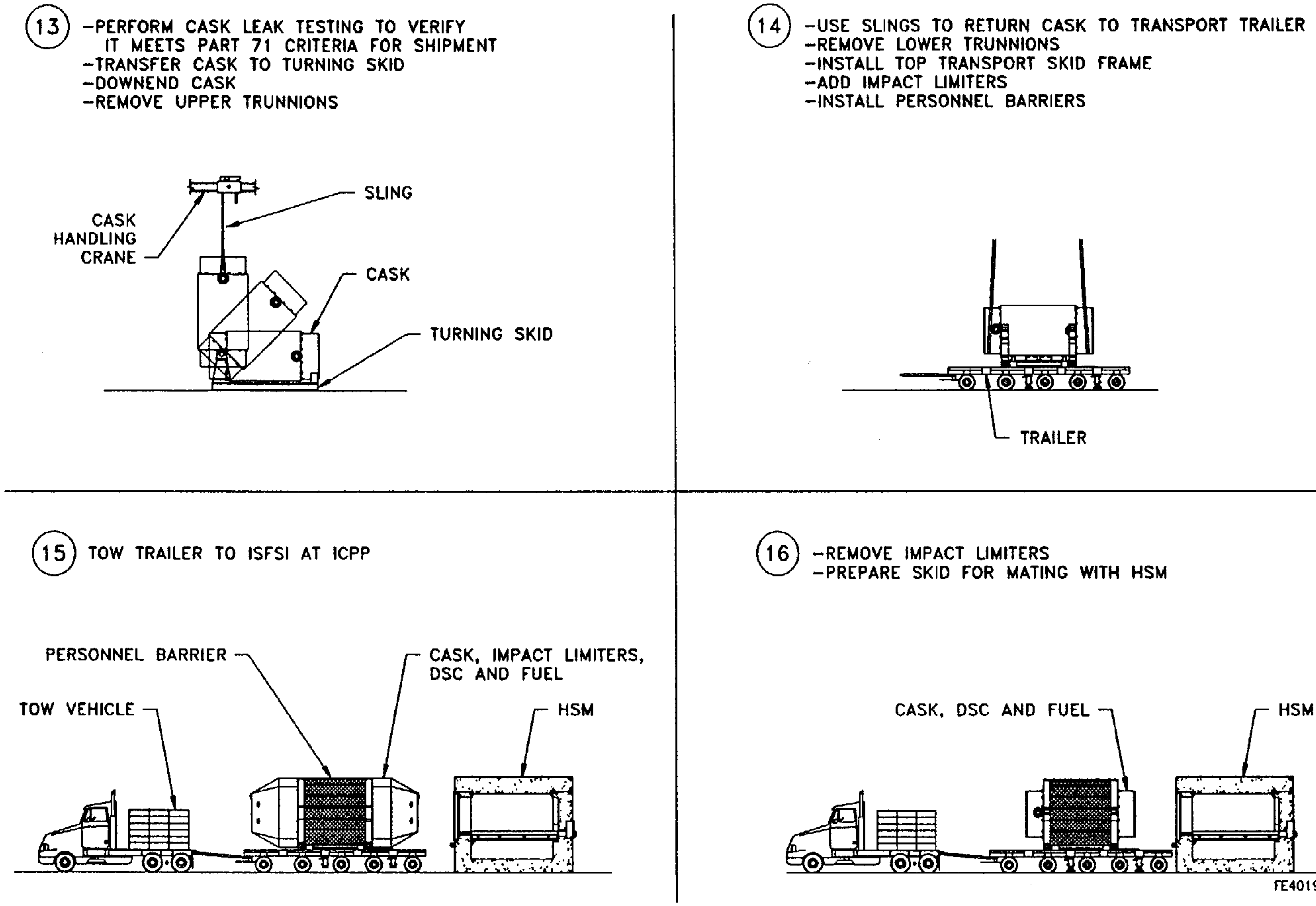

Figure 5.1-1
Primary Operations for the NUHOMS®-12T System
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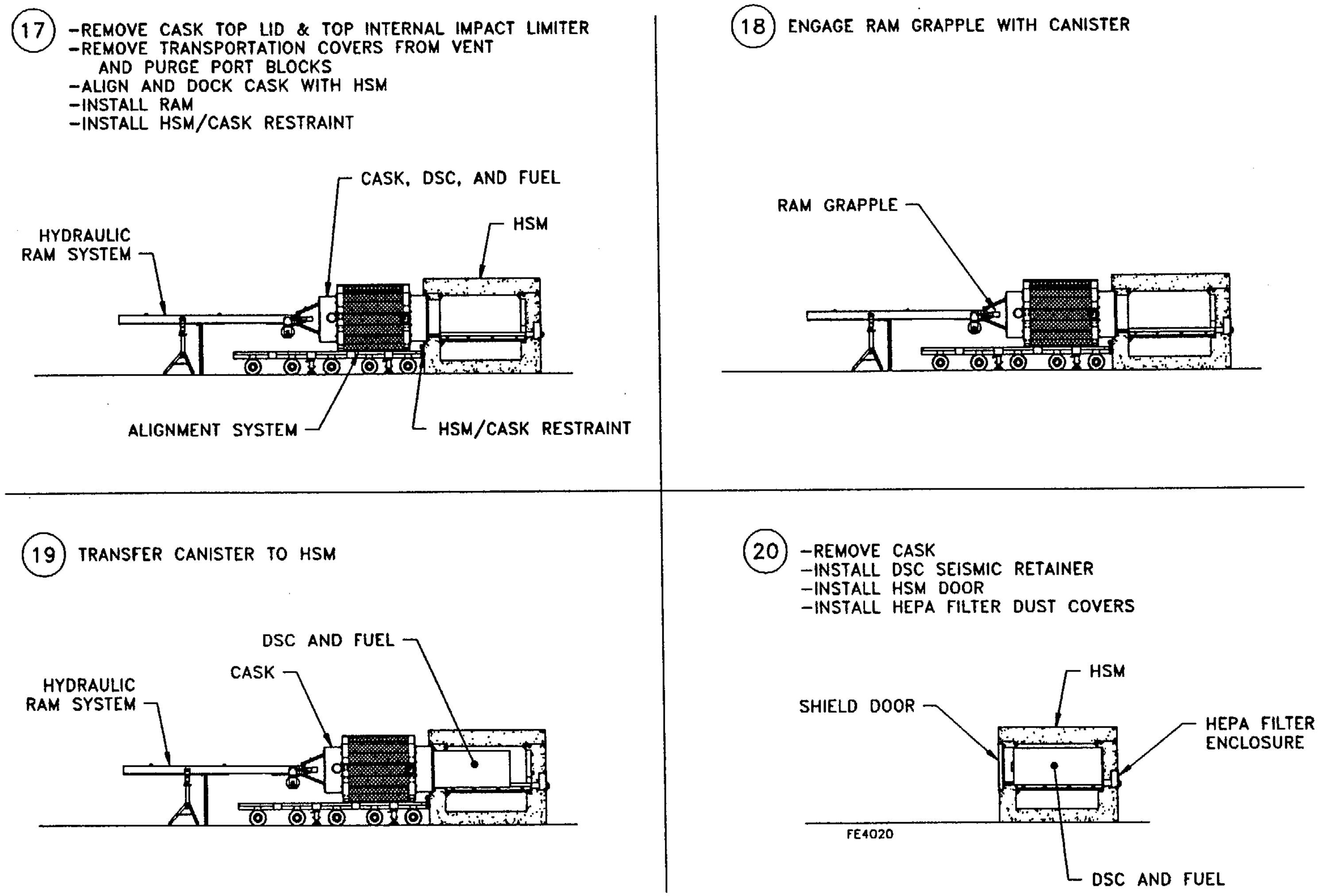

Figure 5.1-1
Primary Operations for the NUHOMS®-12T System
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5.2 Fuel Handling Systems

5.2.1 TMI-2 Canister Handling and Transfer

NUHOMS®-12T is a modular storage system which provides for the dry storage of TMI-2 canisters in a horizontal orientation. NUHOMS®-12T is a system designed to be installed at the INEEL INTEC site. It utilizes the existing systems at the TAN for handling TMI-2 canisters and casks. This section describes the TMI-2 canister handling systems that are unique to NUHOMS®-12T and used during the DSC loading, closure, and transfer operations. The transfer system is described in this section to illustrate the hardware and procedures required for operation of the NUHOMS®-12T system.

5.2.1.1 Function Description

Figure 5.1-1 illustrates the DSC loading, closure, and transfer operations.

Transfer System: The transfer system is composed of the cask, lifting device, support skid, skid positioning system, transport trailer, hydraulic ram, and auxiliary equipment as described in Section 1.3.2.

Cask: The cask is used to transfer a loaded DSC to and from the HSM. The cask provides biological shielding during the transfer, loading, and retrieval operations. During transfer of the DSC to the HSM, the top end of the cask is docked within the HSM access opening sleeve. A description of the cask design criteria and capabilities are provided in Chapters 3, 4, and 8.

Cask Transportation Skid: The purpose of the cask transportation skid, shown in Figure 4.7-7, is to transport the cask in a horizontal position to the ISFSI and maintain the cask alignment during the loading and retrieval operations. The skid is mounted on bearing plates and secured to the transport trailer during transport. These bearings permit the skid to be moved in the longitudinal and transverse directions with respect to the trailer. The skid positioning system shown in Figure 4.7-5, allows the DSC to be precisely aligned with the DSC support structure inside the HSM. Section 3.1.2.1 establishes the criteria for design of the cask transportation skid.

Transport Trailer: The function of the transport trailer is two-fold: 1) to transport the loaded cask in the horizontal position to the ISFSI, and 2) to approximately align the cask with the HSM opening. The trailer shown in Figure 4.7-3 is a standard heavy haul trailer capable of handling a 125 ton payload.

Optical Survey Equipment: After the loaded trailer has been backed up to the HSM, the cask is aligned with the HSM. Alignment is achieved using a transit and optical alignment marks on the cask and HSM as shown in Figure 5.2-1. Once the cask is aligned with the HSM, the trailer jacks and cask restraints ensure that alignment is maintained throughout the DSC transfer or retrieval operations.

Jack Support System: The tires on the trailer are pneumatic. As the DSC is being transferred into or out of the HSM, the transfer of the load may cause the alignment to be altered or cause the DSC to bind in the cask or HSM. To ensure that the alignment is maintained throughout the DSC transfer or retrieval operations, jacks at four locations on the trailer are used as shown in Figure 4.7-3. The design criteria for the jack support system are established in Section 3.1.2.

Cask Restraints: During the DSC transfer or retrieval operations, the resistance of the DSC could cause the cask to move in its axial direction. This motion could cause the alignment to be altered or the shielding by the HSM and cask to be jeopardized. To ensure that the cask does not move in the axial direction, cask restraints join the HSM front wall embedments to the cask.

Ram and Grappling Apparatus: The ram is a hydraulic cylinder which extends from the back of the cask through the length of the cask as shown in Figure 4.7-6. The grappling apparatus is mounted on the front of the ram as shown in Figure 4.7-6. The hydraulics for the grappling apparatus are activated, causing the arms to engage the DSC grapple ring. Once the arms are engaged, the ram is extended, pushing the DSC out of the cask and into the HSM. For retrieval of the cask, the process is reversed. The DSC slides along the cask inner liner rails and onto the support rails inside the HSM.

DSC Support Rails: During the transfer operation, the DSC slides out of the cask on hard surfaced rails and onto the support rails inside the HSM as shown in Figure 4.2-3. The support rails in the HSM serve as both the sliding surfaces during the transfer operation as well as supports during DSC storage. The support rail surface that comes into contact with the surface of the DSC, is coated with a lubricant.

5.2.1.2 Safety Features

Except for the transfer of the DSC from the cask to the HSM, the loaded DSC is always seated inside the cask cavity. The safety features used in handling the cask at the TAN facility are described in the facility safety procedures.

To ensure that the minimum amount of force is applied to the DSC during the transfer operation, the cask cavity rails and the HSM support rails are coated with a lubricant. A low coefficient of friction minimizes the amount of force applied to the DSC, thus minimizing the possibility of damage to the DSC.

If the motion of the DSC is impeded during the transfer operation and the ram continues to travel, the force exerted by the ram on the DSC will increase. To indicate the occurrence of such an event, the amount of force which the ram may exert is limited by the ram control system and monitored by the operator. The stresses which develop in the DSC due to the maximum loading force are less than the allowable limits of the DSC material and, therefore, the integrity of the canister shell and closure welds is not jeopardized.

5.2.2 TMI-2 Canister Storage

Descriptions of the operations used for the transfer and retrieval of the DSC from the HSM are presented in Section 5.1.

5.2.2.1 Safety Features

The features, systems, and special techniques which provide for safe loading and retrieval operations are described in Section 5.2.1.2.

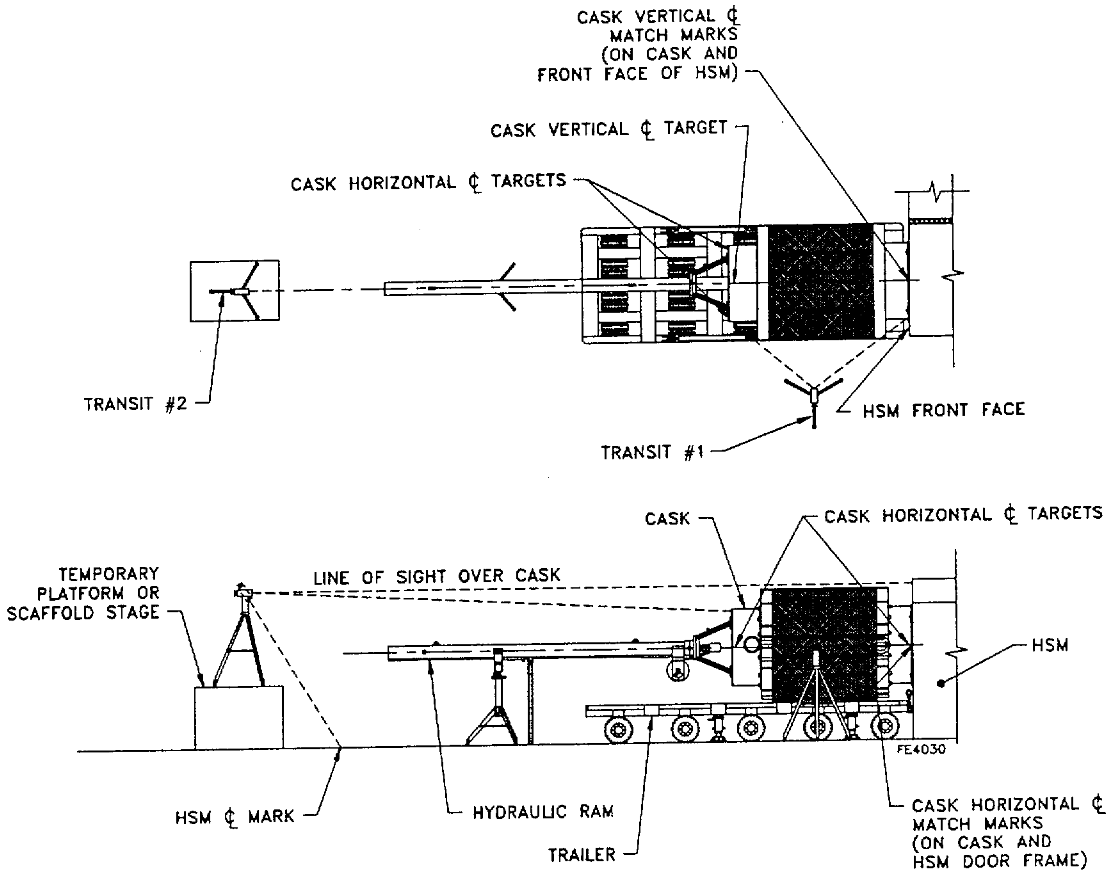

Figure 5.2-1
NUHOMS® Cask/HSM Alignment Verification

5.3 Other Operating Systems

5.3.1 Operating System

NUHOMS®-12T is a passive storage system and requires no operating systems other than those systems used in transferring the DSC to and from the HSM.

5.3.2 Component/Equipment Spares

As discussed in Section 8.2, the INEEL TMI-2 ISFSI is designed to withstand all postulated design basis events. Therefore, no storage component or equipment spares are required for the standardized NUHOMS®-12T system, with the exception of periodic changeout of the HEPA filters.

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5.4 Operation Support System

NUHOMS®-12T is a self-contained passive system and requires no effluent processing systems during storage conditions.

5.4.1 Instrumentation and Control System

There are no instrumentation and control systems included in the system design. The instrumentation and controls necessary during DSC loading, closure, transfer and periodic testing during storage are described in Section 5.1.4.4.

5.4.2 System and Component Spares

There are no instrumentation or control systems used during storage conditions; thus, no other system and component spare parts are required.

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5.5 Control Room and/or Control Areas

There are no control room or control areas for the NUHOMS®-12T system.

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5.6 Analytical Sampling

Periodic DSC sampling is performed for the NUHOMS®-12T system in accordance with the Technical Specification surveillance and monitoring requirements. The objective of this sampling is to ensure that the hydrogen gas remains at safe levels and the vent system and HEPA filters are functioning properly.

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5.6 Analytical Sampling

Periodic DSC sampling is performed for the NUHOMS®-12T system in accordance with the Technical Specification surveillance and monitoring requirements. The objective of this sampling is to ensure that the hydrogen gas remains at safe levels and the vent system and HEPA filters are functioning properly.

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6. SITE-GENERATED WASTE CONFINEMENT AND MANAGEMENT

All waste produced by the INEEL TMI-2 ISFSI is handled and disposed of in accordance with the existing procedures for handling waste at the Idaho National Engineering Laboratory (INEEL). Drying of the TMI-2 canisters is done prior to loading in the DSC in accordance with INEEL procedures. INEEL has existing facilities to treat and dispose both liquid and solid waste.

6.1 On-Site Waste Sources

Transfer operations, routine maintenance and maintenance of the HEPA grade filters in the DSC vent system are the only activities that will generate waste, in the form of dry radioactive waste, during the design life of the system. On the average, the filters could be replaced five times during the 50 year life of the system. This is based on the minimum expected life of the filters per the manufacturer. The vent system is designed with dust covers so plugging or damage of the filters is not expected to contribute significantly to the replacement of the filters. The waste from filter maintenance would consist of the filters and any bags that might be used to cover the filter opening while the filter is being replaced or anti-contamination clothing that may be used in the replacement process. It is estimated that this would consist of about one-half cubic foot per DSC over the design life of the ISFSI. Depending on the handling procedures used, some additional waste, such as plastic bags and tape, could be generated from handling the sampling tool. This is estimated at about one-half cubic foot per DSC. The total dry active waste would be about one cubic foot of waste per DSC.

At the time of closing the ISFSI, the most likely scenario is for the DSCs to be opened, removing the TMI-2 canisters, transporting the DSCs, TMI-2 canisters, and HSMs off-site where they are reassembled for additional storage. Most of the material will be reusable, some such as the DSC lids, filters, seals, etc. would most likely be disposed of. Also some waste will be generated in decontaminating the DSCs and HSMs. The total estimated waste for this activity is less than 10 cubic feet per module. The HSM and basemat, if not reused, would be disposed of as clean free release material after radiological surveys and decontamination which is allowed for in the above waste estimate. The components are fabricated from reinforced concrete and structural steel.

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6.2 Offgas Treatment and Ventilation

As described above, potential radioactive wastes produced by the vent system consists of HEPA grade filters and maintenance equipment used in the replacement of the HEPA filters. The gas velocities in the TMI-2 canisters (where the activity is), the DSC and the vent system are extremely low. There is no significant driving mechanism for the fuel particles inside the TMI-2 canisters and the DSC to become entrained in any air flow and carried to the filters. However, the filters are installed to ensure that none of the material escapes from a DSC. Due to the nature and condition of the core debris, and the fact that the damaged fuel has been vented for over ten years, most of the gases that were readily releasable have been released. Therefore, there is no significant volume of releasable fission gases remaining in the TMI-2 canisters. A more detailed discussion of potential releases is provided in Section 7.2.2.

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6.3 Liquid Waste Treatment and Retention

All contaminated liquids will remain at the TAN facility where the TMI-2 canisters are dried before being placed in the DSC. As such, liquid wastes will be treated in accordance with TAN procedures. All rain water, ice, and snow will run off the outside of the HSM and will not come in contact with contaminated surfaces. The HSMs have individual drains that would allow any water entering them to exit. These drains will be monitored for radioactivity on a periodic basis

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6.4 Solid Wastes

During operation the only solid wastes would be those associated with the HEPA vent system and the facility decommissioning wastes described above. These wastes will be packaged, treated and disposed in accordance with the existing procedures that are in place at the INEEL. Currently, INEEL procedures consist of bagging the waste and placing it in disposal containers where it is transported, either to a waste treatment facility for further treatment, such as incineration, or directly to a low level waste disposal facility.

6.4.1 Design Objectives

The design objectives for the vent system are to minimize the system volume and to use commonly available components. The system is designed to minimize volume of waste generated by activities for maintenance and decommissioning.

6.4.2 Equipment and System Description

There will be no special equipment used for volume reduction, confinement and/or packaging, storage, and disposal.

6.4.3 Operating Procedures

The HEPA filters on the DSC can be replaced by placing new filters in a glove bag with a tool for turning the filters, and securing the bag to the filter housing. The old filters can be removed and the new ones installed within the glove bag. Alternatively, the vent/purge gas sampling system can be used to establish an in-flow of air through the HEPA filter assemblies while work is conducted on the HEPA filter system. This will ensure all potentially loose particles are carried into the DSC.

6.4.4 Characteristics, Concentrations, and Volumes of Solid Wastes

As stated above, there may be about one cubic foot of radioactive waste generated for each stored DSC over the lifetime of the storage system. This waste will consist mainly of the plastic containment bags and filter elements. In addition to the waste that would be generated in the operation of the ISFSI, there will be less than 10 cubic feet of solid waste per module generated during decommissioning of the facility.

6.4.5 Packaging

The waste will be packaged in plastic bags and then in metal or wood disposal containers in accordance with INEEL procedures.

6.4.6 Storage Facilities

No special storage facilities are required. The waste will be transported immediately from the ISFSI to the INEEL waste handling system where it will undergo further treatment, or sent directly to a disposal facility.

6.5 Radiological Impact of Normal Operations-Summary

The total waste generated will be approximately one cubic foot of waste per DSC over the design life of the system, or a total of 29 cubic feet for the complete facility. In addition to the waste generated during the operation of the ISFSI, another 10 cubic feet per module will be generated in decommissioning the facility.

The small volumes of waste generated during loading, closure, and storage operations will have no significant impact on the ability of existing INEEL facilities to handle and process them. None of the waste will be stored at the ISFSI. As waste is generated it will be disposed of in the INEEL waste system.

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7. RADIATION PROTECTION

This chapter presents the radiation protection features of the NUHOMS®-12T system using the NRC certified MP-187 for transportation from TAN to INTEC. Appendix E of this SAR presents the radiation protection features of the NUHOMS®-12T system using the NRC 10 CFR 72 approved OS-197 Transfer Cask for transportation from TAN to INTEC.

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

7.1.1 Policy Considerations

It is the policy of the DOE Idaho Operations Office (DOE-ID) to take every precaution to control radiation and the spread of radioactive contamination in the performance of work, to be in full compliance with the requirements established by the NRC, to prevent unnecessary radiation exposure to employees and the public, and to prevent harmful effects to the environment. Radiological operations at the ISFSI will be conducted in a manner consistent with those at the Idaho National Engineering Laboratory (INEEL). Radiation exposures to workers and the public and releases of radioactivity to the environment are maintained below regulatory limits, and deliberate efforts are taken to further reduce exposures and releases to As-Low-As-Reasonably-Achievable (ALARA) levels.

To comply with this policy, all levels of line management are accountable for radiological performance. The responsibility for compliance with the radiological protection requirements and for minimizing personnel radiation exposure begins at the worker level and broadens as it progresses upward through the line organization. Line managers are responsible for taking all necessary actions to ensure that requirements are implemented and that performance is monitored and corrected as necessary. Radiological Control Technicians (RCTs) assist line management by routinely evaluating and monitoring all radiological conditions. Also, RCTs oversee activities to ensure that all reasonable precautions are taken by personnel.

The requirements for the ALARA policy and program are provided by 10 CFR Part 20, "Standards for Protection Against Radiation" [7.1] DOE-ID is committed to reducing safety and health risks associated with hazardous substances (including ionizing radiation) by promoting ALARA policy awareness, and reducing and keeping radiation exposures to ALARA levels. The following methods are used to achieve ALARA objectives.

A. Establishing employee and organizational level ALARA goals, tracking employee exposure, and maintaining associated records.

B. Allocating the appropriate technical, administrative, and supervisory resources.

C. Appointing an ALARA committee to oversee and evaluate efforts, and to provide technical assistance for identifying needed improvements.

D. Controlling access to radiation and radioactive contamination areas.

E. Minimize the working time required in high radiation areas and high surface contamination areas, as appropriate.

F. Using engineered controls (e.g., ventilation, remote handling, and shielding) and monitoring equipment (e.g., continuous air monitors and remote area monitors).

G. Requiring an ALARA review of procedures and work packages for the INEEL TMI-2 ISFSI that involve radiological work resulting in either 100 mrem individual exposure, 500 mrem collective exposure, or entries into High Radiation Areas where the general area radiation levels exceed 1 rem/hr.

7.1.2 Design Considerations

The NUHOMS®-12T design to be installed at INEEL incorporates design features and improvements from previously constructed NUHOMS® installations at H.B. Robinson, Oconee, Calvert Cliffs, and Davis-Besse. The NUHOMS® design ensures ALARA by minimizing required maintenance operations, minimizing radiation levels and operating times, and providing contamination control during handling, transfer, and storage of radioactive material. The ALARA design criteria for the NUHOMS®-12T system results in generally lower dose rates and exposures than those of the previously licensed Standardized NUHOMS® system [7.3]. Specific features of the NUHOMS® system that are directed toward ensuring ALARA include:

A. Thick concrete walls and roof on the HSM to minimize the on-site and off-site dose contribution from the ISFSI.

B. A thick shield plug on each end of the DSC to reduce the dose to plant workers while performing venting and sealing operations, and during transfer and storage of the DSC in the HSM.

C. Use of a heavy shielded cask for DSC handling and transfer operations to ensure that the dose to employees and the general public is minimized.

D. Fuel loading procedures which follow accepted practice and build on existing experience.

E. A recess in the HSM access opening to dock and secure the cask during DSC transfer so as to reduce direct and scattered radiation exposure.

F. Use of a heavy shielded door on the HSM to minimize direct and scattered radiation exposure.

G. Use of a passive system design for long-term storage that requires minimal maintenance.

H. Use of proven procedures and experience to control contamination during canister handling and transfer operations.

I. Use of temporary shielding during DSC inerting and closure operations as necessary to further reduce the direct and scattered dose.

J. A labyrinth design for the DSC vent and purge ports to minimize exposures during welding and filter installation and change-out.

Further ALARA measures may be implemented, as necessary, by the DOE-ID.

7.1.3 Operational Considerations

Consistent with the DOE-ID's overall commitment to keep occupational radiation exposures ALARA, specific plans and procedures will be followed by ISFSI operations personnel to ensure that ALARA goals are achieved consistent with the intent of Regulatory Guides 8.8 [7.4] and 8.10 [7.5] and the requirements of 10 CFR Part 20. Since the ISFSI is a passive system, minimal maintenance is expected on a normal basis. Maintenance activities that could involve significant radiation exposure of personnel will be carefully planned. They will utilize previous operating experience, and be carried out using well trained and certified personnel and proper equipment. Where applicable, formal ALARA reviews will be prepared which specify radiation exposure reduction techniques, such as those set out in Regulatory Guide 8.8.

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7.2 Radiation Sources

7.2.1 Characterization of Sources

Each DSC stored in the NUHOMS®-12T ISFSI at INEEL will contain up to 12 TMI-2 core debris canisters. At the time of the accident (March 28, 1979), the TMI-2 core was in its initial fuel cycle at 97% of full power with an average core burnup of 3,175 megawatt days per metric ton of uranium (MWd/MTU). The core material includes fuel assemblies, including all fuel rods, control rods, axial power shaping rods, guide tubes, instrument tubes, spacer sleeves, spacer grids, and end fittings. Core material also includes control rod spiders and coupling mechanisms.

The core had 177 Babcock and Wilcox 15x15 fuel assemblies, identical in mechanical construction. Each assembly had 208 fuel rods, 16 control rod guide tubes, one instrument tube, seven spacer sleeves, eight spacer grids, and two end fittings. The guide tubes, spacer grids, and end fittings formed the structural cage which arranged the rods and tubes in a 15x15 array. Three initial enrichments were used in the core, ranging from 1.98 weight percent (w/o) ^{235}U to 2.98 w/o ^{235}U.

The TMI-2 core debris is contained in three types of canisters: *fuel*, *knockout*, and *filter*. The internal structure of each canister type is the differentiating feature and is dictated by the canister function. *Fuel* canisters contain a mixture of large pieces of core debris up to partial-length, full cross-section fuel assemblies. *Knockout* canisters contain loose core rubble of a size small enough to be vacuumed up from the rubble bed. *Filter* canisters contain the filter elements and the small fuel fines removed by the many filters which cleaned the water circulated through the vacuum defueling system and the defueling water cleanup system.

Design basis neutron and gamma-ray sources for the TMI-2 debris canisters were calculated using the ORIGEN2.1 computer code [7.6]. An intact B&W 15x15 fuel assembly was modeled with a burnup of 3,175 MWd/MTU, an initial enrichment of 1.98 w/o ^{235}U (use of the minimum enrichment results in conservative sources), and a specific power of 27.137 MW/MTU. These parameters correspond to a cycle length of 117 days prior to the accident. The specific power used in the ORIGEN model was increased by a factor of 1.879 to convert from a core average burnup to a peak assembly burnup. The resulting sources were decayed for 19 years (to March 1998) and scaled from the 1515 lb fuel assembly weight to the 1908 lb weight of the peak canister payload. This design basis source was then conservatively used in the shielding calculations for all of the TMI-2 canisters.

The neutron source, spectrum, and flux-to-dose rate conversion factors [7.8] are provided in Table 7.2-1. The energy structure is that of the CASK-81 cross-section library [7.9] and the energy spectrum corresponds to the neutron spectrum from the spontaneous fission of ^{240}Pu, which is the primary neutron source. Similarly, the gamma-ray source, spectrum, and flux-to-dose rate factors are provided in Table 7.2-2. The gamma source spectrum was mapped from the 18 ORIGEN2.1 energy groups to the CASK-81 energy groups by assuming that the photon energies are logarithmically distributed within each energy group.

7.2.2 Airborne Radioactive Material Sources

The potential for airborne radioactive material sources exists during fuel handling at the TAN facility, evacuating and sealing of the DSC, and DSC transfer and storage. Potential airborne releases from handling of the TMI-2 debris canisters at the TAN facility will be handled in accordance with existing DOE-ID practices. DSC evacuating and sealing operations are performed using procedures which prevent airborne leakage. During these operations, all vent lines are routed to the existing radwaste systems at the TAN.

During storage, the DSC cavity is vented to the atmosphere through HEPA grade filters. No significant releases are expected from the DSC for the following reasons: (1) Much of the volatile fission product inventory was released during the accident and the remainder is entrapped within the fuel matrix as determined by extensive examinations performed on the core materials following the accident; (2) No differential pressure exists between the DSC and the atmosphere to provide a driving force for a significant release; (3) The DSC HEPA filters will prevent the release of solids and particulates as specified in Section 4.3.1.1. Although no significant releases are expected, both normal and accident (confinement failure) releases have been postulated with release fractions calculated using the methodology of Reference [7.7] to demonstrate the safety of the system. The postulated releases are non-mechanistic in that there is no conceivable event which would result in a significant release of the TMI-2 core debris material.

During normal operation, all 29 DSCs and the spare HSM are assumed to vent to the atmosphere. Each DSC is assumed to contain up to 12 design basis (as defined in Section 7.2.1) TMI-2 canisters. Although excessive temperatures would be required to release the volatile fission products from the fuel matrix, 10% of the noble gas inventory is assumed to be released directly to the environment each year. Additionally, per Reference [7.7], 0.1% and 0.0001% per year of particulates and solids, respectively, are assumed to be released from the canisters to the DSC. Of these releases, 1% of the solids and particulates are released from the DSC to the HEPA filter system which removes all but 0.03% of particulates. The 62 *filter* canisters are assumed to contain particulate matter and the remaining 282 canisters, which contain the larger debris material, are assumed to contain primarily all solids.

Table 7.2-3 provides the total quantity of potential airborne sources in each canister, the postulated annual release during normal operation, and the postulated accident release.

Source activities have been taken from the design basis ORIGEN2.1 model discussed in Section 7.2.1. The postulated accident condition is a breach of one DSC or a failure of the HEPA filters of one DSC. Release fractions for the accident are identical to those of normal operation with the exception that no credit is taken for the HEPA filters. This condition is assumed to occur for one DSC containing 12 *filter* canisters (100% particulate). The periodic surveillances and radiological control surveys will limit the duration of undetected releases resulting from the postulated accident.

Table 7.2-1

Neutron Energy Spectrum and Flux-to-Dose Conversion Factors for PWR Spent Fuel

Cask Group	E_{upper} (MeV)	Spectrum	Source (n/sec/can)	Flux-to-Dose Factor (mrem/hr per n/cm^2/sec)
1	1.492E+01	7.005E-05	4.830E+01	1.945E-01
2	1.220E+01	5.129E-04	3.536E+02	1.597E-01
3	1.000E+01	2.456E-03	1.693E+03	1.471E-01
4	8.180E+00	1.170E-02	8.067E+03	1.477E-01
5	6.360E+00	3.197E-02	2.204E+04	1.534E-01
6	4.960E+00	4.775E-02	3.292E+04	1.506E-01
7	4.060E+00	1.101E-01	7.590E+04	1.389E-01
8	3.010E+00	9.376E-02	6.465E+04	1.284E-01
9	2.460E+00	2.250E-02	1.551E+04	1.253E-01
10	2.350E+00	1.250E-01	8.615E+04	1.263E-01
11	1.830E+00	2.224E-01	1.534E+05	1.289E-01
12	1.110E+00	1.938E-01	1.336E+05	1.169E-01
13	5.500E-01	1.238E-01	8.538E+04	6.521E-02
14	1.110E-01	1.413E-02	9.741E+03	9.188E-03
15	3.350E-03	7.106E-05	4.900E+01	3.713E-03
16	5.830E-04	5.166E-06	3.562E+00	4.009E-03
17	1.010E-04	3.398E-07	2.343E-01	4.295E-03
18	2.900E-05	4.909E-08	3.385E-02	4.476E-03
19	1.010E-05	1.058E-08	7.294E-03	4.567E-03
20	3.060E-06	1.649E-09	1.137E-03	4.536E-03
21	1.120E-06	3.634E-10	2.505E-04	4.370E-03
22	4.140E-07	1.050E-10	7.237E-05	3.714E-03
Total		1.000E+00	6.895E+05	-

Table 7.2-2
Gamma Energy Spectrum and Flux-to-Dose Conversion Factors for PWR Fuel

Cask Group	E_{upper} (MeV)	Source (γ/sec/can)	Flux-to-Dose Factor (mrem/hr per γ/cm^2/sec)
23	10.00	2.401E+02	8.772E-03
24	8.00	1.523E+03	7.479E-03
25	6.50	8.988E+03	6.375E-03
26	5.00	1.027E+04	5.414E-03
27	4.00	1.924E+05	4.622E-03
28	3.00	7.196E+06	3.960E-03
29	2.50	7.066E+07	3.469E-03
30	2.00	3.533E+10	3.019E-03
31	1.66	3.504E+12	2.628E-03
32	1.33	8.250E+12	2.205E-03
33	1.00	1.364E+12	1.833E-03
34	0.80	9.471E+13	1.523E-03
35	0.60	1.773E+14	1.173E-03
36	0.40	5.260E+12	8.759E-04
37	0.30	9.887E+12	6.306E-04
38	0.20	2.068E+13	3.834E-04
39	0.10	4.836E+13	2.669E-04
40	0.05	2.679E+14	9.348E-04
Total		6.372E+14	-

Table 7.2-3
Postulated Airborne Radioactive Material Sources

Nuclide	Activity (Ci/can)	Activity Percent	Normal Operation Release[1] (Ci/yr)	Accident Release[2] (Ci)
CS137	7.34E+03	23.154%	1.439E-03	7.338E-02
BA137M	6.94E+03	21.901%	1.361E-03	6.941E-02
Y90	5.87E+03	18.525%	1.151E-03	5.871E-02
SR90	5.87E+03	18.519%	1.151E-03	5.869E-02
PU241	4.20E+03	13.256%	8.238E-04	4.201E-02
KR85	3.57E+02	1.125%	1.284E+04	3.566E+01
PM147	2.53E+02	0.797%	4.954E-05	2.526E-03
AM241	2.07E+02	0.653%	4.059E-05	2.070E-03
CO60	1.42E+02	0.448%	2.785E-05	1.420E-03
PU239	1.14E+02	0.360%	2.236E-05	1.140E-03
SM151	9.38E+01	0.296%	1.839E-05	9.377E-04
PU240	6.01E+01	0.190%	1.178E-05	6.009E-04
NI63	5.57E+01	0.176%	1.093E-05	5.572E-04
EU154	4.30E+01	0.136%	8.438E-06	4.303E-04
H3	4.27E+01	0.135%	1.539E+03	4.274E+00
EU155	3.10E+01	0.098%	6.081E-06	3.101E-04
PU238	2.95E+01	0.093%	5.783E-06	2.949E-04
SB125	1.93E+01	0.061%	3.776E-06	1.925E-04
CS134	7.96E+00	0.025%	1.560E-06	7.957E-05
I129	3.28E-03	0.000%	6.434E-10	3.281E-08

[1] Normal operation release source for all 30 HSMs in the ISFSI.

[2] Accident release source assumes that all five HEPA filters in a single DSC fail for a period of one month.

7.3 Radiation Protection Design Features

7.3.1 Installation Design Features

The design considerations listed in Section 7.1.2 ensure that occupational exposures to radiation are ALARA and that a high degree of integrity is achieved through the confinement of radioactive materials inside the DSC. Applicable portions of Regulatory Position 2 of Regulatory Guide 8.8 [7.4] have been used as guidance.

A. Access control to the ISFSI is through a controlled gate in the perimeter fence.

B. Radiation shielding substantially reduces the exposure of personnel during system operations and storage.

C. The NUHOMS® system is a passive storage system; no process instrumentation or controls are necessary during storage. The only required surveillance or instrumentation is the periodic HEPA filter monitoring.

D. Airborne contaminants are confined by the high integrity welded DSC assembly and the integral DSC filtration system.

E. No crud is produced by the NUHOMS® system.

F. The necessity for decontamination is reduced by maintaining the cleanliness of the DSC and the cask during fuel loading and unloading operations (see Section 5.1). Additionally, the DSC and cask surfaces are smooth, nonporous, and are generally free of crevices, cracks, and sharp corners.

7.3.2 Shielding

7.3.2.1 Radiation Shielding Design Features

Radiation shielding is an integral part of all NUHOMS® component designs. The features described in this section assure that doses to personnel and the public are ALARA. The following paragraphs and figures describe the radial and axial shielding provided by the NUHOMS®-12T system.

Radial shielding during loading and transfer is provided primarily by the cask. This shielding includes a stainless steel inner liner, lead, and a stainless steel structural shell. Neutron shielding in the radial direction is provided by an outer metal jacket which forms an annulus with the cask structural shell. This annulus is filled with a solid neutron absorbing material to provide neutron dose attenuation. During storage, radial shielding is primarily provided by the thick concrete walls of the HSM.

Axial shielding during loading and transfer is provided by the thick steel DSC shield plugs and the cask steel top and bottom cover plates. Two penetrations in the top shield plug provide a means for evacuating and venting the DSC. The penetrations are located on the perimeter of the DSC away from the TMI-2 canisters and contain sharp bends to minimize radiation streaming. During storage, axial shielding is provided by the concrete HSM rear wall, the concrete and steel HSM door, and the DSC shield plugs. A thick steel cover provides shielding for the ventilation system.

The shielding geometry for the HSM and the cask are shown in Figure 7.3-1 and Figure 7.3-2, respectively. The geometry of the DSC vent is shown in Figure 7.3-3. Additional portable shielding during DSC handling, transport and transfer operations will be used by the M&O contractor as needed in accordance with existing ALARA practices. If used, the base of the welding machine used to place the top cover welds includes an integral neutron and gamma shield to minimize exposures during closure operations.

7.3.2.2 Shielding Analysis

This section describes the radiation shielding analytical methods and assumptions used in calculating the NUHOMS® system dose rates during the handling and storage operations. The dose rates of interest are calculated at the locations listed in Table 7.3-1 for the design basis TMI-2 core debris. These results are shown graphically in Figure 7.3-4 for the HSM. The computer codes used for analysis are described below, each with a brief description of the input parameters generic to its use. Descriptions of the individual analytical models used in the analysis are also provided.

A. Computer Codes: Surface dose rates for the HSM and cask were calculated using the two-dimensional discrete ordinates transport computer code DORT [7.10]. The CASK cross section library, which contains 22 neutron energy groups and 18 gamma energy groups, is applied in an $S_{16}P_3$ approximation in DORT. Calculated radiation fluxes are multiplied by flux-to-dose conversion factors (Table 7.2-1 and Table 7.2-2) to obtain final dose rates. The DORT calculations use coupled neutron and gamma libraries. Therefore, dose rates from both primary and secondary gammas are calculated in each run.

Dose rates around the DSC vent and the DSC top covers were calculated using the three-dimensional monte-carlo computer code MCNP [7.11]. The MCNP code uses continuous energy cross section data for both neutron and gamma-ray transport. Calculated fluxes were converted to dose rates using the ANSI/ANS 6.1.1-1977 flux-to- dose factors [7.8]. The MCNP code was also used for the site dose calculations presented in Section 7.4.2.

Exposures due to postulated radioactive releases are calculated using the RSAC-5 computer code [7.13]. The RSAC code was developed at INEEL to calculate the consequences of the release of radionuclides to the atmosphere. The code has the capability to generate a fission product inventory, decay and ingrow the inventory during transport through processes, facilities, and the environment, model the downwind dispersion of the activity, and calculate doses to downwind individuals. Atmospheric dispersion was calculated using the Markee model of Gaussian plume diffusion, as included in the RSAC code.

B. <u>HSM Surface Dose Rates:</u> Three DORT models were used to model the fuel debris, DSC, and HSM. Two axisymmetric models, shown in Figure 7.3-1, model the HSM roof, front wall, and back wall. The roof model includes everything in Figure 7.3-1 above the DSC centerline and the floor model includes the remainder. The fuel debris is modeled as a homogenous cylinder and no credit is taken for the DSC basket. The 1/4 inch thick debris canister shell has been added to the DSC shell thickness. Using axisymmetric models for the HSM results in conservative dose rates over the bulk of the HSM surface. A third, Cartesian model, is used to estimate the dose rates along the gap between modules. Material properties for concrete are taken from ANSI/ANS-6.4 [7.14] and no credit is taken for reinforcing bars. The neutron and gamma-ray dose rate results for the HSM are reported in Table 7.3-1 and Figure 7.3-4.

C. <u>Cask Dose Rates:</u> The NUHOMS®-MP187 cask will be used during loading, on-site transfer, and off-site transportation of the DSCs. An axisymmetric DORT model of the MP187 cask, using dimensions and materials described in the Rancho Seco ISFSI SAR [7.15], was generated to calculate the neutron and gamma dose rates on the surface of the cask. The fuel debris is modeled as a homogenous cylinder and no credit is taken for the DSC basket. The 1/4 inch thick debris canister shell has been added to the DSC shell thickness. Cask surface dose rates are reported in Table 7.3-1.

D. <u>DSC Vent and Cover Dose Rates:</u> The DSC top shield plug and vent port dose rates were calculated using a three-dimensional MCNP model of the fuel debris, canisters, DSC basket, and DSC. The geometry of the model in the vicinity of the vent opening is shown in Figure 7.3-3. The TMI-2 debris is assumed to be homogenized within each TMI-2 canister, and the design basis gamma source term is applied to each canister. Neutron dose rates were not calculated because the HSM results provide assurance that the neutron doses are negligible. Dose rates at the surface of the vent were calculated using a point detector located as shown in Figure 7.3-3. Dose rates on the shield plug surface were calculated using a surface crossing tally located at the center of the plug.

Dose rates on the surface of the DSC shield plug and external to the vent and purge ports are provided in Table 7.3-1. The DSC shield plug dose rates are well below those of the Standardized NUHOMS® system [7.3]. The peak dose rate external to the vent and purge ports is of a magnitude similar to the annulus dose rates previously observed during loading of NUHOMS® DSCs. Therefore, operational exposures for welding the

NUHOMS®-12T DSC will be similar to those observed for the Standardized NUHOMS® system. To keep exposures ALARA, temporary shielding and remote handling equipment may be utilized when access to the vent and purge ports is required.

7.3.3 Ventilation

As stated in Section 7.2.2, all process flows from the DSC during loading operations at TAN will be handled in accordance with DOE-ID's current practices. During storage, the DSC will be vented to the atmosphere through the venting system described in Section 4.3.1. As stated in Section 7.2.2 and in Section 4.3.1, no significant radioactive releases are expected through the venting system. The majority of volatile fission products were released during the TMI-2 accident or during the 10 years of storage at TAN. Because the DSC is vented to the atmosphere, there is no driving pressure to force material into the environment. In the event that any material does escape the DSC, the venting system includes HEPA grade filters (removal efficiencies of 99.97% for three micron particles).

Although no significant releases are expected from the DSC, Section 7.6 includes an exposure contribution from a postulated normal operation release. Chapter 8 includes an evaluation estimating the consequences of a total failure of the DSC and/or HEPA filters. The results of both analyses show exposures to employees and the general public well below the applicable limits.

7.3.4 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

Radiological monitoring and contamination control at ISFSI will be performed to ensure that radiation exposure and release limits contained in 10 CFR Part 20 will not be exceeded. The ISFSI will be added to the existing INEEL radiological control program which monitors, as appropriate, radiation levels, contamination levels and airborne radioactivity

Table 7.3-1
Shielding Analysis Results

Location	Peak Dose Rate (mrem/hr) Neutron	Peak Dose Rate (mrem/hr) Gamma	Average Dose rate (mrem/hr) Neutron	Average Dose rate (mrem/hr) Gamma
DSC in HSM				
Roof/Side Walls	0.002	10.4	0.001	6.5
Front Wall	0.081	12.7	0.027	4.9
Rear Wall	0.235	104.5	0.034	7.6
Module Gap	0.002	4.34	n/a	n/a
DSC in Cask				
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
DSC Shield Plug	n/a[1]	17.1	n/a	n/a
DSC Vent Port	n/a	926	n/a	n/a

[1] Analysis performed only for gamma-ray doses. Neutron doses represent less than 1.5% of the total doses at these locations based on the DORT model described in section 7.3.2.2(C) and have been neglected.

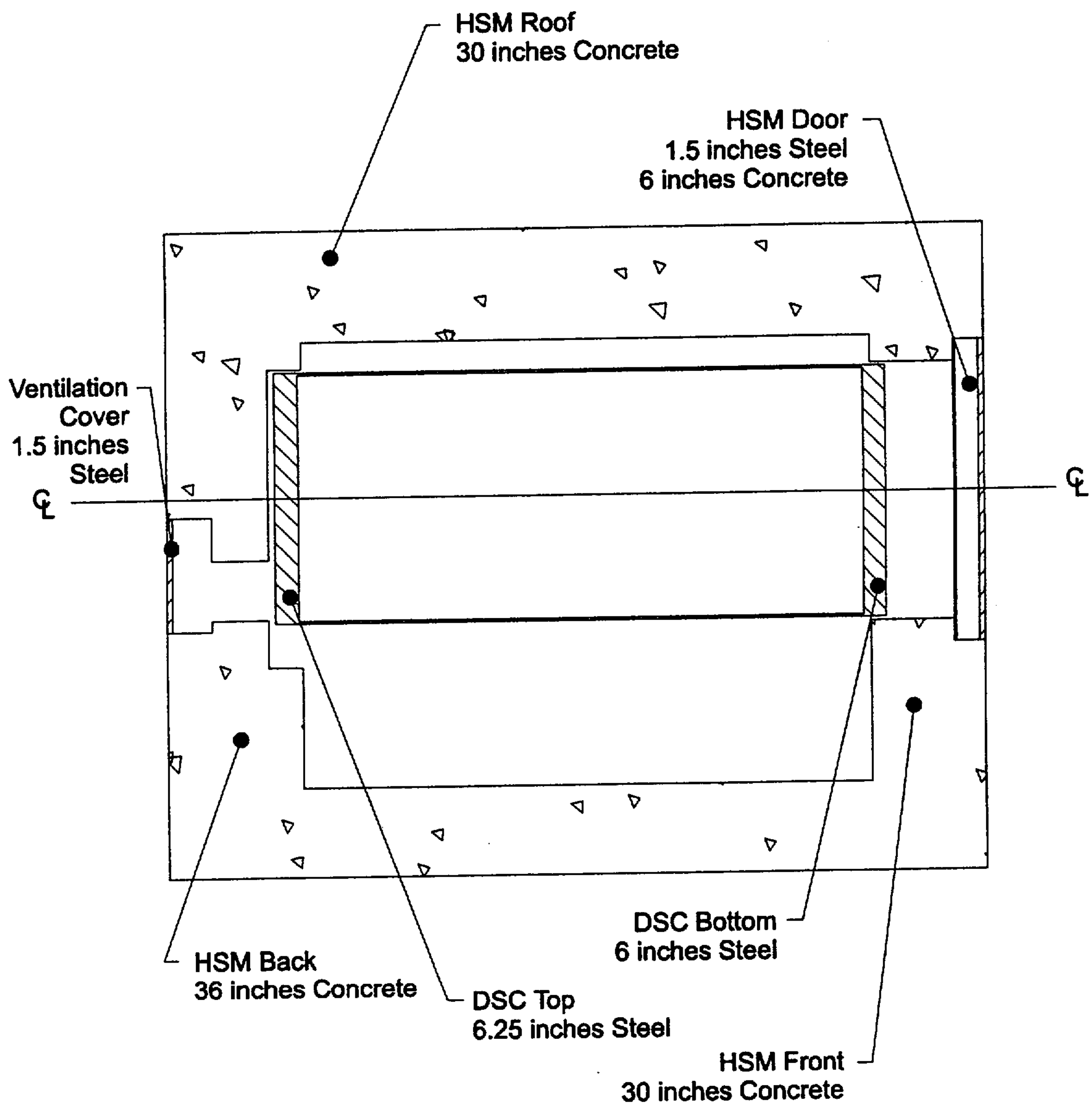

Figure 7.3-1
DSC and HSM Shielding Geometry

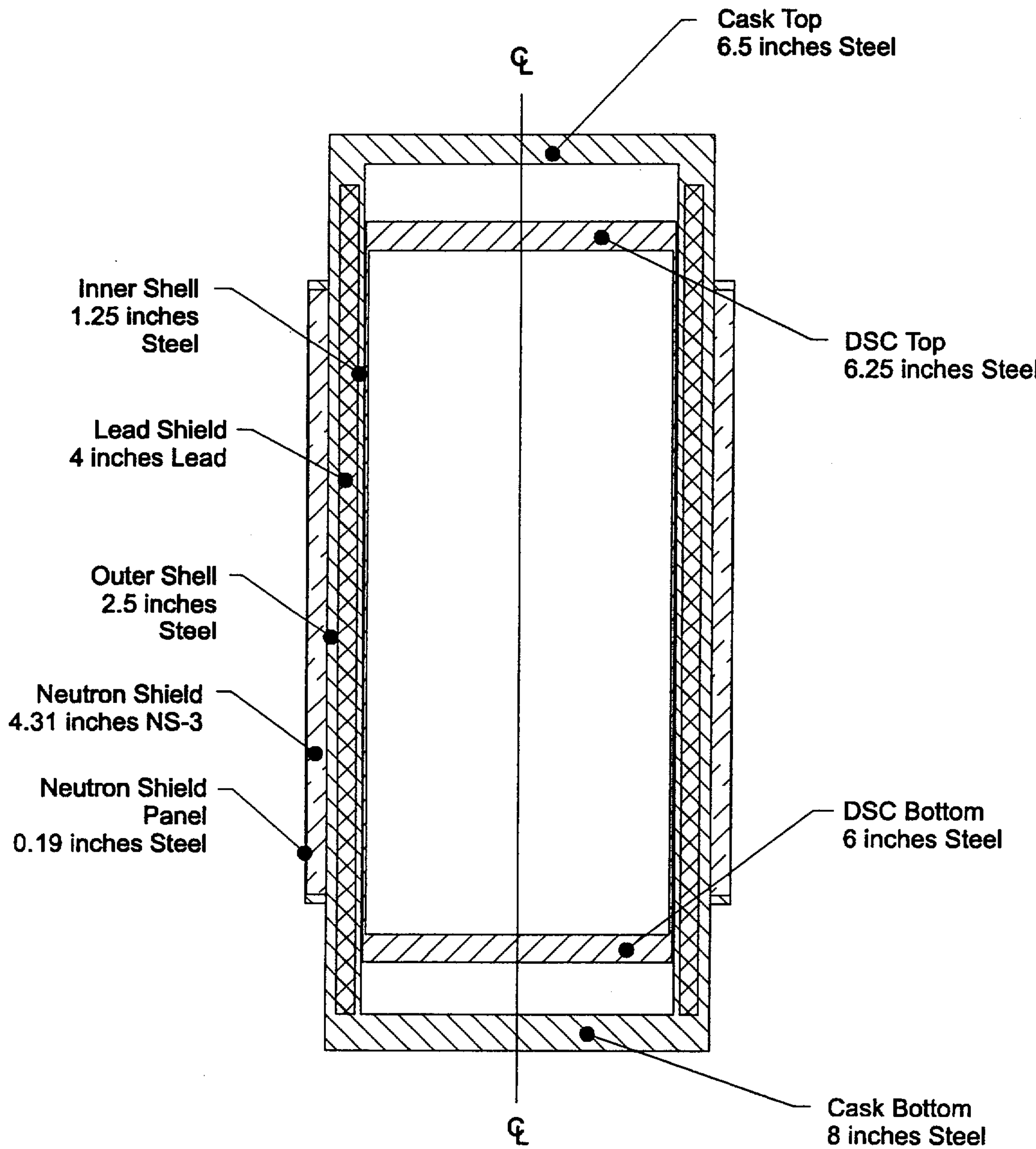

Figure 7.3-2
DSC and Cask Shielding Geometry

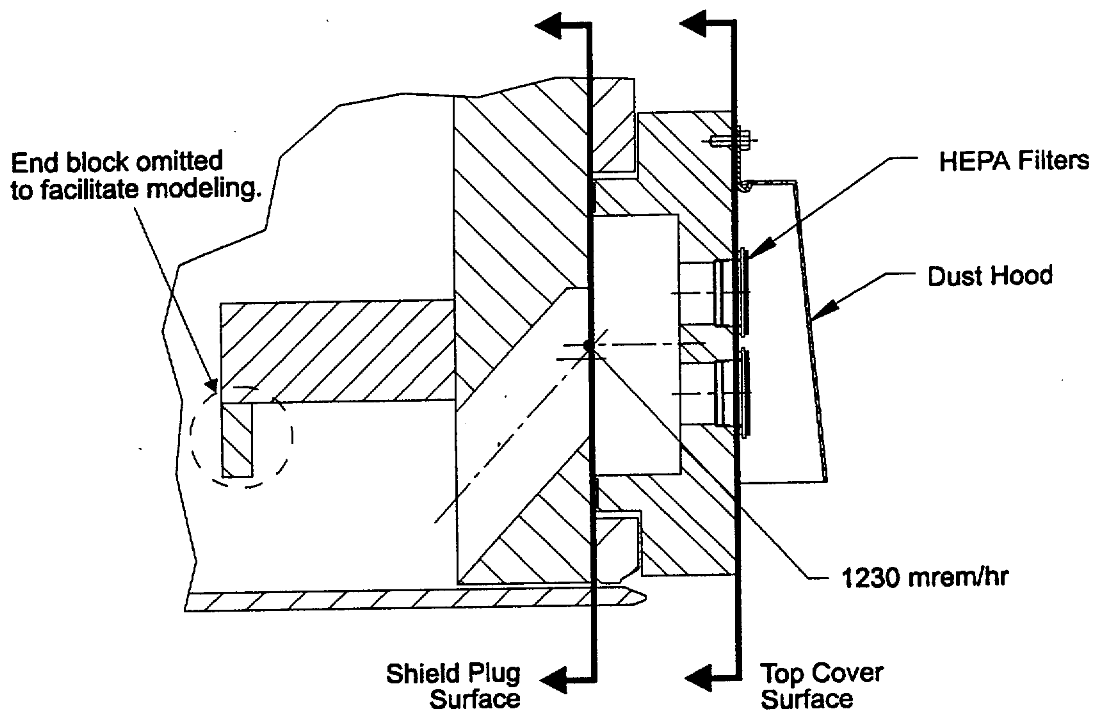

Figure 7.3-3
DSC Ventilation Port Geometry

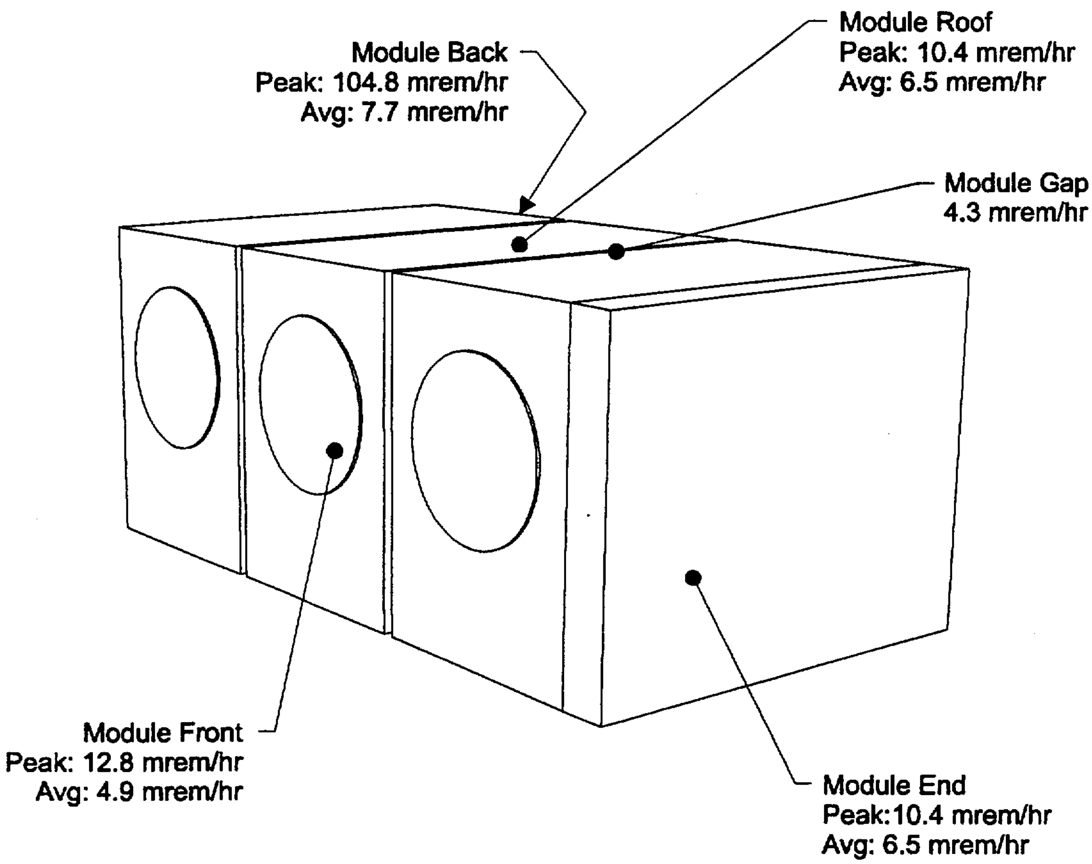

Figure 7.3-4
HSM Shielding Analysis Results

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7.4 Estimated On-Site Collective Dose Assessment

7.4.1 Operational Dose Assessment

This SAR section establishes the anticipated cumulative dose exposure to site personnel during the fuel handling and transfer activities associated with utilizing one NUHOMS® HSM for storage of one DSC. Chapter 5 describes in detail the NUHOMS® operational procedures, a number of which involve potential radiation exposure to personnel.

A summary of the operational procedures which result in radiation exposure to personnel is given in Table 7.4-1. The cumulative dose can be calculated by estimating the number of individuals performing each task and the amount of time associated with the operation. The resulting man-hour figures can then be multiplied by appropriate dose rates near the transfer cask surface, the exposed DSC top surface, or the HSM front wall. Dose rates are referenced in Table 7.3-1 for the DSC, cask, and HSM.

Every operational aspect of the NUHOMS® system, from canister loading through, sealing, transport, transfer, and operation is designed to assure that exposure to personnel is ALARA. Dose rates are kept ALARA by the shielded DSC end plugs and shielded cask. The vent and purge ports have been designed with bends and shield plates to minimize streaming during DSC sealing and filter change-outs. Exposures are kept ALARA by performing most operations remotely as follows: (1) The debris canister drying and loading into the DSC are performed remotely in TAN Hot Shop; (2) If it is used, the welding machine is pre-installed on the top shield plug and top cover plates, away from the DSC, and operated remotely; (3) Transfer operations are performed inside the heavily shielded MP187 cask and trailer; and (4) Cask alignment operations are performed using a remote hand-held pendant and the hydraulic ram is operated using a remote power unit. In addition, many engineered design features are incorporated into the NUHOMS® system which minimize occupational exposure to plant personnel during placement of fuel in dry storage as well as off-site dose to the nearest neighbor during storage. The resulting dose at the ISFSI site boundary is well within the limits specified by 10 CFR 72.

Because the predicted dose rates for the NUHOMS®-12T system are well below those predicted for previous NUHOMS® systems, 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 occupational dose for placing a DSC with TMI-2 core debris into dry storage for the operational steps listed in Table 7.4-1 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

A site dose assessment for the ISFSI has been performed using the average HSM surface dose rates presented in Figure 7.3-4 as input. Locations of interest for the assessment include the INTEC fence and the INEEL site boundary. The INTEC fence serves as the restricted area boundary for demonstrating compliance with the 10 CFR 20.1502 limit 0.5 rems per year, requiring individual monitoring of external and internal occupational dose. The INEEL site boundary serves as the controlled area boundary for compliance with 10 CFR 20.1301, 10 CFR 72.104, and 10 CFR 72.106 [7.2]. Direct and air-scattered radiation doses from all 30 HSMs at these locations have been calculated using the MCNP monte-carlo computer code [7.11].

The MCNP code was used to model the two rows of HSMs, the concrete basemat, and the surrounding land and air as shown in Figure 7.4-1. Source particles are started on the surfaces of the arrays which are modeled as solid concrete simply to account for self shielding and scattering. No credit is taken for shielding by nearby structures or terrain.

Based on the low neutron dose rates on the surface of the HSMs (less than 0.05 mrem/hr as shown in Table 7.3-1), only gamma-rays are considered in the site dose assessment. Source particles are assumed to leave the surfaces of the modules with an angular distribution approximating a cosine function and an energy distribution of photons shielded by three feet of concrete. The total activity (photons/second) of each array face is used as input to the MCNP surface source.

Dose rates have been calculated using point detectors located around the ISFSI fence and the INTEC restricted area fence. Ring detectors are used to calculate dose rates at distances from 200 meters to 1000 meters. The 1000 meter dose rate is assumed to apply to all distances greater than 1000 meters. Ring detectors have been used at these distances to improve the statistical accuracy of the calculations. Because the air-scattered dose rates, which are relatively independent of the orientation relative to the ISFSI, dominate the results at these distances, this assumption has little effect on the results. Dose rates at various locations around the ISFSI and the acceptance criteria are provided in Table 7.4-2. As can be seen in Table 7.4-2, the site dose rates are well below the applicable 10 CFR 20.1301, 10 CFR 20.1502, and 10 CFR 72.104 limits. Figure 7.4-2 provides the dose rate as a function of distance from the ISFSI.

Table 7.4-1
NUHOMS® System Operations Enveloping Times for Loading One DSC

	Number of Workers	Completion Time[3] (hours)
Location: TAN Facility Hot Cell		
Vacuum dry 12 TMI-2 Canisters[4]	2	168
Ready the DSC and MP187 Cask for Service	4	4.0
Place the DSC into the Cask in the TAN Hot Shop	4	1.0
Verify and Load the Dry TMI-2 Canisters[4] into the DSC	2	2.0
Open the TMI-2 canister vents[4]	2	1.0
Place the Top Shield Plug on the DSC[4]	3	1.0
Decontaminate the Outer Surface of the Cask[2]	3	1.0
Set-up Welder	3	1.5
Weld the Shield Plug to the DSC Shell and Perform Examination [1]	3	6.0
Purge the DSC and Backfill the DSC with Helium[1][5]	2	4.0
Helium Leak Test the Shield Plug Weld[5]	2	1.0
Weld the Top Cover Plate to DSC Shell and Perform Examination[1]	3	16.0

Table 7.4-1

NUHOMS® System Operations Enveloping Times for Loading One DSC

(continued)

	Number of Workers	Completion Time[3] (hours)
Location: TAN Facility Hot Cell (Concluded)		
Install Vent System Filter Assemblies and Transportation Covers	2	1.0
Evacuate and Backfill DSC with Helium[5]	2	4.0
Install the Top Internal Spacer and Cask Lid	2	1.0
Ready the Cask Support Skid and Transport Trailer for Service[2]	2	2.0
Place the Cask Onto the Skid and Trailer	4	0.5
Install Skid Frame, Impact Limiters, and Personnel Barrier[5]	4	2.0
Location: ISFSI Site		
Ready the HSM and Hydraulic Ram System for Service[2]	2	2.0
Transport the Cask to the ISFSI	4	6.0
Remove Impact Limiters[5]	3	1.0
Position the Cask in Close Proximity with the HSM	3	1.0
Remove the Cask Lid (note: the top internal spacer is attached to the lid)	3	1.0
Align and Dock the Cask with the HSM	3	2.0

Table

NUHOMS® System Operations Enveloping Times for Loading One DSC

(concluded)

	Number of Workers	Completion Time(3) (hours)
Location: ISFSI Site (Concluded)		
Position and Align Ram with Cask	3	1.0
Transfer the DSC from the Cask to the HSM	3	0.5
Move the Ram Clear of Cask and Un-Dock the Cask from the HSM	3	1.0
Install the HSM Access Door and Seismic Restraint	3	1.0
Open Rear Wall Access Door, Remove the Filter Transportation Covers(5), Visually Check HEPA Filters, and Close Access Door	2	1.0
Perform Radiation Survey	2	1.0

(1) Monitoring operation - personnel may leave the radiation work area.
(2) Operation may be performed in parallel with other activities.
(3) Time shown for each operation is enveloping (i.e. these are operational times and not necessarily exposure time). Actual times for similar operations have been considerably less.
(4) Performed remotely in TAN Hot Shop.
(5) Operations applicable only to the MP-187 transportation cask.

Table 7.4-2

Dose Rates in the Vicinity of the TMI-2 ISFSI at INEEL

Location	Dose Rate (mrem/hr)	Acceptance Criteria
INTEC Fence (max)[1]	4.78E-02	0.5 rems/year (10 CFR 20.1502)
INEEL Site Boundary[2]	3.68E-06	0.1 rem/yr (10 CFR 20.1301)

Notes:

(1) Represents the restricted area boundary. Individuals entering this area are monitored for exposure to radiation and radioactive material at levels sufficient to demonstrate compliance occupational dose limits.

(2) Represents the controlled area boundary. Maximally Exposed Individual (MEI) is assumed to be at this location. This area is controlled by DOE-contracted security forces and DOE exercises authority over its use.

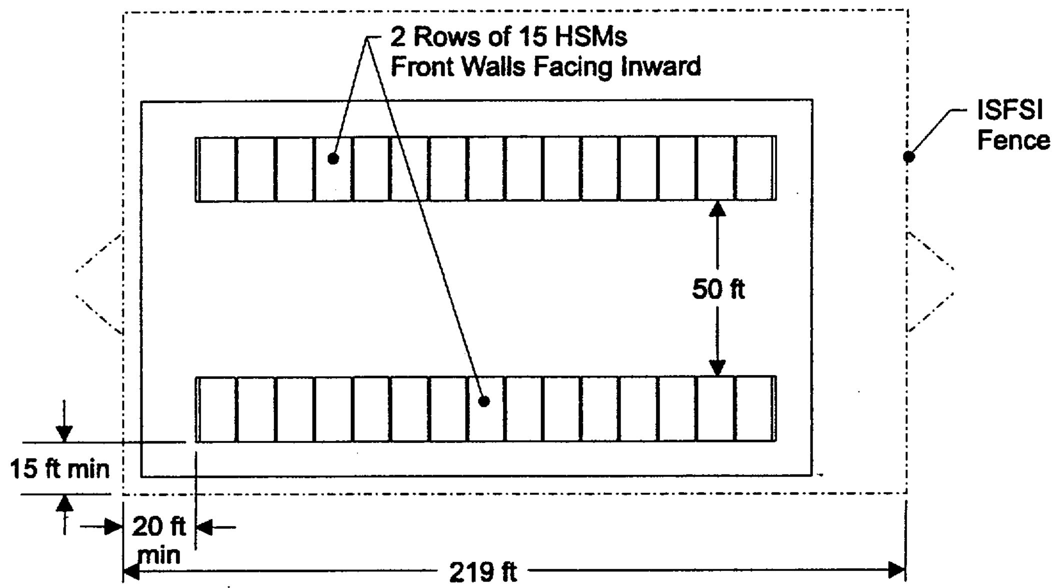

Figure 7.4-1
ISFSI Geometry for Site Dose Calculations

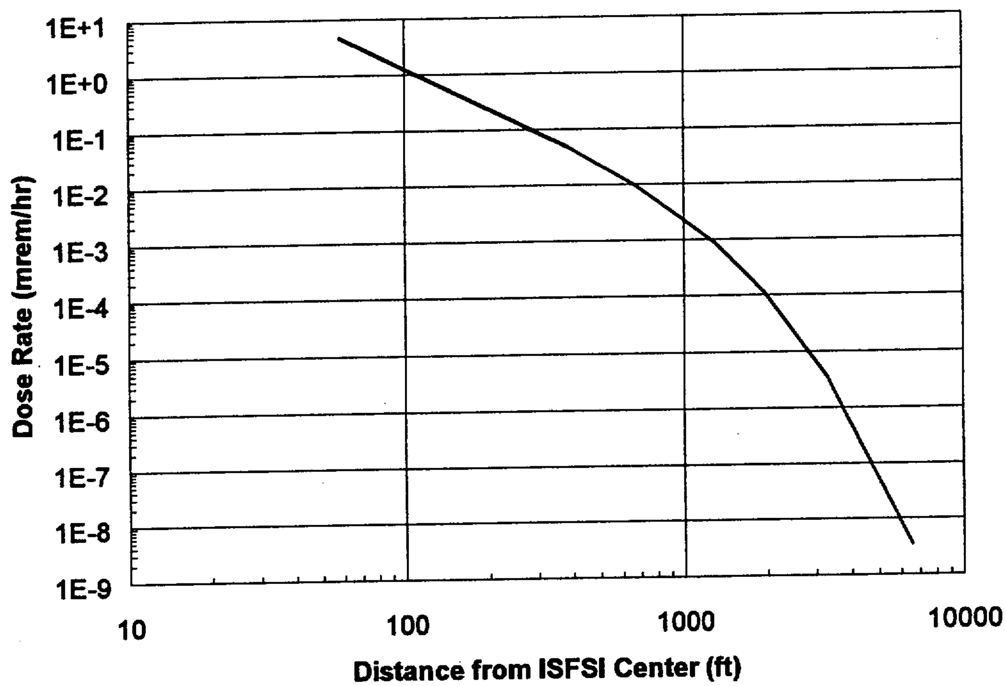

Figure 7.4-2
Dose Rate Versus Distance from the ISFSI

7.5 Health Physics Program

7.5.1 Organization

Because the TMI-2 ISFSI is located entirely within the INEEL site boundary, DOE-ID's existing health physics program will be extended to incorporate the ISFSI. The health physics program is implemented by the Radiological Control Organization (RCO) which is an organization independent from line organizational elements responsible for production, operation, and research activities. The Radiation Control Supervisor (RCS) reports at a management level equivalent to production, operations, and research activities.

The RCS ensures coordination of effort and consistent implementation of radiological control requirements. A staff of qualified radiological engineers is maintained within the RCO to interpret and ensure the implementation of procedures. The RCS assigns dedicated, trained, and qualified RCTs and radiological engineering personnel to operation elements, such as the ISFSI. These dedicated radiological personnel receive their day-to-day priorities from the operational line management, but report administratively and are accountable to the RCS.

7.5.2 Equipment, Instrumentation, and Facilities

The radiological equipment, instrumentation, and facilities for the ISFSI will be those currently used at INEEL. INEEL includes complete health physics facilities to support the RCO and radiological control program. Properly selected, operated, maintained, and calibrated radiological instrumentation is employed at INEEL in order to implement an effective radiological control program. Typical instruments include:

A. A variety of portable beta-gamma detectors and suitable rate meters are used for both surface and contamination monitoring.

B. Low-background alpha-beta counters indicate the level of contamination on smears and air filters.

C. A variety of portable gamma and neutron dose rate meters.

The INEEL Radiological Control Management Control Procedures (MCPs) provide requirements for the calibration, response check, operational inspection, maintenance, and repair of standard radiological instruments used at INEEL. These procedures are applicable to both fixed and portable instruments.

7.5.3 Procedures

7.5.3.1 Radiological Practices

INEEL radiological control practices address precautions required to conduct radiological tasks, such as special personnel protective equipment and permanent or temporary shielding. In general, radiological practices used to control exposure include posting radiological areas, controlling activities within the radiologically controlled areas, and ensuring entry and exit control.

Posting Areas: NRC-approved signs, labels, and radiation symbols are conspicuously posted for radiologically controlled areas as required by 10 CFR Part 20. Each access point to a radiologically controlled area is posted. The size of the area is determined using the guidelines in 10 CFR Part 20. The alteration or removal of control barriers is performed by, or under the direction of, the RCTs.

Radiological Work Permits (RWPs): The RWP is an administrative mechanism used to establish radiological controls for intended work activities. The RWP informs workers of area radiological conditions and entry requirements and provides a mechanism to relate worker exposure to specific work activities. An RWP contains pertinent information for performing the intended work safely and within ALARA guidelines. The information includes, but is not limited to, a description of the work, radiological conditions of the work area, dosimetry requirements, stay time controls, and special dose or contamination reduction considerations.

RWPs are required to enter high and very high radiation areas, high contamination areas, and airborne radioactivity areas. Job-specific RWPs are used for non-routine operations or work in areas with changing radiological conditions. Job-specific RWPs remain in effect only for the duration of the job, whereas general RWPs are used for routine or repetitive activities, such as tours and inspections, or minor work activities in areas with well-characterized and stable radiological conditions. General RWPs can be approved for periods of up to one year.

The RWP is approved by the foreman responsible for the work area and the appropriate radiological control supervisor. Radiological surveys are reviewed to evaluate the adequacy of the RWP requirements. Workers acknowledge that they have read, understand, and will comply with the RWP before their initial entry to the area and after any revisions to the RWP.

Entry and Exit Control: Personnel entry control is maintained for each radiological area per 10 CFR Part 20. The degree of control is commensurate with existing and potential radiological hazards within the area. One or more of the following methods are used to ensure control: posting, control devices on entrances, conspicuous visual and audible alarms, locked entrance ways, or administrative controls.

7.5.3.2 Dosimetry

10 CFR Part 20 establishes the policy, requirements, and training necessary for assignment and use of external dosimetry. External dosimetry devices used for monitoring occupational whole body exposure are accredited by the DOE laboratory Accreditation Program for the appropriate radiation types and categories.

External dosimetry provides indication of the radiation exposures received by personnel, equipment, and the environment. External dosimetry devices are capable of indicating both penetrating and nonpenetrating radiation exposure that contribute to a person's occupational exposure. External dosimetry for equipment and the environment provides an indication of the general radiation field in INEEL areas. All external dosimetry devices used at INEEL are analyzed by the INEEL Radiation Dosimetry and Records group.

Thermoluminescent Dosimetry (TLD) badges are issued to all personnel entering the ISFSI. Each employee is responsible for wearing his or her assigned badge while within the ISFSI. The TLD badges are analyzed to provide input into a computerized record system that accumulates employee and visitor exposure information. The reports are transmitted to management to inform them of the exposure status of all employees. In addition to external dosimetry, all INEEL employees who are likely to receive intakes resulting in an effective dose equivalent greater than 100 mrem undergo initial, periodic, and termination baseline whole-body counts or bioassays.

7.5.3.3 Respiratory Protection

The Management Control Procedures (MCPs) provide guidelines for selecting respiratory equipment for protection against airborne radioactivity. These procedures incorporate the requirements of ANSI Z88.2, "Practices for Respiratory Protection." At INEEL, respirators for radiological exposure control are used in accordance with 10 CFR Part 20. INEEL personnel are formally trained and qualified before using respiratory equipment.

7.5.3.4 Radiological Protection Training

All individuals requiring access to radiological controlled areas at the INEEL receive training that emphasizes the nature of radiological conditions and the control of radiation exposure. 10 CFR Part 20 provides instructions for determining the training requirements, based on activities and responsibilities of the INEEL workers. Upon completion of this training, training certification cards are issued for facility access. The type of certification is based on the type of training received and the type of access required.

Levels of training for RCTs are commensurate with the technician's assignment. Qualifications for RCT's consist of standardized course material, on-the-job training, and both a comprehensive written examination and final examination with the Oral Examination Board. The level of RCT qualification is based on the education, experience, training, orientation, and other qualification achieved and maintained by the individual. RCT qualifications follow a 2-year cycle of continuing training evaluated with a written and oral examination.

Training is also provided for other radiological support personnel (who provide health physics and radiological engineering, dosimetry, bioassay, independent oversight, and instrumentation calibration functions) to ensure that these personnel have the technical qualifications pertinent to their assigned duties. The RCO senior staff consists of health physicists and other professionals with 4-year degrees in science or engineering or equivalent experience.

7.6 Estimated Off-Site Collective Dose Assessment

7.6.1 Effluent and Environmental Monitoring Program

The INEEL environmental surveillance program includes a network of 23 continuous air samplers that measure ambient radiation exposure rates and airborne radioactivity levels. Twelve of the sampling locations are located within the boundaries of the INEEL site and 11 are located off-site, including seven stations near the INEEL site boundary and four distant stations in neighboring communities. The INTEC sampler is located about 1100 ft northwest of the ISFSI site near the INTEC entrance and west perimeter road.

The INEEL environmental surveillance program also includes direct measurements of ambient (environmental) radiation levels using TLDs. These devices measure ionizing radiation exposure rates due to the combined sources of natural radioactivity in the air and soil, cosmic rays, residual fallout from nuclear weapons tests, and radioactivity from INEEL site operations. TLDs are used to record gamma radiation doses at appropriate intervals along the INTEC perimeter fence. Dosimeters are also located at seven distant community locations and six INEEL site boundary locations.

The ISFSI specific radiological environmental monitoring program includes monthly airborne radioactivity sampling within the ISFSI perimeter fence, direct radiation monitoring with TLD's placed along the ISFSI perimeter fence, and periodic loose surface radioactive contamination monitoring adjacent to each DSC vent and purge port and each HSM drain line.

The INEEL meteorological and environmental surveillance programs will be continued through the life of the TMI-2 ISFSI. The ISFSI specific radiological environmental monitoring program will also continue through the life of the TMI-2 ISFSI. Only the results of the ISFSI specific radiological environmental monitoring program will be reported to meet the 60-day reporting requirement of 10 CFR 72.44. The results of the INEEL environmental surveillance program will be available under separate cover, but outside the scope of the 60-day reporting requirement of 10 CFR 72.44.

7.6.2 Analysis of Multiple Contribution

The annual dose calculated for the maximally exposed individual as a result of current and projected INEEL sitewide emissions is about 0.05 mrem. Adding the ISFSI direct and air-scattered radiation at the controlled area boundary from Table 7.4-2 and the estimated effective dose equivalent from effluents from Section 7.6.3 (total of 0.04 mrem) results in a total annual exposure to the MEI of 0.09 mrem, well below the 25 mrem 10 CFR 72.104 limit and 10 mrem 40 CFR 61.92 limit [7.12].

7.6.3 Estimated Dose Equivalents

Dose equivalents from effluents as a function of distance from the ISFSI have been calculated using the RSAC-5 computer code [7.13]. Meteorological parameters were generated using hourly meteorological data taken over a six-year period. The greatest annual average atmospheric dispersion factor over this period is 4.81×10^{-8} s/m^3, established for Atomic City, 18 km from the INTEC. This corresponds to a 4.45 m/s wind speed with class C stability, which was assumed for the effluent dose calculations. Normal operation nuclide releases from Table 7.2-3 were input to the code for calculations of exposure from inhalation, ingestion, ground surface dose, and immersion.

RSAC-5 calculates inhalation doses using the ICRP 30 [7.16] and DOE [7.17] dose conversion factors. The Committed Dose Equivalent (CDE) for each organ or tissue is multiplied by the appropriate weighting factor and summed to determine the Committed Effective Dose Equivalent (CEDE). Ingestion doses are calculated based on the models and equations of Regulatory Guide 1.109 [7.18]. The dose from radioactivity deposited on the ground surface is calculated using DOE [7.19] dose-rate conversion factors. Immersion doses are calculated using a finite plume model.

Table 7.6-1 provides the thyroid organ dose and the effective dose equivalent (applicable to the whole body) at distances of 100 meters (assumed INTEC boundary), 1000 meters, 13.7 km (INEEL boundary, controlled area boundary, and assumed MEI), and 18 km (Atomic City). Table 7.6-1 also provides the calculated χ/Q for each distance. Doses for the on-site locations are calculated assuming 40 hours per week of occupancy with no contribution from the ingestion pathway. The calculated annual dose at the INTEC boundary is 7 mrem, a small fraction of the 10 CFR Part 20 limits for either occupational exposure or dose to members of the public. The calculated effective dose equivalent at the INEEL boundary is well below the 25 mrem 10 CFR 72.104 limit for the whole body.

7.6.4 Liquid Release

Even though the HSM is provided with a drain to remove any moisture that may get into the HSM, no liquids are expected to be released from the INEEL TMI-2 ISFSI.

Table 7.6-1
Estimated Effluent Dose Equivalents

(rem per year, 100% occupancy for off-site locations)

Location	Pathway	Distance (meters) 100	1,000	13,700	18,000
	X/Q (s/m³)	5.06E-04	7.68E-06	6.14E-08	4.81E-08
Thyroid	Inhalation (CDE)	1.62E-06	2.26E-08	4.53E-10	3.35E-10
	Ingestion (CDE)	0.00E+00	0.00E+00	2.26E-08	1.67E-08
	Ground Surface (DE)	8.66E-06	1.21E-07	3.03E-09	2.24E-09
	Total Organ Dose	**1.03E-05**	**1.44E-07**	**2.61E-08**	**1.93E-08**
EDE (whole body)	Inhalation (CEDE)	7.21E-03	1.08E-04	2.74E-06	2.13E-06
	Ingestion (CEDE)	0.00E+00	0.00E+00	6.51E-06	5.09E-06
	Ground Surface (EDE)	7.84E-06	1.09E-07	2.75E-09	2.03E-09
	Cloud Gamma (EDE)	4.36E-05	3.88E-06	3.24E-07	2.53E-07
	Total EDE	**7.26E-03**	**1.12E-04**	**9.58E-06**	**7.48E-06**

1) No ingestion exposure is assumed within the INEEL site boundary
2) On-site exposures calculated using 40 hours per week of occupancy

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7.7 References

7.1 Title 10, "Energy," Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation."

7.2 Title 10, "Energy," Code of Federal Regulations, Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste."

7.3 7.3 "Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," VECTRA Technologies, Inc., Revision 4A, File Number NUH003.0103, 1996.

7.4 U. S. Nuclear Regulatory Commission, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will be As Low As Reasonably Achievable," Regulatory Guide 8.8.

7.5 U. S. Nuclear Regulatory Commission, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low as is Reasonably Achievable," Regulatory Guide 8.10.

7.6 "ORIGEN2.1 - Isotope Generation and Depletion Code - Matrix Exponential Method," CCC-371, Oak Ridge National Laboratory, RSIC Computer Code Collection, August 1991.

7.7 Staley, C. S., "Doses to Maximally Exposed Individuals due to Potential Airborne Releases from the INEL Storage of the TMI-2 Fuel Project," EDF Serial Number EMA-96-001, File Number 219-02.0034, February 16, 1996.

7.8 American Nuclear Society Standards Committee Working Group ANS-6.1.1, "American National Standard Neutron and Gamma-Ray Flux-to-Dose-Rate Factors," ANSI/ANS-6.1.1-1977, American Nuclear Society, 1977.

7.9 Radiation Shielding Information Center, "CASK81 22 Neutron, 18 Gamma Ray Group, P3 Cross-Sections for Shipping Cask Analysis," DLC-23, June 1987.

7.10 "DORT-PC - Two-Dimensional Discrete Ordinates Transport Code System," CCC-532, Oak Ridge National Laboratory, RSIC Computer Code Collection, October 1991.

7.11 "MCNP 4 - Monte-Carlo Neutron and Photon Transport Code System," CCC-200A/B, Oak Ridge National Laboratory, RSIC Computer Code Collection, October 1991.

7.12 Title 40, Code of Federal Regulations, Part 61, "National Emission Standards for Hazardous Air Pollutants."

7.13 Wenzel, D. R., "The Radiological Safety Analysis Computer Program (RSAC-5) User's Manual," WINCO-1123, Revision 1, Idaho National Engineering Laboratory, March 1994.

7.14 American Nuclear Society Standards Committee Working Group ANS-6.4, "American National Standard Guidelines on the Nuclear Analysis and Design of Concrete Radiation Shielding for Nuclear Power Plants," ANSI/ANS-6.4-1977, American Nuclear Society, 1978.

7.15 "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," Sacramento Municipal Utility District, Docket No. 72-11.

7.16 ICRP, "Limits for Intakes of Radionuclides by Workers," Part 1, ICRP Publication 30, Pergamon Press, Oxford, Great Britain, 1979.

7.17 U.S. Department of Energy, "Internal Dose Conversion Factors for Calculation of Dose to the Public," DOE/EH-0071, Washington D.C., 1988.

7.18 U. S. Nuclear Regulatory Commission, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Regulatory Guide 1.109.

7.19 7.19 U.S. Department of Energy, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public," DOE/EH-0070, Washington D.C., 1988.

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9. CONDUCT OF OPERATIONS

This chapter describes the organization and general plans for operating the TMI-2 ISFSI. The organization section includes a brief description of the responsibilities of key personnel. The preoperational testing program is described. The training program for the facility staff is described. Procedures that govern routine operations and maintenance and the records developed as a result of those operations are also discussed.

9.1 Organizational Structure

9.1.1 Corporate Organization

The Manager of DOE-ID is authorized to be the license holder for the TMI-2 ISFSI (license SNM-2508). This authority was delegated and responsibility was assigned to the DOE-ID Manager by the Secretary of Energy pursuant to 10 CFR 72.16(b) in Delegation Order No. 10CFR72.512.1. As the facility owner and licensee, DOE retains ultimate responsibility for the safe operation of the facility and for compliance with all license conditions.

9.1.2 Corporate Functions, Responsibilities, and Authorities

The Manager of DOE-ID is the authorized DOE representative having direct authority and responsibility for compliance with the TMI-2 ISFSI License. The Manager of DOE-ID is responsible for overall executive management of the Idaho Operations Office, has signature authority for the TMI-2 ISFSI license, and is the person ultimately responsible for compliance with the facility's license conditions conditions and overall facility nuclear safety. The DOE-ID Manager shall take any measures needed to ensure acceptable performance of the staff in operating, maintaining, and providing technical support to the facility to ensure nuclear safety and compliant operations. The responsibilities of the personnel reporting directly to the DOE-ID Manager, as depicted in Figure 9.1-1, are described below.

The responsibility of the Assistant Managerfor Environmental Management (AM EM) is the overall execution of EM-funded programs and operations at the INEEL, under which spent nuclear fuel storage (including NRC-licensed ISFSI operations) falls. The actual day-to-day execution of programs and operations associated with the NRC-licensed ISFSIs is performed by the INEEL M&O contractor. The AM EM and staff provide management direction and oversight of contractor performance in accordance with DOE-ID's Quality Assurance Program and commitments herein.

The Assistant Manager for Techinical Support is independent of the facility line management and is responsible for environmental protection, safety, health, quality assurance, and security. This Office provides DOE-ID oversight of the M&O contractor for licensed activities independent of the AM EM organization.

The responsibility for developing the appropriate revisions to the M&O contract is delegated to the Chief Financial and Administrative Officer.

9.1.2.1 Applicant's In-House Organization

This section continues the description of DOE-ID's organization, as depicted in Figure 9.1-1. The responsibility for DOE-ID's role of providing direction to the M&O contractor for spent fuel management is delegated through the Assistant Manager for Environmental Management to the INTEC Programs Division Director. The management responsibilities assigned to the INTEC Programs Division Director are identifying, establishing, and approving requirements and performance objectives applicable to spent fuel management facilities and activities controlled by the DOE-ID, including the NRC-licensed ISFSIs.

Reporting directly to the INTEC Programs Division Director is the TMI-2 Facility Director, who is responsible for oversight of the M&O contractor and to ensure that approved requirements and performance objectives are met. The TMI-2 Facility Director has an alternate, designated in writing, who meet the training and qualification requirements specified below for the Facility Director. The TMI-2 Facility Director has direct access to the Manager of DOE-ID on issues related to the safety and surety of ISFSI operations.

Also reporting to the INTEC Programs Division Director through the Privatized Spent Fuel Project Office Branch Chief is the NRC Licensing Manager. The Licensing Manager is responsible for the preparation and submittal of license applications (including any necessary amendments thereto), timely response to NRC communications and inquiry, and other licensing and interface support to the TMI-2 Facility Director.

The responsibility for oversight of both the M&O contractor's QA Program for the NRC-licensed ISFSIs as well as the DOE-ID oversight program of the ISFSI operations is delegated through the Assistant Manager for Technical Support to the Quality Assurance Division Director. The Quality Assurance Division Director delegates the responsibility for QA oversight of the ISFSIs to the National Spent Nuclear Fuel (NSNF) Quality Assurance Program Manager (QAPM). The roles and responsibilities of the NSNF QAPM are further described in Chapter 11 of this SAR. As with the TMI-2 Facility Director, the NSNF QAPM has direct access to the Manager of DOE-ID on issues related to the safety and surety of ISFSI operations.

9.1.2.2 Interrelationships with Contractors and Suppliers.

The DOE utilizes an M&O contractor for the TMI-2 ISFSI activities. The authority for the management and operation of the facility is contractually delegated and the responsibility for compliance with license requirements and applicable regulations is contractually assigned to the INEEL M&O contractor. To exercise DOE's ultimate responsibility, DOE will: (1) retain responsibility for and perform independent audits of the M&O contractor's TMI-2 ISFSI Quality Assurance program (both the achievement of quality by M&O contractor management and the verification of quality by M&O contractor QA personnel), (2) ensure the license requirements for the facility are included in the M&O contract, (3) assess the performance of the M&O contractor against the terms of the contract, (4) retain the responsibility to budget funds necessary and sufficient to safely operate the facility, and (5) retain the authority to revise the M&O contract in the event contract deficiencies are found relative to proper implementation of license requirements.

The key relationships between DOE-ID's TMI-2 Facility Director, Licensing Manager, and NSNF QAPM and its M&O contractor are also depicted in Figure 9.1-1.

9.1.2.2.1 ISFSI Oversight Program

The Facility Director is the day-to-day management DOE-ID employee responsible for the compliance of TMI-2 ISFSI operations. The TMI-2 Facility Director shall verify or audit the TMI-2 ISFSI for compliance with regulatory requirements and license basis commitments and apprise DOE-ID management of TMI-2 ISFSI status based on observations.

The DOE-ID TMI-2 Facility Director or alternate shall perform surveillances of the contractor's ALARA Committee and the ISFSI Safety Review Committee and shall be an ex officio member (and is a quorum requirement) of these committees to ensure these committees' functions are satisfactory and to report to DOE-ID management as needed. (See Section 9.1.3.1.1 for the duties of the ISFSI Safety Review Committee.)

The DOE-ID TMI-2 Facility Director or alternate shall review the results of management assessments performed for the following contractors' programs: training, security, emergency, quality assurance, and radiation protection.

The DOE-ID TMI-2 Facility Director or alternate shall review and concur with all of the following:

- All 72.48 evaluations and TS Basis evaluations (TS 5.5.1) for the TMI-2 ISFSI
- 10 CFR 72.44(e) – Physical Protection Plan evaluations, 10 CFR 72.44(f) – Emergency Plan evaluations, and evaluations of changes to DOE-ID's other essential programs (TS 5.5.2)
- Changes to TS Bases
- All changes to the SAR
- 10 CFR 72.70 SAR update

- Nuclear Material Status Reports (submitted electronically)
- Annual environmental report
- Other reports which may be submitted to NRC in response to conditions or events which are not submitted by the Manager of DOE-ID.

9.1.2.3 Applicant's Technical Staff.

The DOE Idaho Operations Office has a technical staff representing several areas of expertise with the wide variety of projects and activities at the INEEL. This staff is available to assist the management and oversight of the DOE activities at the TMI-2 ISFSI. Staff assigned to assist the management and oversight in the areas of security, radiation protection, emergency preparedness, and quality assurance are trained and qualified in accordance with Licensing Management Procedures, or perform work directly under the supervision of the TMI-2 Facility Director.

9.1.3 Operating Organization, Management, and Administrative Control System

The operating organization, line management, and administrative control systems are provided by DOE's INEEL M&O contractor personnel. The DOE and its M&O contractor commit to provide the NRC with ready access to the TMI-2 ISFSI, personnel, and records that NRC considers necessary to carry out its responsibilities.

DOE-ID has assigned responsibility and delegated authority for the management and operation of the facility to the INEEL M&O contractor. DOE-ID policy requirements for operating the TMI-2 ISFSI are assigned to the INEEL M&O contractor through the INEEL M&O contract. Specifically, the M&O contract requires the INEEL M&O contractor to manage and operate the TMI-2 ISFSI in compliance with all applicable:

Human health and safety regulations,

- Environmental regulations,
- NRC regulations and license conditions, and
- Quality assurance requirements.

DOE-ID commits to providing a contractor with management and staff for routine operation and maintenance of the TMI-2 ISFSI and support organizations to implement DOE's program commitments in quality assurance, security, training, radiological protection, environmental monitoring, and spent fuel accountability.

9.1.3.1 Onsite Organization

The M&O contractor corporate structure provides the necessary organizations for operating the TMI-2 ISFSI. The M&O contractor organization supports the missions at the INEEL, not all of which are applicable to the management and operation of the ISFSI. The following organizational descriptions document the organizations necessary to manage the TMI-2 ISFSI.

The contractor's chief executive officer is responsible for overall management of M&O contractor activities and is accountable for complying with the INEEL M&O contract conditions. Authorities are delegated and resources are provided to manage the TMI-2 ISFSI in the areas of emergency preparedness, engineering, environmental management, operations, maintenance, quality assurance, radiological control, safety and health, security, training, and transportation. In addition to the interfaces shown on Figure 9.1-1 M&O personnel assigned to the above functions maintain interfaces with their functional counterparts at DOE-ID.

Reporting to the NRC Operations Manager are the FSV ISFSI Manager, the TMI-2 ISFSI Manager, and the Compliance Engineering Lead. Support staff for essential positions within the NRC Operations department report to the TMI-2 ISFSI Manager for services provided for the TMI-2 ISFSI. The NRC Operations Manager also reports to the DOE-ID TMI-2 Facility Director. This interface is the primary operations interface between DOE-ID and its M&O contractor for the TMI-2 ISFSI.

The Quality Assurance manager assigned to the TMI-2 ISFSI reports to a level equal to or above the reporting level of the NRC Operations Manager. The Quality Assurance manager assigned to the TMI-2 ISFSI also interfaces with the DOE-ID NSNF QAP Manager who is responsible for the TMI-2 ISFSI QA Program (see Chapter 11).

9.1.3.1.1 ISFSI Safety Review Committee

Reporting to and chartered by a senior executive for operations is the ISFSI Safety Review Committee. This committee is comprised of senior technical personnel and management personnel with extensive nuclear experience in various areas.

The purpose of this committee is to evaluate the performance of staff level safety review committees, to review performance indicators (such as audit findings, reportable events and conditions, Technical Specification violations); to review 10 CFR 72.48 evaluations (and associated procedure or design changes); to review changes to the Technical Specifications, SAR, Emergency Response Plan, and Physical Protection Plan; and to review preparations for major changes in operation (such as removing fuel from the ISFSI). The ISFSI Safety Review Committee shall also perform special reviews at the direction of the DOE-ID Facility Director or the ISFSI Manager.

Four core members, appointed in writing by the chartering senior executive, provide the needed technical expertise in engineering, radiological control, criticality safety, and quality assurance; their technical qualifications are described in section 9.1.4.1 below.

A quorum shall include 3 members, the technical disciplines appropriate for the matters under review, and the DOE-ID TMI-2 Facility Director. Other members with management experience in nuclear operations may be appointed as considered appropriate by the chartering senior executive.

The DOE-ID TMI-2 Facility Director is informed of all appointments to the Safety Review Committee.

9.1.3.2 Personnel Functions, Responsibilities, and Authorities.

The daily management of the ISFSI operation is provided by the TMI-2 ISFSI Manager. The TMI-2 ISFSI Manager reports to the NRC Operations Manager. Assuring requirements are satisfied in the operation of the ISFSI is the responsibility of the ISFSI Manager.

Personnel assigned to TMI-2 ISFSI operations report to the TMI-2 ISFSI Manager. Other personnel from the INEEL that may be assigned to work at the ISFSI will report to the TMI-2 ISFSI Manager while at the ISFSI site. The TMI-2 ISFSI Manager is responsible for maintaining the Operations log; this log will be used to note the performance of all significant on site activities and conditions.

TMI-2 staff-level committees include an ALARA Committee and staff level safety review committee(s) or board(s) responsible to review changes to license basis documents and any associated evaluations.

9.1.4 Personnel Qualification Requirements

The following DOE-ID positions require minimum qualifications and training for the management and oversight of the TMI-2 ISFSI:

- NSNF QAP Manager
- TMI-2 Facility Director and designated alternate

The following contractor positions require minimum qualifications and training for the operation of the TMI-2 ISFSI:

- ISFSI Safety Review Committee members
- NRC Operations Manager
- TMI-2 ISFSI Manager and designated alternate

- TMI-2 Facility Safety Officer and designated alternate
- Certified ISFSI Operator
- Quality Assurance manager

9.1.4.1 Minimum Qualification Requirements.

In all of the positions below where an academic degree is required, the requirement for a degree may be replaced with an additional five years experience in the technical area (but not necessarily at supervisory level) specified for that position (for a total of ten years experience).

The DOE-ID NSNF QAP Manager shall have a minimum of a Baccalaureate degree in an engineering or physical science field and five years experience in nuclear quality assurance and certification as lead auditor. The minimum training for this position shall include 72.48 process, QA program indoctrination, NRC requirements, and the TMI-2 ISFSI License Basis (consisting of the identification of and orientation to the license and design basis documents).

The DOE-ID TMI-2 Facility Director shall have a minimum of a Baccalaureate degree in an engineering or physical science field and five years experience in nuclear facility operations. The minimum training for this position shall include 72.48 Process, QA program indoctrination,. Technical Specifications, NRC requirements, and the TMI-2 ISFSI License Basis. The designated alternate for the TMI-2 Facility Director shall meet the same minimum qualifications and training requirements.

The Chair, Members, and Alternates of the ISFSI Safety Review Committee (SRC) shall have a minimum of a Baccalaureate degree in an engineering or physical science field and five years experience in one or more of the following technical areas at nuclear facilities:

- Radiological Safety
- Nuclear Safety (with at least two years experience in criticality safety analysis)
- Facility Operations
- Quality Assurance
- Engineering

The minimum training for the Chair, Members, and Alternates of the ISFSI SRC shall include 72.48 process, QA program indoctrination, Technical Specifications, NRC requirements, and the TMI-2 ISFSI License Basis.

The NRC Operations Manager shall have a minimum of a Baccalaureate degree in an engineering or physical science field and five year supervisory experience in nuclear facility operations.

The TMI-2 ISFSI Manager shall have a minimum of a Baccalaureate degree in an engineering or physical science field and five year supervisory experience in nuclear facility operations or equivalents for education and experience as approved by the NRC Operations Manager. The minimum training for this position shall include 72.48 Process, TMI-2 ISFSI License Basis, Radiation Worker, Emergency Response, and TMI-2 Facility Qualification training The designated alternate for the TMI-2 ISFSI Manager shall meet the same minimum qualifications and training requirements.

The TMI-2 Facility Safety Officer shall have a minimum of a Baccalaureate degree in an engineering or physical science field and five year supervisory experience in radiation protection for nuclear facility operations. The minimum training for this position shall be the ISFSI Radiation Protection Program. The designated alternate for the TMI-2 Facility Safety Officer shall meet the same minimum qualifications and training requirements.

The minimum qualifications for the position of Certified ISFSI Operators are successful completion of the biennial medical examination and training and certification in accordance with the requirements in section 9.3.

The minimum qualifications for the QA manager assigned to the TMI-2 ISFSI are a Baccalaureate degree in an engineering or physical science field and five years experience in nuclear operations quality assurance.

9.1.4.2 Qualifications of Personnel.

The resumes or other appropriate documentation of personnel occupying the positions listed in section 9.14.1 will be kept on file to demonstrate compliance with the minimum requirements described in section 9.1.4.1.

9.1.5 Liaison with Outside Organizations

Despite the fact that the TMI-2 ISFSI is a DOE owned facility located on the INEEL with several other DOE owned facilities and DOE managed programs, the external regulation of the TMI-2 ISFSI by the NRC sets this facility apart in some respects. The INEEL is a large, remotely located site and has its own large security police force, a fire department, medical staff, emergency response teams, and full-time INTEC shift plant supervision. Thus, the INEEL infrastructure will be considered to serve equivalent functions as independent local agencies (similar to local city or county) do for typical commercial licensed sites.

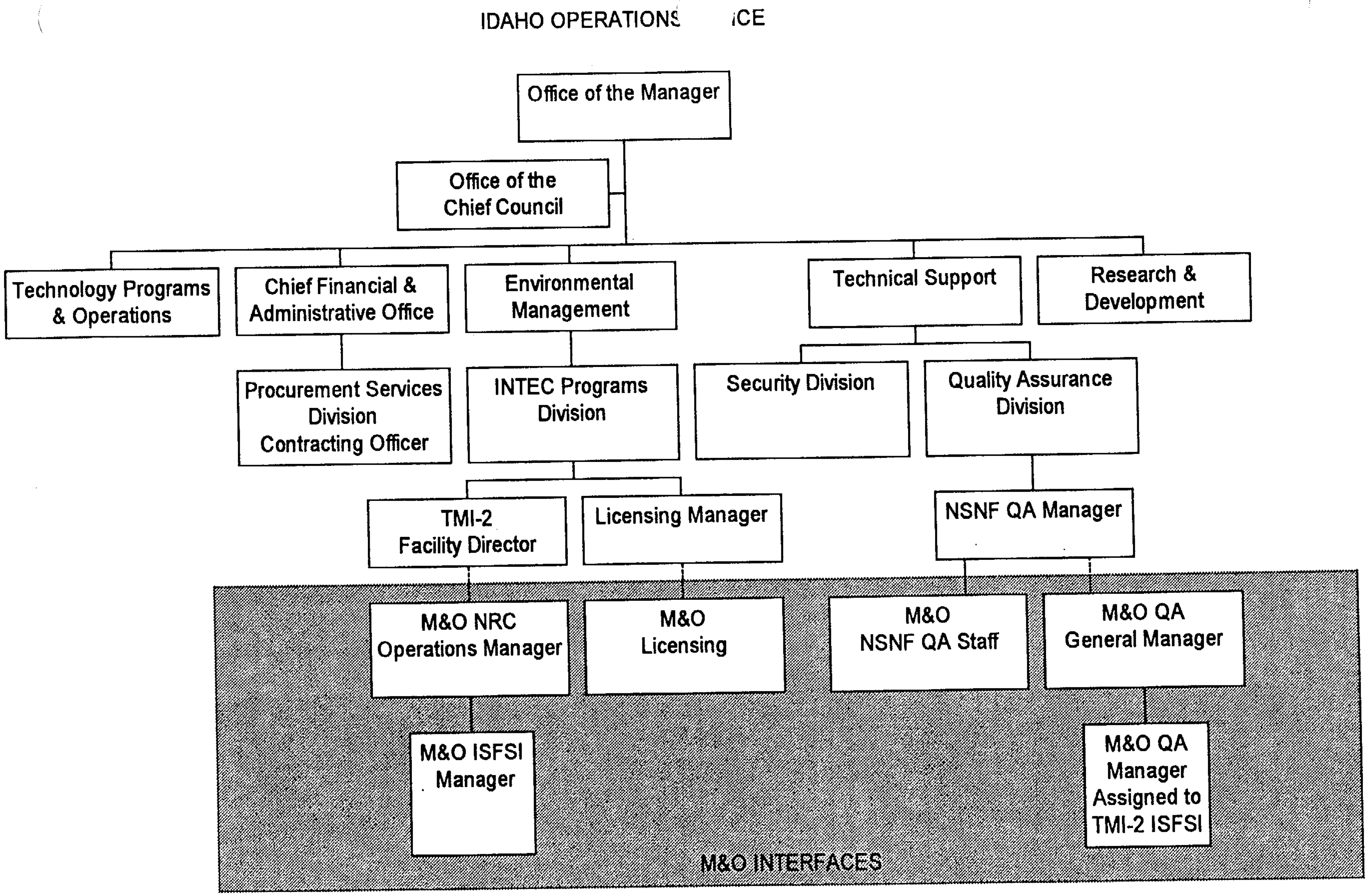

Figure 9.1-1 INEEL TMI-2 ISFSI Organization (DOE – M&O Reporting Chain)

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9.2 Preoperational Testing And Operation

Prior to loading the ISFSI with the TMI-2 canisters, a series of preoperational, startup and performance tests will be developed and implemented. The tests will include functional tests of the in-plant operations, the on-site transport operations, and DSC insertion and retrieval (operations at the ISFSI). These tests are intended to verify that the storage system components (e.g., DSC, HSM, transfer cask, transfer equipment, etc.) operate safely and effectively.

9.2.1 Administrative Procedures for Conducting Test Programs

Test procedures will be developed as part of the spent fuel storage system. Approval of procedures, performance of tests, evaluation of test results, and incorporation of any needed system modifications or procedure changes (based on the results of the tests) will be performed by the INEEL M&O contractor using administrative controls existing at the INEEL.

9.2.2 Test Program Description

The testing program to be conducted utilizes a DSC loaded with mock-up fuel, the transfer cask and associated transfer equipment, and an HSM. The tests will simulate, as nearly as possible, the actual operations involved in preparing a DSC for storage and ensure that they can be performed safely during actual emplacement of TMI-2 core debris in the ISFSI. Verification of ALARA practices, which are not completely achievable during dry runs, will take place during the initial fuel loading. Guidelines for such tests are provided in the following paragraphs.

1. An actual DSC will be utilized for preoperational testing. The DSC will be loaded into the transfer cask to verify fit and adequacy of the cask/DSC annulus seal. Additionally, the DSC may be used in operational testing of the transfer equipment and HSM.

2. Functional testing is to be performed with the transfer cask and lifting devices. These tests are to ensure that the transfer cask can be safely lifted from the trailer, to the upending skid, to the cask work area.

3. The transfer cask will be placed on the transport trailer, which will then be transported to the ISFSI along a predetermined route and aligned with an HSM. Compatibility of the transport trailer with the transfer cask, verification of the transfer route to the ISFSI, and maneuverability within the confines of the ISFSI will be verified.

4. The transfer trailer will be aligned and docked with the HSM. The hydraulic ram will be functionally tested and then used to insert a DSC loaded with test weights into the HSM, and then retrieve it. A weighted DSC will also be loaded into and retrieved from the HSM with the DSC overpack. This testing will be completed

after initiation of the loading operations, but prior to the shutdown of the TAN Hot Shop. Until such time, the TAN Hot Shop will be used for recovery of a challenged DSC. Transfer of the DSC to the HSM should verify that the support skid positioning system and the hydraulic ram system operate safely for both insertion and retrieval of a DSC.

In addition, since a vented system is proposed to address concerns over radiolysis in the TMI-2 canisters, monitoring will be performed at three phases of the loading and storage campaign. First, a representative sample of canisters will be monitored in their current storage location in the TAN pool for generation of off-gases. Second, a sample of actual TMI-2 core debris will be dried and tested for potential release of fissile material. This will aid in the design of the canister dewatering and drying system. Third, each individual DSC (containing up to 12 TMI-2 canisters) will be monitored during storage at the ISFSI for internal build-up of hydrogen and radiological releases in accordance with the corresponding Technical Specifications.

The HEPA filter design for the DSCs will also be tested prior to operation of the ISFSI. This testing will be done in accordance with typical industry testing and acceptance methods for HEPA filters.

9.2.3 Test Discussion

Implementation of the test program is discussed in the paragraphs which follow.

1. The purpose of the preoperational tests is to ensure that a DSC can be properly and safely placed in the TAN hot cell, loaded with TMI-2 fuel, transported to the ISFSI, inserted in the HSM, and retrieved from the HSM. Proper operation of the DSC, transfer cask, and transfer equipment, as well as the associated auxiliary equipment (e.g., automatic welding equipment and vacuum drying system), provides such assurance.

   The purpose of the TMI-2 canister demonstration test program is to ensure that the TMI-2 canisters can be properly and safely dried and stored in the ISFSI.

2. Detailed procedures will be developed and implemented by M&O contractor's personnel who are responsible for ensuring that the test requirements are satisfied.

3. The expected results of the preoperational tests are the successful completion of the following: placement of a DSC into the transfer cask, loading of the DSC with TMI-2 canisters, transporting the transfer cask loaded with a DSC and test weights to the ISFSI, and transfer of a DSC to/from the HSM. The tests are deemed successful if the expected results are achieved safely and without damage to any of the components or associated equipment. The expected results of the TMI-2 canister demonstration test program are the successful completion of canister drying and successful ongoing DSC vent performance.

4. Should any equipment or components require modification in order to achieve the expected results, it will be retested to confirm that the modification is adequate. Should any preoperational procedures change in order to achieve the expected results, the changes will be incorporated into the appropriate operating procedures.

5. INTEC operations are not affected by testing of the ISFSI. Testing operations can generally be conducted concurrently with plant operation. All normal prerequisites for safe handling of components will be satisfied, and normal safety and radiological practices will be employed.

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9.3 Training Program

This section of the SAR comprises DOE's TMI-2 ISFSI Training Program and is submitted pursuant to Subpart I of 10 CFR Part 72. The requirements of this TMI-2 ISFSI Training Program are implemented by M&O contractor procedures providing for the administration of training programs. A management assessment of the contractor's implementation of this training program shall be performed biennially. Changes which do not decrease the effectiveness of this program will be documented with annual SAR updates

The objective of this TMI-2 ISFSI Training Program is to use a systematic approach to training to provide competent M&O contractor personnel to perform all functions related to the operation of the TMI-2 ISFSI. The application of the systematic approach to training will use a graded approach, with the training of Certified ISFSI Operators subject to the most rigorous application.

This training program ensures that qualified individuals will be available to perform planned and unplanned tasks while protecting the health and safety of plant personnel and the public. DOE, through its INEEL M&O contractor, commits to maintain additional training to support the emergency plan, physical protection plan, quality assurance plan, and administrative and safety requirements, as required. Procedures and lesson plans used to implement this training program will be developed and maintained by the INEEL M&O contractor.

9.3.1 Administration

The Training Supervisor is responsible for the administration of training programs and for maintaining up-to-date records on the status of M&O contractor trained personnel, training of new employees, and refresher or upgrade training of present personnel.

The TMI-2 ISFSI Manager is responsible for ensuring that training requirements are specified for personnel assigned to support the TMI-2 ISFSI. In this role, the ISFSI Manager or designee will approve all TMI-2 specific lesson plans.

The TMI-2 ISFSI Manager is responsible for ensuring that training requirements have been satisfied for personnel assigned to the TMI-2 ISFSI.

9.3.2 Records

The following records on the status of trained personnel will be maintained for a minimum of five years in accordance with Section 9.4.2 below:

a. Results of each Certified ISFSI Operator's biennial medical examination.

b. The completed records of certification.

9.3.3 Instructor Qualifications and Development

The M&O contractor shall provide for and document the qualification and training of Training Staff.

9.3.4 Development of Training Material

The M&O contractor shall maintain procedures providing for the analysis of jobs, design of initial and continuing training, development of instructional material, implementation (conduct of training), and evaluation (examinations, boards, performance demonstration, etc.) The development of training material shall be performed by qualified and trained staff. The M&O contractor shall maintain all training materials, both academic lesson plans and On-the-Job training (OJT) guides, developed in accordance with this training program.

9.3.5 Training Improvement

The M&O contractor shall provide for and document the evaluation of training programs in order to ensure the continued improvement of training material and the conduct of training.

9.3.6 Waivers of Training Requirements

Applications for waivers of training requirements shall be approved by the INEEL TMI-2 ISFSI Manager. Successful completion of equivalent training programs may be used as a basis for waiver from academic training requirements. This training should be comparable in content, performance criteria, and duration. Any information used in the evaluation for a waiver should be verified. Previous work experience may be used as a basis for waiver from OJT requirements.

9.3.7 Frequency of Training

Training requirements must be completed within the period specified in the sections below for Certified ISFSI Operator Training; however, a grace period of 25% is allowed. Not completing the retraining requirements within the specified frequency will require completion of the initial training course in order to have qualification reinstated.

9.3.8 General Employee Training

General employee training (GET) and ISFSI overview training will be provided for all plant operators and supervisory personnel who operate equipment or controls that have been identiofied as important to safety in this SAR and in the license.

The GET training program is composed of an initial training course and required biennial retraining. Biennial retraining applicable to active and ongoing TMI-2 ISFSI operations will be conducted as necessary for plant operators and supervisory personnel who operate equipment or controls that have been identified as importsnt to safety in this SAR and it the license.

A score of <80% on the examination will require a retest. Individuals who write or review lesson plans or tests are excused from taking GET exams.

Topics included in GET are:

- Physical description of the TMI-2 ISFSI (Structural characteristics)
- Heat transfer design characteristics
- Applicable regulations and standards
- Engineering principals of passive cooling
- Radiological shielding
- General ISFSI information on:
  - Building monitors
  - Alarms
  - Access control

9.3.9 Certified ISFSI Operator Training

Operations are performed in two locations: the TAN Hot Shop and the ISFSI. Handling equipment and activities inside the TAN Hot Shop such as DSC preparation and handling, fuel loading, transfer cask preparation and handling, and transfer trailer loading are performed under DOE authorization. Procedures and training for these operations are governed by DOE requirements.

The training for Certified ISFSI Operators and supervisior shall provide for initial training and testing of personnel who operate equipment identified as important to safety and will also provide for retraining, proficiency testing, and requalification as required. Certified ISFSI Operators will be actively maintained during transport and HSM loading and unloading operations. During the extended storage period, qualifications will be required for HSM and DSC monitoring activities. During periods when Certified ISFSI Operators are not required, the appropriate lesson plans will be retained as records.

TMI-2 ISFSI equipment and controls that have been identified as important to safety in this SAR and in the license shall be operated by either personnel who have been trained and certified in accordance with this section or who are under the direct visual supervision of a trained, certified individual. Only qualified individuals will operate equipment, machinery, and cranes.

Instructors designated to teach the Certified ISFSI Operator Program shall possess subject matter expertise for a particular subject or topic. Instructors initially qualified will maintain qualifications by instructing classes, and administering or grading examinations and OJT guides, and preparing, reviewing, or revising Certified ISFSI Operator instructional material.

Each individual will be given instructions regarding the hazards and safety precautions applicable to the type of work to be performed, general workplace hazards, and the procedures for protecting themselves from injury. These instructions are normally given during pre-job briefs prior to operations.

The Certified ISFSI Operator Training Program will consist of lesson plans and associated examinations in, but not limited to, the following topics, as applicable to personnel job functions:

A. Fuel Characteristics

- configuration of TMI-2 Canisters (3 types)
- contents of TMI-2 Canisters
- condition of TMI-2 core debris

B. Equipment, Component, and Design Description

- Dry Shielded Canister (DSC)
- Horizontal Storage Module (HSM)
- Transfer Cask (TC)
- alaignment of the cask skid with the HSM
- assembly of the hydraulic ram system
- normal and off-normal operation of the hydraulic ram
- maintenance of the vent and purge system

C. Major Licensed Operations

D. Regulations, Procedures, and Limitations

- administrative control of Certified ISFSI Operator actions
- description of events and sequence of operations
- Technical Specifications

E. Safety Concepts

- accident analysis from the TMI-2 ISFSI SAR for off normal operations and accidents.

- confinement barriers/systems

- criticality prevention

The Certified ISFSI Operator Training Program will include operational training (OJT) involving actual and/or mock control manipulations of the following, as applicable. Manipulations will include Certified ISFSI Operator responses, instrumentation, indications, abnormal situations and corrective measures, prerequisites, and procedures. Actual manipulation and operations are preferred to mock manipulations to the extent practicable based upon equipment availability.

A. transfer trailer

B. hydraulic ram

C. vent and purge system.

Any OJT required for recertification will be repeated biennially. The classroom material and written examinations associated with the OJT will be presented and completed prior to the OJT. Additionally, classroom material will be presented as needed in order to convey pertinent modifications, procedure changes, regulatory changes, or other significant material in a timely manner.

Certification as an TMI-2 ISFSI Certified ISFSI Operator is contingent upon meeting the following criteria: obtaining a score of ≥80% on all Certified ISFSI Operator academic examinations; and satisfactory performance of all OJT practical evaluations. Failure to demonstrate satisfactory performance of the OJT practical examinations will require retesting. Failure to demonstrate satisfactory performance of a second OJT practical examination will constitute cause for dismissal from the Certified ISFSI Operator Training Program.

The evaluation criterion for initial certification of Certified ISFSI Operators shall not be waived; nor shall the evaluation criterion be waived for two or greater consecutive recertification cycles.

The physical condition and general health of certified personnel will be verified by physical examination before initial certification and biennially thereafter. These physical examinations consider conditions which might cause impaired judgement or motor coordination. In addition, if an employee's behavior or condition creates a hazard to health or safety, then stop work may be imposed.

9.3.10 Technical Support Positions

Training for the applicable support positions will include the administrative and management controls associated with ensuring compliance with the INEEL TMI-2 ISFSI license conditions.

9.4 Normal Operations

The ISFSI provides for independent storage of TMI-2 core debris separate from the existing INEEL facilities. With the exception of some limited physical monitoring, maintenance of the DSC vent systems, and security systems, the ISFSI functions as a passive system once the TMI-2 core debris has been placed in dry storage. Placement of TMI-2 core debris in the ISFSI requires specific procedures that are separate from those of normal INEEL operations.

9.4.1 Procedures

Detailed written procedures will be developed and maintained for the applicable ISFSI operations, maintenance, surveillance, and testing and are described in Sections 5.1.1 and 5.1.2. Procedure changes in Section 5.1.1 are subject to DOE Unreviewed Safety Question analysis as they are conducted under the parameters and cognizance of the TAN SAR under DOE regulation. However, any procedure changes that could have an impact or bearing on the design basis or the safety basis of TMI ISFSI components, performance specifications, or requirements in the TMI SAR or Technical Specifications shall also be subject to 10 CFR 72.48. Such applicable activities will be clearly denoted in the Section 5.1.1 procedures. The procedures listed in Section 5.1.2 shall be subject to 10 CFR 72.48. All TMI ISFSI procedures will be developed, reviewed, revised, approved, and controlled by the INEEL M&O contractor in accordance with approved administrative procedures.

The format and content of written procedures include

- Introduction (includes purpose and scope)
- precautions and limitations
- prerequisites
- instructions (sequence, forms to be completed, acceptable conditions, actions if conditions aren't acceptable, approvals)
- records

Maintenance of the written procedures shall be in accordance with Sections 11.5 and 11.6 as implemented by established INEEL management control procedures. The INEEL document control system provides written requirements for review, approval, revision, and controlled distribution of the written procedures.

9.4.2 Records

The following INEEL TMI-2 ISFSI records will be maintained:

- QA records relating to design, construction, testing, surveillance, operation, and maintenance of the ISFSI

- Decommissioning records

  (1) Records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site.

  (2) As-built drawings and modifications of structures and equipment in restricted or inaccessible areas.

  (3) A list contained in a single document of all areas designated and formerly designated as restricted areas and all areas outside of restricted areas that require documentation due to spread of contamination.

  (4) Records of the cost estimate performed for decommissioning.

- Security records

  (1) Records of changes to the Physical Protection Plan made without prior NRC approval

  (2) The Physical Protection Plan and the Safeguards Contingency Matrix

  (3) Other security records as specified in the Physical Protection Plan

- Training records as specified in the TMI-2 ISFSI Training Plan (Section 9.3.2)

- Changes, Tests and Experiments made without prior NRC approval, including the safety evaluations

- Spent fuel material records, including current inventory and material control and accountability procedures

- Emergency preparedness records as specified in the TMI-2 ISFSI Emergency Response Plan

- ISFSI Safety Review Committee records

- Records required by the operating, maintenance, and testing procedures described in Section 9.4.1.

9.5 Emergency Planning

The INEEL TMI-2 ISFSI emergency plan is comprised of the INEEL base plan (the INEEL *Emergency Plan/RCRA Contingency Plan*) and the Addendum # 10 to the INEEL base plan (*Addendum # 10, INEEL TMI-2 ISFSI*). Within the Addendum # 10 is Appendix F which provides a matrix to indicate where requirements of 10 CFR 72.32(a) are implemented in the INEEL TMI-2 ISFSI emergency plan. The INEEL base plan provides the overall process to respond to and mitigate the consequences of emergencies that may arise at the INEEL and is written to meet DOE emergency planning requirements. Therefore, ISFSI-specific and NRC-specific requirements are incorporated into the Addendum # 10.

The INEEL TMI-2 ISFSI emergency plan (the INEEL base plan and Addendum # 10) describes the overall process developed to respond to and mitigate any consequences of emergencies that might arise at the INEEL TMI-2 ISFSI. The plan incorporates a number of emergency elements, including: (a) demonstrating hazards and credible events that could result in emergency situations; (b) preparing for those situations with a trained emergency response organization; (c) maintaining emergency equipment and facilities; (d) determining protective actions; (e) maintaining standards and techniques for notifications. classification, consequence assessment, reentry, medical support, and program administration; (f) providing timely and accurate public information; and (g) identifying the diverse elements involved in recovery and reentry.

All emergency assistance off site with respect to the INEEL TMI-2 ISFSI is obtained from DOE-ID and M&O contractor personnel at the INEEL. There are no credible accidents at the INEEL TMI-2 ISFSI which would require emergency assistance off site with respect to the INEEL site boundary.

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9.6 Decommissioning Plan

The Conceptual Plan for Decommissioning the INEEL TMI-2 ISFSI is included as an enclosure to the TMI-2 ISFSI License Application. This decommissioning plan describes the proposed program (approaches, elements, and cost estimates) for decommissioning the INEEL TMI-2 ISFSI.

9.6.1 Decommissioning Program

The tentative selection of decommissioning alternatives is based on providing decontamination and removal of radioactivity from the site and leaving the basemat intact for unlimited use. DECON is the preferred decommissioning alternative. The program includes preparation (engineering and planning, filing a decommissioning plan with the NRC, and site preparation), decommissioning operations and license termination, and site restoration. The program is described in more detail in the Conceptual Plan for Decommissioning the INEEL TMI-2 ISFSI.

Near the end of operations at the INEEL TMI-2 ISFSI, a decommissioning plan will be developed to provide specific details of decommissioning based on the technologies that exist at that time. The DOE expects to develop decommissioning and decontamination technologies during the ISFSI license period and will select and define the appropriate approaches at the time of decommissioning.

9.6.2 Cost of Decommissioning

The Conceptual Plan for Decommissioning the INEEL TMI-2 ISFSI contains cost estimates for decommissioning the INEEL TMI-2 ISFSI. The DOE Office of Environmental Management has included the INEEL TMI-2 ISFSI decommissioning program in its overall cost estimate for the Environmental Management Program at the INEEL. DOE will request appropriate funding from Congress at the time of decommissioning.

9.6.3 Decommissioning Facilitation

Decommissioning of a NUHOMS® ISFSI can be performed in a manner consistent with that for decommissioning other INEEL facilities. The NUHOMS®-12T DSCs can be retrieved from the HSMs and transferred to an on-site facility where the TMI-2 canisters will be unloaded and placed in a 10 CFR Part 71 licensed transportation cask for shipment off-site to a federal facility.

All components of the NUHOMS® system are manufactured of materials similar to those found at existing plants (e.g., reinforced concrete, carbon steel, and stainless steel). These components can, therefore, be decommissioned by the same methods in place to handle those materials at the INEEL. Any of the components that may be contaminated can be cleaned and/or disposed of using the decommissioning technologies available at the time of decommissioning.

The NUHOMS® system is a dry containment system that effectively confines all contamination within the DSC. When the DSC is removed from the HSM, the freestanding HSM can be manually decontaminated for any radioactive material, dismantled, and removed from the site. It is possible that a thin layer of material comprising the inner wall of the HSM could become activated by the neutron flux after an extended period of time. The specific activity of the HSM inner wall surfaces may be measured at the time of decommissioning and compared with the existing guidelines to determine whether the values are below those acceptable for free release. Disposal procedures can be developed which comply with existing requirements at the time of decommissioning.

The NUHOMS® DSCs are manufactured from carbon and stainless steel material which can be decontaminated. If the activity levels are reduced below the level for free release of the material, the steel could be sold for scrap and shipped off-site. If the activity levels cannot be reduced, the steel material can be disposed of in accordance with requirements existing at the time of decommissioning. Other NUHOMS® components (transfer equipment, vacuum drying equipment, etc.) are expected to be decontaminated and made available for use at other NUHOMS® facilities.

Removal of the TMI-2 canisters from the DSC can be accomplished as described in Chapter 5. The transfer of the TMI-2 canisters from the DSC can be made by use of an existing fuel pool or dry cask transfer in a hot cell.

9.6.4 Recordkeeping for Decommissioning

Records that support decommissioning will be treated as quality assurance records. The Conceptual Plan for Decommissioning the INEEL TMI-2 ISFSI identifies the types of records that will be maintained to facilitate the ISFSI decommissioning.

9.7 Physical Protection Program

The purpose of the INEEL TMI-2 ISFSI physical protection program is to establish and maintain a physical protection program that has the capabilities for the protection of spent fuel stored in the INEEL TMI-2 ISFSI, in accordance with Subpart H, "Physical Protection," of 10 CFR Part 72 and applicable portions of 10 CFR Part 73.

The TMI-2 ISFSI physical protection program is described in the Physical Protection Plan for the INEEL TMI-2 ISFSI. This plan includes, as appendices, the INEEL TMI-2 ISFSI Security Training and Qualification Plan, the INEEL TMI-2 ISFSI Safeguards Contingency Plan and the Threat Analysis and Design for Physical Protection.

This Physical Protection Plan for the INEEL TMI-2 ISFSI contains Safeguards Information, is controlled and protected in accordance with 10 CFR 73.21 and 10 CFR 2.790, and has been submitted for NRC review under separate cover.

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11. QUALITY ASSURANCE

11.0 Quality Assurance

Beginning with initial design of the INEEL TMI-2 ISFSI through to its completed decommissioning, it is the policy of DOE-ID to ensure that the facility is designed, constructed, handled, shipped, stored, cleaned, assembled, inspected, tested, operated, maintained, modified and decommissioned in a manner that assures the health and safety of workers and the public and protects the environment. The Quality Assurance Program is developed to confirm that essential technical and quality requirements for structures, systems, and components are achieved and documented. The INEEL TMI-2 ISFSI may optionally apply greater rigor to quality requirements implementation, in whole or in part, to non-quality related portions, as may be deemed appropriate, by DOE-ID, for the INEEL TMI-2 ISFSI's reliable operation.

DOE-ID maintains full responsibility for the development and execution of the INEEL TMI-2 ISFSI Quality Assurance Program. This program applies to design; purchase; fabrication; handling; shipping; storing; cleaning; assembly; inspection; testing; operation; maintenance; repair; modification of structures, systems, and components; and decommissioning activities that are important to safety. The INEEL TMI-2 ISFSI Quality Assurance Program is maintained to satisfy the requirements established in 10 CFR 72, Subpart G, "Quality Assurance."

The quality assurance program for DOE spent fuel storage and transportation activities is the DOE's Office of Civilian Radioactive Waste Management's Quality Assurance Requirements and Description, DOE/RW-0333P, Revision 5 (QARD) [11.1]. The QARD is included as part of the INEEL TMI-2 ISFSI license application. The contents of the QARD are listed in Table 11.0-1. For INEEL TMI-2 ISFSI activities, DOE-ID and its M&O contractor will apply applicable portions of the QARD to items important to safety. The purpose of this chapter of the SAR is to define the implementation and application of those applicable QARD requirements for the INEEL TMI-2 ISFSI, including the relationship and integration of DOE-ID and M&O contractor quality assurance responsibilities. To facilitate this description, this chapter is written and developed following the format of the QARD. The quality assurance program described in this chapter shall be implemented by DOE-ID and its M&O contractor through the use of approved, controlled implementing documents.

Changes that reduce the effectiveness of quality assurance program commitments and represent a change per 10 CFR 72.48, "Changes, Tests, and Experiments," will be submitted to the NRC for its review and acceptance prior to implementation.

The INEEL ISFSI Quality Assurance Program provides for a graded approach to the implementation of the QARD Elements, Supplements, and Appendices:

The remaining sections of this chapter describe how each of these Elements, Supplements, and Appendices will be implemented for the INEEL TMI-2 ISFSI.

All structures, systems, and components are analyzed to determine whether their functions or physical characteristics are essential to the safety function. Those items determined to be important to safety are subject to the applicable requirements of the QARD and identified in Table 3.4-1, NUHOMS Major Components and Safety Classification. Structures, systems and components which are not important to safety have the QAP applied in a graded approach.

Table 11.0-1. Contents of the QARD Revision 5.

Section No.	Section Title	Rev. No.	Eff. Date
Intro.	Introduction	1	10-31-95
1.0	Organization	2	10-31-95
2.0	Quality Assurance Program	1	10-31-95
3.0	Design Control	1	10-31-95
4.0	Procurement Document Control	1	10-31-95
5.0	Implementing Documents	1	10-31-95
6.0	Document Control	1	10-31-95
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11.1 Organization

The following is the organizational philosophy of the INEEL TMI-2 ISFSI Quality Assurance Program.

DOE-ID, as facility owner and licensee, retains ultimate responsibility for the safe operation of the facility and compliance with all license conditions. The management and operation responsibility of the facility is delegated to INEEL's M&O contractor. To exercise its ultimate responsibility, DOE-ID will:

1) Retain responsibility for and perform independent assessments of the M&O contractor's ISFSI quality assurance program;

2) Ensure that the license conditions for the facility are included in the M&O contractor's contract;

3) Assess the performance of the M&O contractor against the terms of their contract;

4) Retain the responsibility to budget funds necessary and sufficient to safely operate the facility; and

5) Retain the authority to revise the M&O contract in the event contract deficiencies are found relative to proper implementation of license conditions.

The primary role of DOE-ID is management oversight rather than daily, direct management. Therefore, a strong assessment function is retained by DOE-ID . The M&O contractor's Quality Assurance (QA) Director, has responsibility for development, management, and implementation of the M&O contractor's quality assurance program. As part of this responsibility, the QA&O Director ensures that other subtier contractor Quality Assurance Programs meet all applicable requirements of the QARD for their scope of work.

The Quality Assurance Program is implemented by trained personnel with adequate resources so that cost and scheduling considerations do not override the Quality Assurance Program's function. Quality shall be achieved and maintained by those who have been assigned responsibility for performing work. Quality achievement shall be verified by persons and organizations not directly responsible for performing the work. Positions or organizations responsible for establishing and executing the quality assurance program may delegate work to other organizations. However, the positions or organizations making the delegation shall retain overall responsibility for the delegated work. Differences of opinion involving quality assurance requirements shall be brought to the attention of the appropriate management, and, if not resolved, shall be elevated progressively to successively higher levels of management. Stop work authority for significant conditions adverse to quality is assigned to the Manager of DOE-ID. M&O contractor stop work authority resides with the INTEC QA Manager.

Stop work requests and actions are described in the DOE-ID and M&O contractor's implementing documents.

DOE-ID, M&O, and contractor Quality Assurance personnel have the necessary authority, resources, and organizational freedom to implement the Quality Assurance Program, including the ability to identify quality problems; to initiate, recommend and provide solutions; and to verify implementation of solutions. QA personnel also have written authority and responsibility to stop unsatisfactory work, controlling further processing, delivery, installation, or use of nonconforming items.

QA personnel ensure that assessments of the Quality Assurance Program and its effectiveness are reported to the appropriate levels of management. Specific quality assurance responsibilities for the INEEL TMI-2 ISFSI are provided below.

11.1.1 The Office of the Manager

The Manager of DOE-ID is responsible for overall executive management of the Idaho Operations Office. The Manager of DOE-ID has signature authority as the NRC Licensee. (See Figure 9.1-1)

11.1.2 The Office of the Chief Financial and Administrative Officer

The responsibility for developing the appropriate revisions to the M&O contractor's contract with DOE-ID is delegated to the DOE-ID Contracting Officer.

11.1.3 The Office of Environmental Management

The responsibility for the licensee's role of providing program direction to the M&O contractor is delegated through the DOE-ID Assistant Manager, Office of Environmental Management to the DOE-ID INTEC Programs Division Director. The management responsibilities assigned to the INTEC Programs Division Director are identifying and establishing, or approving requirements and performance objectives applicable to facilities and activities under the jurisdiction of INTEC.

DOE-ID personnel performing quality affecting activities are responsible for:

1. Planning and meeting product quality requirements and implementing the Quality Assurance Program in their work

2. Retaining responsibility for delegated work

3. Notifying the immediate supervisor to resolve differing staff opinions related to safety issues and quality issues and if not resolved elevating disputes to successive levels of management until resolved

4. Recommending work to be stopped when significant conditions adverse to quality are identified.

11.1.4 Office of Technical Support

The DOE-ID Assistant Manager, Office of technical Support, is responsible for oversight of the M&O contractor as stated in Section 9.1.2. The responsibility for oversight of both the M&O contractor's Quality Assurance Program for the ISFSI as well as the DOE-ID oversight program of the M&O contractor's performance in ISFSI operations is delegated through the Assistant Manager, Office of Technical Support to the Quality Assurance Division Director. The Quality Assurance Division Director delegates the responsibility for QA oversight of the ISFSIs to the National Spent Nuclear Fuel (NSNF) Quality Assurance Program Manager (QAPM). The management responsibilities of the NSNF QAPM are herein defined.

The NSNF QAPM is at the same or higher organization level as the highest Program Manager/Team Leader responsible for performing work subject to the requirements of the QARD, has knowledge and experience in quality assurance and management, and has no other duties or responsibilities that could compromise the required independence. The NSNF QAPM has the organizational freedom to communicate with senior management and is sufficiently independent from cost and schedule considerations.

The NSNF QAPM is responsible for providing guidance and direction to the DOE-ID line organization and its M&O contractor on quality assurance matters relating to INEEL NRC Licensing activities, developing DOE-ID's Quality Assurance Program implementation of the QARD, and effectively assuring conformance to quality requirements. The NSNF QAPM also is responsible for the overview of work subject to QARD requirements. This overview includes verifying achievement of quality of work by DOE-ID's line organization and its M&O contractor through assessments, surveillances, or other means of verification, as appropriate.

The NSNF QAPM and the M&O contractor's QA Director, respectively, are responsible and accountable for coordinating with the responsible managers to ensure that acceptable QARD requirement implementation is developed and established and for documenting and promulgating Quality Assurance policies, goals and objectives.

Also, the NSNF QAPM is kept current through various reports and verifies the implementation, adequacy, and effectiveness of the overall Quality Assurance Program while maintaining a continual involvement in Quality Assurance matters (See Figure 9.1-1).

The NSNF QAPM is responsible for developing and implementing the Quality Assurance Program. This includes the following activities:

1) Developing, reviewing, approving, issuing, and maintaining the NSNF Program Management Procedures

2) Verifying that the Quality Assurance Program is properly established and executed

3) Ensuring that quality is verified by an organization not responsible for the work and ensuring that the Quality Assurance Program is adequate and being effectively implemented

4) Ensuring Quality Assurance training and qualification programs are developed for DOE-ID and contractor personnel who perform quality affecting activities.

5) Develop, manage, update, and implement a Quality Assurance Audit Plan and schedule, and coordinate NRC participation in audit activities

6) Identifying quality problems; initiating, recommending, or providing solutions to quality problems; and verifying the implementation of solutions to quality problems

7) Determining the cause of significant conditions adverse to quality and ensuring that corrective action is initiated for all conditions adverse to quality

8) Accepting final resolution for all DOE-ID audit findings and proposed corrective actions

9) Initiating stop work orders within the license oversight program, when required

10) Serving as the point of contact for all communications between DOE-ID oversight program and NRC on Quality Assurance matters

11) Receiving and compiling Quality Assurance information and forwarding Quality Assurance program status reports to management

12) Interfacing with NRC to coordinate and clarify NRC Quality Assurance requirements, the Quality Assurance Program, and to resolve Quality Assurance issues to NRC requirements

13) Interfacing with NRC to coordinate plans and schedules relevant to Quality Assurance for NRC overview of licensing activities

14) Being responsible for interpreting and approving Quality Assurance Program requirements as they apply to the M&O contractor's scope of work.

15) Assignment of the Quality Assurance Specialist (QAS) staff.

11.1.5 M&O Contractor Personnel

DOE and its M&O contractor personnel perform work subject to the requirements of the QARD per the controls established in their respective implementing documents. The QARD requirements for the M&O contractor are identified in the appropriate procurement documents. The NSNF QAPM provides overviews of the M&O contractor's work subject to QARD requirements by using appropriate verification methods.

Quality control functions that are performed as part of the line organization's activities will have surveillances performed by the Quality Assurance organization to confirm that there is sufficient independence from the individuals that actually performed the activity.

Quality-related activities are performed by the various M&O contractor departments and contractors of DOE-ID. The DOE-ID M&O contractor is responsible for development of its Quality Assurance Program which shall be consistent with the requirements of the QARD. All M&O contractor personnel have the authority to stop work pending resolution of any quality problem. If a member of another area disagrees, that individual is instructed to take the matter to appropriate management. The disagreement may either be resolved at this level or at any level up to and including the DOE-ID Office of the Manager.

The topics from Section 1.0, Organization, that are implemented from the QARD are:

1.2 Requirements

Requires preparation of controlled documents describing internal and external interfaces.

1.2.1 Line Management

Requires identification of responsibilities and authorities of organizations responsible for achieving quality.

1.2.2 Quality Assurance Management

Describes appropriate knowledge and experience for those performing the Quality Assurance function.

1.2.3 Responsibility For Quality

Assigns responsibility for achieving quality in work and the verification of quality.

1.2.4 Delegation of Work

Discusses the delegation of the execution of the Quality Assurance program and maintenance of overall responsibility.

1.2.5 Resolution of Quality Disputes

Process for resolution of quality disputes.

1.3.3 Other OCRWM Affected Organizations

Section "A" and "C" only

Describes EM-67 as an agent of OCRWM. Also requires that appropriate technical and quality requirements applicable to this scope of work be incorporated into the associated work documents.

11.2 Quality Assurance Program

DOE-ID has overall responsibility and program implementation authority for all Quality Assurance Program requirements. Quality Assurance Program elements that are implemented and discharged by DOE-ID are those identified as Organization, Quality Assurance Program, Implementing Documents, Document Control, Corrective Action, Quality Assurance Records, and Audits. Implementation of the entire QARD is delegated to the M&O contractor for its scope of work.

The NSNF QAPM has the assigned responsibility for ensuring that required DOE-ID quality assurance program implementing documents are established at the earliest practical time consistent with the schedule for accomplishing quality affecting activities. Instructions to DOE-ID personnel for implementation of quality activities including performance of verification activities are described by implementing documents.

Specific DOE-ID performance and verification activities include, but are not limited to:

- Reviews and approvals of various DOE-ID and M&O contractor documents
- Surveillances, assessments, and evaluations of the DOE-ID and M&O contractor's quality assurance program
- Readiness evaluations with the M&O contractor
- Verification and validation of DOE-ID's personnel training and qualification records.

Authority for implementing Quality Assurance Program elements applicable to activities related to important to safety items is delegated by DOE-ID to the M&O contractor. The M&O contractor may pass functional activities to approved subcontractors. Overall responsibility for adequate implementation and performance by DOE-ID's M&O contractor and its subcontractors is retained by DOE-ID. DOE-ID requires its M&O contractor to document its Quality Assurance Program in appropriate descriptions, plans and implementing documents.

The QAPM and the M&O contractor initiate management assessments of the Quality Assurance program All pertinent correspondence, checklists, and reports related to assessments are placed in the Quality Assurance files.

The graded approach for performing management assessments is commensurate with the risk associated with the item or activity affecting quality being assessed. Any identified corrective actions as a result of management assessments shall be tracked to completion.

Delegation of authority for implementation of Quality Assurance Program requirements is accomplished through contracts between DOE-ID and its M&O contractor and/or technical direction given by DOE-

ID. Contracts and technical direction specify that the applicable QARD requirements are to be established and functioning before initiating any activities affected by the M&O contractor's Quality Assurance Program. These documents additionally require that the need for special controls, processes, test equipment, tools, and skills to attain the required quality and the need for verification of quality by inspection and testing be taken into account for the scope of work.

Proficiency of personnel performing quality-affecting activities is maintained by training, examination, and/or certification. The graded approach is applied to indoctrination and training commensurate with the scope, complexity, and nature of the activity. The graded approach is not applied to the qualification and certification of inspectors, NDE personnel, and auditors. Specific documentation of completed training and qualifications will be described in the implementing documents. Qualified personnel are certified per applicable codes and standards.

Nuclear safety related activities are accomplished under controlled conditions. Preparations for such activities include confirmation that prerequisites, identified in the implementing documents, have been satisfied.

The M&O contractor's Quality Assurance Program is monitored by DOE-ID on a continuing basis through review, surveillance, and assessment to evaluate its adequacy and to verify compliance with QARD requirements.

The topics from Section 2.0, Quality Assurance Program, that are implemented from the QARD are:

2.2.1 Quality Assurance Program Documents

Discusses the role of the Policy Statement, Implementing Documents, and Requirements Matrix in the quality program.

2.2.2 Classifying Items

Identifies quality program applicability to systems, structures and components.

2.2.3 Controlling Activities

Identities controls for activities related to quality affecting items.

2.2.4 Applying Quality Assurance Controls

Describes graded approach application.

2.2.5 Planning Work

Provides planning elements for documentation of work under suitable controlled conditions.

2.2.6 Surveillances

Describes quality evaluations for selected work subject to QARD requirements.

2.2.7 Management Assessment

Describes the conduct and criteria for management assessments of Quality Assurance program effectiveness

2.2.8 Readiness Reviews

Identifies the need for and how readiness reviews shall be conducted for major work.

2.2.9 Peer Reviews

Identifies the need for peer reviews and how they shall be conducted.

2.2.10 Document Review

Describes the basic review process for technical and quality requirements in documents and implementing documents.

2.2.11 Quality Assurance Program Information Management

Describes how management shall be apprised of Quality Assurance program information on a continuing basis.

2.2.12 Personnel Selection, Indoctrination, Training, and Qualification

Describes the established program for the evaluation, selection, indoctrination, training, and qualification of personnel performing work subject to the QARD.

2.2.13 Qualification of Personnel Performing Special Quality Assurance Functions

Describes amplified requirements for personnel performing Quality Assurance functions like auditing, inspecting, examining and testing.

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11.3 Design Control

The Quality Assurance Program requires procedures and instructions for implementation and assurance of design control during the various design phase activities. Design control requirements ensure that designs as specified in the license application are correctly defined, controlled, and verified. Appropriate provisions of design control include:

1. Specifying design inputs

2. Correct translation of inputs in design documents

3. Sufficient documentation which entails verification that design outputs relate to design inputs

4. Verification of design by persons other than the originator

5. Assurance that changes to the design are properly reviewed, controlled, and documented.

Designs are reviewed to ensure that the design characteristics can be controlled, inspected, and tested. Inspection and test criteria are identified. Implementing documents ensure that the design is performed per approved criteria which include appropriate regulatory and quality requirements and standards, and that deviations and nonconformances are controlled.

Design control practices provide appropriate attention to design error and deficiency control, design changes, technical reviews, control of experimental and developmental activities, qualification of data, and modification control. Practices shall be established to include the use of valid industry standards and specifications for the selection of suitable materials, parts, equipment and processes for important to safety structures, systems, and components. Modifications that affect licensing parameters are evaluated per 10 CFR 72.48, "Changes, Tests, and Experiments".

Provisions are specified for the control of design analyses such as criticality physics, stress, thermal, hydraulic, and accident; compatibility of materials; accessibility for in service inspection; maintenance and repair; and delineation of acceptance criteria for inspections and tests.

Revisions of controlled documents, including design documents, are reviewed for adequacy and approved for release by the same organization that originally reviewed and approved the documents or by some other designated organization that is qualified and knowledgeable.

Design verification methods include, but are not limited to design reviews, alternate calculations, and qualification testing or a combination thereof. When a test program is to be used to verify the adequacy of a design, a qualification test of a prototype unit under adverse design conditions shall be used.

Independent design verification is completed before relying on the item to perform its function. Confirmation that the correct computer code has been used is part of the design verification. Design verification shall require a level of skill at least equal to that of the original designer, design checking can be performed by less experienced persons. The Design Control activities and their implementing documents are required to be in compliance with the requirements of QARD Section 3.0, Design Control.

Appropriate design verification implementing documents are established and executed commensurate with the importance to safety of the structures, systems, or components and in compliance with requirements of QARD Section 3.0, Design Control.

The graded approach for design verification is a function of importance to safety and the complexity of design, the degree of standardization, the state of the art, and the similarity with previous designs.

When quality related structures, systems, and components are designed or require design modifications, controls are applied commensurate with the controls established for the original design, applicable regulatory requirements, and health and safety of operating personnel and the general public.

DOE-ID delegates implementation authority for QARD Section 3.0, Design Control to its M&O contractor.

DOE-ID monitors its M&O contractor's design control activities, by surveillance and assessment and periodically reviews the M&O contractor's practices to ensure proper implementation and adequacy.

DOE-ID's M&O contractor is assigned Design Control responsibility in support of program activities and is required to implement and maintain design control/verification practices and/or to delegate these quality assurance program requirements to its next lower tier contractor for their implementation.

The topics from Section 3.0, Design Control, that are implemented from the QARD are:

3.2.1 Design Input Control

Describes criteria that provides for adequate control of design inputs.

3.2.2 Design Process

Describes controls for an adequate design process.

3.2.3 Design Analyses

Describes criteria for adequate design analyses.

3.2.4 Design Verification

Provides additional document review criteria for completed design analyses and design output in support of QARD Section 2.2.10, Document Review.

3.2.5 Design Reviews

Describes how design reviews are controlled and performed.

3.2.6 Alternate Calculations

Describes the appropriateness of assumptions and checks required for other calculation methods.

3.2.7 Qualification Testing

Describes criteria for verification of design adequacy.

3.2.8 Design Change Control

Provides criteria for controlling design changes.

3.2.9 Design Interface Control

Provides criteria for controlling design interfaces.

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11.4 Procurement Document Control

Implementing documents are established and executed to ensure that applicable regulatory and technical requirements, design bases, quality assurance program requirements, and other performance requirements necessary to ensure adequate quality are included or referenced in documents for procurement of material, equipment, and services. These implementing documents clearly identify the sequence of actions to be accomplished in the preparation, review, approval, and control of procurement documents.

These actions include: evaluating qualifications of suppliers; ensuring qualified suppliers remain qualified; accepting purchased items or services and invoking applicable technical, regulatory, administrative, and reporting requirements, such as 10 CFR Part 21.

These implementing documents include provisions for ensuring that documentation for structures, systems, and components classified as important to safety provide objective evidence that those items conform to procurement requirements. Those implementing documents further ensure that inspection, test, and acceptance requirements have been used to monitor and evaluate the performance of the supplier and are satisfied before these items are placed in service.

Controls include specifying documents along with their revision level and change status that describe selection criteria, determination of suitability for intended use, evaluation, receipt inspection, and dedication of commercial grade items for use in structures, systems, and components classified as important to safety.

Implementing documents are established and executed to verify that the quality of purchased items and services is evaluated at appropriate intervals and to a depth consistent with the items' and services' importance to safety, complexity, quantity, and frequency of procurement. A review and concurrence of the adequacy of quality requirements stated in procurement documents is performed by qualified personnel. This review shall determine that:

1. Quality requirements are correctly stated, inspectable, and controllable
2. There are adequate acceptance and rejection criteria
3. The procurement document has been prepared, reviewed, and approved per quality assurance requirements.

DOE-ID delegates implementation authority for QARD Section 4.0, Procurement Document Control to its M&O contractor.

The graded approach for applying Quality Assurance Program requirements on suppliers depends on type and end-use of the item or activity affecting quality being procured.

DOE-ID monitors its M&O contractor's procurement document control practices that support program activities, or, by surveillance and assessment, periodically reviews its M&O contractor's practices to ensure their proper implementation and adequacy.

The topics from Section 4.0, Procurement Document Control, that are implemented from the QARD are:

4.2.1 Procurement Document Preparation

Describes necessary provisions for issued procurement documents.

4.2.2 Procurement Document Review and Approval

Provides additional document review criteria in support of QARD Section 2.2.10, Document Review for procurement document review and approval.

4.2.3 Procurement Document Change

Describes change controls imposed on procurement documents of items and services that affect quality.

11.5 Implementing Documents

Implementing documents are instructions, procedures, drawings and other documents that prescribe an approved process for accomplishing work in compliance with Quality Assurance Program requirements. Activities affecting quality are prescribed and accomplished per documented implementing documents. Implementing document requirements ensure that work is prescribed by, and performed per written implementing documents. Methods for complying with each of the applicable Quality Assurance requirements are specified in the implementing documents. The graded approach for the direction of work processes, in the form of instructions, procedures, and drawings is commensurate with risk, complexity, and importance of the work. Document Control requirements provide guidance for the review, approval, and control of implementing documents.

Provisions are established which clearly delineate the sequence of actions to be accomplished in the preparation, review, approval, and control of implementing documents.

M&O QA, as part of a multi-disciplined review team, reviews and concurs with inspection plans; test, calibration, and special processes; procedures; drawings and specifications; and their associated changes.

DOE-ID has a procedural control system for its implementing documents which assigns responsibility and provides instructions for preparation, review, approval, release, issuance, distribution, and control of changes to implementing documents.

The DOE-ID QAPM participates in and monitors program execution of these implementing documents related to program quality affecting activities. Periodically the DOE-ID QAPM performs surveillance or arranges for an independent assessment of DOE-ID Quality Assurance Program practices to document their level of implementation and adequacy.

DOE-ID monitors its M&O contractor's procedural practices related to implementing documents, and, by surveillance or assessments, periodically reviews its M&O contractor's practices to document their level of implementation and adequacy.

DOE-ID's M&O contractor is assigned the authority for performing work activities affecting quality in support of program activities and is required to establish and implement a practice of prescribing those activities per documented instructions, implementing documents, and drawings.

The topics from Section 5.0, Implementing Documents, that are implemented from the QARD are:

5.2 Requirements

Specifies that work done per the QARD shall be performed per controlled implementing documents.

5.2.1 Types of Implementing Documents

Describes the type of document to be used to perform work per the QARD and what they include.

5.2.2 Content of Implementing Documents

Describes the information that implementing documents shall contain.

5.2.3 Review and Approval of Implementing Documents

Requires that implementing documents shall be reviewed and approved per QARD Section 6.0 Document Control.

5.2.4 Compliance With Implementing Documents

Requires individuals to comply with QARD requirements and describes what to do when work can not be completed per QARD requirements.

11.6 Document Control

Document control requirements ensure that the preparation and issuance of documents including changes thereto, are reviewed for adequacy, approved for release, and distributed to and used at the location where the work is being performed. The document control system provides for identification, preparation, review, approval and distribution of documents in a graded manner. The review, approval, distribution and issue of documents and changes thereto, shall be procedurally controlled to ensure that documents are adequate and that Quality Assurance Program requirements are stated. Implementing documents and documents that specify technical and/or quality assurance requirements are controlled per requirements of the Quality Assurance Program.

The controlled documents include but are not limited to:

a. Design specifications

b. Design and fabrication drawings

c. Procurement documents

d. Quality Assurance Program manuals

e. Design criteria documents

f. Fabrication, inspection, and testing instructions

g. Test procedures.

Implementing documents provide program guidance, technical and/or quality assurance requirements, or prescribe work processes that ensure proper execution of Quality Assurance Program activities. Compliance with the Quality Assurance Program's document control implementing documents ensures that the designated document holder and user of these implementing documents have the latest up-to-date information and data available which define technical and quality assurance requirements.

Distribution of new and/or revised controlled documents is in accordance with work processes that are established, approved, and documented in the Quality Assurance Program's implementing documents. Provisions shall be established which identify those individuals or groups responsible for reviewing, approving, and issuing documents and revisions thereto. Approved changes shall be included in implementing documents prior to the implementation of the change.

A master list (either hard-copy or electronic) shall be established and identify the current revision number of procedures, specifications, and drawings. This list shall be updated and distributed to pre-determined responsible personnel to preclude the use of superseded documents.

DOE-ID monitors its M&O contractor's procedural practices related to document control, and, by surveillance or assessments, periodically reviews its M&O contractor's practices to document their level of implementation and adequacy.

DOE-ID's M&O contractor has established and implemented document control practices through their Quality Assurance Program and its associated implementing documents which are responsive to this Quality Assurance program.

The topics from Section 6.0, Document Control, that are implemented from the QARD are:

6.2.1 Types of Documents

Requires that implementing documents and documents that specify technical and quality requirements be controlled per this section.

6.2.2 Preparing Documents

Requires assignment for preparation and maintenance of documents to appropriate organizations.

6.2.3 Reviewing Documents

Requires that documents shall be reviewed per QARD Section 2.2.10, Document Review.

6.2.4 Approving Documents

Requires identification of the position which has approval authority for documents.

6.2.5 Distribution and Use of Documents

Provides criteria for distribution and use of documents.

6.2.6 Changes To Documents

Provides criteria governing changes to documents.

6.2.7 Expedited Changes

Provides criteria for initiating changes at the work location by responsible management.

6.2.8 Editorial Changes

Describes the criteria for editorial changes to documents.

11.7 Control of Purchased Items and Services

Control of purchased items and services requirements provide for planning and executing procurements assuring that purchased items and services meet specified requirements. Technical and quality assurance requirements specified in these documents are verified and incorporated into the program prior to starting work subject to the requirements of the Quality Assurance Program.

Qualified personnel evaluate the supplier's capability to provide acceptable quality services and products before the award of the procurement order or contract. The M&O contractor's quality assurance, requesting organization and technical support as required participate in the evaluation of those suppliers providing important to safety items and services and the responsibilities for each group's participation are provided.

The evaluation of suppliers is based on one or more of the following:

a. The supplier's capability to comply with the elements of the quality assurance criteria that are applicable to the type of material, equipment, and service being procured

b. A review of previous records and performance of suppliers who have provided similar articles of the type being procured

c. A survey of the supplier's facilities and quality assurance program to determine the capability to supply a product that meets the design, manufacturing, and quality requirements.

The results of supplier evaluations are documented and filed. Supplier's certificates of conformance are periodically evaluated by audits, independent inspections, or tests to ensure they are valid.

Receiving inspection of the supplier-furnished material, equipment, and services is performed to ensure that items accepted and released are identified as to their inspection status prior to forwarding them to a controlled storage area or releasing them for installation or for further work.

Surveillance of suppliers during fabrication, inspection, testing, and shipment of materials, equipment, and components shall be planned and performed per written procedures to ensure conformance to the purchase order requirements. These procedures provide for: (a) instructions that specify the characteristics or processes to be witnessed, inspected, or verified, and accepted; the method of surveillance and the extent of documentation required; and those responsible for implementing these instructions, and, (b) assessments and surveillance which ensure that the supplier complies with the Quality Assurance Program requirements. Surveillance shall be performed on those items where verification of procurement requirements cannot be determined upon receipt. That verification documentation shall be available for the life of the NRC issued operating license for the operation of the ISFSI.

The supplier furnishes the following records as a minimum to the purchaser:

a. Documentation that identifies the purchased material or equipment and the specific procurement requirements (e.g., codes, standards, and specifications) met by the items

b. Documentation that identifies any procurement requirements which have not been met together with a description of those nonconformances dispositioned "accept as is" or "repair".

Items accepted and released are identified as to their inspection status prior to forwarding them to a controlled storage areas or releasing them for installation or further work.

The graded approach for verification of supplier activities, the selection of suppliers, and amount of supplier documentation, including planning is applied based on the relative importance, complexity, and quantity of the item or activity being procured.

DOE-ID delegates implementation authority for QARD Section 7.0, Control of Purchased Items and Services, to its M&O contractor.

DOE-ID monitors its M&O contractor's control of purchased items and services practices in support of program activities, and, by surveillance and assessments, periodically reviews its M&O contractor's practices to document their level of implementation and adequacy.

DOE-ID's M&O contractor is assigned authority for implementing QARD Section 7.0, Control of Purchased Items and Services, for procurement of items (structures, components and systems) and services in support of program activities and is required to establish and implement a system for control of the procurement activity that is responsive to the requirements of the QARD. It is required that supplier Quality Assurance Programs be reviewed and accepted before initiation of program activities affecting quality.

The topics from Section 7.0, Control of Purchased Items and Services, that are implemented from the QARD are:

7.2.1 Procurement Planning

Describes criteria for adequate procurement planning and documentation.

7.2.2 Source Evaluation and Selection

Provides criteria for determining supplier selection and supplier capability in providing items and services that affect quality.

7.2.3 Proposal/Bid Evaluation

Provides criteria for the proposal/bid evaluation process and who shall participate in that evaluation.

7.2.4 Supplier Performance Evaluation

Provides criteria for interfacing with suppliers and verifying their performance.

7.2.5 Control of Supplier Generated Documents

Establishes criteria for controlling, processing and accepting procurement documents.

7.2.6 Acceptance of Items and Services

Provides criteria for objective evidence used in the acceptance of procured items and services.

7.2.7 Certificate of Conformance

Provides criteria for when a Certificate of Conformance is used for acceptance of an item or service.

7.2.8 Source Verification

Provides criteria where various methods of source verification may be used. Includes description of the process involved to control and personnel qualifications for source verification.

7.2.9 Receiving Inspection

Establishes the criteria for when receiving inspection is used to accept an item.

7.2.10 Post-installation Testing

Establishes that QARD Section 11, Test Control and that post-installation testing criteria are mutually established by purchaser and supplier.

7.2.11 Control of Supplier Nonconformances

Establishes requirements for both purchaser and supplier to document the process for disposition of items that do not meet procurement document requirements.

7.2.12 Commercial Grade Items

Establishes an acceptable alternative for commercial grade items when and where specified by the design.

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11.8 Identification and Control of Items

Consistent with the importance to safety, implementing documents shall be established and implemented to identify and control materials, parts, and components including partially fabricated sub-assemblies to ensure that only correct and accepted items are used and installed.

Identification requirements are determined during generation of specifications and design drawings. Correct identification of materials, parts, and components is verified and documented prior to release for fabrication, assembly, shipment, and installation.

The graded approach for identification and control of items, and traceability requirements are specified in applicable codes, standards, or specifications.

DOE-ID delegates implementation authority for QARD Section 8.0, Identification and Control of Items, to its M&O contractor.

DOE-ID monitors its M&O contractor's identification and control of item practices and, by surveillance and assessments, periodically reviews its M&O contractor's practices to ensure proper implementation and adequacy.

DOE-ID's M&O contractor is assigned responsibility for implementing QARD Section 8.0, Identification and Control of Items, for items which support program activities and is required to establish and implement identification and control practices that are responsive to the requirements of the Quality Assurance Program.

The topics from Section 8.0, Identification and Control of Items, that are implemented from the QARD are:

8.2.1 Identification

Establishes the requirements for maintenance of identification of items.

8.2.2 Physical Markings

Establishes physical marking requirements for item identification.

8.2.3 Traceability

Provides requirements for the established and maintenance of traceability criteria to items.

8.2.4 Conditional Requirements

Establishes controls for item identification to be specified in specifications.

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11.9 Control of Special Processes

Implementing documents are established and implemented to control special processes such as welding, heat treating, and nondestructive examination. Implementing documents are used to ensure that process parameters are controlled and that the specified environmental conditions are maintained.

Special processes are accomplished by qualified personnel using qualified implementing procedures and equipment per applicable codes, standards, specifications or other special program requirements. The graded approach is not applicable for special processes. Special processes are performed by qualified personnel and accomplished per written process sheets or equivalent, with recorded evidence of verification per Quality Assurance Program requirements. Qualification records of procedures, equipment, and personnel associated with special processes shall be established, filed, and kept current.

DOE-ID delegates implementation authority for QARD Section 9.0, Control of Special Processes, to its M&O contractor.

DOE-ID monitors its M&O contractor's special processes control practices related to program activities, and, by surveillance and assessments, periodically reviews its M&O contractor's practices to ensure proper implementation and adequacy.

DOE-ID's M&O contractor is assigned responsibilities for implementing QARD Section 9.0, Control of Special Processes, for activities where special processes in support of program activities are involved, and is required to establish and implement practices to ensure adequate performance and control of production special processes. DOE-ID's M&O contractor's special process controls shall be responsive to the requirements of the QARD.

The topics from Section 9.0, Control of Special Processes, that are implemented from the QARD are:

9.2.1 Special Processes

Establishes requirements for control and verification of quality for special processes.

9.2.2 Personnel, Implementing Documents, and Equipment Qualifications

Establishes requirements that process parameters are controlled and environmental conditions are maintained.

9.2.3 Qualification of Nondestructive Examination Personnel

Establishes the requirements for the control and administration of training, examination, and certification of nondestructive examination personnel.

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11.10 Inspection

The inspection program's implementing documents shall be established and implemented to describe the planning (performance and documentation) and execution of inspections. These inspections shall verify conformance of quality affecting activities with requirements. The inspection program shall be established, documented, and accomplished per written, controlled procedures.

Implementing documents address inspection planning, acceptance criteria, inspection techniques to be applied, establishment of hold points, documentation of inspection results, and actions to be taken when acceptance criteria are not met. Inspection implementing documents address source, in-process, final, receipt, maintenance, modification, operations, and eventually, decommissioning activities. Inspections are conducted by certified personnel who are independent of the inspected activity. Inspection results are documented by the inspector and reviewed by the cognizant quality assurance organization.

Inspection practices identify and verify conformance of items and services with the documented specifications, instructions, implementing documents and drawings for accomplishing the required activities. Documented inspection practices shall be responsive to the requirements of the Quality Assurance Program. Inspection personnel shall be sufficiently independent from the individuals performing the activity being inspected.

Inspection procedures, instructions, and checklists shall provide for the following:

a. Identification of characteristics and activities to be inspected

b. Identification of the individuals or groups responsible for performing the inspection operation

c. Acceptance and rejection criteria

d. A description of the method of inspection

e. Recording evidence of completing and verifying a manufacturing, inspection, or test operation

f. Recording inspector or data recorder and the results of the inspection operation.

The graded approach for inspection, verification and documentation is applied based on the importance or complexity of the item or activity affecting quality being inspected or tested. Modifications, repairs, and replacements are inspected per the original design and inspection requirements or acceptable alternatives.

The individuals or groups who perform receiving and process verification inspections are identified and shown to have sufficient independence and qualifications.

DOE-ID delegates implementation authority for direct inspection of items and work practices per QARD Section 10.0, Inspection, to its M&O contractor.

DOE-ID monitors its M&O contractor's inspection practices associated with program activities, and, by surveillance and assessments, periodically reviews its M&O contractor's practices to ensure proper implementation and adequacy.

DOE-ID's M&O contractor is assigned responsibility for performing procurement, manufacturing, fabrication and assembly, testing, constructing, and operational activities in support of program activities, and, is required to establish and implement inspection practices of sufficient scope to be fully effective.

The topics from Section 10.0, Inspection, that are implemented from the QARD are:

10.2.1 Inspection Planning

Establishes requirements for performing and documenting inspection planning.

10.2.2 Selecting Inspection Personnel To Perform Inspections

Establishes qualification requirements for inspection personnel.

10.2.3 Inspection Hold Points

Establishes criteria for mandatory hold points to control work.

10.2.4 Statistical Sampling

Requires that statistical sampling shall be based on recognized standard practices.

10.2.5 In-Process Inspections and Monitoring

Establish criteria for in-process inspection of items to verify quality. These criteria include those necessary for coordination and sequencing of work at established inspection points.

10.2.6 Final Inspection

Establishes criteria for final inspection of items.

10.2.7 Accepting Items

Establishes criteria for acceptance of items. QARD Section 14.0, Inspection, Test, and Operating Status governs the item's inspection status.

10.2.8 Inspection Documentation

Provides criteria that govern contents of inspection documentation.

10.2.9 Qualifications of Inspection and Test Personnel

Provides guidance for qualification, determination of initial capabilities, indoctrination and training of inspection and test personnel, and functional qualification levels and associated documentation.

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11.11 Test Control

Written and controlled procedures are established and executed to verify conformance to specified requirements and demonstrate that items provide satisfactory performance. These procedures contain:

a. Instructions and prerequisites to perform the test

b. Use of proper test equipment

c. Acceptance criteria

d. Mandatory witness and hold point inspections

e. Other specified technical and/or quality assurance requirements.

Written test procedures incorporate and reference:

a. The requirements and acceptance limits contained in applicable design and procurement documents

b. Instructions for performing the test

c. Test prerequisites

d. Mandatory inspection hold points

e. Acceptance and rejection criteria

f. Methods of documenting or recording test data results.

Test results shall be documented, evaluated, and their acceptability determined by a qualified, responsible individual or group. When practicable, testing will test the structure, system, or component under conditions which will be present during normal and anticipated off-normal operations.

DOE-ID delegates implementation authority for QARD Section 11.0, Test Control, to its M&O contractor.

DOE-ID monitors its M&O contractor's testing and test control practices related to program activities, and, by surveillance and assessments, periodically reviews its M&O contractor's practices to ensure proper implementation and adequacy.

DOE-ID's M&O contractor is assigned responsibilities for documenting, evaluating, and determining test result acceptability in support of program activities, and is required to establish, as applicable, proof tests, pre-operational tests, product certification tests, and other testing activities that are responsive to the requirements of the QARD.

The topics from Section 11.0, Test Control, that are implemented from the QARD are:

11.2.1 Test Planning

Establishes criteria for effective test planning.

11.2.2 Performing Tests

Establishes criteria that implementing documents shall address for tests.

11.2.3 Use of Other Testing Documents

Establishes criteria for incorporation of test information directly from testing documents into the testing implementation documents.

11.2.4 Test Results

Establishes criteria for documentation and evaluation of test results.

11.2.5 Test Documentation

Establishes criteria for contents of test documentation.

11.2.6 Qualification of Test Personnel

Establishes criteria that test personnel shall be qualified per QARD Section 10, Inspection.

11.12 Control of Measuring and Test Equipment

Implementing documents are established and executed to ensure that appropriate tools, gauges, instruments, and other measuring and testing devices used in activities which have quality assurance requirements or health and safety considerations are properly controlled, calibrated, adjusted, and maintained at specified intervals. The graded approach is not applicable for measuring and test equipment used for activities affecting quality.

Provisions, contained in procedures, describe the calibration technique and frequency, maintenance, and control of the measuring and test equipment (instruments, tools, gages, fixtures, reference and transfer standards, and nondestructive test equipment) which is used in the measurements, inspection, and monitoring of important to safety structures, systems, and components.

These implementing documents shall maintain equipment accuracy within necessary limits and maintain traceability to National Institute of Standards and Technology (NIST) or other known standards.

Calibration standards have an uncertainty requirement of no more than 1/4th of the tolerance of the equipment being calibrated. A greater uncertainty may be acceptable when limited by the "state-of-the-art".

The complete status of all items under the calibration system shall be documented and maintained.

DOE-ID delegates implementation authority for QARD Section 12.0, Control of Measuring and Test Equipment, to its M&O contractor.

DOE-ID monitors its M&O contractor's measuring and test equipment control practices related to program activities, and, by surveillance and assessments, periodically reviews its M&O contractor's practices to ensure proper implementation and adequacy.

DOE-ID's M&O contractor is assigned responsibility for performing inspections, examinations, or tests which support program activities, and is required to establish and implement a system of calibration and control of measuring and test equipment that is responsive to the requirements of the QARD.

The topics from Section 12.0, Control of Measuring and Test Equipment, that are implemented from the QARD are:

12.2.1 Calibration

Provides criteria for calibration, adjustment and maintenance of measuring and test equipment.

12.2.2 Documenting the Use of Measuring and Test Equipment

Requires that use of M&TE be documented.

12.2.3 Out-of-Calibration Measuring and Test Equipment

Provides criteria for when MT&E shall be considered as out-of-calibration.

12.2.4 Lost Measuring and Test Equipment

Provides criteria for lost M&TE.

12.2.5 Handling and Storage

M&TE shall be properly handled and stored to maintain accuracy.

12.2.6 Commercial Devices

Provides criteria for rulers, tape measures, levels, and other commercial equipment.

12.2.7 Measuring and Test Equipment Documentation

Provide criteria for M&TE documentation information.

11.13 Handling, Storage, and Shipping

Consistent with an item's or activity's importance to safety, procedures are established and executed to control handling, storage, shipping, cleaning, packaging, and preservation of material and equipment shall be accomplished by qualified individuals to prevent damage or loss, and to minimize deterioration.

Procedures shall be prepared which control the cleaning, handling, storage, packaging, shipping, and preservation of materials, components, and systems per design and specification requirements to preclude damage, loss, or deterioration by environmental conditions such as temperature or humidity.

Application of the graded approach for handling, storage, and shipping of items is specified in work and inspection instructions, and depends on how critical, sensitive, perishable, or high-value the item is.

DOE-ID delegates implementation authority for QARD Section 13.0, Handling, Storage, and Shipping, to its M&O contractor.

DOE-ID monitors its M&O contractor's handling, storage, and shipping practices related to program activities, and, by surveillance and assessments, periodically reviews its M&O contractor's practices to ensure implementation and adequacy.

DOE-ID's M&O contractor is assigned the authority to develop special handling, preservation, storage, cleaning, packaging, and shipping practices which support program activities, and is required to establish and execute implementing procedures which control the cleaning, handling, storage, packaging, shipping, and preservation of materials, components, and systems per design and specification requirements which preclude damage, loss, or deterioration by environmental conditions. These practices shall be responsive to the requirements of the QARD.

The topics from Section 13.0, Handling, Storage, and Shipping, that are implemented from the QARD are:

13.2.1 Controls

Provides criteria for handling, storage, cleaning, packaging, shipping, and preservation of items.

13.2.2 Special Equipment, Tools, and Environments

Provides criteria for special equipment and protective environments for particular items.

13.2.3 Marking and Labeling

Provides criteria for establishment of marking and labeling for packaging, shipping, handling and storage of items.

11.14 Inspection, Test, and Operating Status

Implementing documents are established and executed to identify the inspection, test, and operating status of items. The Quality Assurance Program has provisions to ensure that inspection, test, and operating status is verified before release, fabrication, installation, test, and use of items to preclude inadvertent bypassing of inspections and tests and to prevent accidental operation. Application and removal of status indicators, welding stamps, and other tags, markings, and labels shall be procedurally controlled.

The graded approach is not applicable for inspection, test and operating status. The status is identified either on the item or on documents to ensure the inspections and tests have been performed, and to ensure items are not inadvertently installed, used, or operated.

Bypassing of inspections, tests, and other critical operations shall be procedurally controlled under the cognizance of the M&O contractor's quality assurance organization.

DOE-ID delegates implementation authority for QARD Section 14.0, Inspection, Test and Operating Status, to its M&O contractor.

DOE-ID monitors its M&O contractor's practices related to program activities for indicating inspection, test, and operating status, and, by surveillance and assessments, periodically reviews its M&O contractor's practices to ensure implementation and adequacy.

DOE-ID's M&O contractor is assigned authority for: (1) developing practices that identify the inspection and test status of structures, systems, and components throughout their fabrication; (2) documenting bypassed inspections, tests, and other critical processes that are under the purview of the Quality Assurance Program; (3) identifying the organization responsible for documenting and identifying the status of nonconforming, inoperative, or malfunctioning structures, components, and systems which support program activities; and (4) establishing and implementing those practices to be responsive to the requirements of the QARD.

The topics from Section 14.0, Inspection, Test and Operating Status, that are implemented from the QARD are:

14.2.1 Identifying Items

Provides criteria for identification of items passing or not passing required inspections and tests.

14.2.2 Indicating Status

Provides criteria for indicating status of required inspections and tests and authority of application and removal of status indicators.

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11.15 Nonconformances

Nonconformance requirements shall establish control of items (material, components, and systems) that do not conform to requirements in order to prevent their inadvertent installation or use through written documents. The identification, documentation, tracking, segregation, review, disposition, and notification to affected organizations of nonconforming material, components, systems, services, or activities shall be procedurally controlled to prevent inadvertent test, installation, or use.

A corrective action system is established and executed which promotes a "no fault" attitude toward identification of conditions that are adverse to quality. Nonconforming items must be reviewed and accepted, rejected, repaired, or re-worked per implementing documents.

Documentation shall:

a. Identify the nonconforming item

b. Describe the nonconformance, the disposition of the nonconformance, and the inspection requirements

c. Includes signature approval for the disposition.

Provisions shall be established identifying those individuals or groups delegated the responsibility and authority for the disposition and the close out of nonconformances.

The graded approach is not applicable for the identification and control of nonconforming items. All items that do not conform to the quality requirements shall be controlled to prevent their inadvertent installation or use. Nonconforming items shall be segregated from acceptable items and identified as discrepant until properly dispositioned and closed out.

Dispositions to nonconformances shall identify materials, components, and systems to be used-as-is, rejected, or re-worked. Dispositioned nonconformance reports shall be made part of the quality records.

Acceptability of re-work or repair of materials, parts, components, systems, and structures shall be verified by re-inspecting and re-testing the item as originally inspected and tested or by a method which is at least equal to the original inspection and testing method. Inspection, testing, re-work, and repair procedures shall be documented.

Nonconformance documentation is analyzed to identify adverse trends in the performance of the Quality Assurance Program. Results of these analyses are reported to DOE-ID's, and its M&O contractor's, senior management.

DOE-ID also retains authority to identify and require that DOE-ID and M&O contractor identified nonconformances be entered into its M&O contractor's nonconformance control system.

DOE-ID monitors its M&O contractor's nonconformance control practices related to program activity, and, by surveillance and assessments, periodically reviews its M&O contractor's nonconformance practices to ensure implementation and adequacy.

DOE-ID delegates implementation authority to its M&O contractor for developing procedurally controlled practices that identify, document, track, segregate, review, disposition, and notify affected organizations of nonconforming materials, components, and systems, and is required to establish and implement those practices for the control of nonconforming materials, components, and systems in support of program activities. These practices shall be responsive to the requirements of the QARD.

The topics from Section 15.0, Nonconformances, that are implemented from the QARD are:

15.2.1 Documenting and Evaluating Nonconforming Items

Provides criteria for nonconformance identification and describing nonconforming characteristics of an item. Corrective action criteria used for evaluation use the requirements of QARD Section 16.0, Corrective Action.

15.2.2 Identifying Nonconforming Items

Provides criteria for identification of nonconforming items through marking, tagging or other means.

15.2.3 Segregating Nonconforming Items

Provides criteria for segregation of nonconforming items to prevent inadvertent use.

15.2.4 Disposition of Nonconforming Items

Provides criteria of the use of "use-as-is", "reject", "repair", or "rework" dispositions for nonconforming items.

15.2.5 Quality Trending

Requires that nonconforming documentation shall be periodically analyzed to identify quality trends per QARD Section 16.0, Corrective Action.

11.16 Corrective Action

The corrective action system elements consist of prompt identification, documentation, classification, cause analysis, correction of condition, elimination of root cause factors for significant conditions, and follow-up activities. All conditions adverse to quality shall be promptly identified and corrected.

Procedures have been established and implemented for the identification and correction of conditions adverse to quality including the causes of significant conditions adverse to quality identified through internal DOE-ID surveillance and assessments or external surveillance and assessments performed on the program. Procedural instructions and policy guidance provide criteria for determining the existence of significant conditions adverse to quality. The DOE-ID QAPM provides follow-up to verify timely and proper implementation of corrective action.

Corrective action is required for conditions adverse to quality such as failures, nonconformances, malfunctions, deficiencies, deviations, and defective material, components or systems. Significant conditions adverse to quality identified by DOE-ID overview or assessments of the M&O contractor's activities requires corrective action by the DOE-ID M&O contractor and DOE-ID's review and approval prior to the corrective action's implementation. Corrective action to preclude recurrence of a nonconforming condition is commensurate with the item's importance.

Corrective action documentation is provided to appropriate DOE-ID and its M&O contractor's management, and requires appropriate quality assurance organizational concurrence with proposed actions.

DOE-ID monitors its M&O contractor's corrective action systems related to program activities, and, by surveillance and assessments, periodically reviews its M&O contractor's systems to ensure implementation and adequacy.

DOE-ID's M&O contractor is required to establish and implement a corrective action system which supports program activities and is responsive to the requirements of the Quality Assurance Program. Quality information is promptly analyzed and examined for adverse quality trends. Trend analysis identifies adverse quality trends.

Quality trends and results of remedial actions are reported to DOE-ID's QAPM who is responsible for corrective action tracking and providing appropriate DOE-ID upper management appraisal.

DOE-ID's M&O contractor collects key information from program assessments, surveillance, and assessments reports. Analysis is performed to ensure prompt identification of adverse quality trends. Evaluations are performed to determine systemic root cause(s) and determine if a course of action for correction is required.

The topics from Section 16.0, Corrective Action, that are implemented from the QARD are:

16.2.1 Identifying Conditions Adverse To Quality

Provides criteria for identification of conditions adverse to quality.

16.2.2 Classification of Conditions Adverse To Quality

Provides classification criteria for conditions adverse to quality

16.2.3 Conditions Adverse To Quality

Provides criteria for documenting and reporting to appropriate levels of management conditions adverse to quality.

16.2.4 Significant Conditions Adverse To Quality

Provides criteria for determining, evaluating, investigating, and concurring of proposed remedial actions for significant conditions adverse to quality.

16.2.5 Follow-up and Closure Action

Requires Quality Assurance verify implementation of corrective actions and closed related corrective action documentation when complete.

16.2.6 Quality Trending

Provides criteria for determining adverse quality trends and the manner in which trend evaluation shall be conducted.

11.17 Quality Assurance Records

Quality Assurance records requirements ensure that Quality Assurance records are specified, prepared, maintained and retrievable. As identified in the implementing documents Quality Assurance records are classified as lifetime of the facility license or as nonpermanent. The graded approach for Quality Assurance Records is as specified in design documents, procurement documents, test procedures, and operational procedures. To aid in minimizing the retention of unnecessary records, the records program shall list records to be retained by "type of data" rather than by record title.

Implementing documents control records that document: design, design review and peer review reports, engineering, procurement, manufacturing, construction, inspections, tests, installation, pre-operation, start-up, operations, maintenance, modification, decommissioning, audits, manufacturer's records, proof, receipt, training and qualification records of personnel, procedures and equipment, operating logs, results of reviews, assessments, material analyses, monitoring of work performance, calibration procedures and reports, nonconformance reports and corrective action reports.

Implementing documents are established and executed to ensure that sufficient records of structures, components, systems and activities are generated and maintained to reflect completed work. These implementing documents provide for the administration, receipt, retrieval, and disposition of Quality Assurance records. All Quality Assurance records are retained in storage, and are identified and retrievable. DOE-ID delegates to its M&O contractor the maintenance and control of the records storage facilities per the requirements of the QARD for the life of the ISFSI.

Established implementing documents assign responsibility for storage, filing system, transmittal verification, record access, retrieval and removal, filing supplemental information and for the disposition of superseded records.

DOE-ID monitors its M&O contractor's records' practices related to program activities, and by surveillance and assessments, periodically reviews its M&O contractor's practices to ensure implementation and adequacy.

Quality Assurance records generated by DOE-ID will be maintained within the DOE-ID records management system.

DOE-ID's M&O contractor is assigned authority for performing work activities, and is required to establish and implement a practice of specifying, preparing, and maintaining records in a manner that is responsive to the requirements of the QARD.

The topics from Section 17.0, Quality Assurance Records, that are implemented from the QARD are:

17.2.1 Classifying Quality Assurance Records

Provides criteria for classification of quality assurance records.

17.2.2 Creating Valid Quality Assurance Records

Provides criteria for identification, creation, handling, and validating of quality assurance records.

17.2.3 Receiving and Indexing Quality Assurance Records

Provides criteria for establishment of a receipt control system for quality assurance records.

17.2.4 Correcting Information in Quality Assurance Records

Provides criteria for correction and approval of information changes to quality assurance records.

17.2.5 Storing and Preserving Quality Assurance Records

Provides criteria for storing and preserving methods for quality assurance records in predetermined storage facilities.

17.2.6 Retrieval of Quality Assurance Records

Provides for planned retrieval time of quality assurance records and provides criteria for controlling access to storage facilities.

17.2.7 Retention of Quality Assurance Records

Establishes criteria for retention and preservation of quality assurance records. Provides criteria for disposal of nonpermanent quality assurance records.

17.2.8 Turnover of Quality Assurance Records

Section "A" only

Provides criteria for temporarily stored quality assurance records subject to records turnover requirements.

17.2.11 Temporary Storage Facility

Provides criteria for temporary storage of quality assurance records during processing, review, or use until turnover to DOE-RW for disposition.

17.2.12 Replacement of Quality Assurance Records

Provides criteria for replacement, restoration, or substitution of lost or damaged quality assurance records.

11.18 Audits

Quality Assurance audits are to be performed by the M&O contractor in accordance with their DOE-ID approved Quality Assurance Program. DOE-ID retains responsibility for the development and implementation of an audit plan which will evaluate the performance of the M&O contractor as well as the adequacy of DOE-ID's oversight of the M&O contractor.

DOE-ID Quality Assurance audits and surveillances conducted under the direction of the NSNF QAPM will be planned, performed, and reported by trained and qualified personnel in accordance with implementing procedures. All audits of the M&O contractor related to NRC regulated activities will be lead by and Audit Team Leader who is not an employee of the M&O contractor or parent organizations. Subjects for Quality Assurance audits and surveillances shall include, but not be limited to:

- Compliance, implementation, and effectiveness of the DOE-ID and M&O contractor's Quality Assurance programs,
- Compliance with the 10 CFR Part 21 reporting requirements,
- Personnel training, and
- The managerial and administrative controls used to ensure safe operation of the TMI-2 ISFSI.

Regularly scheduled audits are supplemented by special audits when conditions which warrant special audits exist or when requested by DOE-ID management.

DOE-ID's M&O contractor has established and executed implementing documents to confirm that activities affecting quality comply with the Quality Assurance Program and that they have been effectively executed and responsive to the requirements of the Quality Assurance Program.

DOE-ID monitors its M&O contractor's records practices related to audits, and by surveillance and assessments, periodically reviews its M&O contractor's practices to ensure implementation and adequacy.

The topics from Section 18.0, Audits, that are implemented from the QARD are:

18.2.1 Scheduling Internal Audits

Provides criteria for scheduling internal quality audits.

18.2.2 Scheduling External Audits

Provides criteria for scheduling external quality assurance audits.

18.2.3 Audit Schedule

Provides criteria for development of an audit schedule.

18.2.4 Audit Planning

Provides criteria for development of an audit plan and scope of the audit.

18.2.5 Audit Team Independence

Provides criteria for audit team independence, authority, and organizational freedom.

18.2.6 Audit Team Selection

Provides criteria for identification of audit team, team leader and technical specialists.

18.2.7 Performing Audits

Provides performance criteria for the audit team leader to ensure that the audit team is prepared to perform the audit.

18.2.8 Reporting Audit Results

Provides criteria for preparation, contents, and signing of the audit report.

18.2.9 Responding To Audits

Provides criteria for management to respond to the audit report.

18.2.10 Evaluating Audit Responses

Provides for audit responses to be evaluated per QARD Section 16, Corrective Action.

18.2.11 Follow-up Action

Provides criteria for follow-up actions to be taken by the auditing organization to verify that corrective actions were accomplished per QARD Section 16, Corrective Action.

18.2.12 Technical Specialist Qualifications

Provides criteria for the indoctrination and training of technical specialist personnel to QARD Section 2, Quality Assurance Program.

18.2.13 Auditor Qualifications

Provides criteria for appropriate training and orientation of auditors for developing their competency in performing audits.

18.2.14 Lead Auditor Qualifications

Provides criteria for lead auditor skills at organizing and directing personnel.

18.2.15 Lead Auditor Education and Experience

Provides criteria for certification of education and experience of lead auditors.

18.2.16 Lead Auditor Communication Skills

Requires that lead auditors have effective communications skills.

18.2.17 Lead Auditor Training

Provides criteria for training lead auditors to attain proficiency.

18.2.18 Lead Auditor Audit Participation

Requires lead auditors to participate in five (5) Quality Assurance audits with at least one (1) being nuclear-related within one-year prior to certification as a lead auditor.

18.2.19 Lead Auditor Examination

Provides criteria for examination that evaluates lead auditor comprehension and ability to apply audit knowledge.

18.2.20 Certification of Lead Auditor Qualifications

Provides criteria for certification of qualified lead auditors by the auditing organization.

18.2.21 Maintaining Lead Auditor Proficiency

Provides criteria for lead auditors to maintain proficiency, management evaluation of proficiency, and qualification requirements.

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11.19 Supplements and Appendices

11.19.1 Software (QARD, Supplement I)

This QARD Supplement establishes requirements for the development, modification, control, and use of software.

DOE-ID delegates implementation authority for QARD Supplemental I Software for configuration management which supports program activities, such as design, to its M&O contractor.

DOE-ID monitors its M&O contractor's practices related to program activities for software configuration, and, by surveillance and assessments, periodically reviews its M&O contractor's practices to assure implementation and adequacy.

DOE-ID's M&O contractor is assigned authority implementation of QARD Supplement I, Software for construction, fabrication, assembly and/or operation functions which support program activities, and is required to establish and implement software configuration management practices for individual items throughout the program and operational status of structures, components or systems. These practices shall be responsive to the requirements of the Quality Assurance Program.

The topics from Supplement I, Software, that are implemented from the QARD are:

I.2.1 Software Life Cycles, Baselines, and Controls

Provides software life cycle criteria for developed or modified software.

I.2.2 Software Verification and Software Validation

Provides criteria for software validation and verification prior to release.

I.2.3 Software Verification

Provides criteria for software baseline elements to meet established requirements and be documented accordingly.

I.2.4 Software Validation

Provides criteria for software validation activities to be integrated in the software life cycle.

I.2.5 Documentation

Provides criteria for software activities to be sufficiently documented to demonstrate the ability of the software.

I.2.6 Software Configuration Management

Provides criteria for software configuration management to include configuration identification, configuration control, and status accounting.

I.2.7 Defect Reporting and Resolution

Provides criteria for software defect reporting and resolution which shall be integrated into the software configuration management system.

I.2.8 Control of the Use of Software

Provides criteria for controlling, documenting, and using released software items.

11.19.2 Sample Control (QARD, Supplement II)

Sample control practices as described in the QARD are not applicable to the INEEL TMI ISFSI. Scientific samples taken, handled, or recorded for any purpose in order for the INEEL TMI ISFSI to perform its function are covered by other procedures.

11.19.3 Scientific Investigation (QARD, Supplement III)

Scientific investigation practices are not applicable to the INEEL TMI ISFSI. The facility is passive and its only function is SNF storage.

11.19.4 Field Surveying (QARD, Supplement IV)

Field surveying practices are not applicable to the INEEL TMI ISFSI. The facility construction location is pre-established and identified in existing documents. The INEEL TMI ISFSI does not need the surveying controls as outlined for a mined geological repository in the QARD.

11.19.5 Control of the Electronic Management of Data (QARD, Supplement V)

This supplement applies to the controls on the electronic management of data used as the controlled source for information used in design analysis or process control.

DOE-ID delegates implementation authority for control of the electronic management of data activities which support program activities to its M&O contractor.

DOE-ID monitors its M&O contractor's practices related to program activities for control of the electronic management of data, and, by surveillance and assessments, periodically reviews its M&O contractor's practices to assure implementation and adequacy.

DOE-ID's M&O contractor is assigned implementation authority for QARD Supplemental V, Control of the Electronic Management of Data, for design, construction, fabrication, and assembly and/or operation functions which support program activities. The M&O contractor is required to establish and implement practices which control electronic management of data as the controlled source of information used in design analysis or process control. These practices are responsive to the requirements of the QARD.

The topics from Supplement V, Control of the Electronic Management of Data, that are implemented from the QARD are:

V.2.1 Control of the Electronic Management of Data

Provides criteria for data input, subsequent changes to data input, security of data, including integrity of the data, and retrieval of data using a query language.

11.19.6 High-Level Waste Form Production (QARD, Appendix A)

High-Level Waste Form Production practices are not applicable to the INEEL TMI ISFSI. The facility does not produce High-Level Waste in any form. The INEEL TMI-ISFSI is a passive facility.

11.19.7 Storage and Transportation (QARD, Appendix B)

The Licensee and the INEEL M&O contractor do not directly design or fabricate storage casks, transportation casks, or multi-purpose canisters.

11.19.8 Mined Geological Disposal System (QARD, Appendix C)

Mined Geological Disposal System practices are not applicable to the INEEL TMI ISFSI. The INEEL TMI ISFSI is a passive interim storage facility and is not a disposal system.

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11.20 References

11.1 DOE/RW-0333P, Office of Civilian Radioactive Waste Management's Quality Assurance Requirements and Description (QARD)

11.2 DOE National Spent Nuclear Fuel (NSNF) Quality Assurance (QA) Program Documents Manual

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Appendix C

RADIOLYSIS

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C.1 Background

The TMI-2 canisters evolve hydrogen and other gases due to radiolysis. This phenomenon has been documented and measured, and has been discussed within numerous licensing and technical documents. (For example, see Reference C.1.) There are three different types of canisters: *fuel*, *knockout*, and *filter*. All three types of canisters may evolve hydrogen gas due to the radiolysis of water. Drying of the canisters will be performed prior to their placement in dry storage. There is only water within the debris, consistent with the criticality analysis. However, conservatively for radiolysis, water is assumed to be present in the interstices of the debris. In addition, water of hydration may be present within the Licon concrete that fills the void area outside the former plates of the *fuel* canisters. (Neither the *knockout* canisters nor *filter* canisters contain this concrete.) All of this water may serve as a source of hydrogen from radiolysis. The lack of water in the debris of the actual material will provide a significant margin of safety since water will not be present to absorb the energy.

All of the TMI-2 canisters contain hydrogen recombiner assemblies that were provided during their initial construction. These recombiners use precious metal catalysts (e.g., platinum, palladium) on inorganic substrates to recombine gaseous hydrogen and oxygen that may be present in the canisters as a result of radiolysis. However, these recombiners have been submerged in both the TMI-2 and INEL pool waters for many years. While the recombiners are not necessarily damaged by this extended submergence, for conservatism they are assumed to be inoperable during the future dry storage period.

Since the recombiners within the canisters are assumed to be inoperable, and it is desired to have a passive storage system to the greatest possible extent, hydrogen within the system may be safely controlled by diffusion. Under the proposed plan, the canisters will be vented to the DSC via their two existing penetrations for venting and dewatering. The DSC will, in turn, be vented to the outside atmosphere via a HEPA-filtered vent. In addition, the purge port from the DSC will also be connected to a HEPA filter and also serve as a passive vent. A number of calculations and studies are performed to evaluate the theoretical generation rate of hydrogen within the canisters, and to evaluate the expected transport of hydrogen gas within the proposed dry storage equipment.

C.2 Canister Gas Generation Rates

After being loaded with radioactive core materials, all of the canisters were monitored for gas production prior to their shipment from the TMI-2 to the INEL. This monitoring was performed to ensure that the canisters' atmospheres would remain at a concentration of less than the lower flammability limit of hydrogen during the shipping period. The canisters were then inerted with two atmospheres of argon prior to shipment. In order to more accurately evaluate hydrogen gas production rates, eight of the canisters were subjected to a "long-term" gas sampling study at the INEL. Reference C.2 is a summary of the results of that study. The highest hydrogen gas generation rate that was measured at the INEL was 1.95 cc per hour (0.00195 liters per hour) for canister number D-188. During all of the gas generation testing that was done to the various canisters, hydrogen recombiners were present. Since the recombiners were installed in the canisters during their initial construction, there is no field data on hydrogen gas generation rates within these canisters without the recombiners present.

The storage canisters will evolve gases as a result of radiolytic decomposition of residual water and any organic materials that may be present. The rate of gas production is a function of the energy emitted by the canister's contents, the fraction of the energy absorbed by the material that decomposes, and a gas generation constant or 'G-value' (typically expressed as the number of molecules of gas or free radicals formed per 100 eV of energy absorbed).

The gas generation rate will also be a function of the quantity and location of the water that is present. The fraction of decay heat energy that is absorbed by the water will affect the amount of hydrogen generated by radiolysis. In order to estimate the amount of water that could be in the canisters after drying, information on the canisters' void volumes was analyzed. The void volume of the fuel debris particles determined during the TMI-2 cleanup ranged from 8 to 31%. It was assumed that water filled the entire void volume of 31%. This is a conservative assumption for radiolysis evaluation because the canisters will be dried consistent with the criticality analysis prior to loading in the DSC.

Considerable data is available on appropriate 'G' values for water. The most commonly supported value, and the one generally accepted in this type of analysis is for a hydrogen production (or G_{H2}) of 0.44 molecules per 100 eV absorbed [C.3]. Similarly, previous analyses have assumed that hydrogen and oxygen gases are produced by water radiolysis in stoichiometric proportions (G_{O2} = 0.22). The assumption of a G_{O2} of 0.22 is an acceptably conservative approach for safety analyses. Current calculations also considered the total radiation emitted (i.e., alpha, beta, and gamma) because of the close proximity of the water to the radiation source.

The original NRC-approved safety analysis for the defueling canisters [C.4] calculated a maximum canister theoretical gas generation rate of 0.076 liters per hour of hydrogen and 0.038 liters per hour of oxygen. There was significant conservatism used in this earlier calculation that may be relaxed today. First, the maximum theoretical gas calculations assumed that the canister was loaded to its maximum design payload of 800 kg (1764 lb). Those calculations were performed prior to actual loading of any canisters, while we may now calculate a gas generation rate using known measured payload data. The earlier calculations used a decay heat load for the core debris for a date of March

1986. Thirteen more years of decay will have occurred, significantly reducing the decay heat and gas generation rate. Current calculations use a total core decay heat load obtained for the year 1999 (a projected time of actual fuel transfer).

The projected hydrogen and oxygen generation rates (in liters per hour) may be calculated by the following formula:

$$Rate = Ewatts \times P \times F \times \frac{1eV}{1.6 \times 10^{-19} watt - \sec} \times G \frac{molecules}{100eV} \times \frac{22.4 liters}{6.02 \times 10^{23} molecules} \times \frac{3600 \sec}{hour}$$

where:

E is the decay heat energy of a single canister and is obtained by multiplying the total TMI-2 core decay heat of 4776 watts (for year 1999) by the canister payload weight divided by the total core mass of 127400 kg.

P is the peaking factor or the ratio of the peak energy from the debris in a canister to the energy in the same quantity of average fuel. This value is 1.9.

F is the fraction of the alpha, beta, and gamma energy (i.e., the decay heat) absorbed by the water assumed to be in the canisters. For these canisters, this value is calculated to be 0.0345 [C.5].

The above equation was used to calculate the gas generation from all of the canisters. The maximum calculated gas generation is from a single *knockout* canister at 0.008 liters of hydrogen per hour. (There is only a single canister at this 0.008 liter per hour maximum rate.) The maximum fuel-type canister has a calculated generation rate of 0.007 liters per hour.

C.3 Other Possible Sources of Hydrogen

There are possible sources of hydrogen in the canisters' atmospheres other than that from radiolysis of water. However, these sources are not expected to be significant for the TMI-2 core canisters for the following reasons:

- Corrosion of the canisters is not expected to be the source of a significant quantity of gas. The canisters were manufactured from stainless steel and will not be subjected to a corrosive environment while in dry storage. The core materials are not expected to significantly corrode when subjected to ambient atmospheric conditions. The fuel itself is uranium dioxide and is, thus, already oxidized. In summary, corrosion is not expected to provide a hydrogen source term that is significant relative to the hydrogen source term from radiolysis.

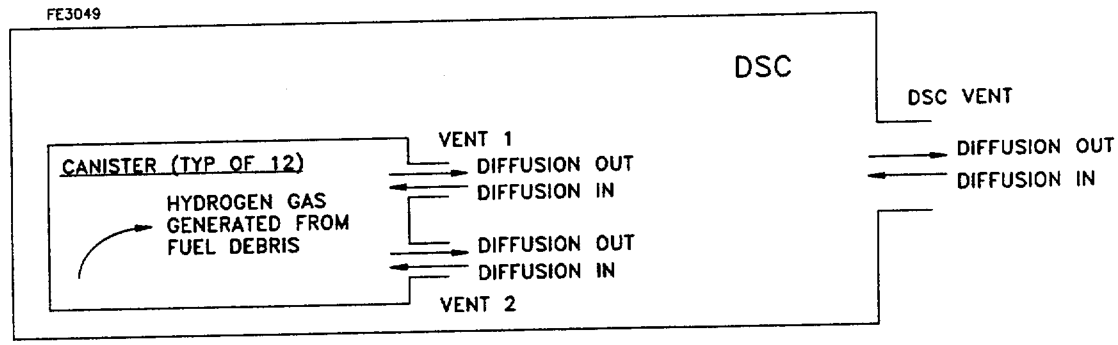
- The TMI-2 core materials do not contain significant quantities of hydrogen in comparison to the radiolysis of water within the canisters. The two materials for which the various canisters were designed were defueling water and fuel debris; organic and hydrogenous materials were avoided during both the design and use of the TMI-2 canisters.

- Hydrogen generated by chemical reaction with the boric acid solution of a fuel pool is not a likely scenario for the TMI-2 canisters. The present plan is that the TMI-2 canisters will be loaded in the DSC while dry. Therefore, it is unlikely that the chemical reaction scenario that has occurred for some dry storage systems will be repeated during the loading of the TMI-2 canisters.

- The production of hydrogen from the radiolysis of waters of hydration within the Licon cement should also be of a negligible quantity relative to that from the water in the interstices of the fuel debris. The Licon cement is separated from the fuel debris by a 0.135" boral shroud, which is sandwiched between 0.04" thick and 0.08" thick stainless steel plates [C.6]. This shroud will prevent essentially all alpha and beta radiation emanating from the core debris from reaching the concrete. The alpha and beta radiation comprise the majority of the debris decay energy. A considerable quantity of the gamma radiation will be attenuated by the shroud materials, or will be absorbed by the "non-water" substances (e.g., the aggregate, the calcareous and silicate portions of the cement crystal) within the concrete. Given the above, it is assumed that the presence of the Licon concrete within the debris canisters does not constitute a hydrogen generation concern relative to the water interspersed in the debris.

C.4 Gas Transport Assumptions and Calculations:

The following is a graphical presentation of the proposed canister/DSC arrangement, with an explanation of the various diffusion flows of hydrogen gas that were assumed in the analysis model.

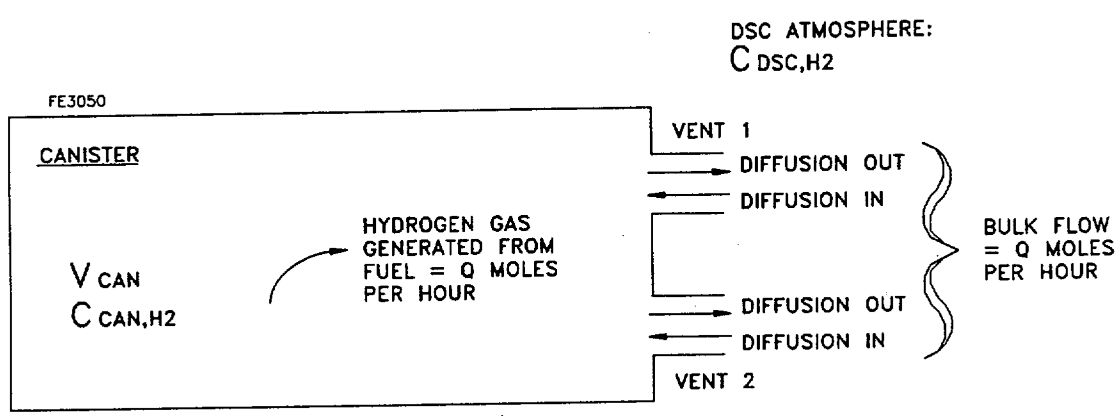


The canisters will have internal hydrogen gas being generated at the generation rates previously described. For the purposes of the gas transport model, the generated gas will be assumed to be pure hydrogen.

There are two possible vent paths from the canisters, one vent penetration and one dewatering penetration. The diffusion flow through these two vents will be assumed to be equimolar counter diffusion. That is, hydrogen will diffuse out of the canisters while air will diffuse into the canister. For every molecule of hydrogen that diffuses out, a molecule of air (i.e., nitrogen, oxygen, etc.) will diffuse into the canister.

Along with the generation of hydrogen gas in the canisters, and the diffusion flow from their vents, there will be a "bulk" flow of gas out of the canisters due to the evolved gas. That is, for every cubic centimeter (cc) of hydrogen that is evolved from the waste debris within the cans, a cc of gas will be pushed out the vents. If this didn't occur, the canister would pressurize. In summary, isobaric conditions for the canister, DSC, and outside atmospheres are assumed.

In summary, the flow paths from the canisters are:



A hydrogen gas balance may be written for the canisters:

Hydrogen **in** - Hydrogen **out** = Hydrogen **accumulated** in the canister

This may be further elaborated as:

(Hydrogen in due to gas generated) - (Hydrogen diffusing out of Vent #1) -

(Hydrogen diffusing out of Vent #2) - (Hydrogen out with "bulk flow") =

Hydrogen accumulated.

This may be further written as the following differential equation:

EQUATION 1 (Canister Unsteady- state):

$$Q-\left[D\frac{(C_{CAN,H2}-C_{DSC,H2})(\text{vent 1 area})}{(\text{vent 1 length})}\right]-\left[D\frac{(C_{CAN,H2}-C_{DSC,H2})(\text{vent 2 area})}{(\text{vent 2 length})}\right]-Q(C_{CAN,H2}) = V_{CAN}\left(\frac{dC_{CAN,H2}}{dt}\right)$$

where:

Q	= *Canister hydrogen generation rate*
D	= *Diffusion coefficient for hydrogen in air*
$C_{CAN,H2}$	= *hydrogen concentration in canister*
$C_{DSC,H2}$	= *hydrogen concentration in DSC*
vent 1 area	= *cross-sectional area of canister vent 1*
vent 1 length	= *length of canister vent 1*
vent 2 area	= *cross-sectional area of canister vent 2*
vent 2 length	= *length of canister vent 2*

$\frac{dC_{CAN,H2}}{dt}$ = *time rate of change of hydrogen concentration in canister, and*

V_{CAN} = *free volume of canister*

At steady state (where the right hand side of the equation is zero), we find:

EQUATION 2 (Canister Steady State):

$$C_{CAN,H2}\text{ (at steady state)} = \frac{Q + D\left(\frac{\text{(vent 1 area)}}{\text{(vent 1 length)}} + \frac{\text{(vent 2 area)}}{\text{(vent 2 length)}}\right)\cdot\left(C_{DSC,H2}\text{ (at steady state)}\right)}{Q + D\left(\frac{\text{(vent 1 area)}}{\text{(vent 1 length}} + \frac{\text{(vent 2 area)}}{\text{(vent 2 length)}}\right)}$$

A similar model is derived for the DSC and for a mass balance around the entire DSC/canisters system. These models give us the unsteady-state and steady-state equations for the DSC:

EQUATION 3 (DSC Unsteady-state):

$$\left[12Q\left(C_{CAN,H2}\right) + 12\left[D\frac{\left(C_{CAN,H2} - C_{DSC,H2}\right)\text{(vent 1 area)}}{\text{(vent 1 length)}}\right] + 12\left[D\frac{\left(C_{CAN,H2} - C_{DSC,H2}\right)\text{(vent 2 area)}}{\text{(vent 2 length)}}\right]\right] -$$

$$-\left[D\frac{\left(C_{DSC,H2} - C_{OUTSIDE,H2}\right)\text{(DSC vent area)}}{\text{(DSC vent length)}} + 12Q\left(C_{DSC,H2}\right)\right] = V_{DSC}\left(\frac{dC_{DSC,H2}}{dt}\right)$$

where:

V_{DSC} = *Free volume of the DSC*

Q = *Canister hydrogen generation rate*

D = *Diffusion coefficient for hydrogen in air*

$C_{CAN,H2}$ = *Hydrogen concentration in canister*

$C_{DSC,H2}$ = *Hydrogen concentration in DSC*

$C_{OUTSIDE,H2}$ = *Hydrogen concentration outside the DSC = 0.0*

vent 1 area = *Cross-sectional area of canister vent 1*

vent 1 length = *Length of canister vent 1*

vent 2 area = *Cross-sectional area of canister vent 2*

vent 2 length = *Length of canister vent 2*

DSC vent area = *cross-sectional area of the DSC vent*

DSC vent length = *length of the DSC vent*

$\frac{dC_{DSC,H2}}{dt}$ = *Time rate of change of hydrogen concentration in the DSC*

EQUATION 4 (DSC Steady-state):

$$C_{DSC,H2} = \frac{12Q}{12Q + \left[D \frac{(\text{DSC vent area})}{(\text{DSC vent length})} \right]}$$

for the steady state.

These equations show that the hydrogen concentrations in both the canister and the DSC depend heavily on their vent geometries and the hydrogen generation rate (G), as well as the canister vent paths to the DSC atmosphere.

C.5 Canister Vent Paths

There are two possible "bottlenecks" for the diffusion process in this system: the canister vents and the DSC vent. It is important that the hydrogen concentration in both the DSC and the canister atmospheres remain below 5%. An analysis of the canisters' vent and drain paths has indicated that the fuel debris-type canisters have the design with the least hydrogen diffusivity (i.e., this canister has the highest resistance to diffusion). A description of the existing debris canister vent paths is as follows:

The *fuel* canisters have (from inside the canister to outside) a drain/dewatering line that is nominally 142" long and 0.527" I.D. . The bore through the head of the canister is 0.500" in diameter and is 7/8" long. (This 0.500" bore is tapped for 3/8" NPT threads.)

The *fuel* canisters have a head space vent path that consists (from inside the canister to outside) of an 1/8" diameter bore that is 1/4" in length, then a bore of 27/64" that is 1-1/8" long. (This 27/64" bore was tapped with 1/4" NPT threads.)

Given the above geometries for the possible vent paths, it is possible to convert these paths to equivalent lengths of 1/2" I.D. tubing as shown in Table C.5-1 below. This is done because diffusion of a gas proceeds at a rate proportional to the ratio of the cross-sectional area of a pipe to its length. For conservatism, add 10% to the equivalent length of 1/2" I.D. tubing to account for entrance and exit losses, despite the fact that hydrogen generation rate and hence diffusion is a very slow process (the diffusion of a few cc's of gas per hour) and would not expect significant entrance losses.

Table C.5-1 Equivalent Length of 1/2" I. D. Tubing

Item	I.D. (in)	Length (in.)	Cross-Sectional Area (sq. in.)	Area/length	**Equivalent length of 1/2" I.D. tube**. (Area=0.196 sq. in.)
***Fuel* Canister Dewatering/Drain Tube**					
Drain Tube	0.527"	142"	0.218	.00153	128
Head Boring	0.50"	7/8			0.875
					Subtotal: 129"
					+10% = 13"
					TOTAL: 142"
***Fuel* Canister Head Space Vent**					
Head Boring	0.125"	.25	0.0123	0.049	4
Head Boring	0.421"	1.125	0.139	0.124	1.6
					Subtotal:5.6"
					+ 10% = 0.6"
					TOTAL: 6.2"

C.6 Calculations

Equations 2 and 4 are used to evaluate the maximum steady-state canister and DSC hydrogen concentrations that can be expected for given canister and DSC vent geometries. By substituting into the equations it can be demonstrated that a DSC vent geometry equivalent to 5" diameter and 14" length provides a low steady state DSC concentration (about 1%). Calculations in Section C.7 show that this DSC vent geometry requirement is satisfied. Utilizing a DSC vent of this size, and removing the Hansen fittings on the TMI-2 canisters, steady state hydrogen concentration in the DSC and TMI-2 canisters is calculated as shown below:

Using the steady state formula for the DSC (Equation 4):

Hydrogen Conc. in the DSC =12Q/ (12Q+D(DSC vent area/DSC vent length))

where:
12 = the number of canisters in a DSC
Q = the hydrogen generation rate in cc/hr per canister = 7 cc/hr
D = the diffusion coeff for hydrogen in air @ 0°C = 0.611 sq. cm/sec =2,200 sq. cm/hour
Canister vent 1 area = 1.27 sq. cm (½" I.D. pipe equivalent)
Canister vent 1 length = 142" = 361 cm (from preceding table)
Canister vent 2 area = 1.27 sq. cm (½" I.D. pipe equivalent)
Canister vent 2 length = 6.2" = 15.7 cm (from preceding table)
DSC vent area = 126.7 sq. cm (5" I.D. pipe equivalent)
DSC vent length = 14" = 35.6 cm

Canister vent cross-sectional areas and lengths are from the table above.

$$C_{DSC} = (12*7) / [(12*7) + 2200(126.7 \text{ sq. cm}/ 35.6 \text{ cm})] = 0.01 = 1.0\ \%$$

Substituting this steady-state DSC concentration into the equation for the canister (Equation 2):

$$C_{canister} = \frac{7 + (2200((1.27 / 361)+(1.27 / 15.7))(0.01))}{7 + 2200((1.27 / 361)+(1.27 / 15.7))} = 0.046 = 4.6\%$$

This shows that a DSC vent with this geometry (or equivalent from a diffusion standpoint) will maintain both the DSC and canister atmospheres at less than 5% hydrogen.

Note: The above calculations do not include the Hansen quick-disconnect fittings presently installed on the canisters' vent ports. These fittings make the diffusion path from the canisters more difficult, and increase the expected steady-state hydrogen concentration in the canisters and, will be removed from the canisters prior to dry storage.

The following are the input parameters to the model, and a brief discussion of the values that have been analyzed:

Canister free volume: Reference C.7 indicated that the canisters would be dried to the extent that the average *fuel* canister has a void volume of 3.85 cubic feet, the *knockout* canisters have an average void volume of 7.35 cubic feet, and the *filter* canisters have an average void volume of 5.96 cubic feet. To be conservative, a canister free volume of 100,000 cc's, or 3.53 cubic feet is used in the radiolysis evaluation. The use of low canister free volume is conservative in these calculations. Note that the canister free volume does not enter into the final steady state concentration of hydrogen in the canister (see Equation 2). The canister free volume affects only the rate at which the hydrogen concentration builds up in the canister (i.e., before it reaches steady state). Also, to meet criticality requirements the free water will be removed from the canisters prior to loading into a DSC. Therefore, these calculations are based on a conservatively high volume of free water and low canister free volume.

Canister initial hydrogen concentration: An initial concentration of 0% by volume is assumed.

Single canister hydrogen generation rates: The generation rate of hydrogen within a canister, Q, is the dominant input parameter to these calculations. 7 cc/hr/canister is used as the design basis hydrogen generation rate.

Diffusion coefficient of hydrogen in air: A value of .611 sq. cm/sec at 0°C (32°F) from Reference C.8 is used. This is a conservative value since diffusion rate will increase with temperature. (The average annual temperature at the INEL site is approximately 42°F per Reference C.9.)

Canister vent 1 cross-sectional area, Canister vent 1 length, Canister vent 2 cross-sectional area, and Canister vent 2 length: See the previous section on canister vent paths.

Number of canisters per DSC: A total of 12 canisters will be stored per DSC. All 12 of the canisters are assumed to have the same geometry (i.e., vent sizes) and hydrogen generation rates.

DSC free volume: 3,200,000 cc is used as the internal free volume of the DSC. Note, however, that the DSC free volume does not enter into the final steady state concentration of hydrogen in the DSC (see Equation 4). The DSC free volume affects only the rate at which the hydrogen concentration builds up in the DSC (i.e., before it reaches steady state).

DSC initial hydrogen concentration: An initial concentration of 0% by volume is assumed.

DSC vent cross-sectional area: The cross-sectional area of the DSC vent is an important parameter in the evaluation of the hydrogen transport from the DSC.

DSC vent length: The length of the DSC vent is an important parameter in the evaluation of the hydrogen transport from the DSC.

C.7 DSC Vent Filtration

The hydrogen transport from the canister/DSC system is highly dependent on the vent geometries. A proposed DSC vent filter may be added to the "equivalent pipe length technique" (similar to those methods used for pump calculations) wherein the proposed filter is "converted" to a pipe of similar hydrogen diffusivity.

The DSC vent will exhaust to the outside atmosphere. Thus, it must provide a particulate capture efficiency that is equivalent to that provided by HEPA filters that are inservice at other nuclear facilities. It also must have sufficient hydrogen diffusivity and flow ratings to allow for proper diffusion of hydrogen.

The DSC vent filters will have essentially the same specifications as the Drum Filter Vents (DFVs) and similar filters presently being utilized by the DOE. These DFVs and similar filters are used to exhaust hydrogen from radwaste containers in which hydrogen generation is a concern. The Trupact-II SAR [C.10] has described carbon composite filters designed for high efficiency particulate air (HEPA) filtration with tested hydrogen diffusivities. (These filters are manufactured by Nuclear Filter Technology, Inc.) Recent work by Pall Corporation has described all stainless steel HEPA filters with tested hydrogen diffusivities [C.11]. Either of these filters will provide sufficient hydrogen diffusivity for this application.

Under the conservative analysis described earlier, the DSCs will have a steady state hydrogen concentration of approximately 1% by volume (a hydrogen mole fraction of 0.01). The hydrogen generation rate within the DSC/canister system will be (12 canisters times 7 cc/hr/canister or) 84 cc/hr of hydrogen. As an example, the NucFil-016 carbon composite filter has a hydrogen diffusivity of 9.34E-5 mole/sec/mole fraction; the Pall DFV #1 stainless filter has a diffusivity of 5E-6 mole/sec/mole fraction. For a DSC hydrogen concentration just inside the filter of 1% (a mole fraction of 0.01), these filters would release 75 cc/hr and 4 cc/hr, respectively. (The difference in these two filters is that the NucFil-016 is a 2" diameter filter while the Pall filter is 3/4" diameter. Pall is able to manufacture larger filters.)

The NucFil-016 has a diffusivity of 9.34E-5 mole/sec/mole fraction. The filter is 2" in diameter and approximately 1" long. An empty pipe that is 2" diameter and about 2-1/2" long has the same diffusivity. (This indicates that, so far as the molecular hydrogen is concerned, much of the filter is empty space.) Since the diffusion through the filters is additive, two filters has half the equivalent length of one filter, four filters gives 1/4 the equivalent length as one filter, etc. (That is, if one filter provides a diffusivity of 9.34E-5 mole/sec/mole fraction, two filters will provide twice that diffusivity or 18.68 E-5 mole/sec/mole fraction. etc.)

The DSC vent includes four NucFil-016 filters in parallel and has an equivalent length of less than 14" of 5" I.D. pipe as shown in the calculations below. [Note that four NucFil-016 filters could be installed or another filter with a hydrogen diffusivity of (4 times 9.34E-5 mole/sec/mole fraction =) 3.74E-4 mole/sec/mole fraction is also acceptable]. The steady state values of hydrogen using previous equations and equivalent length of filters is calculated as shown below:

The gas enters the DSC shield block through the two inch wide, six inch long openings. It then passes through the openings in the lid, shield plug, vent attachments, filter access areas and filter before it exits to the ambient. These vent paths are converted to equivalent lengths of 5" diameter tube as shown below:

Area of a 5 inch pipe = $2.5^2 * \pi = 19.63 \text{ in.}^2$

The shield block is 1.75 inches in length.

$L_{SB} = 19.63*1.75/(2*2*6) = 1.43$ in.

Length up to the lid.

$L_B = 19.63*1/(7.54*.5*6.83) = 0.76$ in.

Length through the shield plug with five inch diameter opening.

$L_{SP} = 6.04$ in.

Length of vent attachment.

$L_{VA} = 19.63*3/(4.75^2*\pi) = 0.83$ in.

Length of filter access.

L_{FA}= 19.63*1.4/((2.259/2)^2*π*4)=1.17

The equivalent length of the five inch pipe for the NucFil filters is calculated below:

Diffusion equation :

N/A= D(ΔC/ L_F)

Where:

N= moles/sec

A= cross-sectional area (cm^2)

D= Diffusion coefficient = 0.611 cm^2/sec for hydrogen in air at 0°C

ΔC= concentration gradient (moles/cm^3)

L_F = equivalent length cm

For the filter term N/ΔC, cc per time is given as 9.34 E-5 mole/sec/mole fraction

Mole fraction =1.0 gram mole/ 22400 cc

N/ΔC = 9.34 10^{-5}/22400 = 2.094 cc/sec

A for a 5 inch pipe is 127 cm^2 =(5*2.54)π/4

Substituting in to the diffusion equation and solving for L_F:

2.094 cc/sec = (0.611 cm^2/sec)(127 cm^2)/ L_F

L_F = 37 cm = 14.58 inches of 5 in. Dia. Pipe.

One filter has equivalent length of 14. 58 inch of five inch diameter pipe. Four filters in parallel have an equivalent length of:

$L_{FT} = 14.58/4 = 3.65$ in.

Equivalent total length for the DSC vent geometry is:

$L=L_{SB}+L_{B}+L_{SP}+L_{VA}+L_{FA}+L_{FT} = 1.43+0.76+6.04+0.83+1.17+3.65 = 13.88$ inches.

This is less than the 16 inches used in the hydrogen concentration calculation that follows. Therefore, there is considerable margin in the DSC vent design.

Using the steady state formula for the DSC (Equation 4):

Hydrogen Concentration in the DSC =12Q/ (12Q+D(DSC vent area/DSC vent length))

where:
12 = the number of canisters in a DSC
Q = the hydrogen generation rate in cc/hr per canister = 7 cc/hr
D = the diffusion coeff for hydrogen in air @ 0°C = 0.611 sq. cm/sec =2,199.6 sq. cm/hour
DSC vent area = 126.7 sq. cm
DSC vent length = 16" = 40.6 cm

$C_{DSC} = (12*7) / [(12*7) + 2200(126.7 \text{ sq. cm}/ 40.6 \text{ cm})] = 0.012 = 1.2\ \%$

$$C_{canister} = \frac{7 + (2200((1.27\ /\ 361)+(1.27\ /\ 15.7))(0.012))}{7 + 2200((1.27 / 361)+(1.27 / 15.7))} = 0.048 = 4.8\%$$

Equations 1 and 3 are solved with the following inputs to calculate canister and DSC hydrogen concentration as a function of time:

DSC vent diameter of 5"

DSC vent length of 16"

Canister generation rate of 7 cc/hr per canister

No Hansen couplers were used on the canisters

Other inputs are:

Individual Fuel Debris Canister free volume = 100,000 cc

Canister initial hydrogen concentration = 0%

Single canister hydrogen generation rate =7 cc/ hr per canister = Q

Diffusion coefficient of hydrogen in air = 0.611 sq. cm/sec = 2,200 sq. cm/hr

Canister vent 1 cross-sectional area = 1.27 sq. cm. (1/2" I.D. Tube)

Canister vent 1 length = 360 cm (see preceding table)

Canister vent 2 cross-sectional area = 1.27 sq. cm. (1/2" I. D. Tube)

Canister vent 2 length = 60.2 cm (see preceding table)

Number of canisters per DSC = 12

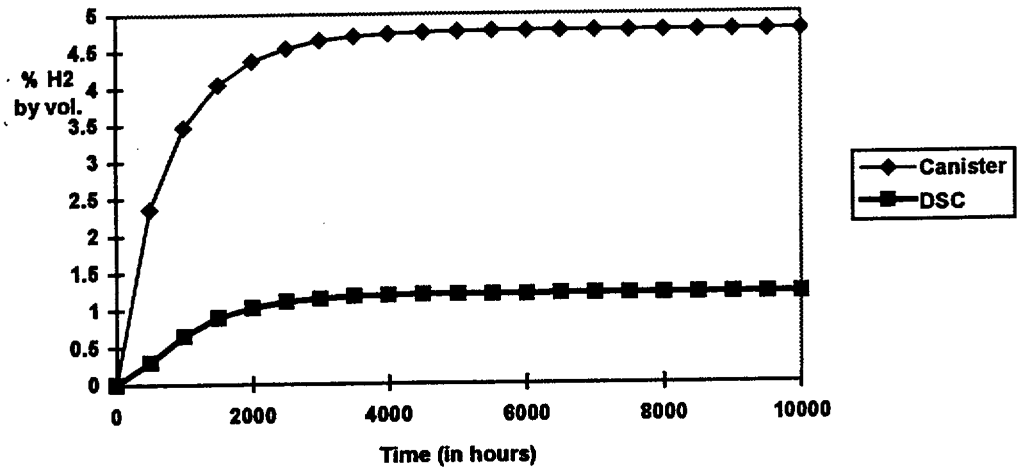
DSC free volume = 3,200,000 cc

DSC initial hydrogen concentration = 0%

DSC vent cross-sectional area = 127 sq. cm. (5" I.D. pipe)

DSC vent length = 16" = 40.6 cm

The following is a plot of the concentration versus time data calculated:



As calculated in the previous section, the steady-state DSC and canister hydrogen concentrations for this plot are 1.2% and 4.8%, respectively. The addition of the filters on the end of the DSC vent raised the steady-state concentrations slightly.

A carbon or stainless steel HEPA filter may be installed. The analysis above has used the diffusivity of the four NucFil-016 carbon filter with efficiencies of greater than 99.97% for 0.3μm DOP particles, but any filter with sufficient diffusivity and particulate capture efficiency may be used.

The radioactive drum vent filters manufactured by Nuclear Filter and Pall meet the essential specifications for the DSC vent filter.

C.8 Conservatisms of these Methods

The analysis has neglected the normal diurnal atmospheric pressure variation for the INEL location. The analysis assumed that the canister/DSC dry storage system was isobaric (i.e., at constant pressure). (The average station barometric pressure is 25.06" Hg. Per Reference C.9, the annual mean daily pressure range is 0.10" Hg. in summer, which equates to a gas volume change of about 0.4% of the system volume per day.) It is conservative to neglect this breathing, since the daily pressure "breathing" will introduce approximately 400 cc (0.4 %) of DSC air into each canister free volume of approximately 100,000 cc, as well as introduce approximately 12,800 cc (0.4 %) of air into the atmosphere of the DSC. Note that while 0.4% of a canister volume (400 cc) is a relatively small amount of daily gas exchange, it is a large volume compared to the 7 cc/hr (=168 cc/day) of hydrogen generated in a canister over the same period. This gas will dilute the hydrogen gas within the dry storage system and also will move hydrogen gas out of the dry storage system at a faster rate than that achieved by diffusion alone. In summary, there is substantial conservatism in neglecting the daily atmospheric pressure variation since, during a typical day, a greater volume of air will be introduced into the system than hydrogen.

The TMI-2 fuel debris has some decay heat that will cause thermal convection currents to be created. This convection will help aid the transport of the hydrogen. However, thermal convection currents were also neglected in the analyses.

The lowest diffusion coefficient for hydrogen in air is used. A higher diffusion coefficient would increase the rate of hydrogen transport from the system.

It was assumed that a stoichiometric mixture of oxygen and hydrogen was created as a result of the radiolysis. However, any bulk flow out of the canisters and DSC that would be provided by the appearance of oxygen in the canisters was neglected. Had the evolution of a stoichiometric amount of oxygen within the canisters been considered, the "bulk flow rate out" volume terms in Equations 1 through 4 would be increased from Q to 1.5Q for the canisters, and from 12Q to 18Q for the DSC. This would lower the steady-state concentrations for both the canisters and DSC.

It is assumed that the hydrogen recombiners present in all of the canisters were not functional.

It is assumed that entrance losses of the diffusion through the canister vents would amount to 10%, although this is a very slow process and there is little reason to suspect that entrance losses will be significant.

It is assumed that each of the 12 canisters in a single DSC will evolve hydrogen at the maximum calculated rate. It is unlikely that a single DSC will have a source term of 84 cc/hr hydrogen.

There will be a second (albeit smaller) filtered vent path provided from the DSC to the outside atmosphere. The drain line of the DSC will be used as a vent; however the contribution of that line to the hydrogen removal from the system was ignored.

C.9 Conclusions

The analysis shows that the DSC venting system will maintain the DSC and canisters below 5% hydrogen. Considering the above-mentioned conservatisms of the calculations, it is probable that both the DSC and the canisters will never even approach this 5% concentration.

C.10 References

C.1 GEND 051, "Evaluation of Special Safety Issues Associated with Handling the Three Mile Island Unit 2 Core Debris," J. Henrie and J. Appel, June 1985.

C.2 GPU Nuclear Letter #4410-87-L-0127/0214P, F. R. Standerfer to U.S. Nuclear Regulatory Commission, "Defueling Canister Gas Sampling," October 21, 1987.

C.3 D. Fletcher, et al, "Post-LOCA Hydrogen Generation in PWR Containments," Nuclear Technology, Volume 10, pp. 420-427, April 1971.

C.4 NRC Letter NRC/TMI 85-083: William D. Travers to Frank Standerfer, "Defueling Canister TER," November 5, 1985.

C.5 "TMI-2 Canister Dry Storage: Hydrogen Gas Generation and Transport Evaluation," GPU Nuclear, Inc., September 1996.

C.6 Babcock and Wilcox Co. Drawings as follows:

#1161301, Rev. 1, "*Knockout* Canister SAR Information"
1150943, Rev. (illegible from microfiche), "*Knockout* Canister Head"
#1154030, Rev. 2, "*Knockout* Canister End Cap Assembly"
#1150961, Rev. 1, "*Knockout* Canister End Cap"
#1161299, Rev. 1, "*Filter* Canister SAR Information"
#1150958, Rev. 3, "*Filter* Canister Upper Head"
#1161300, Rev. (illegible from microfiche), "*Fuel* Canister SAR Information"
#1150989, Rev. (illegible from microfiche), *Fuel* Canister Upper Head"
#1154070, Rev. B3, "Assembly - *Fuel* Canister"
#1155381, Rev. 0, "Drain Tube"
#1154095, Rev. 0, "3/8 NPT Close Nipple"
#1154115, Rev. 1, "1/4 NPT Special Nipple"

C.7 Lockheed Idaho Technologies Company, "Performance Specification ICPP Interim Storage System (ISS) for the Long Term Storage of the TMI-2 Fuel Project," February 1995.

C.8 Chemical Engineer's Handbook, Fifth Edition, Perry and Chilton, McGraw-Hill Book Company, pp. 3-222, 1973.

C.9 Climatography of the Idaho National Engineering Laboratory, 2nd edition, U.S.D.O.E., December, 1989.

C.10 NuPac Trupact-II Safety Analysis Report (SAR), Revision 3, July, 1989.

C.11 L. Weber, et al, "Validation Testing of Radioactive Waste Drum Filter Vents," Pall Corporation, 1996.

APPENDIX D

CRITICALITY MODEL INPUT DECKS

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Criticality Evaluation

The input decks for the three types of TMI-2 canister, a DSC loaded with 12 *knockout* canisters in the MP187, and a DSC loaded with 12 *knockout* canisters in an HSM are provided below.

Extensive annotated input is provided in lieu of sketches of the models. Where input is redundant from one model to the next, descriptive text is not repeated.

Fuel Canister Model

```
=csas2x
```

Indicates that the control module CSAS2X (which uses the functional modules BONAMI-S, NITAWL-II, and XSDRNPM-S) will be called.

```
single fuel canister model'
```

Title card.

```
44groupndf5 latticecell
```

Indicates that the 44 group cross section library will be used and that the lattice cell fuel region geometry will be used.

```
uo2   1 0.91075 293 92235 2.98 92238 97.02 end
```

The standard composition component name uo2 is used, the volume fraction is 0.91075, the temperature used is 20 Celsius, 2.98 w/o uranium-235 and 97.02 w/o uranium-238 was specified.

```
o       2 0 2.942-6    293 end
h       2 0 5.884-6    293 end
```

The number densities of oxygen and hydrogen corresponding to 8.8E-05 grams/cc are entered individually since a density for a standard composition component with multiple elemental constituents cannot be readily specified.

```
ss304  4    1.0        293 end
```

The standard composition component name ss304 is used for stainless steel with a volume fraction of 1.0.

```
h2o    9     0.29      293 end
```

The standard composition component h2o was used to specify water at 0.9982 grams/cc occupying 29% of the low density concrete.

```
o       9 0 1.1855-2   293 end
na      9 0 1.4380-4   293 end
mg      9 0 3.5859-5   293 end
al      9 0 2.8385-3   293 end
si      9 0 8.7196-4   293 end
ca      9 0 1.3101-3   293 end
fe      9 0 1.3576-5   293 end
```

The other elements contained in the LDC were specified by atomic number densities.

```
b-10 11 0 5.2650-3    293 end
b-11 11 0 2.9198-2    293 end
al    11 0 4.1548-2   293 end
```

The elemental composition of the borated aluminum sheet was specified based on 75% of the B-10 used in the 125-B SAR and 100% of the other components.

```
end comp
```

Ends the composition data input.

```
triangpitch 0.93904 0.93904 1 2 end
```

Specified a triangular pitch with the pitch equal to the diameter of the fuel lump, thus making a close packed fuel cell for geometric and resonance self shielding as well as other calculations.

```
fuel canister model
```
Title card.
```
read para
  tme=800.0  gen=515  npg=500  run=yes  flx=no  fdn=no
  far=no  plt=no  nsk=15
end para
```
Maximum problem run time, number of generations, number of neutrons per generation, number of skipped generations and output options are specified.
```
read geom
global
  unit  2
    com=" fuel canister inside storage sleeve "
    cuboid    500 1 4p11.59  381.00  -0.0
```

Mixture 500 is specified for the fuel area inside the fuel canister. The maximum shell outer diameter is 14.093" (3.18) and the nominal thickness is 0.25" (3.18). Using these bounding dimensions, a conservative fuel region is calculated by assuming that the poison shroud is the maximum size which can fit inside the canister shell. The following assumptions are made: inner stainless steel skin is 0.04" thick, the borated aluminum is 0.130" thick, the outer skin is 0.080" thick and the borated aluminum is continuous in the shroud. As such, the maximum fuel area would be bounded by an area 23.18 cm by 23.18 cm and is represented by a 4p11.59, 381 cm high cuboid.

```
    cuboid    4  1 4p11.69  381.00  -0.0
    cuboid   11  1 4p12.02  381.00  -0.0
    cuboid    4  1 4p12.22  381.00  -0.0
```
The three cuboids above represent the inner skin, the borated aluminum, and the outer poison skin.
```
    cylinder  9  1 17.29    381.00  -0.0
```
This cylinder represents the LDC (slightly oversized).
```
    cylinder  4  1 17.78    381.00  -0.0
```
This cylinder represents the canister shell (slightly undersized).
```
    com="infinite void to isolate one canister"
    cylinder  0  1 200.000  500.0000  -50.0000
end geom
end data
end
```

This input gives output results of 0.26057 + OR - 0.00055.

Knockout Canister Model

```
=csas2x
single knockout canister model'
44groupndf5 latticecell
uo2  1 0.91075 293 92235 2.98 92238 97.02 end
o      2 0 2.942-6    293 end
h      2 0 5.884-6    293 end
ss304  4    1.0       293 end
b-10  12 0 9.525-3    293 end
b-11  12 0 5.08-2     293 end
c     12 0 1.58-2     293 end
end comp
triangpitch 0.93904 0.93904 1 2 end
knockout canister model
read para
  tme=800.0  gen=515  npg=500  run=yes  flx=no  fdn=no
  far=no  plt=no  nsk=15
end para
read geom
unit  3
    com="displaced center poison tube"
```

```
    cylinder  12  1  2.5337  360.680  -0.0
    com="ss b4c liner"
    cylinder  4  1  2.6988  360.680  -0.0
    com="void annulus"
    cylinder 0 1  2.8575  360.680  -0.0
    com="structural ss center poison tube"
    cylinder  4  1  3.6513  360.680  -0.0
```

Unit 3 provides the dimensions of the center poison tube used in the model

```
  unit  4
    com=" radial poison 75% B-10 for ko can"
    cylinder  12  1  1.0351  360.680  -0.0
    cylinder  4  1  1.6701  360.680  -0.0
```

Unit 4 provides the dimensions of the radial poison tubes used in the model

```
global
  unit  5
    com="fuel inside can id"
    cylinder 500 1 17.263  381.000  -0.0
    com="insert center poison tube, 1in displ"
      hole  3   0.0   2.54  0.0
    com="inserting four (small) poison tubes, 1in displ"
      hole  4   6.35  8.89  0.0
      hole  4  -6.35  8.89  0.0
      hole  4  -6.35 -3.81  0.0
      hole  4   6.35 -3.81  0.0
    com="canister od"
    cylinder  4 1 17.78  381.000 -0.0
```

Unit 5 provides the fuel area, the offset locations of the five poison tubes, and the canister shell. The poison tubes are modeled as 8" shorter than the height of the fuel region.

```
end geom
end data
end
```

This input gives output results of 0.26174 + OR - 0.00055.

Filter Canister Model

```
=csas2x
single filter canister'
44groupndf5 latticecell
uo2  1 0.91075 293 92235 2.98 92238 97.02 end
o      2 0 2.942-6     293 end
h      2 0 5.884-6     293 end
o      3 0 2.942-6     293 end
h      3 0 5.884-6     293 end
ss304  4    1.0        293 end
b-10 12 0 9.525-3      293 end
b-11 12 0 5.08-2       293 end
c    12 0 1.58-2       293 end
end comp
triangpitch 8.5-4 8.5-4 1 2 end
filter canister
read para
  tme=800.0  gen=515  npg=500  run=yes  flx=no  fdn=no
  far=no  plt=yes  nsk=15
end para
read geom
 unit 6
  com="filter canister"
  com="drain tube fuel cell"
  cylinder 500 1 2.2225 351.00 -0.0
  cylinder 4    1 2.54   351.00 -0.0
```

Unit 6 is the single drain tube in the canister

```
 unit 7
  com="tie rod"
  cylinder 4 1 .9525 381.00 -0.0
```

Unit 7 is the tie rods

```
  unit  8
```

```
com="filter elements for filter can"
cylinder  500  1  1.1938  351.00  -0.0
cylinder  4  1  1.8161  351.00  -0.0
```
Unit 8 is the tube portion of the filter element. The tubes are modeled 30cm shorter than the fuel region. The filter media is conservatively assumed to not exist.
```
unit  9
  com="poison tube"
  cylinder   12 1  2.54  378.00  -0.0
  com="ss b4c liner"
  cylinder  4  1  2.69875  378.00  -0.0
  com="void annulus"
  cylinder 0 1  2.8575  378.00  -0.0
  com="ss center poison tube"
  cylinder  4  1  3.175  378.00  -0.0
```
Unit 9 is the central poison tube, one inch shorter than the fuel region.
```
GLOBAL
 unit 10
  com="fuel inside can id"
  cylinder 500 1 17.2631  381.00  -0.0
  com="inserting filter tubes"
  hole 8 6.59 -5.49 0.0
  hole 8 -0.23 -9.91 0.0
  hole 8 -6.16 -6.16 0.0
  hole 8 -5.26 -1.18 0.0
  hole 8 -1.68 2.28 0.0
  hole 8 5.64 0.16 0.0
  hole 8 12.58 -5.56 0.0
  hole 8 9.57 -9.57 0.0
  hole 8 3.52 -13.20 0.0
  hole 6 -4.59 -13.59 0.0
  hole 8 -9.18 -10.13 0.0
  hole 8 -12.25 -6.05 0.0
  hole 8 -13.65 -1.30 0.0
  hole 8 -9.51 1.56 0.0
  hole 8 -12.53 5.57 0.0
  hole 8 11.58 7.34 0.0
  hole 8 9.95 2.61 0.0
  hole 8 13.75 -0.66 0.0
  hole 9 0.55 -3.64 0.0
  hole 7 9.11 -2.19 0.0
  hole 7 5.42 -9.46 0.0
  hole 7 -4.70 -10.07 0.0
  hole 7 -9.12 -3.25 0.0
  hole 7 -5.77 3.51 0.0
  hole 7 6.21 4.24 0.0
  com="canister od"
  cylinder  4  1 17.7800  381.00  -0.0
```
Unit 10 generates the complete canister. The tie rods, drain tube, filter tubes, and poison tube are slumped to one side.
```
end geom
end data
end
```
This input gives output results of 0.24641 + OR - 0.00051.

DSC WITH 12 KNOCKOUT CANISTERS IN THE MP187

```
=csas2x
mp187 with 12 knockout canisters'
44groupndf5 latticecell
uo2  1 0.91075 293 92235 2.98 92238 97.02 end
o       2 0 2.942-6    293 end
h       2 0 5.888-5    293 end
o       3 0 2.942-6    293 end
h       3 0 5.884-6    293 end
ss304  4    1.0        293 end
carbonsteel 5 1.0         293 end
pb     7     1.0       293 end
h2o    9     0.29      293 end
o      9 0 1.1855-2    293 end
na     9 0 1.4380-4    293 end
mg     9 0 3.5859-5    293 end
al     9 0 2.8385-3    293 end
si     9 0 8.7196-4    293 end
ca     9 0 1.3101-3    293 end
fe     9 0 1.3576-5    293 end
b-10  12 0 9.525-3     293 end
b-11  12 0 5.08-2      293 end
c     12 0 1.58-2      293 end
o      15 0 3.7793-2   293 end
c      15 0 8.2505-3   293 end
h      15 0 5.0996-2   293 end
al     15 0 7.0275-3   293 end
si     15 0 1.2680-3   293 end
ca     15 0 1.4835-3   293 end
fe     15 0 1.0628-4   293 end
end comp
triangpitch 0.93904 0.93904 1 2 end
mp187 with 12 knockout canisters
read para
  tme=800.0  gen=515  npg=500  run=yes  flx=no  fdn=no
  far=no  plt=yes  nsk=15
end para
read geom
unit  3
    com="displaced center poison tube"
    cylinder  12  1  2.5337  360.680  -0.0
    com="ss b4c liner"
    cylinder  4  1  2.6988  360.680  -0.0
    com="void annulus"
    cylinder 0 1  2.8575  360.680  -0.0
    com="ss center poison tube"
    cylinder  4  1  3.6513  360.680  -0.0
  unit  4
    com=" radial poison 75% B-10 for ko can"
    cylinder  12  1  1.0351  360.680  -0.0
    cylinder  4  1  1.6701  360.680  -0.0
  unit  5
    com="knockout canister"
    com="fuel inside can id"
    cylinder 500 1 17.2631  381.000  -0.0
    com="insert center poison tube, 1in displ"
      hole   3   0.0   2.54  0.0
    com="inserting four (small) poison tubes, 1in displ"
      hole   4   6.35  8.89  0.0
      hole   4  -6.35  8.89  0.0
      hole   4  -6.35 -3.81  0.0
      hole   4   6.35 -3.81  0.0
    com="canister od"
    cylinder  4 1 17.78  381.000 -0.0
 unit 11
  cylinder  3  1 80.7438  381.00 -0.0
  hole 5    0.000          0.0    0.0
  hole 5   35.56           0.0    0.0
  hole 5  -35.56           0.0    0.0
```

```
hole 5   53.35        30.80   0.0
hole 5   17.78        30.80   0.0
hole 5  -17.78        30.80   0.0
hole 5  -53.35        30.80   0.0
hole 5    0.0         61.62   0.0
hole 5   53.35       -30.80   0.0
hole 5   17.78       -30.80   0.0
hole 5  -17.78       -30.80   0.0
hole 5  -53.35       -30.80   0.0
```

Unit 11 places the TMI-2 knockout canisters into a close packed array.

```
unit  12
      cylinder 3 1 83.743801 474.98 0.0
      hole 11 0.0 3.0 0.0
      cylinder 5 1 85.3313 474.98 0.0
      cylinder 0 1 86.3600 474.98 0.0
      cylinder 4 1 89.5350 474.98 0.0
      cylinder 7 1 99.6950 474.98 0.0
      cylinder 4 1 106.045 474.98 0.0
      cylinder 0 1 117.005 474.98 0.0
      cylinder 4 1 117.483 474.98 0.0
      cuboid 0 1 4p117.484 474.98 0.0
```

Unit 12 generates the mist moderator inside the DSC, places the close packed TMI-2 canisters into the DSC, and generates the carbon steel DSC shell, the gap between the DSC and the MP187, the inner shell of the MP187, the lead shield, the outside shield wall, void where neutron shield material is, and outermost stainless steel shell.

```
 unit  13
      cylinder 4 1 117.483 15.24 0.0
      cuboid 0 1 4p117.484 15.24 0.0
```

Unit 13 generates the top and bottom MP187 lids

```
 global
 unit  14
      array  1  0.0 0.0 0.0
end geom
read array
      com='MP187 (187" long with 6" steel lid and bottom)'
      ara=1   nux=1 nuy=1 nuz=3
      fill 13 12 13 end fill
end array
```

The array builds the MP187 with a full DSC in it and top and bottom lids

```
read bounds
   all=mirror
end bounds
```

Provides infinite lattice of MP187 casks

```
end geom
end data
end
```

This input gives output results of 0.54881   + OR - 0.00062.

DSC WITH 12 KNOCKOUT CANISTERS IN AN HSM

```
=csas2x
hsm with 12 knockout canisters'
44groupndf5 latticecell
uo2  1 0.91075 293 92235 2.98 92238 97.02 end
o       2 0 2.942-6     293 end
h       2 0 5.888-5     293 end
```

The number density for hydrogen includes hydrogen from the mist water moderator and hydrogen generated by radiolysis.

```
o       3 0 2.942-6     293 end
h       3 0 5.884-6     293 end
ss304  4    1.0         293 end
carbonsteel 5 1.0       293 end
orconcrete 6.0 1.0      293 end
pb     7     1.0        293 end
```

```
h2o    9     0.29        293 end
o      9 0 1.1855-2      293 end
na     9 0 1.4380-4      293 end
mg     9 0 3.5859-5      293 end
al     9 0 2.8385-3      293 end
si     9 0 8.7196-4      293 end
ca     9 0 1.3101-3      293 end
fe     9 0 1.3576-5      293 end
b-10  12 0 9.525-3       293 end
b-11  12 0 5.08-2        293 end
c     12 0 1.58-2        293 end
o      15 0 3.7793-2     293 end
c      15 0 8.2505-3     293 end
h      15 0 5.0996-2     293 end
al     15 0 7.0275-3     293 end
si     15 0 1.2680-3     293 end
ca     15 0 1.4835-3     293 end
fe     15 0 1.0628-4     293 end
end comp
triangpitch 0.93904 0.93904 1 2 end
hsm with 12 knockout canisters
read para
  tme=800.0  gen=515  npg=500  run=yes  flx=no  fdn=no
  far=no  plt=yes  nsk=15
end para
read geom
unit  3
    com="displaced center poison tube"
    cylinder  12  1  2.5337  360.680  -0.0
    com="ss b4c liner"
    cylinder  4  1  2.6988  360.680  -0.0
    com="fuel annulus"
    cylinder 500 1  2.8575  360.680  -0.0
    com="ss center poison tube"
    cylinder  4  1  3.6513  360.680  -0.0
  unit  4
    com=" radial poison 75% B-10 for ko can"
    cylinder  12  1  1.0351  360.680  -0.0
    cylinder  4  1  1.6701  360.680  -0.0
  unit  5
    com="knockout canister"
    com="fuel inside can id"
    cylinder 500 1 17.2250  381.000  -0.0
    com="insert center poison tube, 1in displ"
      hole   3   0.0   2.54  0.0
    com="inserting four (small) poison tubes, 1in displ"
      hole   4   6.35  8.89  0.0
      hole   4  -6.35  8.89  0.0
      hole   4  -6.35 -3.81  0.0
      hole   4   6.35 -3.81  0.0
    com="canister od"
    cylinder  4 1 17.78  381.000 -0.0
 unit 11
  cylinder  3  1 80.7438  381.00 -0.0
  hole 5   0.000        0.0    0.0
  hole 5  35.56         0.0    0.0
  hole 5 -35.56         0.0    0.0
  hole 5  53.35        30.80   0.0
  hole 5  17.78        30.80   0.0
  hole 5 -17.78        30.80   0.0
  hole 5 -53.35        30.80   0.0
  hole 5   0.0         61.62   0.0
  hole 5  53.35       -30.80   0.0
  hole 5  17.78       -30.80   0.0
  hole 5 -17.78       -30.80   0.0
  hole 5 -53.35       -30.80   0.0
 unit  12
       cylinder 3 1 83.743801 474.98 0.0
       hole 11 0.0 3.0 0.0
       cylinder 5 1 85.3313 474.98 0.0
       cylinder 6 1 147.00  474.98 0.0
```

```
        cuboid 0 1 4p147.00  474.98 0.0
```
Unit 12 has a two foot thick cylinder of concrete to approximate the HSM.
```
  unit  13
        cuboid 6 1 4p147.00 60.96 0.0
```
Unit 13 generates two foot thick HSM end walls.
```
  global
  unit  14
        array  1  0.0 0.0 0.0
end geom
read array
        com='HSM (2 foot cylinder of concrete and 2 foot lid and bottom)'
        ara=1   nux=1 nuy=1 nuz=3
        fill 13 12 13 end fill
end array
read bounds
   all=mirror
end bounds
end geom
end data
end
```
This input gives output results of 0.54051 + OR - 0.00082.

Discussion of Criticality Modeling/Analysis

The expected composition of the canister contents includes slightly depleted fuel, cladding, control rod debris, and some residual soluble absorber material. The fuel may have been degraded to less dense oxides. No credit is taken for these realistic conditions because, while real and present, qualification of these conditions is extremely difficult. Therefore, the actual condition of the fuel in the canisters provide an additional, albeit un-quantified, margin of safety from those conditions as described below.

Control Parameter	**Controls/Barriers**
Mass	It is not possible to increase the mass in the canisters above the theoretical triangular close packed columns of whole fuel pellets assumed in the models.
Enrichment	No burnup credit is taken. The maximum initial enrichment (batch 3 average plus 2 sigma). There are no mechanisms possible to increase the enrichment above the 2.98 w/o U-235 assumed in the models.
Geometry	1) Worst case TMI-2 canister poison displacements from original manufacturer's drop testing were used in the evaluation.

2) No structural credit is taken for the DSC basket and hence the TMI-2 canisters are assumed to be close packed.

3) Whole fuel pellets are used in the models and shown to remain subcritical.

4) Fuel pitch is minimized for triangular pitch columns of cylindrical fuel pellets.

5) No credible mechanisms exists for fuel to escape from the TMI-2 canisters to the DSC.

Reflection

The DSC has been modeled essentially fully reflected by concrete in the HSM and reflected by the MP187 in the cask model. No significant additional reactivity can be added via external reflection over that shown to be subcritical in this analysis.

Interaction

1) The DSC has been shown subcritical with twelve canisters loaded to the theoretical maximum payload which exceeds that measured for any of the TMI-2 canisters.

2) The canisters are not over moderated or isolated neutronically from each other. No increase in interaction is physically possible in the DSC.

Absorbers

1) The boron carbide and borated aluminum absorbers were fabricated, tested and verified by the original manufacturer. Degradation of the absorbers is not credible due to the materials of construction and methods used to isolated them from the external environment.

2) Only 75% of the minimum specified B-10 was used in the models.

3) Under the conditions of storage system, the poisons provide little negative reactivity since the fuel region is not moderated and the system multiplication factor would remain far subcritical without the absorbers.

Moderator	The TMI-2 canister contents are dried prior to loading into the DSC. No credible mechanism exists which could introduce water into the system.
Natural Phenomena	1) The DSC is located well above the flood plain preventing water from reaching the DSC or the vent system filters. 2) If water was used to fight a fire in or near the ISFSI, no direct path exists which would allow for impingement of the water stream on the system filters. 3) Seismic events could not relocate the fuel from the TMI-2 canisters to other locations in the system.

Second Criticality Evaluation

The input decks for a DSC loaded with 12 *knockout* canisters in an HSM is provided below.

Extensive annotated input is provided in lieu of sketches of the models.

DSC WITH 12 KNOCKOUT CANISTERS IN AN HSM

```
=CSASIX
```

Indicates that the control module CSASIX (which uses the functional modules BONAMI-S, NITAWL-II, XSDRNPM-S, ICE, and WAX) will be called.

```
DSC420  1908lb fuel, 1.35cm pitch, 8l water, fuel above, upside down cask vf=0.6
```

Title card.

```
27GROUPNDF4 LATTICECELL
```

Indicates that the 27 group cross section library will be used and that the lattice cell fuel region geometry will be used.

```
U-238   1 0  2.18749-2  293 END
U-235   1 0  6.81347-4  293 END
O       1 0  4.51125-2  293 END
```

The fuel region number densities at 20 Celsius are specified.

```
H2O     2    1.0        293 END
```

Full density water for the moderator region is specified.

```
END COMP
```

Ends the composition data input for the wet fuel region.

```
TRIANGPITCH 1.35 0.93904 1 2 END
```

Specifies a triangular 1.35 cm pitch (optimal) with a 0.93904 cm diameter fuel lump, thus making a fuel cell for geometric and resonance self shielding as well as other calculations.

```
END
```

Ends (temporarily) the CSAS input to the file.

```
=WAX
0$$ 12 2
1$$ 1  1T
2$$ 2 1 2T
3$$ 500
4$$ 500  3T
END
```

The WAX portion of the input. Mixes the fuel/moderator region, and names it region 500.

```
=CSASIX
DSC420  1908lb fuel, 1.35cm pitch, 8l water, fuel above, upside down cask vf=0.6
27GROUPNDF4 LATTICECELL
U-238   1 0  2.18749-2  293 END
U-235   1 0  6.81347-4  293 END
O       1 0  4.51125-2  293 END
```

Back into the CSAS input to the file, and specifies the number densities for the dry fuel region. The densities are the same as for the wet fuel region since it is the same fuel.

```
H2O    7  0.6  293 END
```

Specifies region 7, which is the region between the TMI canisters, as 0.6 volume fraction water (optimal).

```
H2O    8  1.0  293 END
```

Specifies region 8, which is used to represent the boron carbide poison columns in the canisters, as full density water.

```
ORCONCRETE 5 1.0 293 END
```

The standard composition component used to specify region 5 as ordinary concrete. Not used in this calculation.

```
CARBONSTEEL 6 1.0 293 END
```

The standard composition component used to specify region 6 as steel. Used to represent the shell of the DSC.

```
C       9 0  1.6000-3   293 END
O       9 0  3.9700-2   293 END
NA      9 0  5.5000-4   293 END
AL      9 0  1.6000-3   293 END
SI      9 0  1.5200-2   293 END
S       9 0  5.0000-5   293 END
CA      9 0  3.1000-3   293 END
FE      9 0  3.8000-4   293 END
H2O     9  0.114        293 END
```

The number densities for region 9, modeled as INTEC concrete. Used to represent the HSM.

```
PB      3 0   3.2988-2       END
```

The number density for region 3, modeled as lead. Not used in this calculation.

```
END COMP
```

Ends the composition data input for the dry fuel region, and for the other components of the system.

```
TRIANGPITCH 0.93904 0.93904 1 2 END
```

Specifies a triangular pitch with the pitch equal to the diameter of the fuel lump, thus making a close packed fuel cell for geometric and resonance self shielding as well as other calculations for the dry fuel region.

```
END
```

Ends the CSAS input to the file.

```
=WAX
0$$ 4 2
1$$ 2  1T
2$$ 12 1 2T
3$$ 500
4$$ 501   3T
2$$ 2 8 2T
3$$ 3 4 5 6 7 8 9 500
4$$ 3 4 5 6 7 8 9 502  3T
END
```

Back into WAX, mixes fuel and void for the dry fuel region and names it region 502. Renames the wet fuel region (previously 500) as region 501.

```
=KENOV
```

Starts the KENO portion of the input.

```
DSC420  1908lb fuel, 1.35cm pitch, 8l water, fuel above, upside down cask vf=0.6
```

Title card.

```
READ PARA
  TME=800.0  GEN=215  NPG=1200  RUN=YES  FLX=YES  FDN=NO
  FAR=NO  PLT=YES  NSK=15  LIB=4
END PARA
```

Maximum problem run time, number of generations, number of neutrons per generation, number of skipped generations and output options are specified.

```
READ MIXT
  MIX=3 3 1.0  MIX=4 4 1.0  MIX=5 5 1.0
  MIX=6 6 1.0  MIX=7 7 1.0  MIX=8 8 1.0
  MIX=9 9 1.0  MIX=501 501 1.0  MIX=502 502 1.0
END MIXT
```

Specifies full density for each of the mixtures specified in the composition data

```
READ GEOM
  UNIT  2
    COM=* KNOCKOUT CANISTER INSIDE STORAGE SLEEVE -(1289)  LOWER CASK *
    CYLINDER    8  1  2.5337      0.353   0.0
    CYLINDER    4  1  2.6988      0.353   0.0
```

```
CYLINDER   501 1  2.8575       0.353   0.0
CYLINDER     4 1  3.6513       6.703   0.0
CYLINDER   501 1 17.2250      15.593   0.0
CYLINDER     4 1 17.7800      20.673   0.0
```

Unit 2 models the top portion of the canister and central poison tube. The poison is modeled as full density water, stainless steel is used to represent the structural regions, and the wet fuel is used to fill all other spaces. Only the water mixed with the fuel is considered when calculating the limiting water volume per canister.

```
UNIT  3
  COM=* RADIAL POISON TUBE WITHOUT POISON  - (1289) 1st layer  *
  CYLINDER    8  1  1.0351     96.666   0.0
  CYLINDER    4  1  1.6702     98.888   0.0
```

Unit 3 provides the dimensions of the radial poison tubes used in the middle portion of the canister model.

```
UNIT  4
  COM=* KNOCKOUT CANISTER INSIDE STORAGE SLEEVE -(1289)  LOWER CASK *
  CYLINDER    8  1  2.5337    101.71    0.0
  CYLINDER    4  1  2.6988    101.71    0.0
  CYLINDER  502  1  2.8575    101.71    0.0
  CYLINDER    4  1  3.6513    101.71    0.0
  CYLINDER  502  1 17.2250    101.71    0.0
    HOLE   3   6.35  6.35  0.0
    HOLE   3   6.35 -6.35  0.0
    HOLE   3  -6.35  6.35  0.0
    HOLE   3  -6.35 -6.35  0.0
  CYLINDER    4  1 17.7800    101.71    0.0
```

Unit 4 models the middle portion of the canister and central poison tube. The radial poison tubes are placed in the region as holes. The dry fuel is used to fill all other spaces.

```
UNIT  5
  COM=* RADIAL POISON TUBE WITHOUT POISON  - (1289) 1st layer  *
  CYLINDER    8  1  1.0351    231.947   0.0
  CYLINDER    4  1  1.6701    231.947   0.0
```

Unit 5 provides the dimensions of the radial poison tubes used in the bottom portion of the canister model.

```
UNIT  6
  COM=* KNOCKOUT CANISTER INSIDE STORAGE SLEEVE -(1289)  LOWER CASK *
  CYLINDER    8  1  2.5337    231.947   0.0
  CYLINDER    4  1  2.6988    231.947   0.0
  CYLINDER    8  1  2.8575    231.947   0.0
  CYLINDER    4  1  3.6513    231.947   0.0
  CYLINDER    0  1 17.2250    231.947   0.0
    HOLE   5   6.35  6.35  0.0
    HOLE   5   6.35 -6.35  0.0
    HOLE   5  -6.35  6.35  0.0
    HOLE   5  -6.35 -6.35  0.0
  CYLINDER    4  1 17.2250    231.947  -6.35
  CYLINDER    8  1 17.2250    231.947  -8.89
  CYLINDER    4  1 17.7800    231.947  -9.53
```

Unit 6 models the bottom portion of the canister and central poison tube. The radial poison tubes are placed in the region as holes. Full density water is modeled between the two stainless steel tubes of the central poison tube, and in the bottom inch of the canister. Neither of these water volumes is counted in the calculation for the water limit per canister. Void is used to fill all other spaces.

```
GLOBAL
 UNIT  7
  COM=* SILO *
  CYLINDER    7  1    79.400001  474.98  0.0
  HOLE   6             0.0        0.0     9.5301
  HOLE   6            35.56       0.0     9.5301
  HOLE   6           -35.56       0.0     9.5301
  HOLE   6            53.35      30.80    9.5301
  HOLE   6           -53.35      30.80    9.5301
```

```
      HOLE   6          53.35  -30.80    9.5301
      HOLE   6         -53.35  -30.80    9.5301
      HOLE   6          17.78   30.80    9.5301
      HOLE   6         -17.78   30.80    9.5301
      HOLE   6          17.78  -30.80    9.5301
      HOLE   6         -17.78  -30.80    9.5301
      HOLE   6           0.0    61.62    9.5301
      HOLE   4           0.0     0.0   241.4772
      HOLE   4          35.56    0.0   241.4772
      HOLE   4         -35.56    0.0   241.4772
      HOLE   4          53.35   30.80  241.4772
      HOLE   4         -53.35   30.80  241.4772
      HOLE   4          53.35  -30.80  241.4772
      HOLE   4         -53.35  -30.80  241.4772
      HOLE   4          17.78   30.80  241.4772
      HOLE   4         -17.78   30.80  241.4772
      HOLE   4          17.78  -30.80  241.4772
      HOLE   4         -17.78  -30.80  241.4772
      HOLE   4           0.0    61.62  241.4772
      HOLE   2           0.0     0.0   343.1873
      HOLE   2          35.56    0.0   343.1873
      HOLE   2         -35.56    0.0   343.1873
      HOLE   2          53.35   30.80  343.1873
      HOLE   2         -53.35   30.80  343.1873
      HOLE   2          53.35  -30.80  343.1873
      HOLE   2         -53.35  -30.80  343.1873
      HOLE   2          17.78   30.80  343.1873
      HOLE   2         -17.78   30.80  343.1873
      HOLE   2          17.78  -30.80  343.1873
      HOLE   2         -17.78  -30.80  343.1873
      HOLE   2           0.0    61.62  343.1873
      CYLINDER    6  1   80.9875   474.98  0.0
      CUBOID      9  1 4P142.0     534.98  -60.0
  END GEOM
```

Unit 7 places the TMI-2 knockout canisters into a close packed array inside of the DSC, and surrounds the DSC with concrete. The space between the canisters is filled with 0.6 volume fraction water, which is not counted in the calculation of the limiting water volume per canister.

```
  READ PLOT
    PIC=MIX  TTL=* X-Y THRU TUBES *
    NCH=' X-C.*SL'
      XUL=0.0     YUL=38.2    ZUL=148.0
      XLR=38.2    YLR=0.0     ZLR=148.0
      UAX=1.0  VDN=-1.0  NAX=130     END
  END PLOT
  END DATA
  END
```

End of the KENO input, and a function to plot the geometry in the output to assure the system has been modeled correctly. This input gives output results of 0.91112 + OR - 0.00118. This becomes 0.9235 with the addition of the 1% bias and two standard deviations of the statistical uncertainty.

Discussion of Criticality Modeling/Analysis

The expected composition of the canister contents includes slightly depleted fuel, cladding, control rod debris, and some residual soluble absorber material. The fuel may have been degraded to less dense oxides. No credit is taken for these realistic conditions because, while real and present, qualification of these conditions is extremely difficult. Therefore, the actual condition of the fuel in the canisters provide an additional, albeit un-quantified, margin of safety from those conditions as described below.

Control Parameter	Controls/Barriers
Mass	The payload of the heaviest canister is assumed to consist completely of $UO2$, and this canister is modeled in all positions. This is a conservative assumption since there are other materials (zirconium clad, etc.) mixed with the fuel.
Enrichment	No burnup credit is taken. The maximum initial enrichment (batch 3 average plus 2 sigma). There are no mechanisms possible to increase the enrichment above the 2.98 w/o U-235 assumed in the models.
Geometry	1) No structural credit is taken for the DSC basket and hence the TMI-2 canisters are assumed to be close packed. 2) Whole fuel pellets are used in the models and shown to remain subcritical. 3) Fuel pitch is optimized for triangular pitch columns of cylindrical fuel pellets. 4) No credible mechanism exists for fuel to escape from the TMI-2 canisters to the DSC.
Reflection	The DSC has been modeled essentially fully reflected by concrete in the HSM. No significant additional reactivity can be added via external reflection over that shown to be subcritical in this analysis.
Interaction	1) The DSC has been shown subcritical with twelve canisters maximum loaded payload which equals or exceeds that measured for any of the TMI-2

	canisters.
	2) The canisters are not over moderated or isolated neutronically from each other. No increase in interaction is physically possible in the DSC.
Absorbers	1) The boron carbide and borated aluminum absorbers were fabricated, tested and verified by the original manufacturer. Degradation of the absorbers is not credible due to the materials of construction and methods used to isolated them from the external environment.
	2) The boron carbide was modeled as full density water.
Moderator	A volume limit of 8.0 liters of water per canister is imposed by the results of the analysis. The TMI-2 canister contents are dried prior to loading into the DSC, leaving much less than the 8.0 liter limit. No credible mechanism exists which could introduce water into the system.
Natural Phenomena	1) The DSC is located well above the flood plain preventing water from reaching the DSC or the vent system filters.
	2) If water was used to fight a fire in or near the ISFSI, no direct path exists which would allow for impingement of the water stream on the system filters.
	3) Seismic events could not relocate the fuel from the TMI-2 canisters to other locations in the system.

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Appendix E
On Site Fuel Transportation

Docket No. 72-20

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CONTENTS

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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.

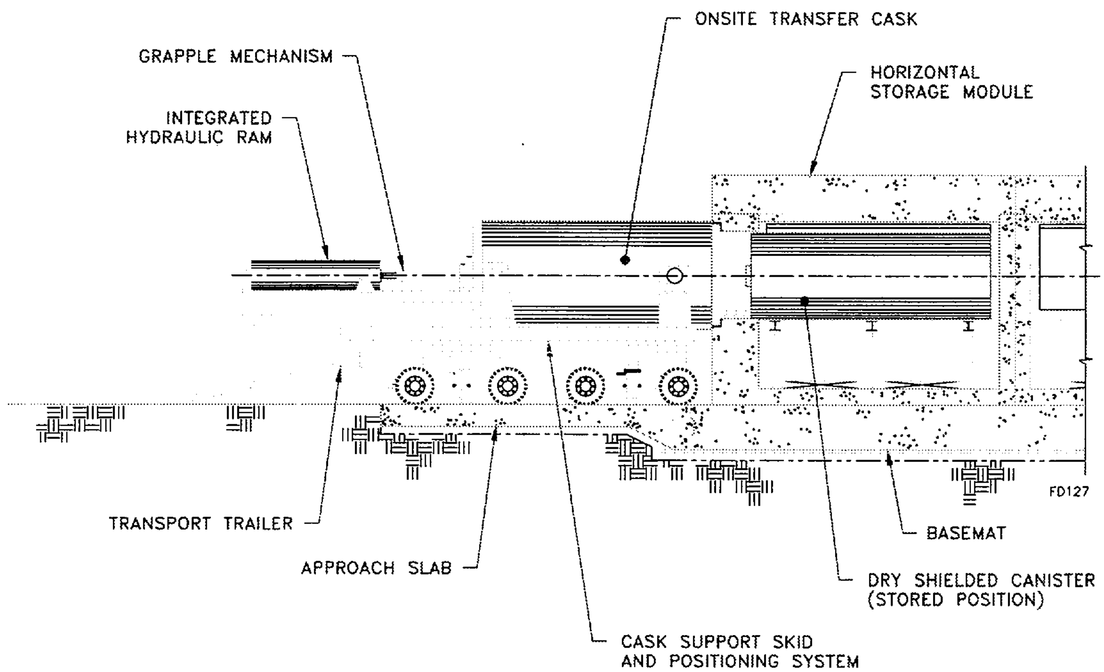


Figure E1.2-1
Typical NUHOMS® System Components, Structures, And Transfer Equipment Using OS-197 Cask

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.

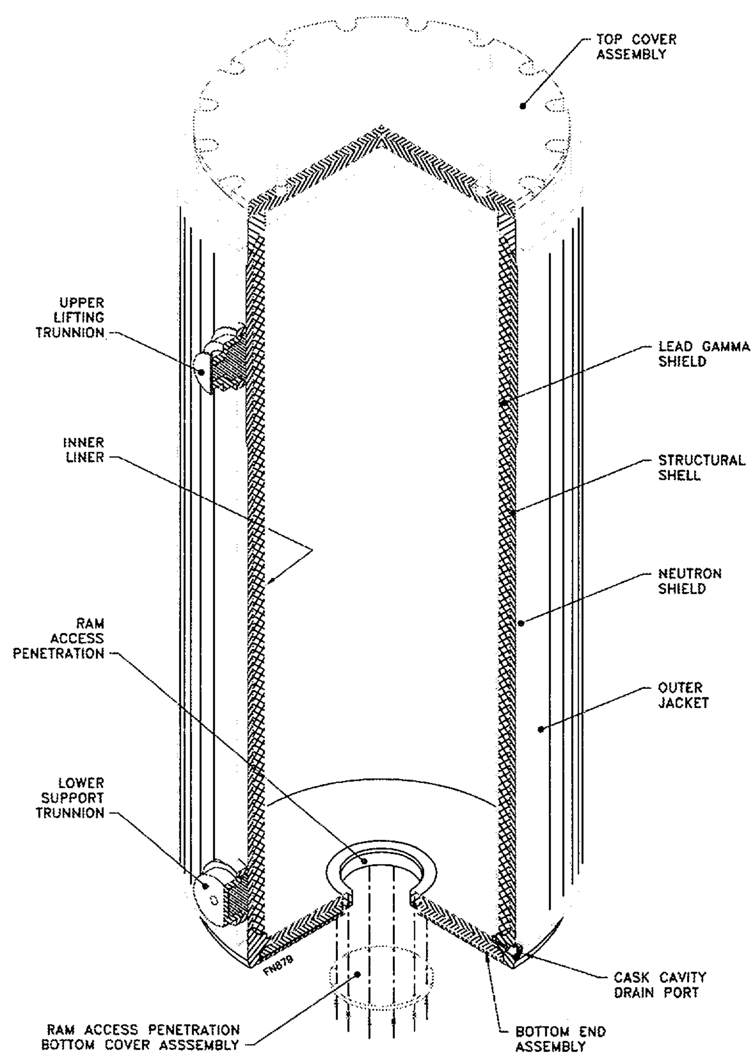
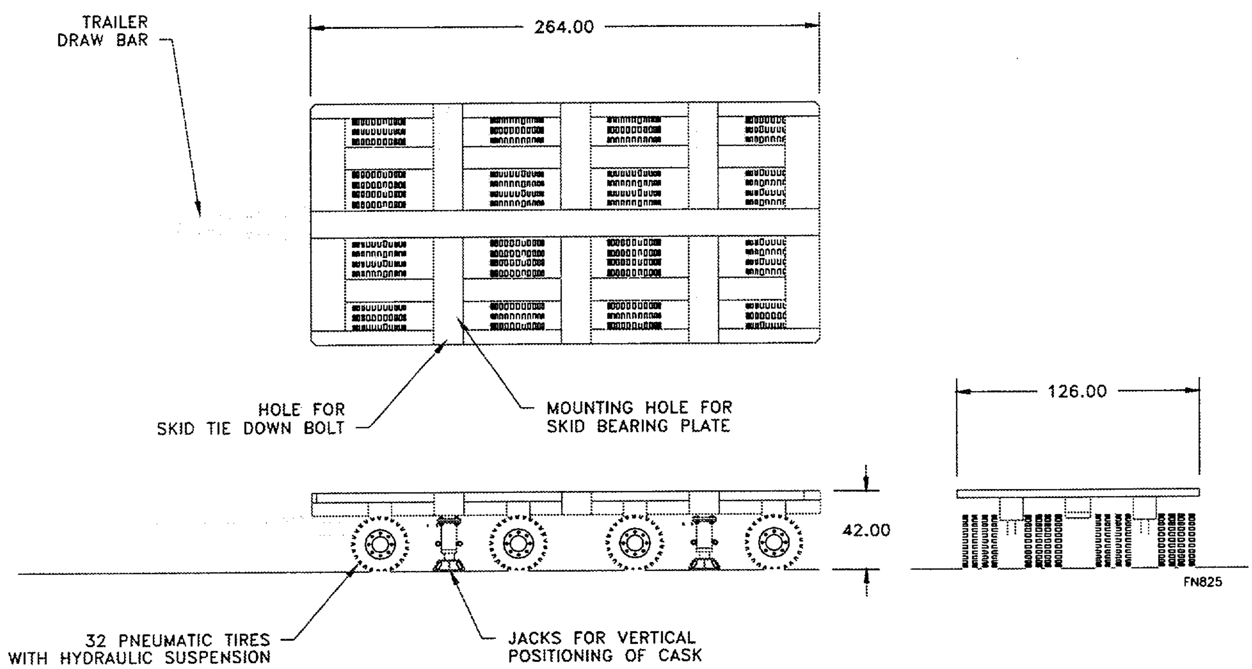


Figure E1.3-1
NUHOMS® OS-197 On-Site Transfer Cask

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.

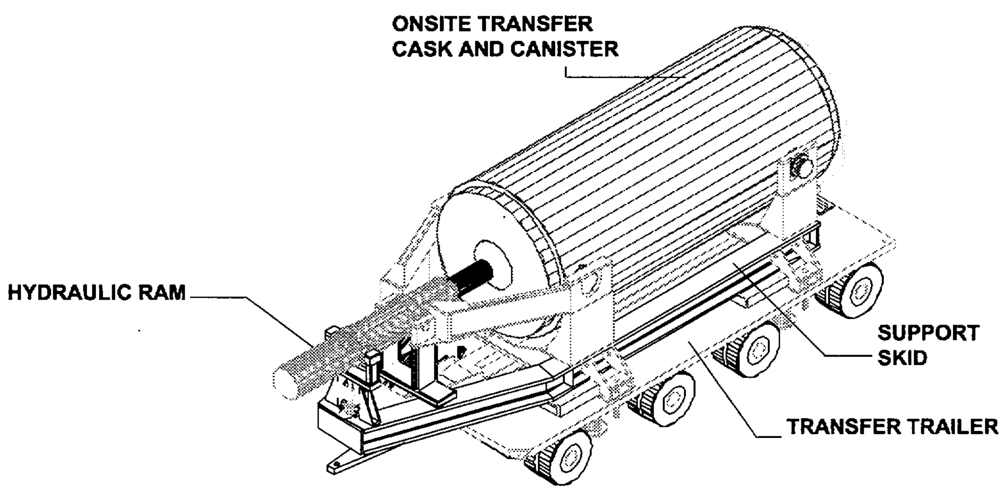


Figure E1.3-3
Typical NUHOMS® OS-197 Cask Support Skid and Hydraulic Ram System

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.

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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.

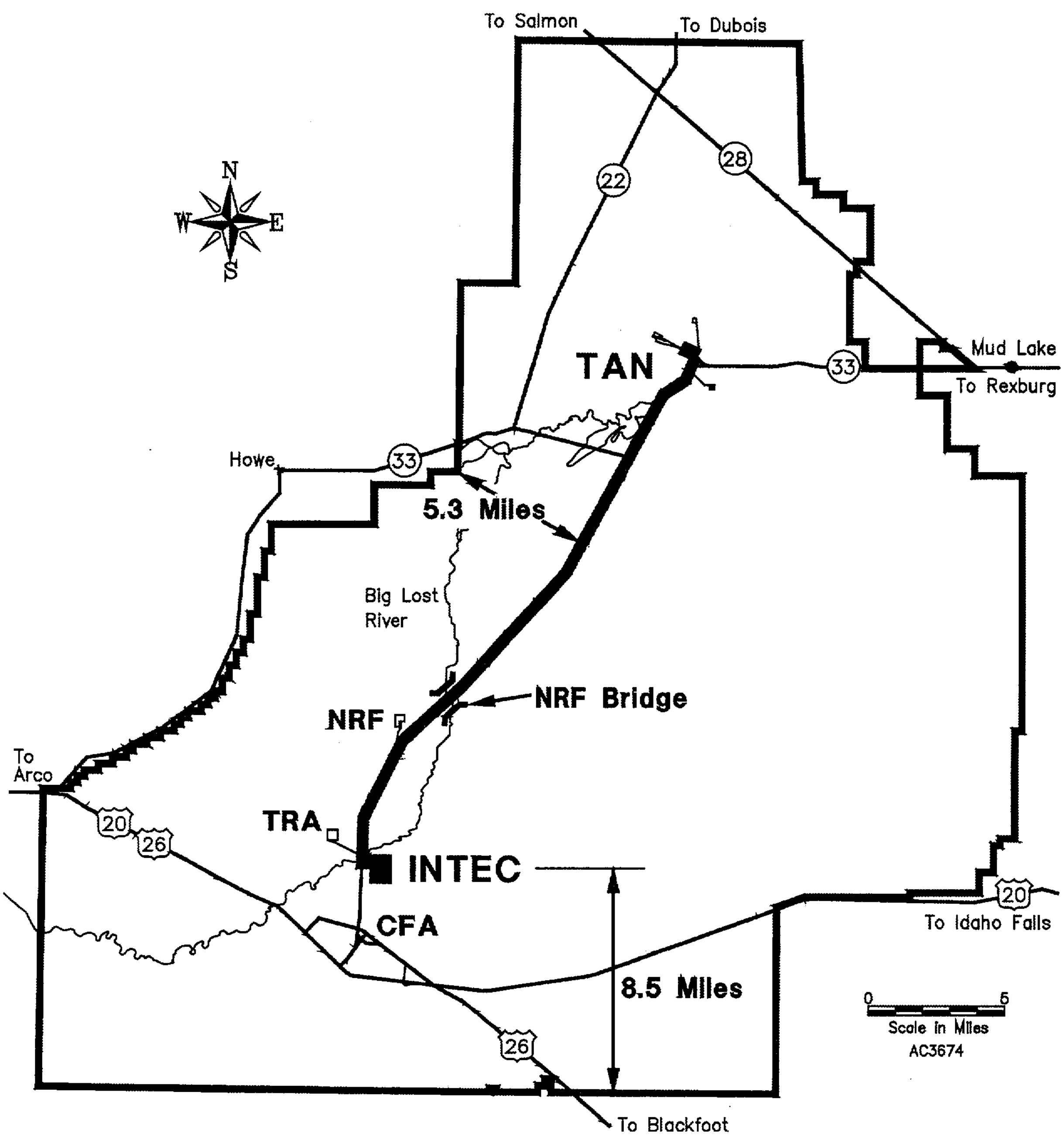
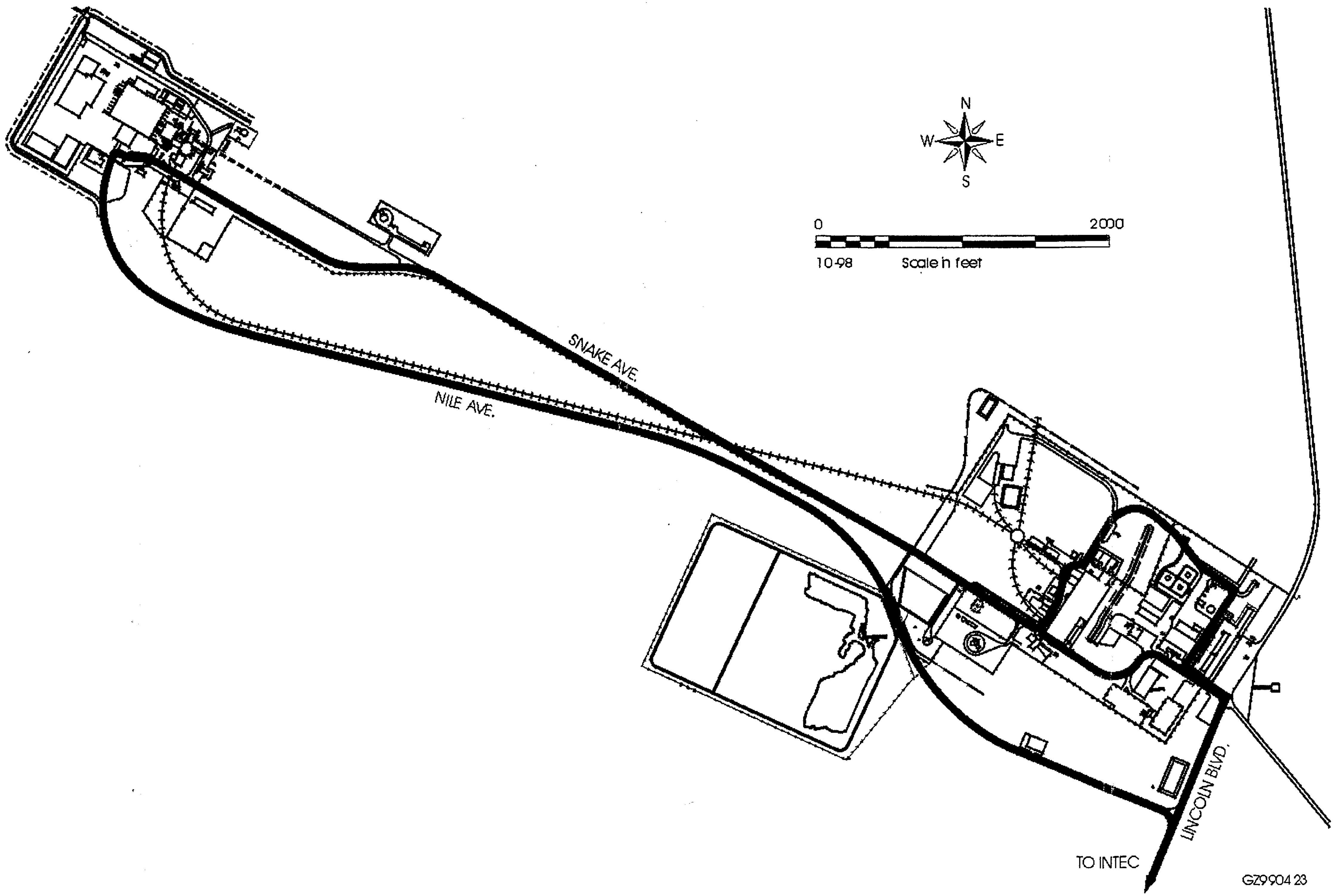


Figure E2.1-2
Map of Idaho National Engineering and Environmental Laboratory.

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



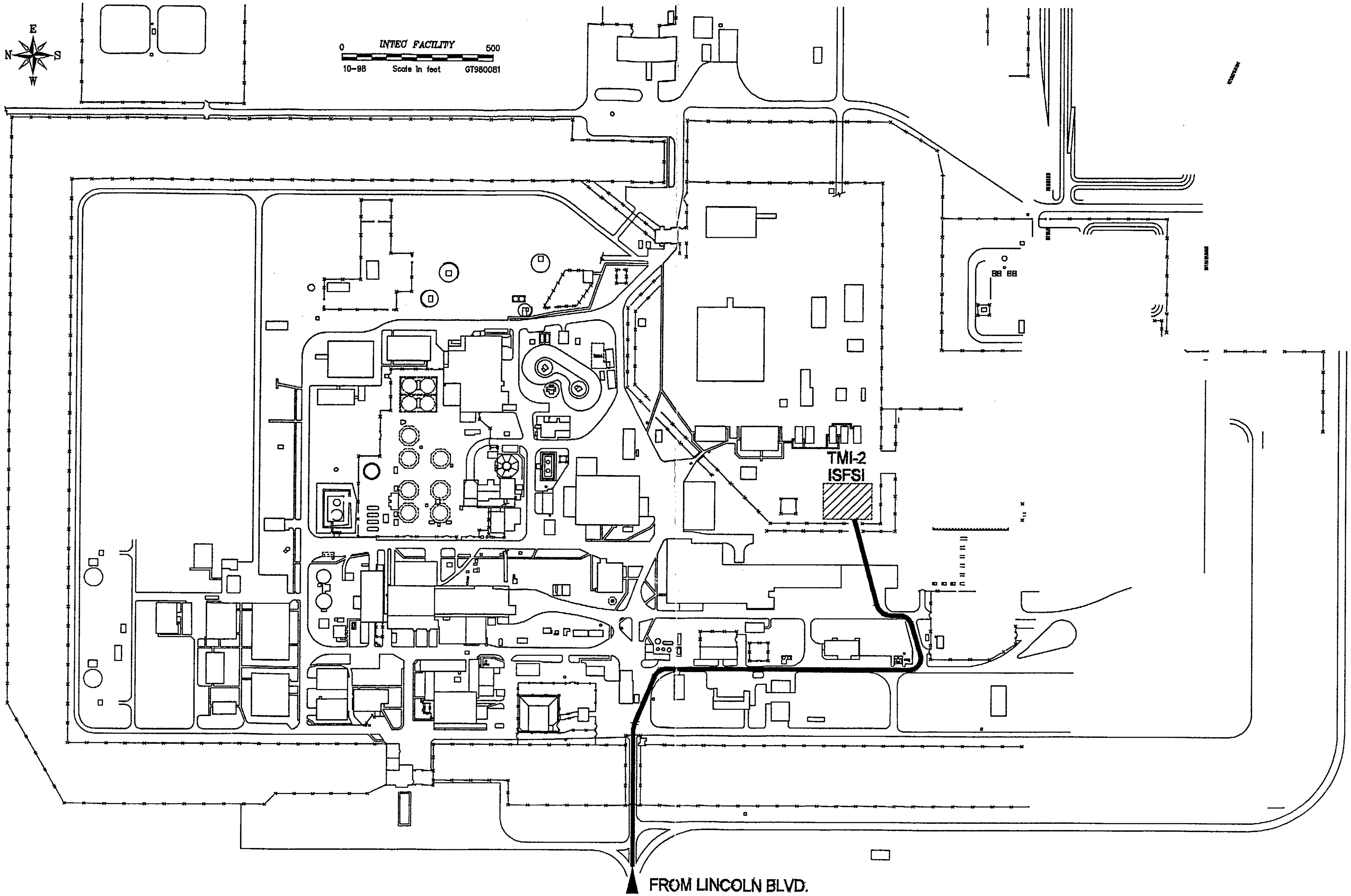


Figure E2.1-4.
INTEC Area Plot Plan

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

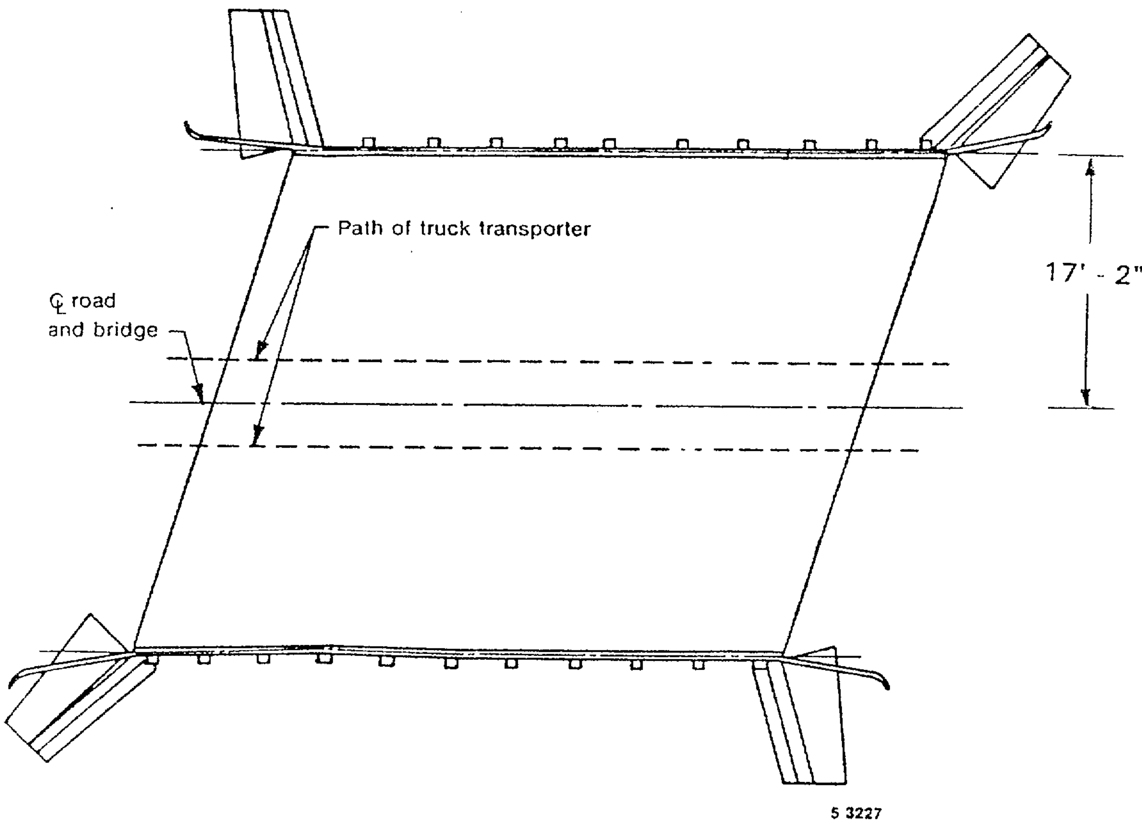


Figure E2.1-4
Transfer Path of Truck Transporter Across the Lincoln Boulevard Bridge.

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

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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).

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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.

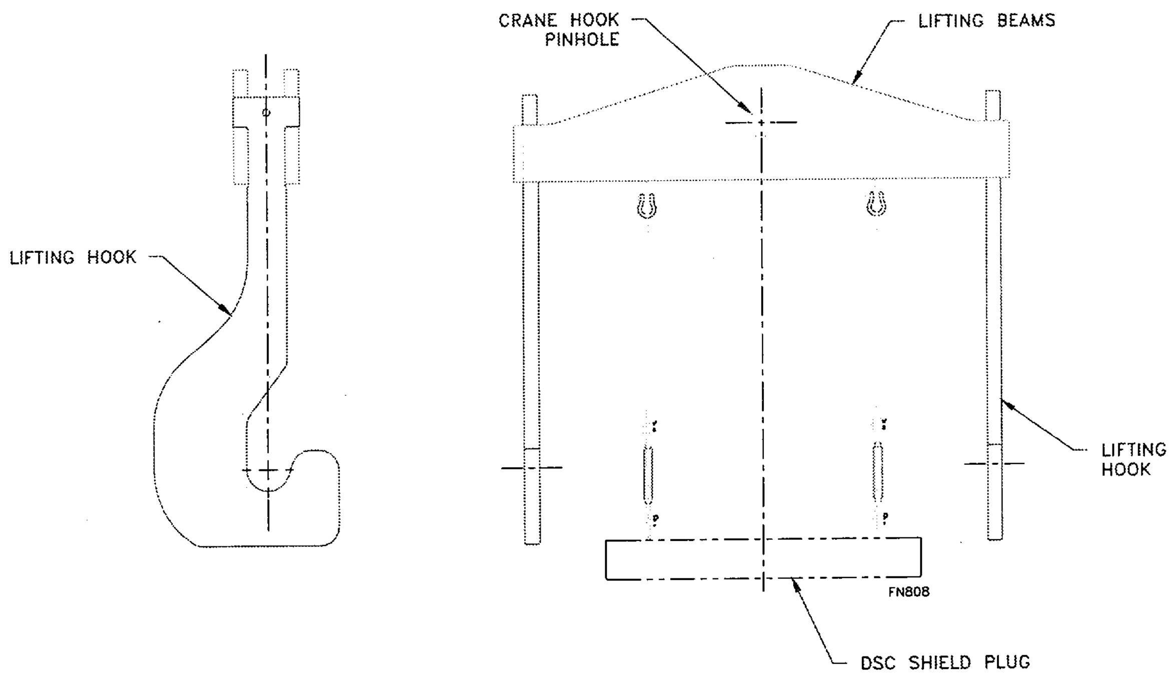


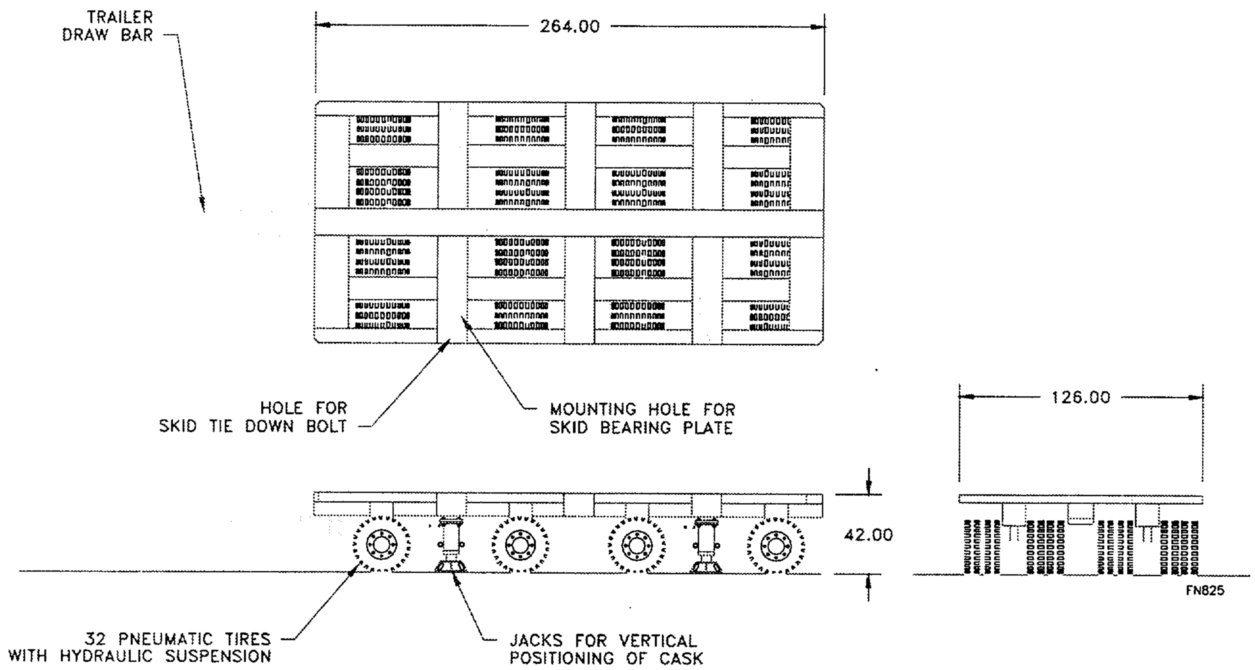
Figure E4.7-5
NUHOMS® OS-197 Transfer Cask Lifting Yoke.

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.

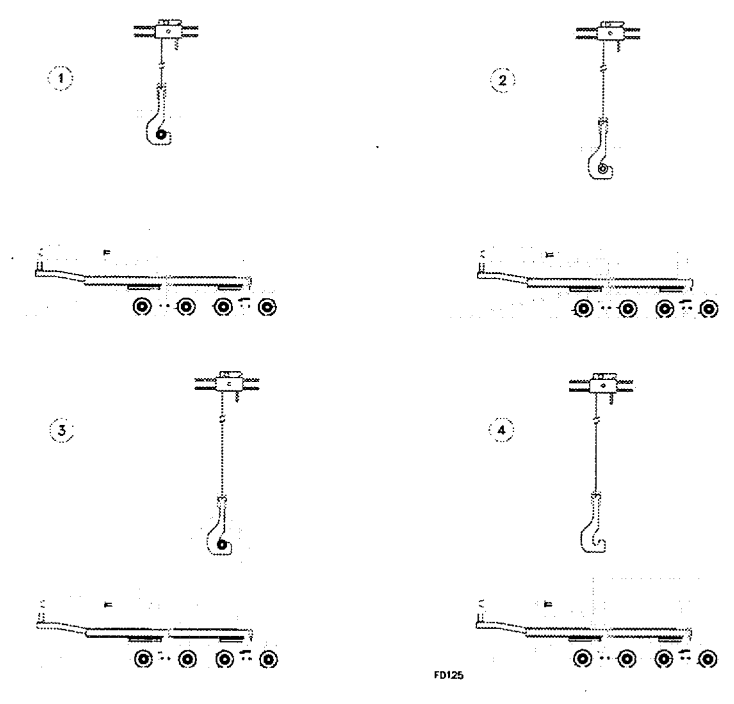


Figure E4.7-7
NUHOMS® OS-197 Transfer Cask Downending Sequence.

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.

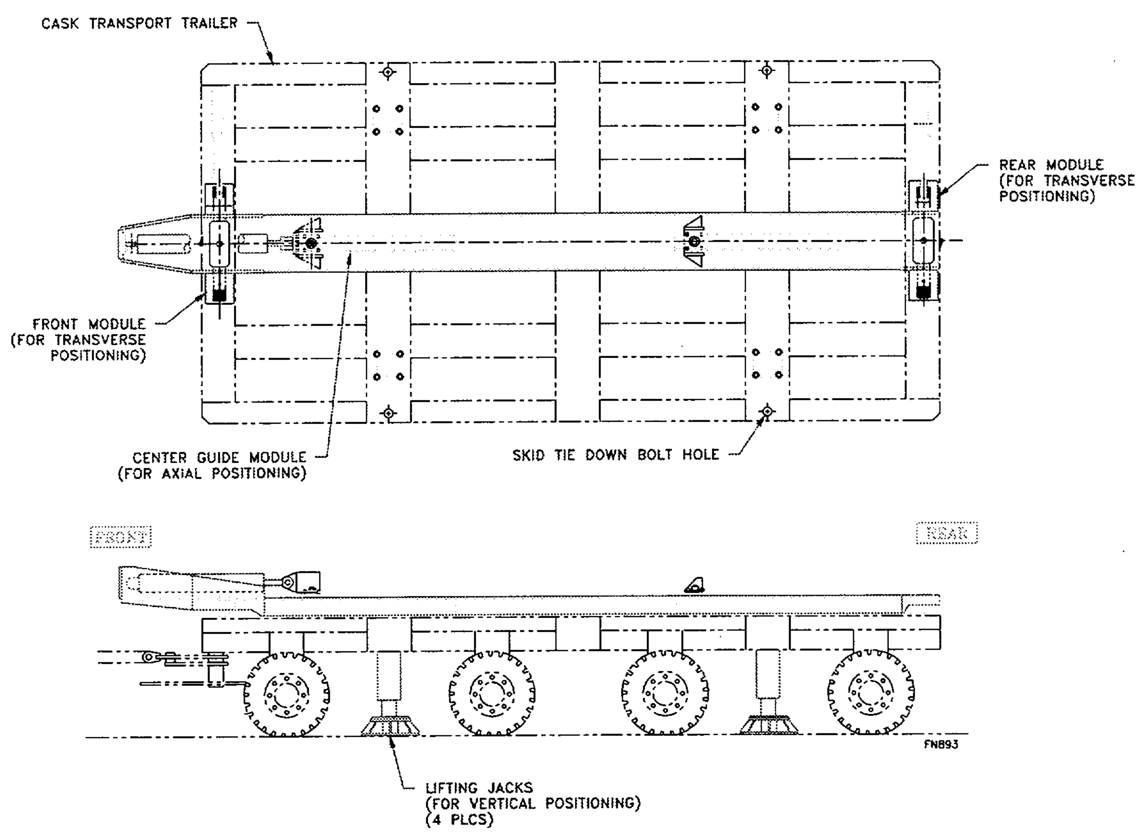


Figure E4.7-8
NUHOMS® Skid Positioning System (SPS).

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.

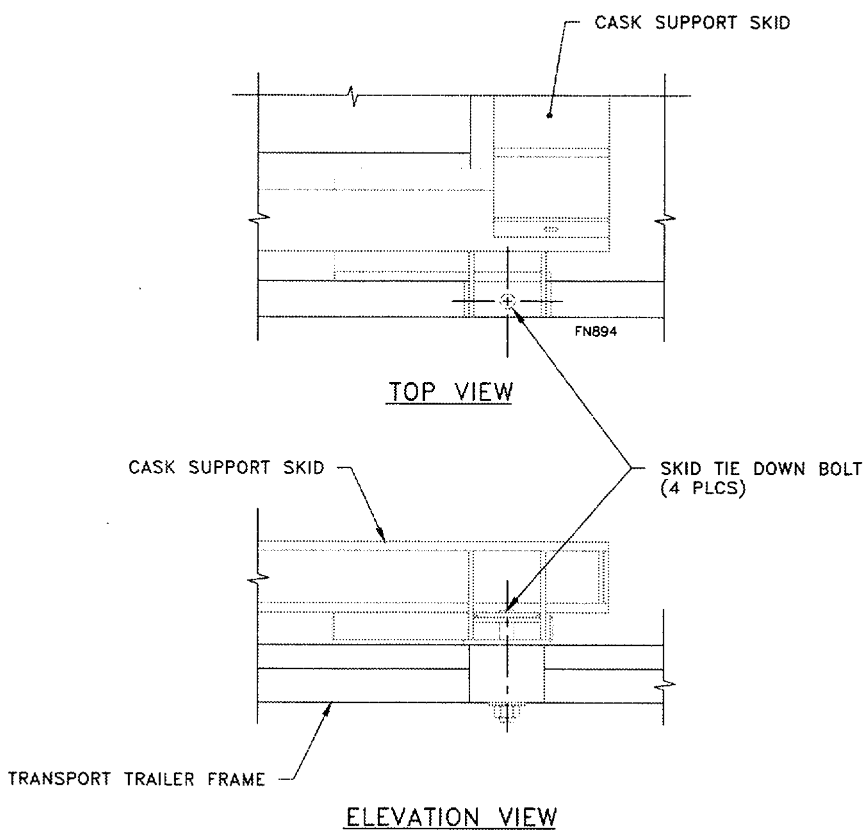


Figure E4.7-9
NUHOMS OS-197 Cask Support Skid Tiedown Bracket.

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.

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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.

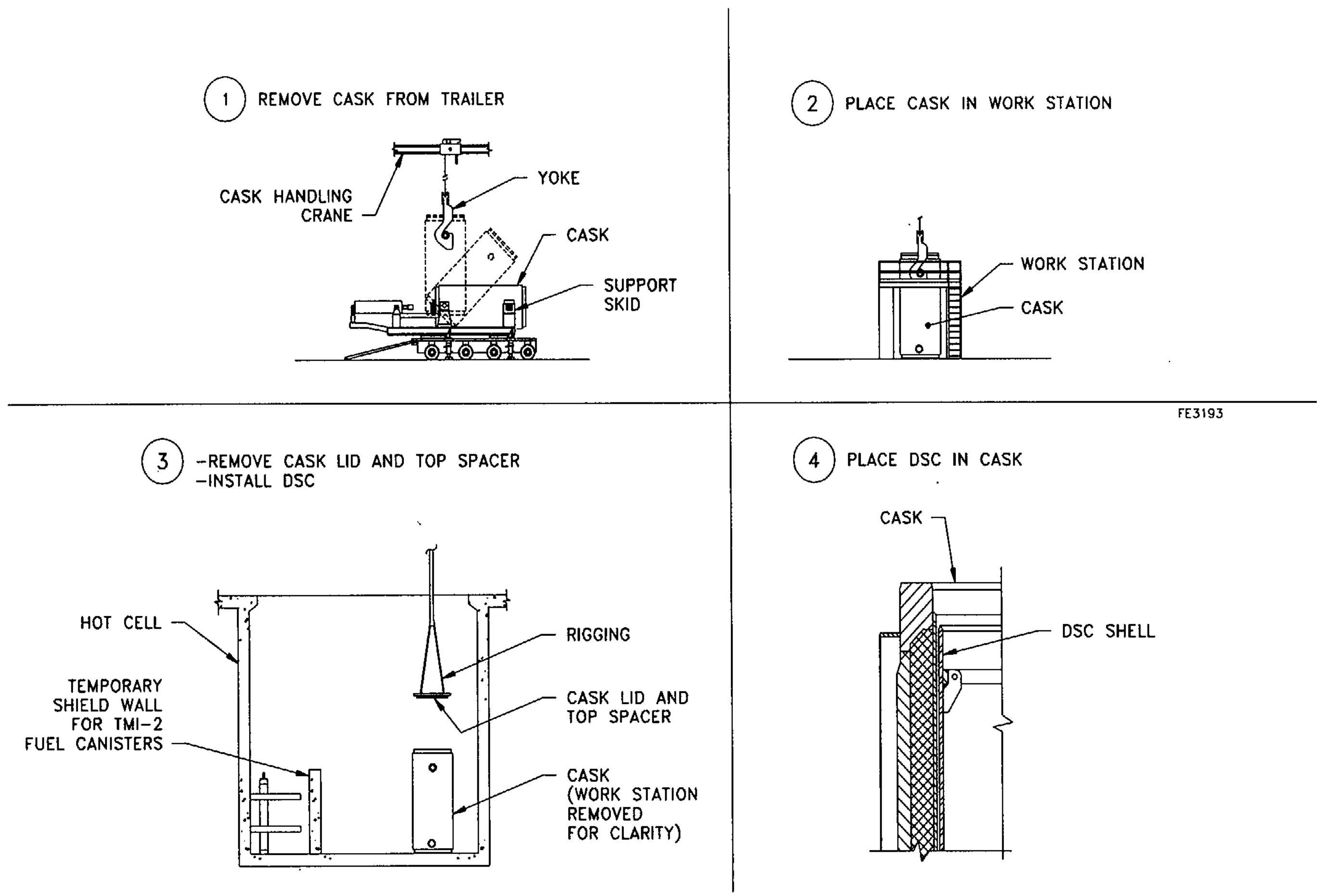

Figure 5.1-10

Primary Operations for the NUHOMS®-12T System

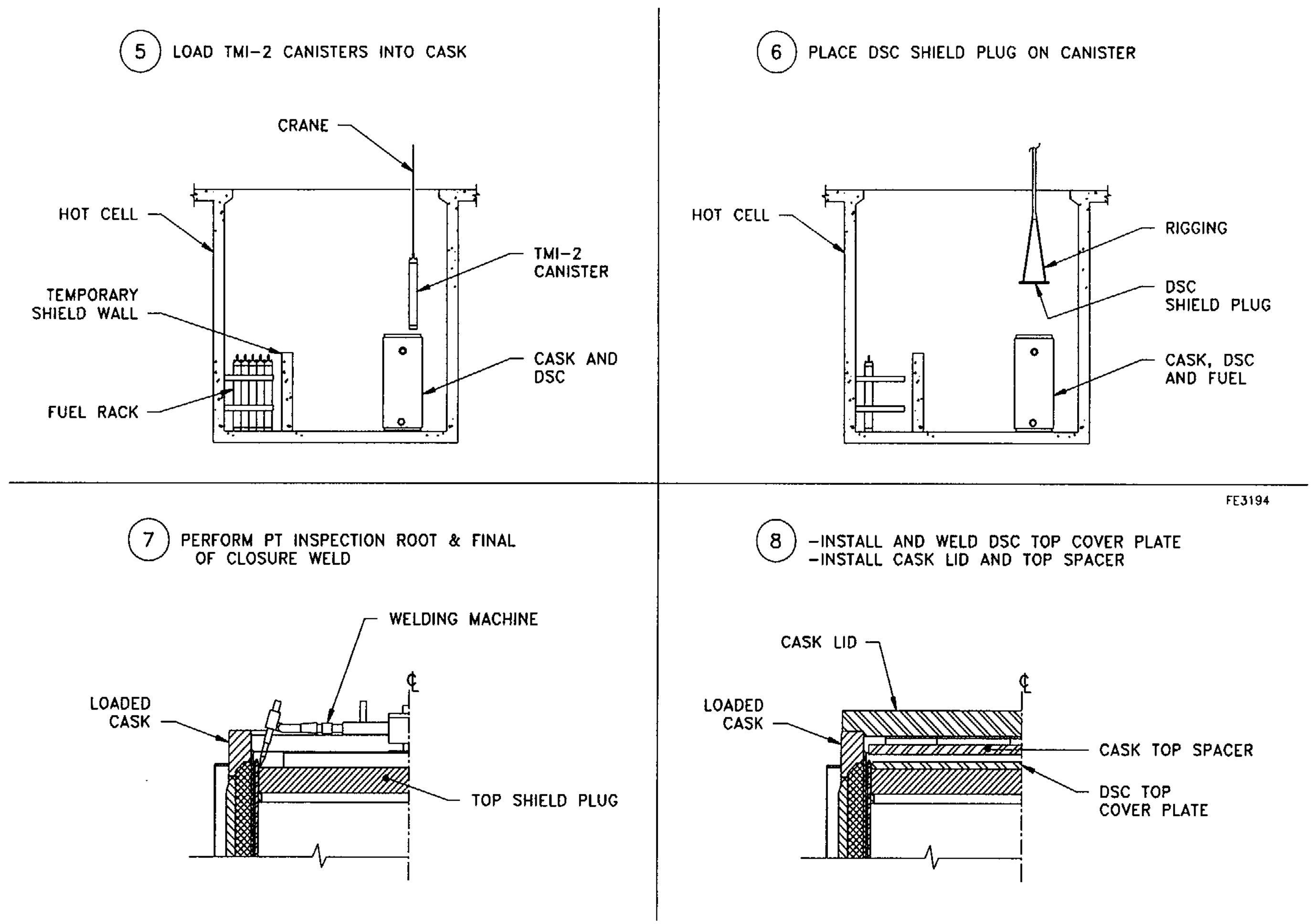

Figure 5.1-1
Primary Operations for the NUHOMS-12T System (continued)

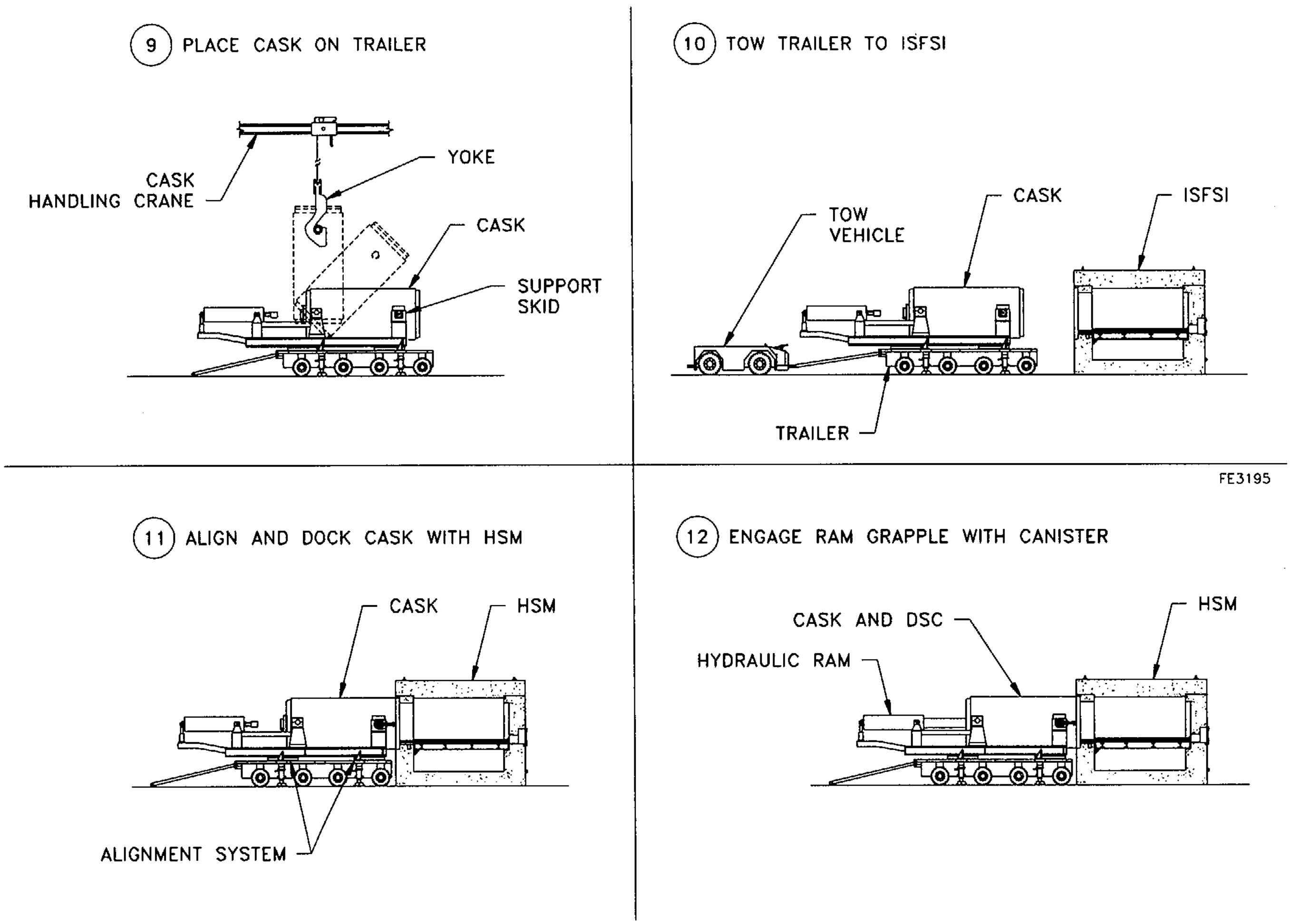

Figure 5.1-1
Primary Operations for the NUHOMS-12T System (continued)

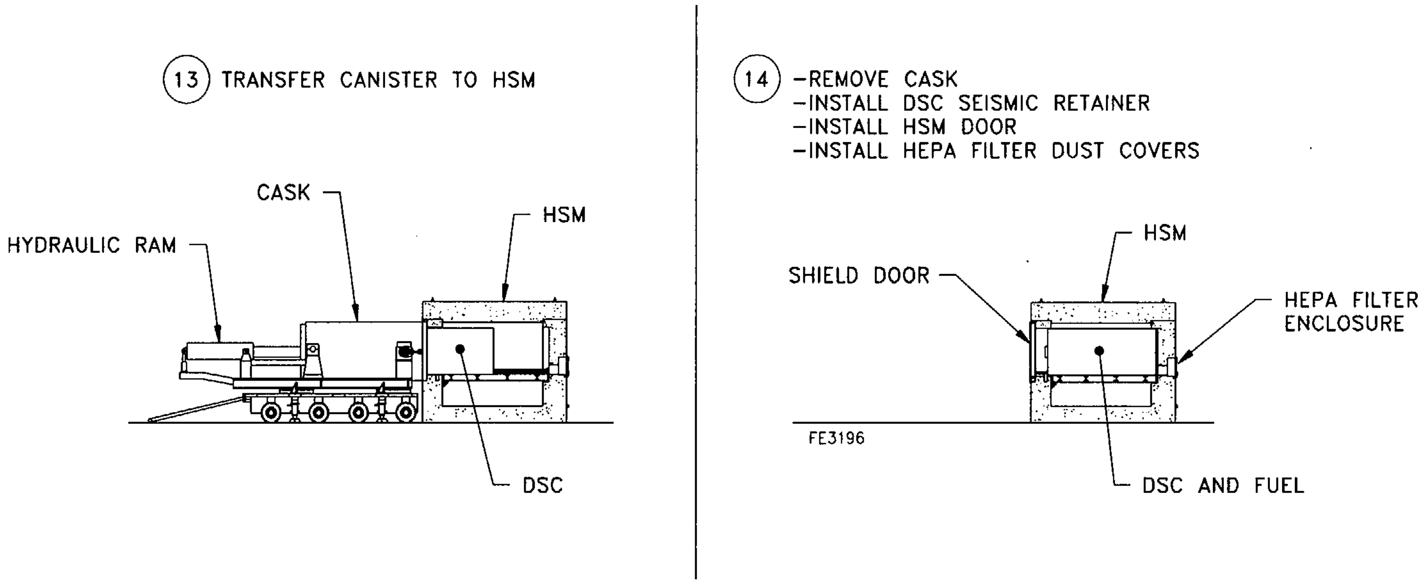

Figure 5.1-1
Primary Operations for the NUHOMS-12T System (continued)

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.

5.1.1.5 Transfer Cask Downending and Preparation forTransfer to ISFSI

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.

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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

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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 WITHHELD UNDER 10 CFR 2.390

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

7.3.2.2 Shieldina 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).

<u>Gamma Dose Rates for the OS-197 Cask With the Neutron Shield Filled With Water</u>

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. 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	44.6	66.6	111
Cask Top	0.11	5.0	5.1
Cask Bottom	0.08	18.4	19

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.

	Dose Rate (mrem/h)		
Location	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	111	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.

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.

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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*g*s for end and side drops, 25*g*s 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*g*s.

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.

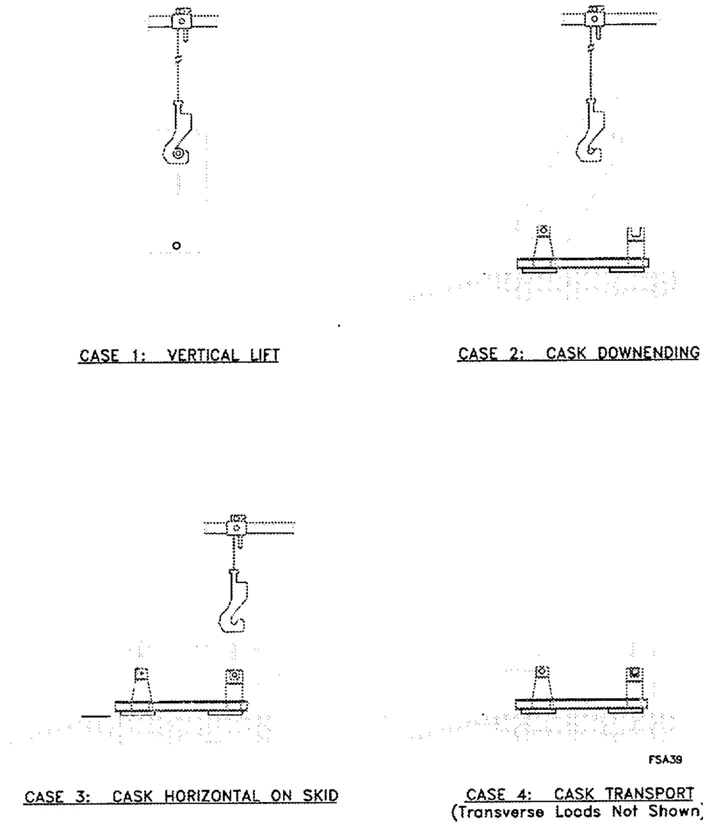

Figure 8.1-12
OS-197 Transfer Cask Handling Loads
(hydraulic ram not shown)

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^{0}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 Ir 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

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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.

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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.

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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.

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12.0 OS-197 CASK DRAWINGS

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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.

FIGURE WITHHELD UNDER 10 CFR 2.390

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