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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 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 TMI-2 ISFSI is located on the 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 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 TMI-2 ISFSI installation are described in Sections 1.2 and 1.3. There are no utility systems required during storage conditions within the 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 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 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 TMI-2 ISFSI are described in Chapter 3. In accordance with 10 CFR 72.3 [4.1], the only storage components at the 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 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 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 INL 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 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 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.

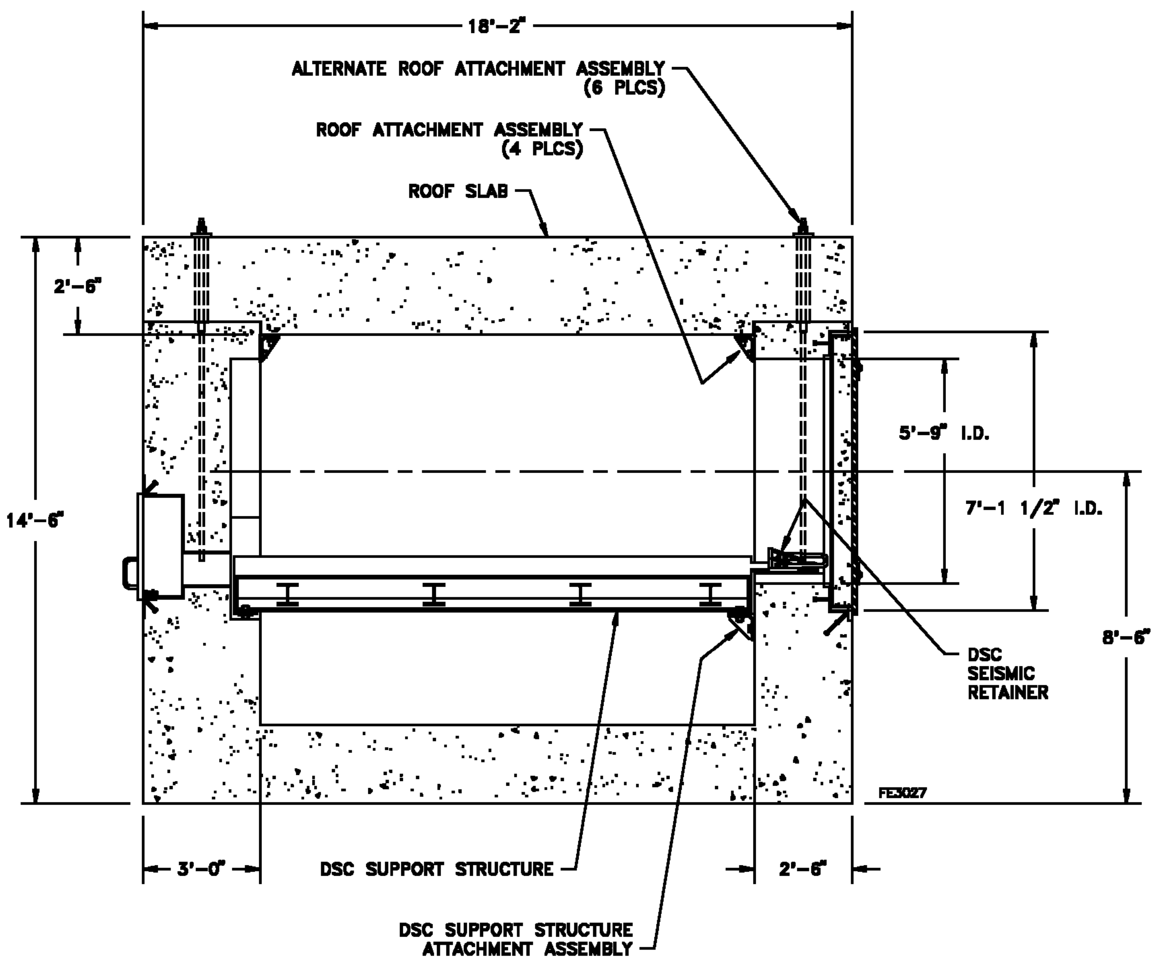

Figure 4.2-1
Prefabricated NUHOMS® 12T Module Longitudinal Section

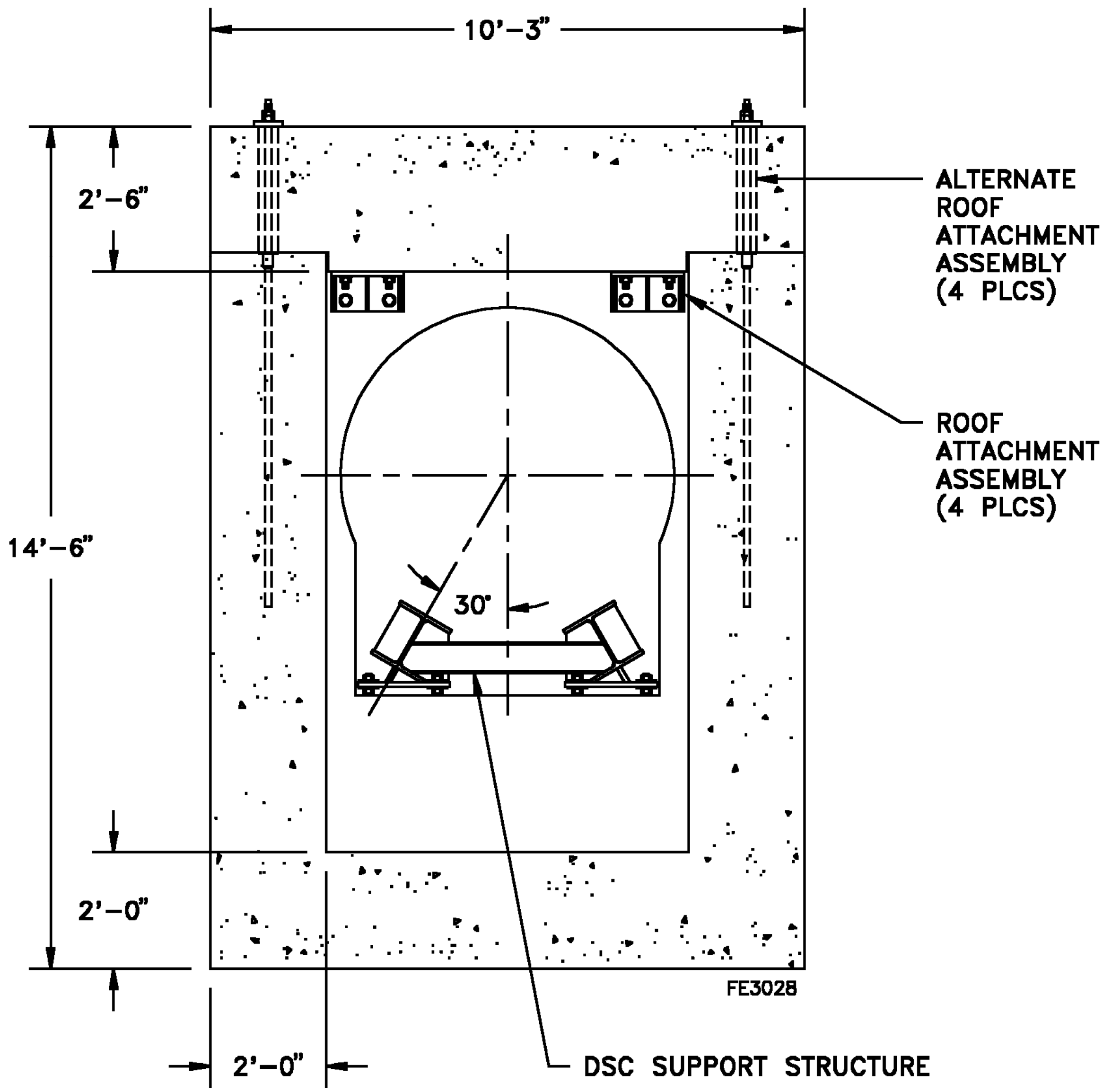

Figure 4.2-2
Prefabricated NUHOMS®-12T Module Cross-Section

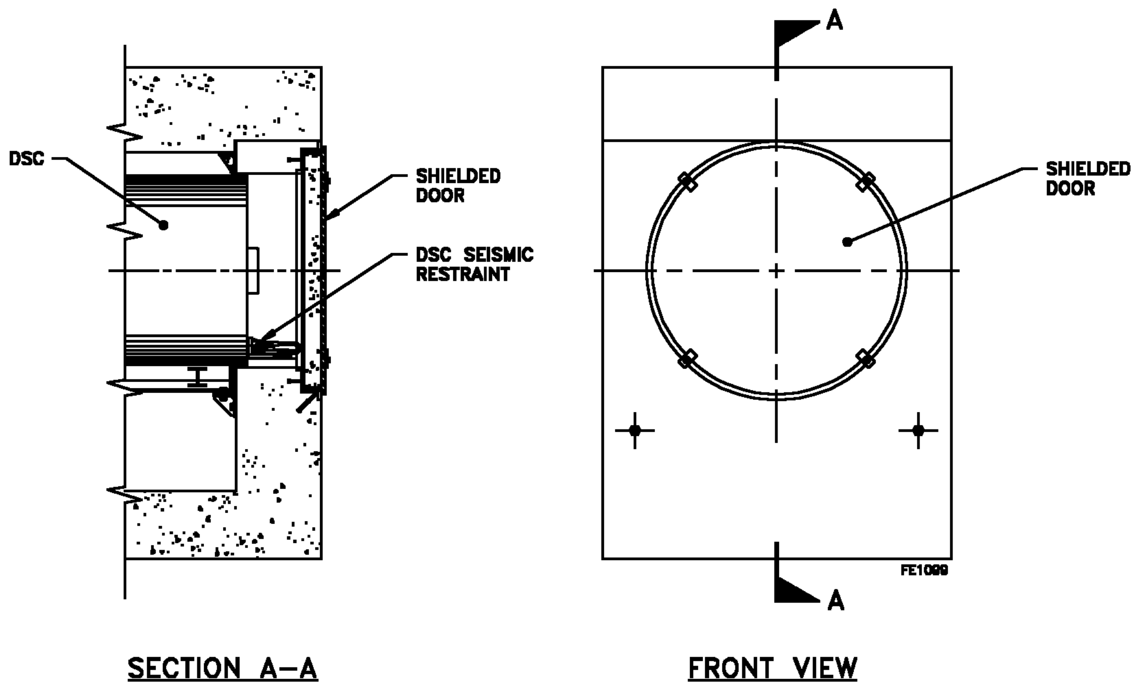

Figure 4.2-3
<u>HSM Front Wall Details</u>

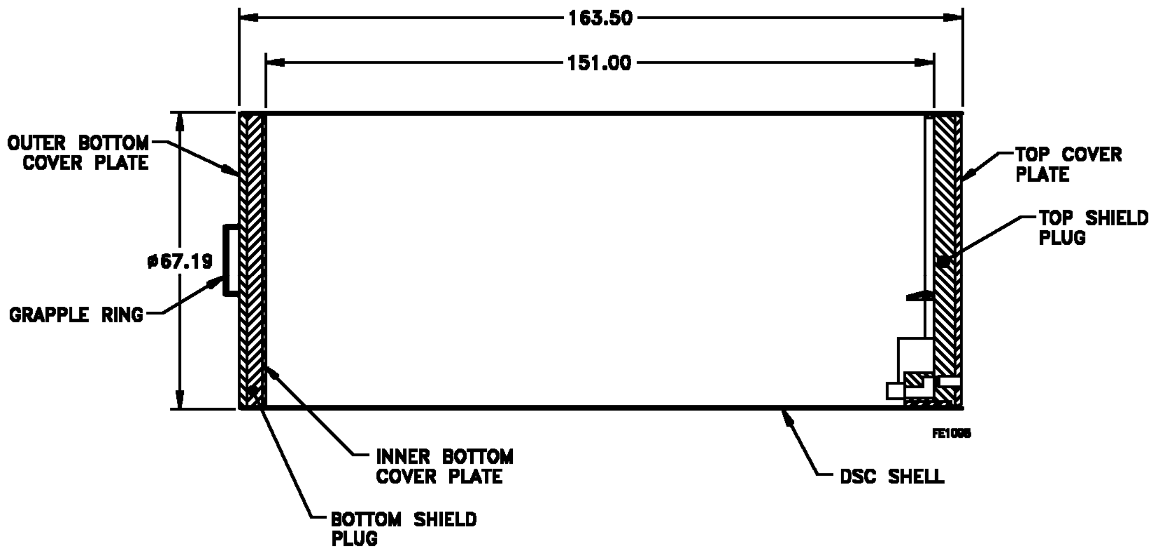

Figure 4.2-4
NUHOMS®-12T Canister Shell Assembly

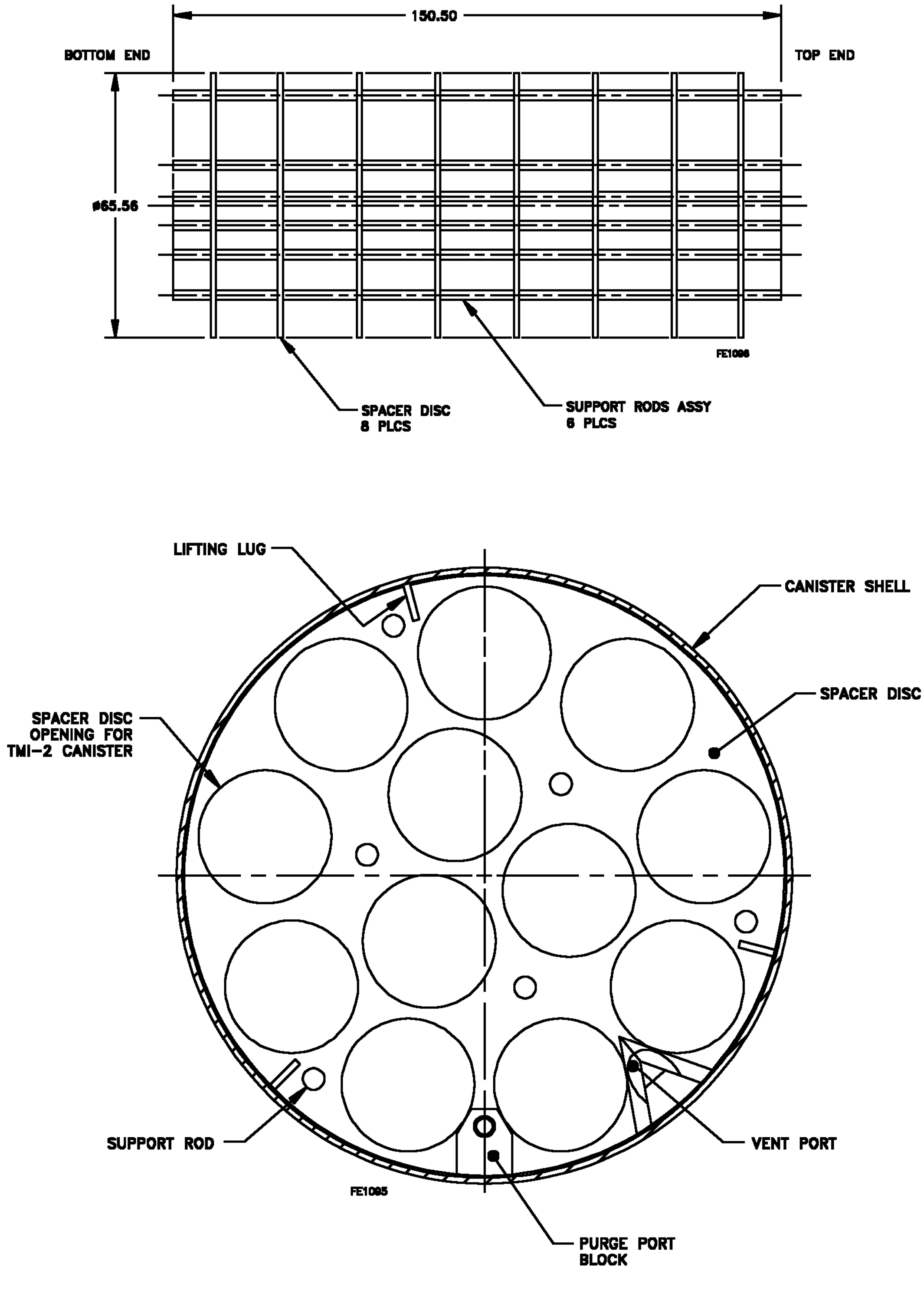

Figure 4.2-5
<u>NUHOMS®-12T Canister Basket</u>

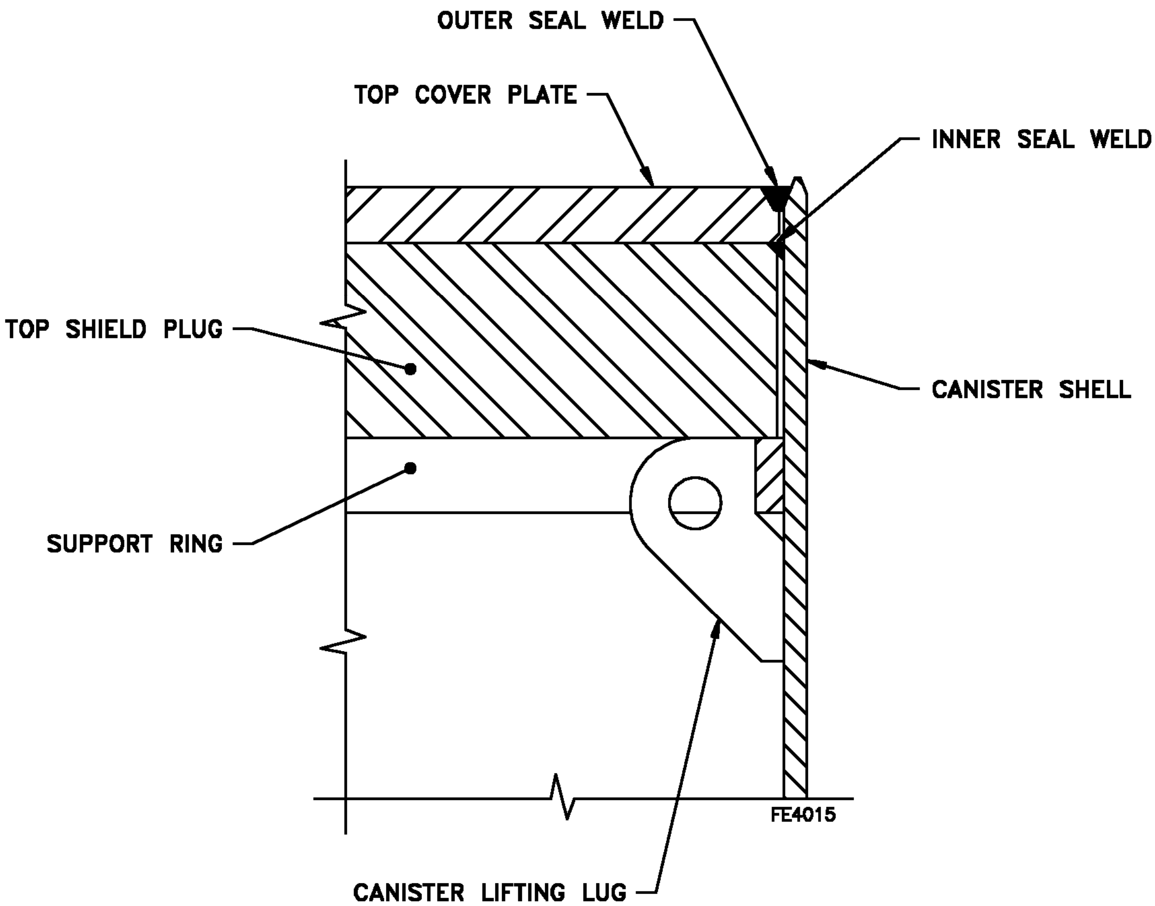

Figure 4.2-6
DSC Top Shield Plug and Cover Plate Closure Welds

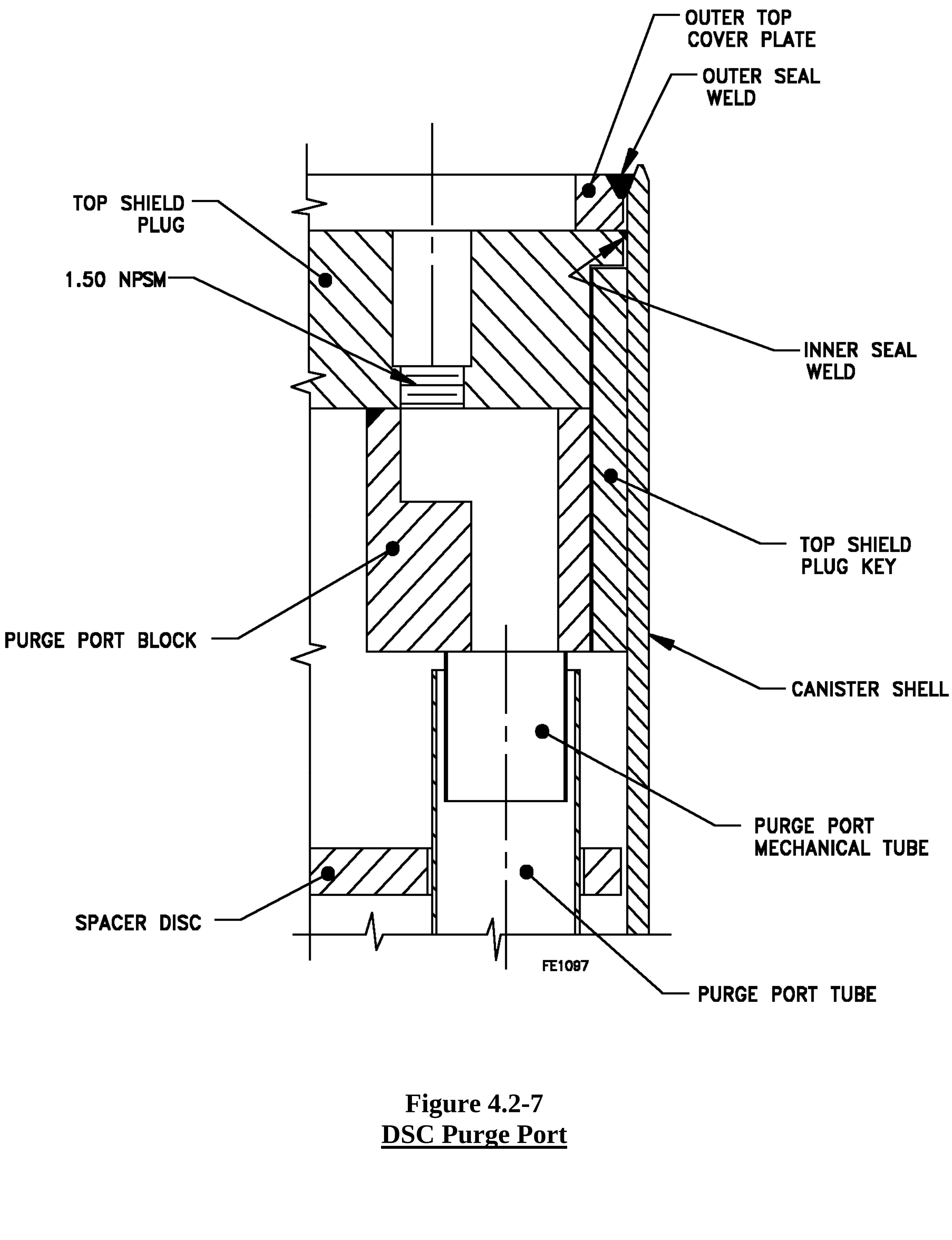

Figure 4.2-7
DSC Purge Port

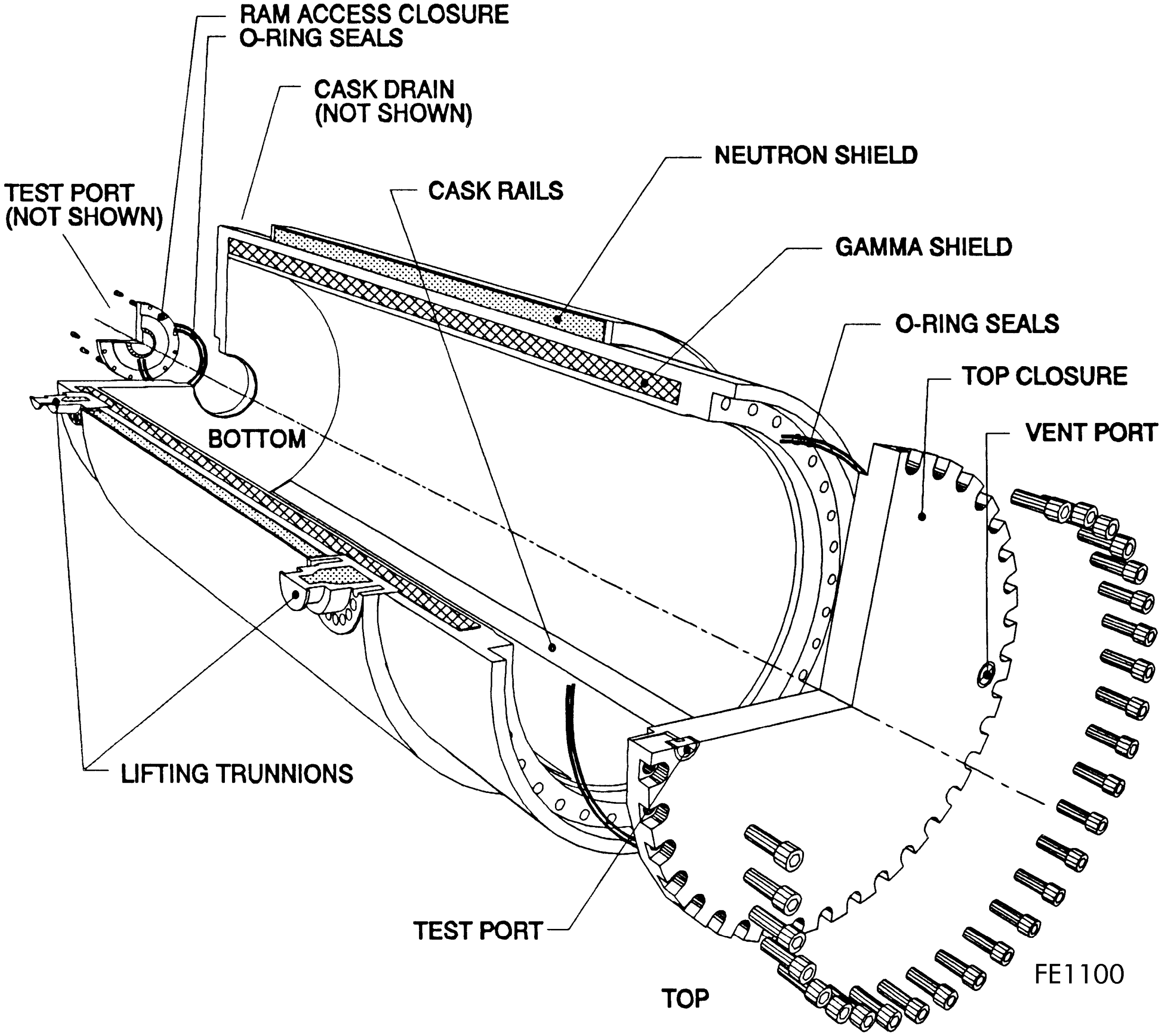

Figure 4.2-8
Composite View of NUHOMS®-MP187 Cask

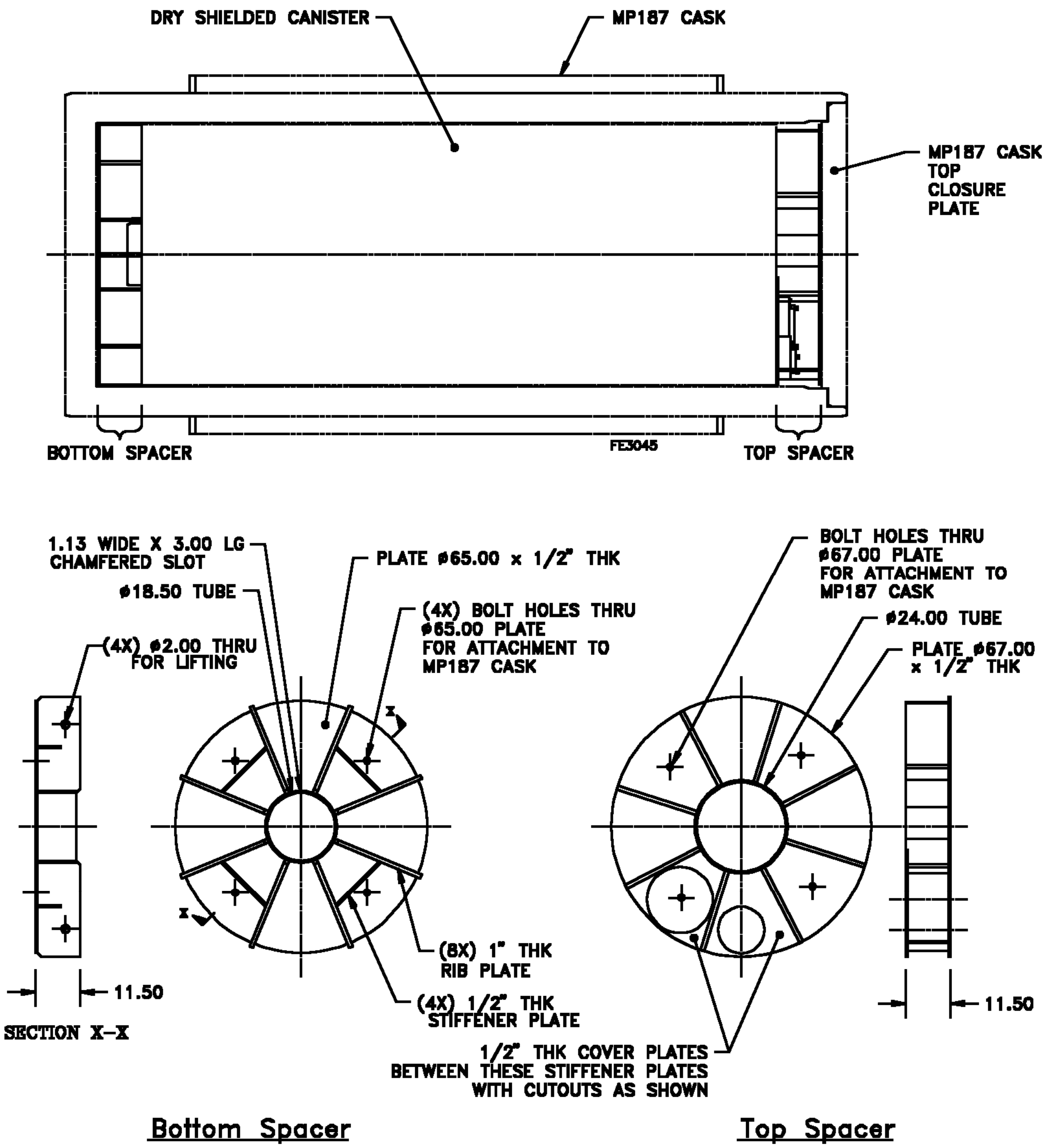

Figure 4.2-9

Cask Spacers

Intentionally Blank

4.3 Auxiliary Systems

The 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 INL, 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 INL. 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 leak rates of the double metallic seals between the filter/purge housings and the DSC are periodically tested. Failure of this test requires resealing and retesting. The surface of the DSC was polished to a very smooth finish prior to installation of the metallic seals so that a good seal could be established. Resealing the metallic seals while the DSC is horizontal could be difficult. An elastomeric seal has been specified and tested and shown to be a suitable alternate for the metallic seal [4.16]. The elastomeric rings would require testing and replacement on a shorter time schedule than the metallic rings due to concerns with the life of the material.

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 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 TMI-2 ISFSI.

4.3.7 Communication and Alarm Systems

No communication systems are required for the safe operation of the 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 TMI-2 ISFSI. The HSMs contain no combustible materials. The provisions needed for fire response will be provided consistent with existing INTEC requirements.

4.3.9 Cold Chemical Systems

There are no cold chemical systems for the 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 includes ensuring the vent access doors remain operational and no blockage occurs in the vent areas of the door.

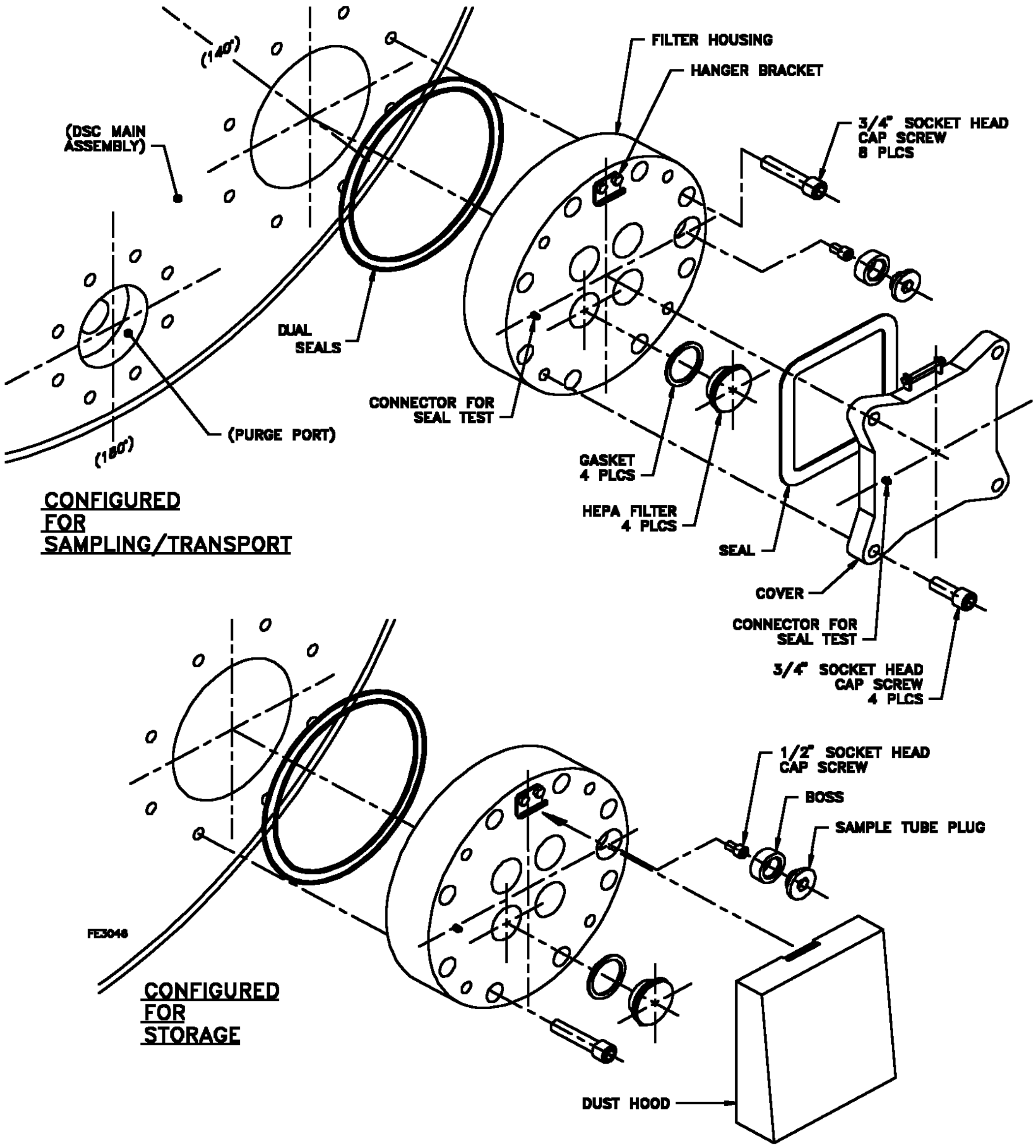

Figure 4.3-1
<u>DSC Vent and Purge Assemblies</u>

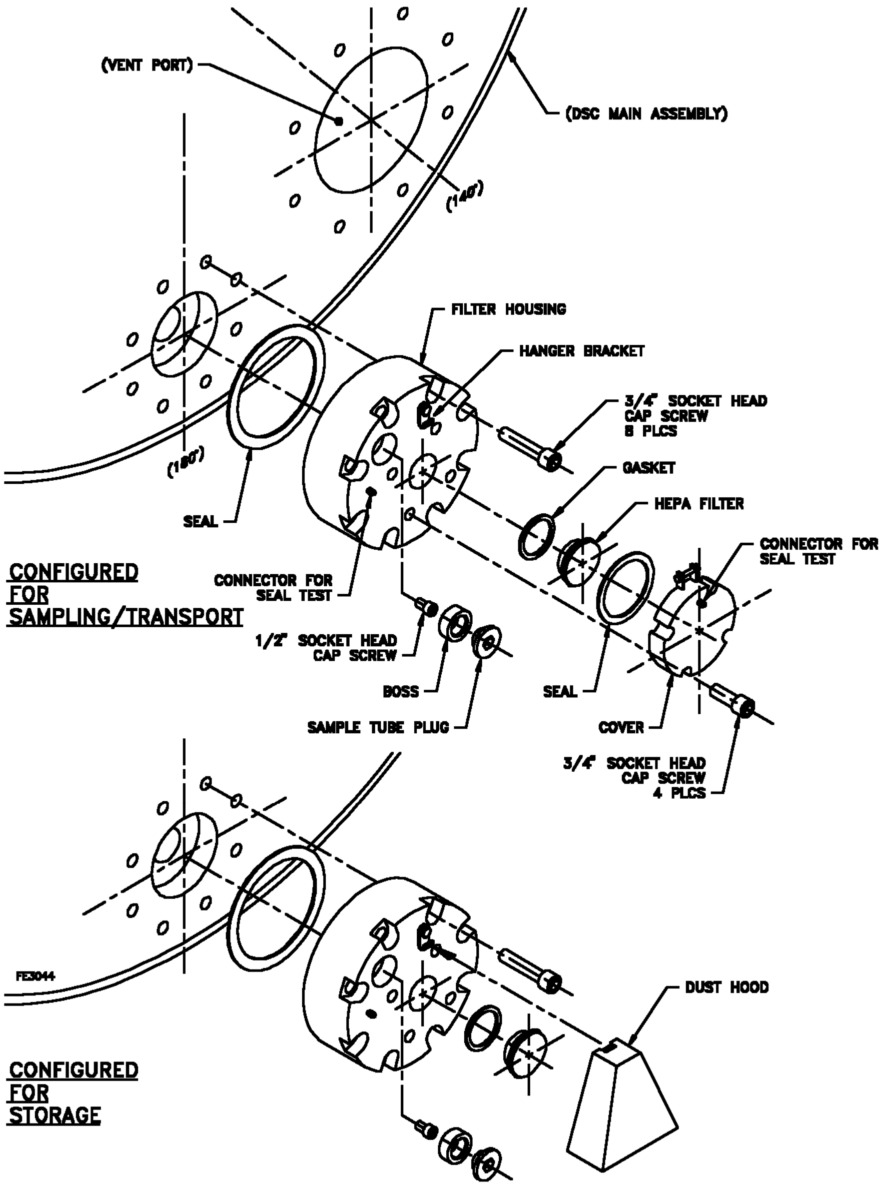

Figure 4.3-1
<u>DSC Vent and Purge Assemblies</u>
(Concluded)

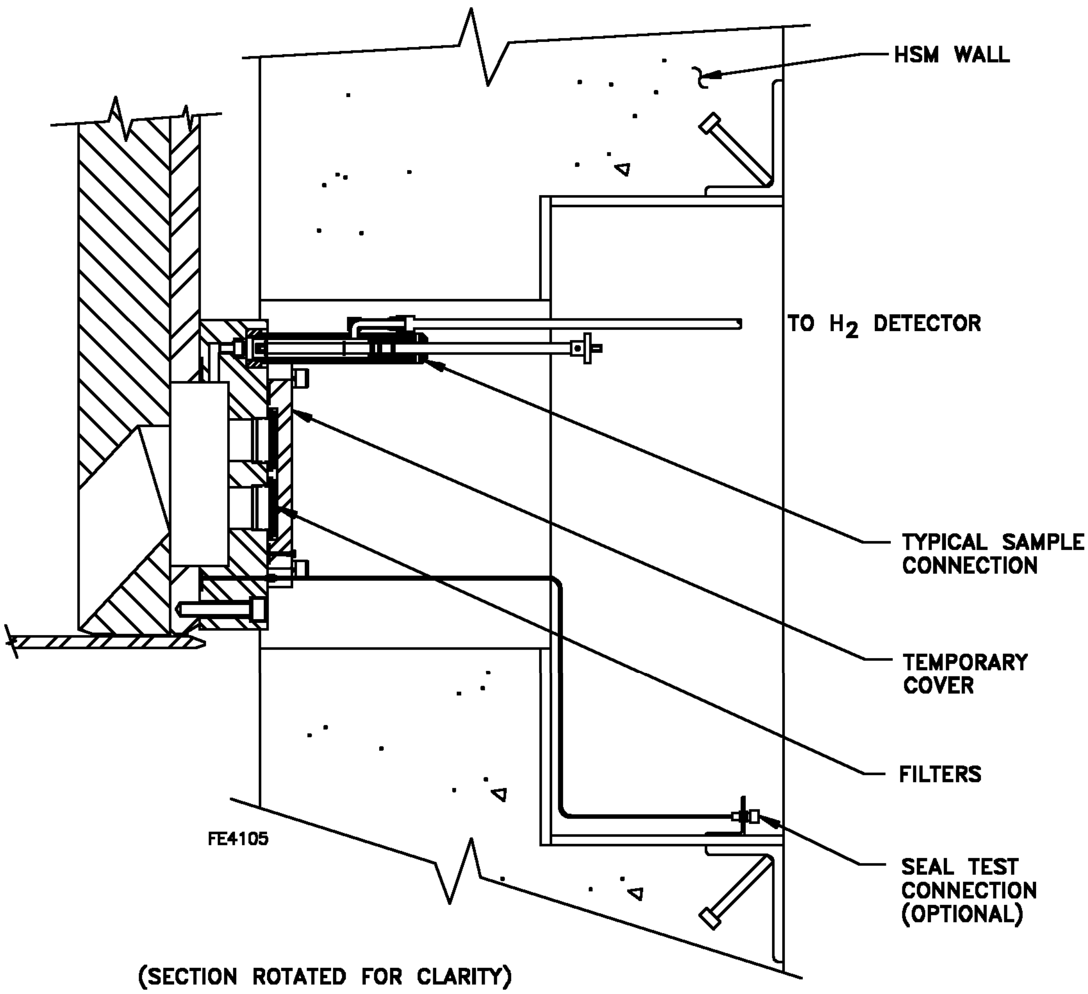

Figure 4.3-2
DSC Sampling System

4.4 Decontamination System

4.4.1 Equipment Decontamination

No decontamination equipment is required at the 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 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 TMI-2 ISFSI transfer operations may be performed at existing INL 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 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

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 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 TMI-2 ISFSI is discussed in Section 4.1.1.

4.7.2.1 Building Plans

There are no buildings required at the 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 INL 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.

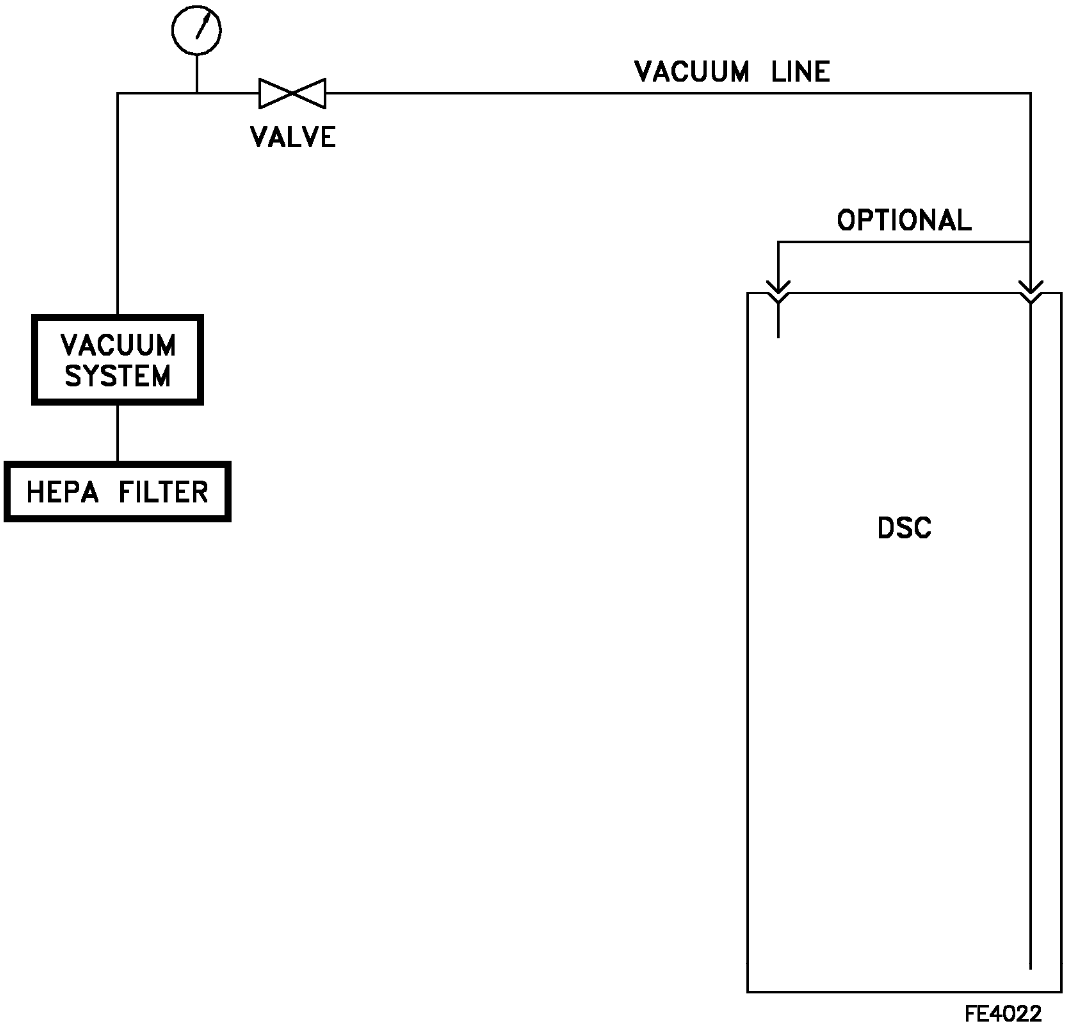
4.7.3.6 Ram Support Assembly

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.



CONFIGURATION FOR DSC EVACUATION

Figure 4.7-1
DSC Evacuation

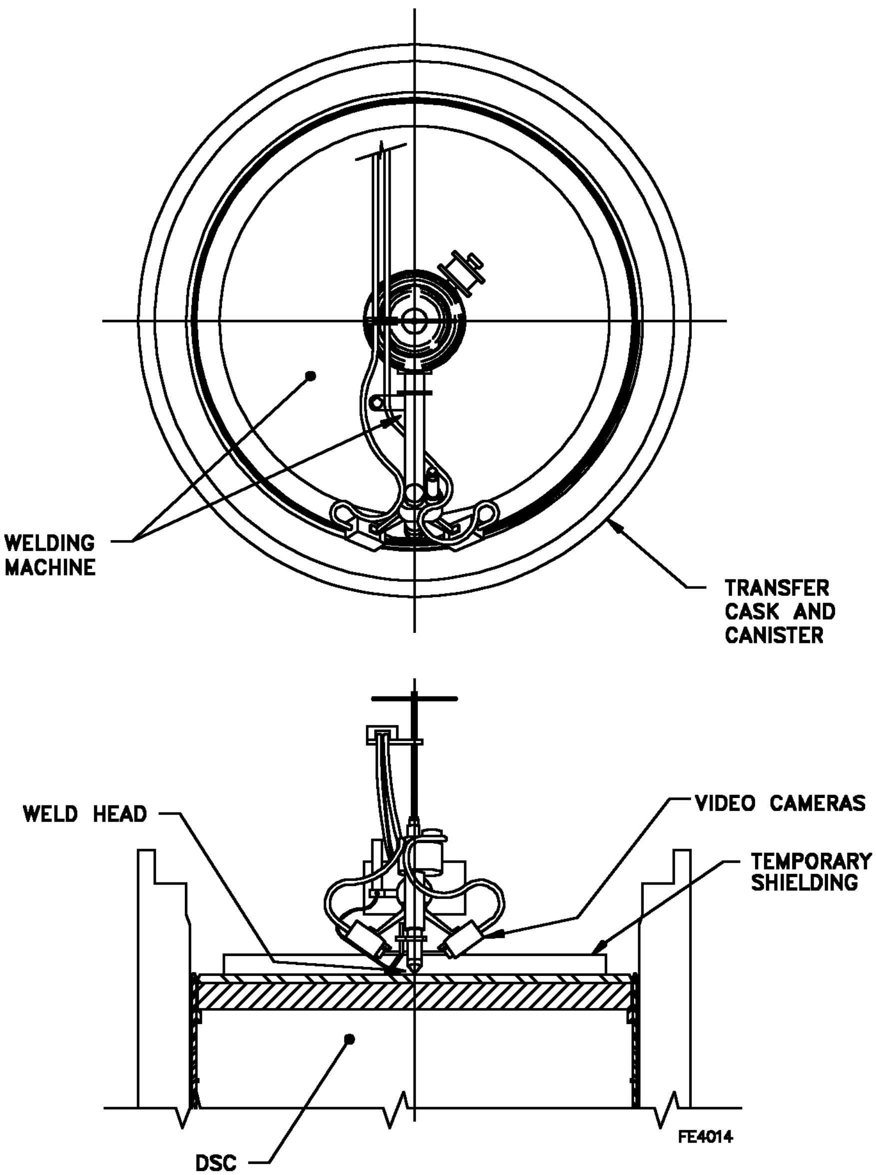


Figure 4.7-2
DSC Automated Welding System

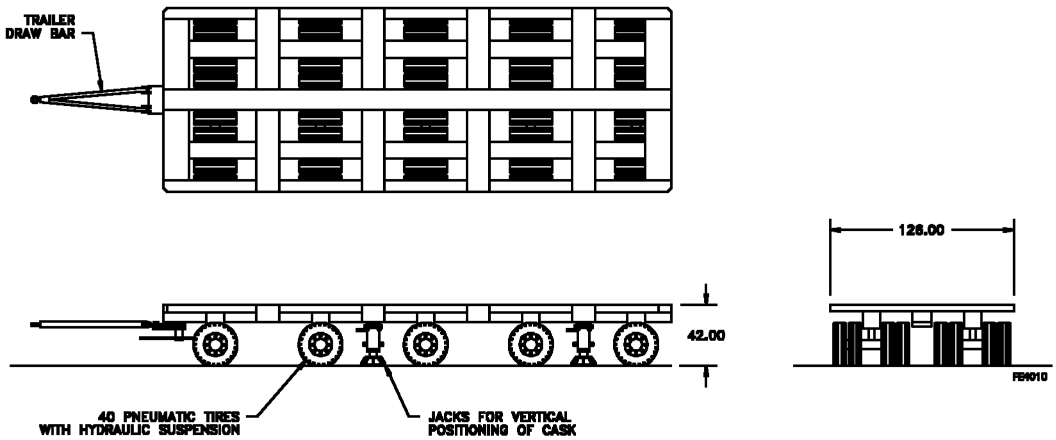


Figure 4.7-3
NUHOMS®-12T Transport Trailer

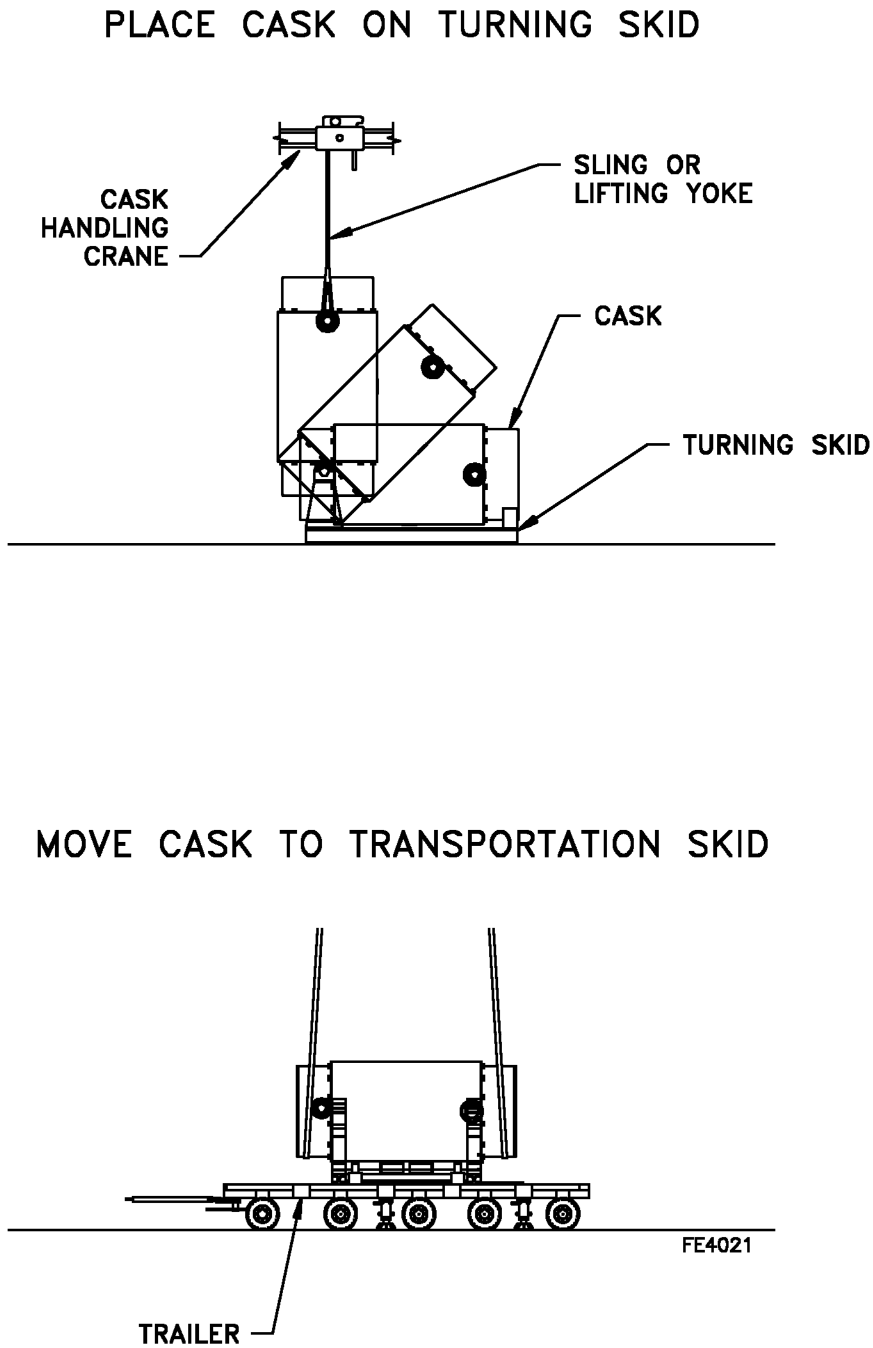


Figure 4.7-4
NUHOMS®-12T Cask Downending Sequence

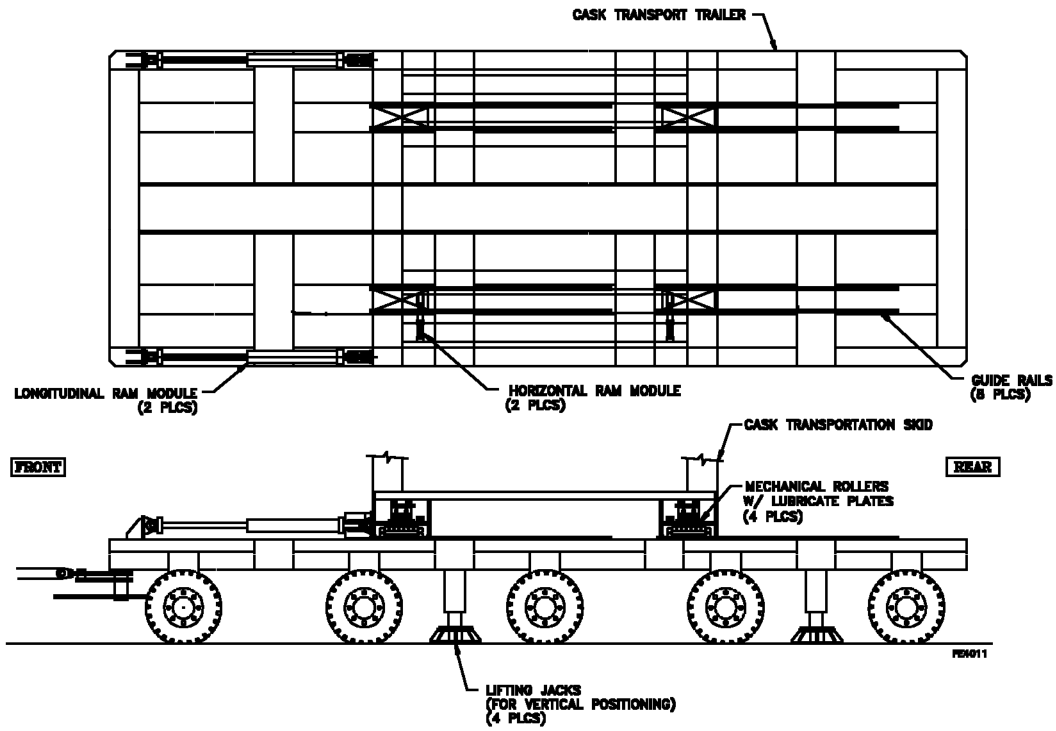


Figure 4.7-5

NUHOMS®-12T Skid Positioning System (SPS)

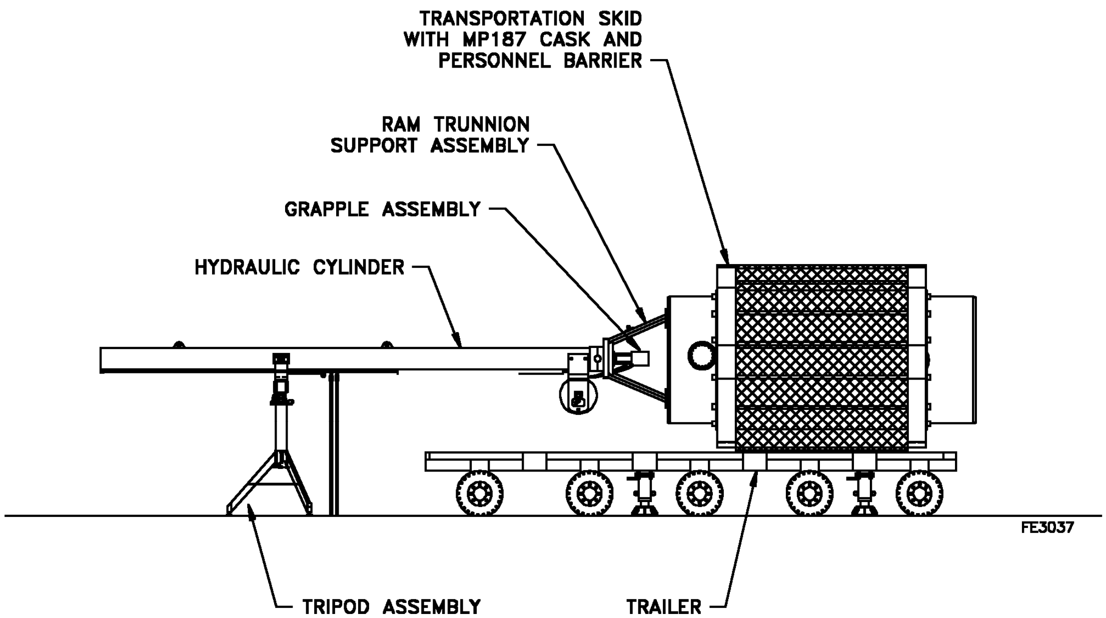


Figure 4.7-6
Hydraulic Ram and Transportation Skid

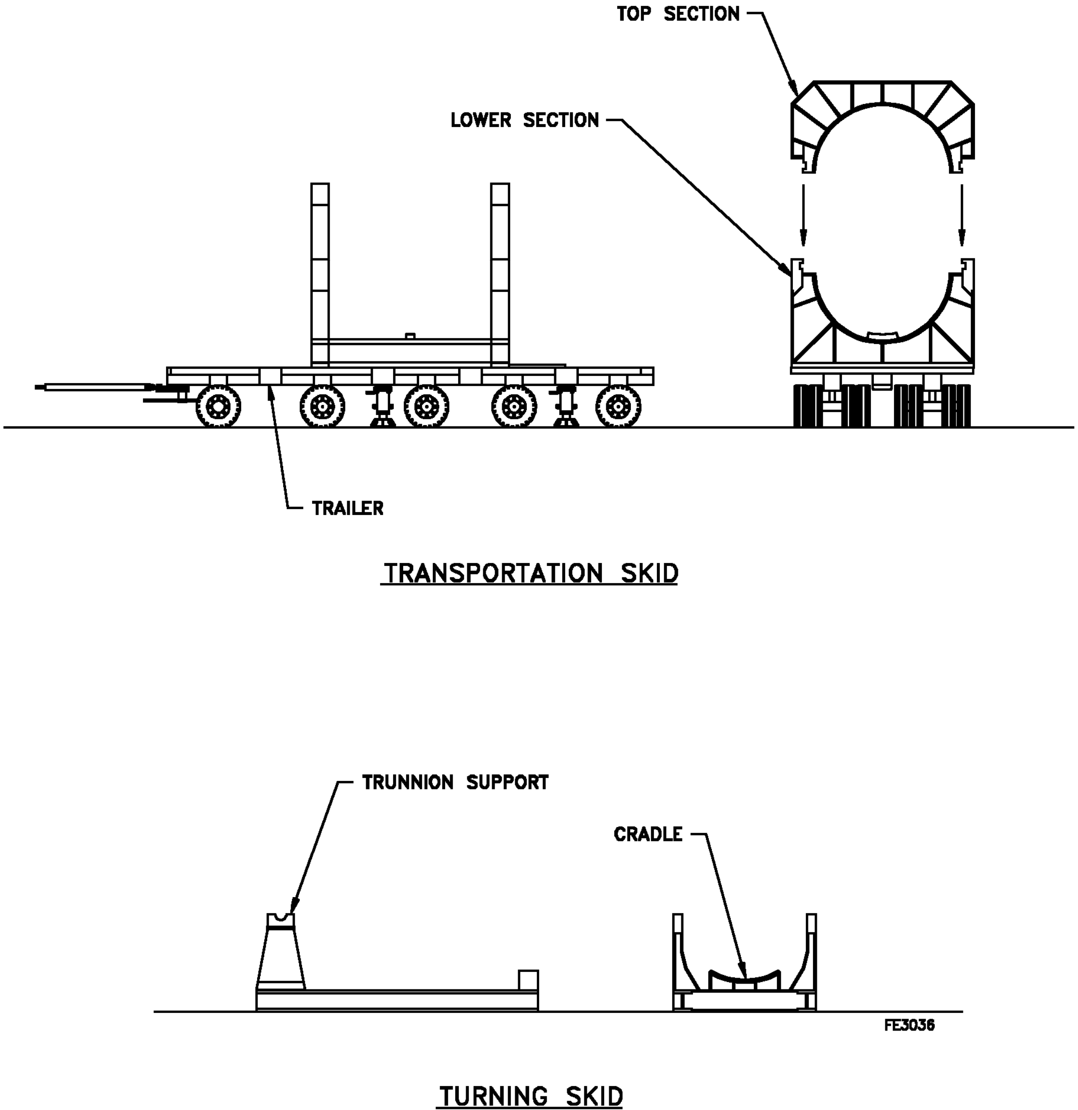


Figure 4.7-7
Cask Transportation Skid

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