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LIST OF ACRONYMS

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
B&PV	Boiler and Pressure Vessel
CFR	Code of Federal Regulations
DSC	Dry Shielded Canister
HSM	Horizontal Storage Module
HRS	Hydraulic Ram System
ISFSI	Independent Spent Fuel Storage Installation
NFPA	National Fire Protection Association
NUHOMS	Nutech Horizontal Modular Storage®
SPS	Skid Positioning System
SRV	Safety Relief Valve

4.0 INSTALLATION DESIGN

4.1 SUMMARY DESCRIPTION

4.1.1 LOCATION AND LAYOUT OF THE INSTALLATION

The location and layout of the Calvert Cliffs Independent Spent Fuel Storage Installation (ISFSI) with respect to other plant site structures is shown in Figure 1.1-1. This figure also denotes the route for transport of the transfer cask carrying dry shielded canisters (DSCs) from the Auxiliary Building to the ISFSI.

The initial construction phase of the ISFSI included four 2x6 horizontal storage module (HSM) arrays which store up to 48 DSCs. Additional HSM storage capacity will be added incrementally up to a total of ten 2x6 HSM arrays as needed. Figure 4.1-2 shows the arrangement of the storage arrays.

The area around the ISFSI is sloped to direct surface drainage to collection ditches for channeling rain water away from the site. As noted in Section 2.4, the ISFSI is about 86' above the probable maximum flood elevation. Local intense rainfall is not a problem since the resulting flood water would need to rise at least 18" above yard grade in order to block the HSM air inlets. (This height represents the bottom of the air inlet penetration on the inside of the air inlet plenum.) Adequate surface drainage exists at the ISFSI yard to assure that water will not collect to a depth of any concern.

The chosen transport route has been reviewed and is found to be in compliance with the design criteria of the transfer cask drop analysis discussed in Section 8.2 of the Nutech Horizontal Modular Storage® (NUHOMS)-24P Topical Report (Reference 4.1). Furthermore, the transport route has been reviewed to assure that no roadways, subgrade structures, buried pipes or trenches will be damaged by the transport trailer wheel loads. The approach slab has adequate space for turning the transport trailer and tow vehicle. No other turning areas are needed along the transport route. The roadway or ground surface elevation perpendicular to the route to or from the ISFSI within an 8.0' proximity of the transfer trailer is not more than 20" below the road surface centerline elevation. The paved portion of the road is a minimum of 16' wide and with the adjacent paved, gravel or soil shoulder the transfer route is at least 28' wide. The lowest point in the width of the transfer route is not lower than 20" below the road centerline. The transfer route contains typical roadside fixtures, including curbs, fences, guard rails, and light poles which do not constitute potential puncture mechanisms for the cask. The shoulders do not contain items such as light pole pedestals which protrude above the shoulder surface and could represent a potential cask puncture device. The components associated with the vehicle barrier system have been analyzed and do not represent a puncture risk to the transfer cask. The road is closed to other vehicles when transporting the spent fuel. The maximum drop height of the cask from the transfer trailer to the roadbed does not exceed 80".

4.1.2 PRINCIPAL FEATURES

4.1.2.1 Site Boundary

The property owned by Calvert Cliffs Nuclear Power Plant, Inc. surrounding the Calvert Cliffs ISFSI is shown in Figure 2.1-2.

4.1.2.2 Controlled Area

The controlled area for the ISFSI, as defined by Title 10, Code of Federal Regulations (CFR) 72.106, is identified in Figure 2.1-2. Its border from the HSM array is a minimum of 3900' (1189 meters) as shown in Figure 2.1-2.

4.1.2.3 Site Utility Supplies and Systems

No utility systems are required for the storage phase of the ISFSI. Electrical power is provided to operate the hydraulic pumps used during DSC insertion or withdrawal operations at the HSM, and for lighting and security systems. No water or sewer systems are necessary. The existing plant page system is extended to provide telephone and paging communications.

4.1.2.4 Storage Facilities

There are no holding ponds, chemical or gas storage vessels, or other open-air tankage on or near the ISFSI. When empty DSCs are stored at the ISFSI site, they are placed horizontally on wooden cribbing with their ends facing north and south.

4.1.2.5 Stacks

The ISFSI has no stacks. Two HSM air outlet vents are located on the roof of each HSM. A concrete shielding cap is located over each outlet.

4.2 STORAGE STRUCTURES

4.2.1 STRUCTURAL SPECIFICATIONS

The principal storage structures in the ISFSI are the HSM and the DSC. The HSM and DSC design bases, materials of construction, codes and standards, etc., are in full compliance with the NUHOMS-24P Topical Report (Reference 4.1) and are listed below. Activities which are covered by the Quality Assurance Program are discussed in Chapter 11.

4.2.1.1 Horizontal Storage Modules

A. American Concrete Institute (ACI) 349-85 and 349B, "Code Requirements for Nuclear Safety-Related Concrete Structures" (For design, not construction)

B. ACI 318-83, "Building Code Requirements for Reinforced Concrete" (For construction, not design)

C. American Welding Society D1.1-88, "Structural Welding Code-Steel"

D. American National Standards Institute (ANSI) 57.9-1984 "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)"

E. ANSI A58.1-1982, "Minimum Design Loads for Building and Other Structures"

F. American Institute of Steel Construction (AISC), "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings," 8th Edition

G. National Fire Protection Association, No. 78, "Lightning Protection Code," 1983 Edition

4.2.1.2 Dry Shielded Canister – NUHOMS-24P

A. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Section III, Division 1, Subsection NB, "Class 1 Components," I983 Edition through Winter I985 Addenda used as a guide for design and fabrication. An N-stamp is not required.

B. ANSI/American Nuclear Society 57.9-1984, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)"

C. ANSI N14.5-1977, "Leakage Tests on Packages for Shipment of Radioactive Materials"

D. ANSI Y14.5M-1982 "Dimensioning and Tolerancing"

E. ANSI N45.2-1977, "Quality Assurance Program Requirements for Nuclear Power Plants"

F. PNL-6189, "Recommended Temperature Limits for Dry Storage of Spent Light Water Reactor Zircalloy Clad Fuel Rods in Inert Gas"

G. PNL-4835, "Technical Basis for Storage of Zircalloy-Clad Spent Fuel in Inert Gases"

H. ANSI-57.2-1983, "Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants"

I. ANSI-8.17-1984, "Criticality Safety Criteria for Handling, Storage, and Transportation of LWR Fuel Outside Reactors"

4.2.1.3 Dry Shielded Canister – NUHOMS-32P

Unless replaced below, the specification in Section 4.2.1.2 also applies.

A. ASME B&PV Code, Section III, Division 1, Subsection NB, NF, NG, and Appendix F, 1988 with 1999 Addenda. N – stamp is not required.

B. ANSI/ANS 57.9-1992, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)

C. ANSI N14.5-1987, Leakage Tests on Packages for Shipment for Radioactive Materials

4.2.2 INSTALLATION LAYOUT

4.2.2.1 Building Plans

Engineering drawings of the storage structures (HSM and DSC) have been developed and are maintained in accordance with the Quality Assurance Program described in Chapter 11.

4.2.2.2 Building Sections

Engineering drawings of the storage structures (HSM and DSC) have been developed and are maintained in accordance with the Quality Assurance Program described in Chapter 11.

4.2.2.3 Confinement Features

Radioactive particulate matter and gaseous fission products are confined within the DSC. The containment features of the DSC are fully described in the NUHOMS-24P Topical Report (Reference 4.1). The integrity of the Calvert Cliffs ISFSI DSCs is tested using a helium leak test. The acceptance criterion for the test is specified in the Technical Specifications.

4.2.3 INDIVIDUAL UNIT DESCRIPTION

4.2.3.1 Horizontal Storage Module Description

The HSM provides structural support for the DSC, protects the DSC against extreme natural hazards such as tornado missiles, and provides radiation shielding. The concrete walls form interconnected sub-units of modules which are six wide and two back-to-back to form a 2x6 array. The modules are designed to provide surface dose rates at or below the design criteria of 20 mrem/hr on the HSM side and 100 mrem/hr at the HSM door. The HSM array sizes selected are in compliance with the array size criteria discussed in Section 4.2.3.2 of Reference 4.1.

The HSM dissipates decay heat from the spent fuel by a combination of radiation, conduction, and convection. Natural convection air flow enters at the bottom of the HSM, circulates around the DSC, and exits through the flow channels in the HSM roof slab. A thermal radiation shield is used to reduce the HSM roof temperature to within acceptable limits for all conditions.

Two thermal considerations form the basis for the HSM design: maximum concrete temperatures and maximum fuel cladding temperatures. All concrete temperatures are within the limits set by ACI-349 except for the blocked vents case in which the concrete temperatures exceed the applicable ACI-349 limits but are the same as, or less than, the temperatures reported and accepted in Reference 4.1. The maximum fuel cladding temperatures are below the cladding temperature limit described in Chapter 3. The thermal analysis of the HSM, described in Sections 8.1.3 and 12.8, indicates that all temperatures will remain within acceptable limits under all conditions, including the blocked vent case, for at least 36 hours. The inspection interval for the HSM air inlets has therefore been specified in the Technical Specifications as every 24 hours.

The design of the HSM system includes consideration of both normal and off-normal operating conditions including a range of postulated and hypothetical accidents. The HSM design and analysis for the Calvert Cliffs ISFSI were performed in accordance with Chapters 3, 8, and 12 and Reference 4.1. The design calculations for the reinforced concrete are specific for the Calvert Cliffs ISFSI, and support the design as presented on the drawings. These calculations form the basis for reducing the amount of reinforcing steel in the HSM compared to the topical report design.

The approach slab in front of the HSMs is constructed separately from the HSM foundations. The transfer system is designed to accommodate any credible differential settling between the two slabs. The approach slab and HSM foundation have been designed to minimize differential settlement over the life of the facility.

4.2.3.2 Dry Shielded Canister Description

The DSC provides mechanical confinement of the stored fuel assemblies and all radioactive materials for two purposes: to prevent the dispersion of particulate or gaseous radionuclides from the fuel, and to maintain a barrier of helium around the fuel in order to mitigate corrosion of the fuel cladding and prevent expansive oxides from forming in the fuel itself.

Another function of the DSC is to provide for criticality safety during the wet loading operations and during the DSC drying operations. A detailed discussion of the criticality analyses is included in Sections 3.3.4 and 12.3.3.4.

The DSC provides radiological shielding in both axial directions. The top shield plug serves to protect operating personnel during the DSC drying and sealing operations. The bottom end shielding reduces HSM door area dose rates during storage. The DSC shielding is designed for a maximum contact dose of 100 mrem/hr (flooded cavity).

The DSC is designed to slide from the transfer cask into the HSM and back without undue galling, scratching, gouging, or other damage to the sliding surfaces. This is accomplished by the addition of Nitronic 60 hard sliding rails to the transfer cask and HSM. The HSM and cask rails are coated with dry film lubricants.

The DSC provides physical protection and structural support of the spent fuel during loading operations and during storage. The DSC is designed so that the worst-case postulated accidents will not result in deformation of the basket or the DSC shell to such a degree that post-accident removal of intact fuel assemblies is prohibited.

Calvert Cliffs Nuclear Power Plant implemented use of a modified DSC design for DSC R025 through R048. Design changes were made to the internal basket assembly in order to better accommodate the effects of postulated cask drop accidents. The modified DSC internal basket assembly design closely resembles the original design. The notable difference is with the modified DSC, the guide sleeves are not attached to any spacer disc. Refer to the DSC analysis and internal basket analysis in Chapter 8 for further discussion.

4.3 AUXILIARY SYSTEMS

The ISFSI is a self-contained, passive storage facility which requires no auxiliary systems.

4.3.1 VENTILATION AND OFF-GAS

Spent fuel confined in storage at the ISFSI is cooled by conduction and radiation within the DSC, and conduction, convection, and radiation from the DSC surface. An air inlet near the bottom of the HSM front wall and outlets in the HSM roof allow convective cooling by natural circulation. The driving force for this ventilation system is described in Section 8.1.3. No auxiliary ventilation is used or required at the ISFSI. Fuel loading and DSC closure operations take place in the plant's Auxiliary Building and make use of the ventilation system in that facility. Auxiliary Building ventilation is discussed in Section 9.8.2.3 of Reference 4.2.

The Vacuum Drying System provides a means for removing water and water vapor from the DSC and for backfilling the DSC with helium. This function is required to ensure that fuel is stored in an inert atmosphere, to take advantage of the favorable heat transfer properties of helium, and to ensure the long-term maintenance of the fuel clad integrity.

The Vacuum Drying System is designed to operate in four modes: liquid removal by pump, liquid removal by a source of pressurized helium, nitrogen or air, vacuum drying, and helium backfill. The evacuation is performed in several stages to allow the DSC pressure to stabilize. When the pressure can be held at 3 torr for at least 30 minutes, this indicates that all liquid water has evaporated in the DSC cavity, and that the resulting inventory of oxidizing gases is less than 0.25% (Vol%). The cavity is then backfilled with helium. After again pumping the cavity down to 3 torr, a final helium backfill is made and the DSC is sealed. This process further reduces the partial pressure of any water vapor still present in the DSC.

4.3.2 ELECTRICAL

No electrical systems are required for the HSM or DSC during long-term storage, other than for lighting and security system power. Electrical power is used during DSC closure operations in the plant's Auxiliary Building and during DSC transfer operations to the HSM at the ISFSI. The required electrical power in the Auxiliary Building is obtained from the existing plant system. Power at the ISFSI is supplied from the site power distribution system which is powered from 11 and/or 21 13 kV plant busses.

4.3.3 AIR SUPPLY

Compressed helium or filtered plant air is used to force water from the DSC during closure operations.

4.3.4 STEAM SUPPLY AND DISTRIBUTION

There are no steam systems required.

4.3.5 WATER SUPPLY

Borated water is used to fill the DSC cavity prior to insertion into the spent fuel pool. The water source is compatible with the plant's existing spent fuel pool. The source of supply may be the pool itself. Demineralized water is needed for filling the DSC/cask annulus, and for washdown operations. This water is supplied by the existing Auxiliary Building demineralized water supply.

4.3.6 SEWAGE TREATMENT

No sewage treatment system is required for the ISFSI.

4.3.7 COMMUNICATIONS AND ALARM

No communication systems are required for the safe operation of the ISFSI. The existing plant page and telephone system has been extended to the ISFSI for convenience during transfer operations.

Security alarm systems are described in Reference 4.3.

4.3.8 FIRE PROTECTION

No fire detection or suppression system is required at the ISFSI, since no combustible materials are present within the ISFSI controlled area boundary. Response to a forest fire in the vicinity of the ISFSI is provided by Calvert Cliffs Nuclear Power Plant personnel, using portable fire suppression equipment. Off-site fire fighting equipment and personnel are also available, if needed.

4.3.9 MAINTENANCE

The NUHOMS system is designed to be totally passive with minimal maintenance requirements. During fuel storage, the system only requires visual inspection of the air inlets once every 24 hours to ensure that no blockage has occurred.

The transfer cask is designed to require only minimal maintenance. Transfer cask maintenance is limited to periodic inspection of critical components and replacement of damaged or non-functioning components. A detailed discussion of these requirements is provided in Section 4.5.

4.3.10 COLD CHEMICAL

There are no cold chemical systems at the ISFSI.

4.3.11 AIR SAMPLING

No air sampling systems are required at the ISFSI. Airborne activity during fuel loading and DSC closure operations is monitored by the existing Auxiliary Building ventilation and radiological detection systems.

4.4 DECONTAMINATION SYSTEMS

4.4.1 EQUIPMENT DECONTAMINATION

No equipment decontamination facilities will be needed at the ISFSI.

Within the Auxiliary Building, decontamination of equipment is required for the transfer cask and yoke exterior surfaces, the top surface of the DSC shield plug, and for tools which may become contaminated during DSC drying and sealing operations.

Decontamination of the transfer cask exterior after removal from the spent fuel pool is performed in the Auxiliary Building Cask Washdown Pit. The transfer cask is manually decontaminated using detergents and wiping cloths before removal from the Auxiliary Building. The DSC top shield plug is decontaminated in the same manner prior to being seal welded to the DSC body.

It is not anticipated that either the exterior of the DSC or the inside of the transfer cask will become contaminated. The DSC/transfer cask annulus is filled with demineralized water and sealed with an inflatable seal. However, in the event that such contamination occurs, the DSC/transfer cask annulus will be flushed with demineralized water or the DSC/cask surfaces decontaminated by other suitable means until an acceptable level of contamination is achieved.

Contaminated tools will be cleaned using existing plant procedures and facilities.

4.4.2 PERSONNEL DECONTAMINATION

No personnel decontamination facilities are needed at the ISFSI. Personnel decontamination in the Auxiliary Building, if necessary, is accomplished using existing plant equipment and procedures.

4.5 TRANSFER CASK REPAIR AND MAINTENANCE

Since the transfer cask utilizes a solid neutron shield, no periodic maintenance other than a visual inspection is anticipated. The transfer cask and trailer will not be stored at the ISFSI when not in use, but will normally be stored in the Equipment Storage Building near the ISFSI. Repairs, if needed, will be performed in the Equipment Storage Building, a low-level radioactive waste processing and storage facility, or in the plant's Auxiliary Building, using existing plant equipment, personnel, and procedures.

4.6 CATHODIC PROTECTION

No cathodic protection is required for the ISFSI.

4.7 FUEL HANDLING OPERATION SYSTEMS

Fuel handling at the Calvert Cliffs ISFSI is performed in two general locations. Individual fuel assemblies are loaded into the DSC in the plant's Auxiliary Building. Once in the DSC, the fuel is transported to the ISFSI and loaded into the HSM. Fuel handling activities inside the Auxiliary Building are performed under the plant's 10 CFR Part 50 license. Fuel handling operations outside the Auxiliary Building are performed under the 10 CFR Part 72 license. Fuel handling operation systems in the Auxiliary Building include:

A. Spent Fuel Cask Handling Crane
B. Spent fuel handling machine
C. Transfer cask and lifting yoke

The fuel handling operation systems outside the Auxiliary Building include the equipment required to transport the DSC to the HSM and insert the DSC into the HSM. These are the:

A. Transfer cask
B. Transfer trailer and skid
C. Skid Positioning System (SPS)
D. Hydraulic Ram System (HRS)

4.7.1 STRUCTURAL SPECIFICATIONS

The Spent Fuel Cask Handling Crane and spent fuel handling machine are described in Section 9.7 of the Calvert Cliffs Nuclear Power Plant Updated Final Safety Analysis Report. The bases and engineering design for the transfer cask are described in Section 4.7.4.1.

4.7.2 INSTALLATION LAYOUT

Fuel handling operations will occur within the existing Auxiliary Building. Figures 1-5 through 1-16 of Reference 4.2 show applicable plans and sections. Confinement features of the Auxiliary Building relate to ventilation systems and are described in Section 9.8 of Reference 4.2.

4.7.3 INDIVIDUAL UNIT DESCRIPTION

4.7.3.1 Cask Handling Crane

The Spent Fuel Cask Handling Crane will be used for all DSC and transfer cask movements within the Auxiliary Building. This crane meets the single-failure-proof criteria of NUREG-0554 and NUREG-0612.

4.7.3.2 Spent Fuel Handling Machine

The spent fuel handling machine will be used to load spent fuel assemblies into the DSC.

4.7.3.3 Transfer Cask

The transfer cask is a cylindrical vessel with a bottom end closure assembly and a bolted top cover plate. This cask is shown in Figure 4.7-1. 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 pressure vessel with a solid neutron absorbing material poured between the structural shell and outer shell 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 water-tight, bolted cover plate, with a core of solid neutron absorbing material, is used for transfer operation within the Auxiliary Building. The bolted ram access penetration cover plate assembly is replaced by a two-piece neutron shield plug assembly for transfer operations from/to the Auxiliary Building to/from the HSM (not shown in Figure 4.7-1). At the HSM site, the inner shield plug of the neutron shield plug assembly is removed to provide access for the ram/grapple to push/pull the DSC to/from the HSM.

The top cover plate is bolted to the top flange of the cask during transport from/to the Auxiliary Building to/from 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 in the Auxiliary Building. Two lower trunnions, located near the base of the cask, serve as the axis of rotation during downending/uprighting operations and as supports during transport to/from the ISFSI.

The use of a solid neutron shield is a departure from the transfer cask design described in Reference 4.1. The material selected for use as a neutron shield is BISCo Products NS-3, a shop castable, fire resistant material with a high hydrogen content. It is designed for use in shielding doors, hatches, plugs, and other nuclear applications. The solid neutron shielding material used in the cask outer annulus, top and bottom covers, and temporary shield plug, produces water vapor and a small quantity of non-condensable gases when heated above 212°F. The off-gassing produces an internal pressure which increases with temperature. As the temperature is reduced, the off-gas products are reabsorbed into the matrix, and the pressure returns to atmospheric. The annular neutron shield containment is designed for an internal pressure of 95 psig and the bottom neutron shield containment is designed for an internal pressure of 45 psig.

On an extreme ambient day with a design basis heat load, the maximum NS-3 steady state temperature is conservatively calculated to be approximately 300°F. This temperature, assumed to exist throughout the entire shield, would result in an internal cavity pressure of 60 psig. Although this pressure is well within the design allowable value for the neutron shield, pre-set safety relief valves are included to protect the neutron shield cover in the event that its design pressure is exceeded. The relief valves are set at 95 psig and 40 psig, respectively, for the annular and bottom neutron shield covers. The release of off-gas products (water vapor) does not affect the predicted neutron doses since the hydrogen content assumed in the shielding analysis is 4.38 w/o. This compares with the manufacturer's guaranteed minimum hydrogen content of 4.85 w/o and actual test samples values of as-delivered product which average about 5.1 w/o (Reference 4.5).

The basis for the relief valve setpoint values is that the design pressures for the annulus and bottom shield are 95 psig and 45 psig, respectively. These cavities are tested during fabrication to pressures of 100 psig and 50 psig, respectively. Redundant relief valves are provided in each shield for additional safety margin. The transfer cask top lid neutron shield does not require safety relief valves (SRVs) as there are three 1/2" diameter holes open to atmosphere. The relief capacity of the transfer cask neutron shield SRVs is 80.55 scfm air @ 70°F for design pressure = 100 psig and 45.44 scfm air @ 70°F for design pressure = 50 psig.

Steady-state calculations for the extreme ambient day conditions of temperature and solar heat load assume continuous exposure to 103°F ambient. Lying horizontally, the top half of the transfer cask is assumed to receive a heat flux due to insolation of 127°Btu/hr-ft^2. The resulting mass average bulk temperature of the NS-3 in the neutron shield of the transfer cask is 277°F.

The design pressures are based on tests performed by Bisco on sealed NS-3 samples. These tests show that the maximum pressure in the neutron shield annulus will be 45 psig at an NS-3 bulk temperature of 278°F. Similarly the maximum pressure of NS-3 in the transfer cask bottom neutron shield will be 15 psig, based on an NS-3 bulk temperature of 225°F. The setpoints of both SRVs have sufficient margin so that off-gassing of NS-3 is not expected to cause the SRVs to activate even under the worst design basis conditions. Test data further showed that the off-gassing of NS-3 causes very slow pressure buildup in the sealed NS-3 samples, so the relief capacity of the transfer cask neutron shield SRVs will not be exceeded in the unlikely event of SRV actuations.

The mixing and placement of NS-3 material is controlled by the cask fabricator under the direction of Bisco Products, Inc. The hydrogen content is assured by taking samples from each batch of material prior to shipment and by taking specific gravity samples of each batch after it is mixed and before it is poured. The absence of voids is controlled by geometry of the cask neutron shield design and by the orientation of the cask during the pour to ensure that no air pockets are trapped by the NS-3 as it fills each cavity into which it is poured. Specific procedures to prevent this are developed by the cask fabricator in conjunction with Bisco and Transnuclear West.

Although the loss of this solid shield is highly unlikely, each loss of neutron shield accident case presented in Section 8.2.5.3 of Reference 4.1 has been performed for the Calvert Cliffs transfer cask design. The transfer cask is designed to provide adequate shielding to maintain the maximum radiation surface dose to less than 5 R/hr combined gamma and neutron for a cask drop accident event with loss of neutron shielding.

The neutron shield cavity has 16 support angles which form a 45° angle with the transfer cask structural liner and the outer neutron shield panel. The 45° angle of the stand-offs minimize neutron streaming through the 16 support angles. The neutron and gamma dose rates on the outside transfer cask side surface are approximately the same. Any increase in neutron dose due to streaming through these support angles will be offset by a similar decrease in gamma dose thereby keeping approximately the same total dose on the transfer cask surface.

The effect of hot spots in the NS-3 region will not be a problem because maximum pressure in the NS-3 layer is 45 psig corresponding to the maximum average temperature of 280°F. The setpoint of the transfer cask SRVs is 95 psig in the neutron shield annulus. So there is considerable margin in the pressure relief capacity of the neutron shield cavity to accommodate any possible increase in the maximum pressure in the NS-3 region due to hot spots.

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

4.7.3.4 Transfer Cask Lifting Yoke

The lifting yoke is a special lifting device which provides the means for performing all cask handling operations within the plant's Auxiliary Building. It is designed to support a loaded transfer cask weighing up to 109.25 tons. A lifting pin connects the Spent Fuel Cask Handling Crane hook and the lifting yoke. The lifting yoke is shown in Figure 4.7-2.

The lifting yoke is designated safety-related since it is in the direct load path of the cask. The codes and standards used to design and fabricate the lifting yoke are presented in Section 4.7.4.

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. It is designed to be compatible with the Spent Fuel Cask Handling Crane hook and load block. 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.

4.7.3.5 Transfer Trailer

The transfer trailer is designed for use with the ISFSI Transfer System. Its function is to move the transfer cask and cask skid from the Auxiliary Building to the ISFSI location. Once there, the trailer is jacked 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 (Figure 1.3-3). The codes and standards governing the design and construction of the trailer are provided in Section 4.7.4.

The loading sequence for the transfer cask is shown in Figure 4.7-4 where it is illustrated that the cask is never lifted above the maximum drop height of 80” after it is loaded onto the cask skid. The transfer trailer and other transfer equipment are shown in their configuration at the HSM in

Figure 4.7-5. The trailer itself is considered not important to safety since its failure would not result in a cask drop exceeding the cases evaluated in Chapters 8 or 12.

The trailer is configured as a 4x2 dolly. Eight hydraulic suspensions carry four pneumatic tires each and are located two wide, in four axle lines. There are a total of 32 tires. 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 or repair of failed suspensions or tires, and automatic compensation for road surface irregularities. The trailer has all-wheel braking using industrial grade air/spring brakes.

The trailer deck height is adjustable from 35" to 52" using the trailer suspension hydraulics (transport configuration). When the trailer is resting on its hydraulic jack feet (docking configuration), the deck height is adjustable from 35.11" to 44.80" using the hydraulic jack cylinders. The distance from the trailer deck elevation to the top of the skid pad bearing plates is fixed at 5.81".

The fully raised elevation of the skid pad bearing plates is therefore 57.81" in the transport mode and 50.61" in the docking mode.

The trailer is pulled by a drawbar steering unit which is connected to the wheel groups by mechanical linkages. A hydraulic cylinder provides the motive force for remote manual steering of the trailer. The trailer may also be steered manually using a remote steering control located on a pendant. This feature allows precise control as the trailer is backed up to the HSM. The pendant allows the operator the freedom to observe the trailer from the side and also reduces the operational exposure by increasing operator distance and reducing operating time.

4.7.3.6 Skid Positioning System

The functions of the SPS are to hold the cask skid stationary (with respect to the transport trailer) during cask loading and transport, and to provide alignment between the transfer cask and the HSM prior to insertion or withdrawal of the DSC. It is composed of tie down or travel lock brackets, bolts, three hydraulically powered horizontal positioning modules, four hydraulic lifting jacks, and a remotely located hydraulic supply and control skid. The SPS hardware located on the transport trailer is illustrated in Figure 4.7-6.

The codes and standards governing the design and construction of the SPS are provided in Section 4.7.4. 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 Chapters 8 or 12.

The skid tie-down brackets are shown in Figure 4.7-7. The brackets were designed to withstand the design basis loads for the skid which are described in Chapters 8 or 12.

The hydraulic jacks are designed to support the transfer cask setdown load, and the loads applied to them during HSM loading and unloading. They are utilized at two locations: in the Auxiliary Building 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 will be 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.

Three 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 modules 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. The alignment is verified using commercially available optical survey equipment.

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. Steel boxes on the skid 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, the boxes will protect the skid from excessive travel.

The hydraulic power supply and controls for the SPS are located on a skid which is normally stored on the hydraulic ram utility trailer. The hydraulic pump is powered by an electric motor. Directional metering valves are used to allow precise control of cylinder motion. 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. Fourteen small hydraulic quick connect lines provide power to the seven SPS hydraulic cylinders.

The vertical distance from the transfer cask upper trunnion centerline to the top of the skid pad bearing plates is 58.12".

The maximum cask centerline height therefore occurs in the transport configuration and is 57.81" + 58.12" = 115.93". The maximum potential drop height in this configuration is therefore 115.93" - 44.50" (the transfer cask outer radius) = 71.43".

In the docking configuration, the transfer cask centerline can be raised to 50.61" (refer to question 3.0-20) + 58.12" = 108.73" which gives a design margin of about 6" over the HSM centerline height of 102.00" for concrete slope or irregularities.

4.7.3.7 Hydraulic Ram System

The HRS provides the motive force for transferring the DSC between the HSM and the transfer cask (Figure 1.3-5). Since operation of the HRS cannot result in damage to the fuel inside the DSC, it is considered not important to safety. The codes and standards used in the design of the HRS are listed in Section 4.7.4.

The HRS includes the following main subcomponents: one single-stage hydraulic cylinder; one grapple assembly; one hydraulic power unit; one ram/cask support frame assembly; one tripod support assembly; hydraulic hoses and fittings; one hose reel; all necessary appurtenances, pressure limiting devices and controls for the system operation; and, one light duty trailer (for transport and storage of all HRS equipment).

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 is designed to apply pushing and pulling forces of 20,000 pounds during normal operation. The HRS and all other components of the transfer system are conservatively designed for off-normal pushing and pulling loads of up to 80,000 pounds.

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 front of the ram hydraulic cylinder is aligned using a ram trunnion support assembly, and the rear of the ram is aligned using an adjustable tripod assembly.

The ram hydraulic power unit and controls are designed to provide the range of flows and pressures as required to push or pull the DSC under normal to maximum load conditions at safe design speeds. All controls are mounted in one trailer-mounted control panel. Safety features of the control system are included 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 HRS.

The equipment safety concerns are addressed using a relatively simple control system and comprehensive operational procedures. 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 verify that design force limits are not exceeded.

Components defined in Reference 4.1 as important to safety are those which provide containment of the fuel or biological shielding to the public and plant personnel. The components are required to be constructed according to stringent codes under a quality assurance program commensurate with the importance of their functions. The hydraulic ram does not fall into this category, but has a secondary impact on system operational safety, similar in function to the tractor which tows the trailer from the fuel building to the ISFSI.

Nonetheless, safe DSC insertion and retrieval is the primary design objective of the HRS. The force applied to the ram is under the direct control of the ram operator and is regulated by a pressure-compensated flow control valve. The ram speed is similarly controlled. The ram force available to the operator is limited by two sets of factory set and sealed relief valves which control the maximum hydraulic pressure which can be applied to the ram in both extend and retract modes.

4.7.3.8 Ram Trunnion Support Frame

As shown in Figure 1.3-5, the ram trunnion support frame is a light weight AISC structural steel frame fabricated from tube steel and plate. The frame is bolted to tapped holes located in the transfer cask bottom flange, and the hydraulic ram front trunnions are mounted into pillow blocks located on the frame. All hydraulic ram push/pull loads are transmitted into this frame directly to the base of the transfer cask, through the cask to the cask restraint system and into the HSM front wall.

4.7.3.9 Cask Support Skid

The cask support skid is a structural steel frame fabricated from standard American Society for Testing and Materials A36 wide flange members, built up box beam cross-members and trunnion support towers. The cask support skid, shown in Figure 1.3-4, is designed according to the AISC code for its operating loads. The cask support skid is rigidly attached to the transfer trailer by four bolted brackets during transfer from the Auxiliary Building to the ISFSI. 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 four Lubrite spherical bearing pads located on the trailer 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 and Spent Fuel Cask Handling Crane are then used to lower the upper trunnions into the rear trunnion supports. The yoke is then removed and the trunnion and capture plates are installed.

Several changes to the generic NUHOMS-24P design neutron shielding were required in order to accommodate the higher neutron source term. The changes to neutron shield thicknesses are summarized in Table 4.1-1. Other changes to the shielding design thicknesses were also made as indicated in the CCNPP ISFSI SAR.

4.7.4 TRANSFER EQUIPMENT

Applicable sections of 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 (B&PV) Code, Section III, Division 1, Subsection NC "Class 2 Components," 1983 Edition through Winter I985 Addenda used as a guide for design and fabrication. An N-stamp is not required.

B. ASME (B&PV) Code, Section III, Division 1, Appendices

C. ANSI N14.6-1978 "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. American Welding Society D1.1-88, "Structural Welding Code - Steel"

H. Steel Structures Painting Council (Standards)

I. Electric Power Research Institute NP-4830, "Comparison of Pad Hardness Study with Drop Test Results"

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

4.7.4.2 Transfer System Equipment

A. AISC, "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. ANSI (Standards)

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

TABLE 4.1-1
GENERIC NUHOMS-24P DESIGN NEUTRON SHIELDING

Neutron Shield		NUHOMS-24P Generic Design	CCNPP NUHOMS ISFSI Design
Component	Direction		
Transfer Cask	Top Axial	2.00" NS-3	3.00" NS-3
Transfer Cask	Bottom Axial	2.50" NS-3	3.50" NS-3
Transfer Cask	Radial	3.00" Water	4.00" NS-3
HSM	Door (Axial)	2.00" NS-3	10.75" Concrete[a]
HSM	Radial	36" Concrete	36" Concrete
DSC	All	None	None

(a) This HSM door design is an improvement of the one originally presented in the initial submittal of the CCNPP ISFSI SAR. Calvert Cliffs Nuclear Power Plant will revise the SAR to incorporate this design.

4.8 REFERENCES

4.1 Topical Report for the Nutech Horizontal Modular Storage System for Irradiated Nuclear Fuel, NUHOMS-24P, Nutech Engineers, Inc., NUH-002, Revision 1A, July 1989

4.2 Calvert Cliffs Nuclear Power Plant, Updated Final Safety Analysis Report, Docket Nos. 50-317 and 50-318, Baltimore Gas and Electric Company

4.3 Calvert Cliffs Independent Spent Fuel Storage Installation Security Plan, Baltimore Gas and Electric Company

4.5 Letter from Mr. G. C. Creel (BGE) to Director, Office of Nuclear Material Safety and Safeguards (NRC), dated December 20, 1990, Response to NRC's Comments on the Safety Analysis Report (SAR) for BGE's License Application for Calvert Cliffs Independent Spent Fuel Storage Installation (ISFSI)