11.7 INDEPENDENT ”Dry Fuel Storage”

11.7.1 Design Basis

Independent Dry Fuel Storage is necessary to provide temporary on-site spent fuel dry storage at Susquehanna Steam Electric Station (SSES). This storage capacity is required as a result of the unavailability of an off-site repository. The original plant design provided spent fuel storage capacity in the spent fuel pools based on the assumption the spent fuel would be continuously shipped off-site to a repository for disposal. The Independent Dry Fuel Storage system allows for the temporary storage of spent fuel without impacting plant operations.

The Independent Dry Fuel Storage system is composed of the Independent Spent Fuel Storage Installation (ISFSI) and the NUHOMS® Dry Spent Fuel Storage system. Although many portions of the ISFSI and NUHOMS® system are considered “Important to Safety”, only the Lifting Yoke is considered “Safety-Related”. No other component of the ISFSI and NUHOMS® system is considered “Safety-Related.”

The Dry Fuel Storage System implements the NUHOMS® Horizontal Modular Dry Storage Systems (NUHOMS® System) offered by Transnuclear (formerly Vectra Technologies) and the NUHOMS® ISFSI. The components which make up the Transnuclear NUHOMS® Dry Storage System conform to all requirements of:

1. 10CFR72 as documented in Transnuclear “NUH-003 – Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular System for Irradiated Nuclear Fuel” (known as the Certified Safety Analysis Report (CSAR),
2. USNRC “Safety Evaluation Report of Vectra Technologies Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel” (SER) and
3. USNRC “Certificate of Compliance for Dry Spent Fuel Storage Casks” Number 1004 (C of C).

The Dry Fuel Spent Storage System is constructed and operated in accordance with general license requirements of 10CFR72. The SSES Spent Fuel Storage Project 10CFR72.212 Evaluation demonstrates that the spent fuel transfer and storage process, equipment and facilities meet the conditions and the requirements of the C of C.

Codes and standards applicable to the ISFSI are listed in both Table 3.2-1 and Transnuclear CSAR (Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel” [NUH-003])

11.7.2 NUHOMS® Horizontal Modular Dry Storage System Description (NUHOMS® System)

The NUHOMS® Horizontal Modular Dry Storage System (NUHOMS® System) provides for horizontal, dry storage of canisterized spent fuel assemblies in a concrete storage module. Three canister models are utilized at SSES, the 52B, 61BT and 61BTH. Each canister is capable of housing either fifty-two or sixty-one spent fuel assemblies. The 61BT and 61BTH canisters are transportable and the 61BTH canister is capable of housing High Burnup Rate fuel. Each concrete storage module houses one canister. The main components of the

NUHOMS® System are the Independent Spent Fuel Storage Installation (ISFSI), Horizontal Storage Modules (HSM), Dry Shielded Canisters (DSC) and associated transfer/ auxiliary equipment. The ISFSI is comprised of HSMs (164 maximum), basemats, approach slabs, roads, fencing, drainage system, lighting, lightning protection and Temperature Monitoring System. The transfer equipment consists of an On-Site Transfer Cask (TC), Transfer Cask Lifting Yoke, Transfer Trailer and rigging assemblies. The transfer equipment interfaces with the existing SSES Reactor Building Refueling Floor equipment, Unit 1 Reactor Building Crane and overall plant infrastructure. The auxiliary equipment consists of the Vacuum Drying System, the Helium Leakage Testing System and the Automatic Welding System.

11.7.3 ISFSI Source Terms

11.7.3.1 Radiation Source Term

The neutron and gamma radiation sources include the BWR spent fuel, activated portions of the fuel assembly, and secondary gamma radiation. All sources, except secondary gamma radiation, are considered physically bound in the source region. Secondary gamma radiation is produced by radiation passing through shielding regions.

Spent fuel assemblies with various combinations of burnup, enrichment, and cooling times can be stored in the DSCs. The criteria for spent fuel assembly parameters for each DSC model is specified in the C of C. Spent fuel assemblies which meet these criteria are bounded by the source strengths used in the design analysis for the NUHOMS® System and meet the criteria established in 10CFR72.104.

11.7.3.2 Airborne Radioactive Material Source Term

The release of airborne radioactive material is addressed for three phases of NUHOMS® System operation: irradiated fuel handling in the Reactor Building Cask Storage Pit and Spent Fuel Storage Pools, drying and sealing of the DSC, and DSC transfer and storage.

Potential airborne releases from irradiated fuel assemblies in the Reactor Building Cask Storage Pit and Spent Fuel Storage Pools are discussed in Section 12.2.2.

DSC drying and sealing operations are performed using procedures which prohibit airborne leakage. During these operations, all vent lines are routed to the plant's existing radwaste systems. Once the DSC is dried and sealed, there are no design basis accidents which could result in the release of airborne radioactivity.

During transfer of the sealed DSC and subsequent storage in the HSM, the only postulated mechanism for the release of airborne radioactive material is the dispersion of non-fixed surface contamination on the DSC exterior. By filling the TC/DSC annulus with demineralized water, placing an inflatable seal over the annulus, and utilizing procedures which require examination of the annulus surfaces for smearable contamination, the contamination limits on the DSC are below the permissible level for off-site shipments of fuel. Therefore, there is no possibility of significant radionuclide release from the DSC exterior surface during transfer or storage.

11.7.4 Dry Shielded Canister (DSC)

The BWR Dry Shielded Canisters (DSCs) used to store spent fuel in the Horizontal Storage Modules (HSMs) at the ISFSI are designed to preclude or reduce the occurrence of uncontrolled releases of radioactive materials due to handling, transfer or storage of spent fuel.

The CSAR describes the principal design features and design parameters for the DSC. The cylindrical shell, and the top and bottom cover plate assemblies form the pressure retaining containment boundary for the spent fuel. The DSC is equipped with two shield plugs so that occupational dose at the ends is minimized during drying, sealing, and transfer operations.

The DSC has double, redundant seal welds that join the shell and the top and bottom covers to form the containment boundary. The bottom end assembly containment boundary welds are made during fabrication of the DSC. The top end assembly containment boundary welds are made after spent fuel loading. Both top plug penetrations (siphon and vent ports) are redundantly sealed after DSC drying operations are complete. This assures that no single failure of the DSC top or bottom end assemblies will breach the DSC containment boundary.

The internal basket assembly contains a storage position for each of the spent fuel assemblies. Fixed neutron absorbing material is used for criticality control in the DSC. Subcriticality during wet loading, drying, sealing, transfer and storage operations is maintained through the geometric separation of the fuel assemblies by the DSC basket assembly and the neutron absorbing capability of the DSC materials of construction.

11.7.5 Horizontal Storage Module (HSM)

Prefabricated Horizontal Storage Modules (HSMs) are utilized to form an array of HSMs at the ISFSI. Each HSM provides a self contained modular structure for storage of spent fuel in a single DSC. The CSAR describes the principal design features and design parameters for the HSM.

The HSM is constructed from precast reinforced concrete and contains a structural steel support for the DSC and heat shields. Adequate radiation shielding is accomplished by adding shield walls at each end of a row of HSMs and/or adding a shield wall at the rear of each HSM if configured as single row of HSMs.

The HSM provides a means of removing spent fuel decay heat by a combination of radiation, conduction, and convection. By design, ambient air enters the HSM through openings below the loaded DSC and exits through openings above the loaded DSC. The passive cooling system for the HSM is designed to assure that peak cladding temperatures during long term storage remain below acceptable limits to ensure fuel cladding integrity.

The HSMs are constructed on a load bearing foundation, which consists of a reinforced concrete basemat on compacted fill.

11.7.6 Transport Equipment

11.7.6.1 On-Site Transfer Cask

The On-Site Transfer Cask (TC) used in the NUHOMS® System provides shielding and protection from potential hazards while the DSC is loaded with spent fuel. The fully loaded TC has a gross weight of approximately 100 tons and is limited to on-site use under 10CFR72.

The TC is designed to provide sufficient shielding to ensure that dose rates are ALARA. Two lifting trunnions are provided for handling the TC in the Reactor Building using a Lifting Yoke and the Unit 1 Reactor Building Crane. Lower support trunnions are provided on the TC for pivoting the TC from/to the vertical and horizontal positions on the Transfer Trailer.

11.7.6.2. Transfer Trailer

The Transfer Trailer consists of a heavy haul industrial trailer, support skid assembly/positioning system and hydraulic ram. The Transfer Trailer is designed to ride as low to the ground as possible to ensure that the TC height during transport is less than the 80 inch drop height used as the accident drop design basis for the TC/DSC. A conventional heavy haul tractor or other suitable mover is used to tow the Transfer Trailer.

11.7.7 NUHOMS® System Operation

The primary operations (in sequence of occurrence) for the NUHOMS® System are described in the following sections:

11.7.7.1 On-Site Transfer Cask (TC) Preparation

TC preparation includes exterior washdown and interior decontamination. These operations are performed in the Steam Dryer and Separator Storage Pit.

11.7.7.2 Placement of DSC in Cask

The empty DSC is inserted into the TC ensuring proper alignment by visual inspection of the alignment match marks on the DSC and TC.

11.7.7.3 Fill TC/DSC Annulus with Water and Seal

The TC/DSC annulus is sealed prior to placement in the Cask Storage Pit to prevent contamination of the DSC outer surface.

11.7.7.4 TC Movement to the Cask Storage Pit

The TC/DSC is moved to the Cask Storage Pit using the Unit 1 Reactor Building Crane. Alternately, the Cask Storage Pit water level can be lowered for this process by installing the Cask Storage Pit Gates and draining the water from the Pit in accordance with procedures as described in Section 9.1.3.3.

11.7.7.5 DSC Spent Fuel Loading

Prior to transferring spent fuel, the Cask Storage Pit water level is maintained at normal level. Spent fuel assemblies are placed into the DSC using the Refueling Platform. Upon completion of 61BT or 61BTH DSC Spent Fuel loading, a hold down ring is installed. The 52B DSC does not require a hold down ring.

11.7.7.6 DSC Top Shield Plug Placement

This operation consists of placing the DSC top shield plug onto the DSC using the Unit 1 Reactor Building Crane.

11.7.7.7 Lifting TC from Cask Storage Pit

The loaded TC/DSC is moved to the Steam Dryer and Separator Storage Pit. Alternately, the Cask Storage Pit water level can be lowered for this process by installing the Cask Storage Pit Gates and draining the water from the pit in accordance with procedures as described in Section 9.1.3.3.

11.7.7.8 Inner DSC Top Cover Plate

Using a pump, the water level in the DSC is lowered below the inside surface of the DSC top shield plug. The inner top cover plate is put in place and welded.

11.7.7.9 DSC Drying and Backfilling

The initial blow-down of the DSC is accomplished by pressurizing the vent port with nitrogen, helium or shop air. The remaining liquid water in the DSC cavity is forced out the siphon tube and routed back to the pool or to the plant radwaste processing system. For the 52B, the DSC is then evacuated to remove any residual liquid water and water vapor in the DSC. The DSC is backfilled with helium and slightly pressurized. A helium leak test of the inner seal weld is then performed and the drain and fill port penetrations seal welded closed.

11.7.7.10 Outer DSC Top Cover Plate

The DSC outer top cover plate is installed and welded. For the 61BT or 61BTH, the DSC is then backfilled with helium and slightly pressurized. A helium leak test of the inner seal weld is then performed and the drain and fill part penetrations seal welded closed.

11.7.7.11 TC/DSC Annulus Draining and Top Cover Plate Placement

The TC is drained, removing the water from the TC/DSC annulus and flushing the TC/DSC annulus to remove any contamination left on the DSC exterior. The TC top cover plate is then put in place and bolted.

11.7.7.12 Placement of TC on Transfer Trailer

The TC is then moved to the Transfer Trailer using the Unit 1 Reactor Building Crane and downended to a horizontal position. The TC is secured to the Transfer Trailer for the subsequent transport operations.

11.7.7.13 Transport of TC to HSM

The Transfer Trailer is moved to the ISFSI along a predetermined route on plant roads. Upon entering the ISFSI, the Transfer Trailer is positioned and aligned with the HSM in which a DSC is to be stored.

11.7.7.14 TC/HSM Preparation

With the TC positioned in front of the HSM, the TC top cover plate is removed and the HSM door is removed. The Transfer Trailer is then backed into close proximity with the HSM and the skid positioning system is used for the final alignment and docking of the cask with the HSM.

11.7.7.15 Loading DSC into HSM

After final alignment of the Transfer Trailer with the HSM, the DSC is pushed into the HSM by the hydraulic ram.

11.7.7.16 Spent Fuel Storage

After the DSC is inside the HSM and the Transfer Trailer is pulled away, the HSM door is installed and the DSC axial retainer inserted.

11.7.7.17 Spent Fuel Retrieval

For retrieval of the DSC, the TC is positioned at the HSM and the DSC is transferred from the HSM by using the hydraulic ram to pull the DSC into the TC. Once back in the TC, the DSC with spent fuel assemblies is ready for return to the Spent Fuel Storage Pools.

11.7.8 Radiological Assessment

11.7.8.1 Introduction

The ISFSI is designed to limit off-site doses from the on-site storage of dry spent fuel to a fraction of the 40CFR190 limits for SSES, and on-site radiation exposure within the guidelines of 10CFR20 and 10CFR72. In all instances, the facility is designed to maintain dose rates ALARA as outlined in Regulatory Guides 8.8 and 8.10. Exposure of on-site workers is minimized by the use of concrete shielding, shielded transfer equipment, and controlled access to the ISFSI.

11.7.8.2 Dose

Compliance with Subpart K of 10CFR72 requires a written evaluation to demonstrate that the annual whole body, organ, and thyroid dose equivalent limits of 10CFR72.104 for an individual beyond the SSES Controlled Area are not exceeded as the result of the combined exposure to radiation from the storage of spent fuel on-site and all other nuclear fuel cycle contributors during normal operations. Evaluation shows that annual dose equivalents from the ISFSI and SSES operation are below the limits of 10CFR72.104 and that the maximum dose equivalent rates from the ISFSI and SSES operation are less than the 10CFR20.1301 limits for an Unrestricted Area when controlled in accordance with the SSES Dry Fuel Storage Project 10CFR72.212 Evaluation.

11.7.8.3 ISFSI Controlled Area

A design basis accident dose limit to the whole body, or to any organ for any individual beyond the nearest controlled area boundary of the ISFSI is established in 10CFR72.106. The ISFSI design/location ensures that the criteria of 10CFR72.106 are satisfied.

11.7.8.4 Fully Loaded ISFSI Dose Assessment

An analysis was performed to determine the expected annual dose to an individual as a result of operation of a fully loaded ISFSI (164 HSMs). Impacted personnel include operators performing daily surveillance of the HSMs and health physics personnel performing routine weekly surveys of the ISFSI. An analysis was performed to determine the exposure impact for a loading campaign. The analysis which is included in the SSES Dry Fuel Storage Project 10CFR72.212 Evaluation determined that the maximum annual dose for routine surveillance of the ISFSI and the estimated dose to perform a loading campaign remain within acceptable limits of the Radiological Protection Program.

11.7.9 Site Specific Evaluations

11.7.9.1 Average Ambient Air Temperature and Temperature Extremes

The average annual air temperature and air temperature extremes for the SSES are within the NUHOMS® System CSAR limits.

11.7.9.2 Earthquake Intensity/Seismic Acceleration

10CFR72 requires an evaluation be performed to establish that the cask storage pads and areas have been designed to adequately support the static load of the stored casks. A seismic evaluation has demonstrated that the design of the SSES ISFSI pad is adequate for all design basis loads for the HSM and DSC loading sequence and is adequate for the site specific loads at SSES due to a seismic event.

11.7.9.3 Flooding

The maximum water level at SSES, under the effects of probable maximum precipitation with coincident wind induced waves produces a flood level in the Susquehanna River that is well below the ISFSI elevation. The SSES ISFSI is not subject to flooding.

11.7.9.4 Tornado Wind Pressure and Missiles

The NUHOMS® System components are designed and analyzed to perform their intended functions under the extreme environmental and natural phenomena specified in 10CFR72. The HSMs are designed to withstand the design basis tornado generated missiles defined in 10CFR72 and the tornado missile loading specified by NUREG0800. Supplemental analysis has demonstrated that the HSM design is adequate to withstand all SSES tornado generated missiles. This evaluation also shows that the TC is structurally adequate to withstand the SSES tornado generated missiles.

11.7.9.5 Snow

The NUHOMS® System snow load capacity envelops the SSES site criteria for snow loads.

11.7.9.6 Lightning

The review of the SSES site for lightning damage was performed in accordance with the criteria of the National Fire Protection Association (NFPA) 780 “Standard for the Installation of Lightning Protection Systems, “formerly NFPA 78 "Lightning Protection Code." Lightning protection system is installed on the HSMs which meets code requirements.

11.7.9.7 Fire and Explosion

10CFR72 requires that the NUHOMS® System ISFSI be designed and located so that it can continue to perform its safety functions effectively under credible fire and explosion exposure conditions. The ISFSI is located away from other plant structures and protected by its own chain link fence.

The ISFSI is located near internal Protected Area roads where minimal, essential traffic is experienced. Some of this traffic involves occasional deliveries of materials such as propane and fuel within the Protected Area. Vehicles transiting the roads are continually attended so that any malfunction would be quickly mitigated.

The closest buildings are the Low Level Radwaste Holding Facility (LLRWHF) and the Central Alarm Station (CAS). These buildings are approximately 100 feet and 300 feet away respectively. The LLRWHF was designed and built to store low-level radwaste generated by SSES. Trucks are parked at the LLRWHF door for loading and unloading activities for a minimal time and are continually attended. Due to the distances between the ISFSI and LLRWHF and the minimal time any vehicle is at the LLRWHF, risk of fire or explosion is minimal. The CAS does not present a risk to the ISFSI. There are no hazards (e.g. compressed gases) in the vicinity that would pose an explosion concern to the ISFSI.

The design of the NUHOMS® System does not pose a fire or explosion hazard and provides protection against fire. The concrete and steel construction provides protection against any transient fire that would manage to start. The installed fencing along with the routine inspections of the area will keep any loose combustibles from accumulating in the area of the HSMs.

During the period when a transporter is in use within the storage area, controls will ensure that an attendant is present. Thus the attendant can notify the Control Room should any malfunction occur. The plant fire brigade will respond to the area upon notification of a fire. Manual fire suppression equipment is available for fighting a fire in the area.

The Hydrogen/Oxygen Tank Farm located near the South Gate house is along the transport path of the Transfer Trailer during transit from the Reactor Building to the ISFSI. Evaluation to determine the effects of a postulated accidental hydrogen explosion at the Hydrogen/Oxygen Tank Farm on the TC and Transfer Trailer indicated that the TC/Transfer Trailer are not compromised.

The above review of the NUHOMS® System shows that there is no credible fire or explosion exposure that would prevent the system from performing its function.

11.7.10 Heavy Loads

All lifting of TC or DSCs in the Reactor Building will utilize the Unit 1 Reactor Building Crane (single failure proof) with rigging/lifting mechanisms meeting the requirements of the SSES Heavy Loads Program and NUREG 0612. The Unit 1 Reactor Building Crane single failure proof certification is maintained via the SSES Preventative Maintenance Program.

11.7.11 Auxiliary Systems

11.7.11.1 Electrical Systems

Electrical power is required at the ISFSI for the lighting and for HSM Temperature Monitoring System.

11.7.11.2 Instrumentation

The Independent Spent Fuel Storage Installation contains a Temperature Monitoring System to continuously monitor the temperature of each HSM's concrete roof slab. HSM cooling relies on natural air circulation through the modules, therefore, the roof slab represents the hottest portion of the HSM concrete. Temperature monitoring provides a means to identify abnormal increases in temperature that could threaten proper HSM operation. The normal temperature range of the concrete at the temperature sensor(s) location is predicted in the range of 60° F to 240° F, based on age of contained fuel and ambient conditions.

The Temperature Monitoring System consists of one thermocouple per roof slab to provide a signal to a Data Acquisition based system capable of displaying and recording the concrete temperature for each HSM. A local temperature indicator (gauge) is also installed in each HSM to provide a backup in the event of a thermocouple or PLC/recorder failure. The Temperature Monitoring System provides the means of monitoring temperature to meet the requirements in the C of C Number 1004.

11.7.12 Dry Fuel Storage Aging Management Program (AMP)

Orano Certificates of Compliance (C of C) No. 1004, Revision 1, Renewed for Amendment 0, 4, 8, 9, and 10, and Renewed Amendment 14, direct development of an Aging Management Program for the Dry Fuel Storage System, specifically for the following areas:

- DSC External Surfaces Aging Management Program
- DSC Aging Management Program for the Effects of CISCC (Coastal Locations, Near Salted Roads, or in the Path of Effluent Downwind from the Cooling Tower(s)).
- HSM Aging Management Program for External and Internal Surfaces
- HSM Inlets and Outlets Ventilation Aging Management Program
- Transfer Cask Aging Management Program
- High Burnup Fuel Aging Management Program

This program was implemented within the 20-year period following initial loading on the ISFSI pad.

Areas addressed under 10 CFR Part 54, License Renewal Rule, are addressed in Chapter 3, Section 3.14.