SAFETY EVALUATION REPORT

for the

NORTH ANNA

INDEPENDENT SPENT FUEL STORAGE INSTALLATION

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1.0 INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

1.1 Introduction

This Safety Evaluation Report (SER) documents the U.S. Nuclear Regulatory Commission (NRC) staff's review and evaluation of the Technical Specifications (TS) and Safety Analysis Report (SAR) for the proposed North Anna Independent Spent Fuel Storage Installation (ISFSI). The North Anna ISFSI SAR and application for a 10 CFR Part 72 license under the provisions of 10 CFR 72.16 were filed by Virginia Electric and Power Company (Virginia Power) and Old Dominion Electric Cooperative (ODEC) on May 9, 1995, and were subsequently supplemented from time to time.

The applicants proposed to use a dry cask storage technology in which fuel from the North Anna Power Station (NAPS) facility will be stored in dry casks which, in turn, will be emplaced on a nearby concrete storage pad. The staff's review of the North Anna ISFSI SAR primarily addresses the safety aspects of cask handling and storage once the casks have left the NAPS Fuel and Decontamination Building. The staff evaluated the North Anna ISFSI SAR and license application against the applicable requirements of 10 CFR Part 72 for spent fuel storage and 10 CFR Part 20 for radiation protection. The staff also reviewed for informational purposes those aspects of the NAPS design and operation for transferring spent fuel from the operating reactor facility to the ISFSI. Design features and operations for fuel and cask handling within the NAPS facility are subject to NRC review under the provisions of the NAPS license which is issued pursuant to 10 CFR Part 50.

The applicant referenced the TN-32 cask designed by Transnuclear, Inc. as the cask it proposed to use at the North Anna ISFSI. The staff issued a safety evaluation (TN-32 SER) on the Transnuclear Topical Safety Analysis Report for the TN-32 cask design on November 7, 1996 (TN-32 SAR). The TN-32 is not currently included in 10 CFR 72.214 as approved for use under general license. However, as described in this safety evaluation and as conditioned in License Condition 9 of the North Anna ISFSI license, the TN-32 is approved for use at North Anna.

1.2 General Description of Installation

The ISFSI will be owned by the applicants and operated by Virginia Power for the purpose of storing spent nuclear fuel assemblies from NAPS Units 1 and 2. The NAPS spent fuel pool is expected to lose the capacity for single unit full core offload in 1998, and additional storage space is necessary for continued operation of NAPS. Virginia Power plans to load some of the older fuel assemblies in the spent fuel pool, which meet TS requirements, into the dry casks for storage at the ISFSI, thus creating additional pool space for future reactor off-loads. Together with the existing spent fuel pool, the ISFSI will provide the capacity to store all spent fuel expected to be generated by NAPS Units 1 and 2 during their currently licensed operating periods. The ISFSI will be licensed for an initial term of 20 years, with the possibility of renewal, as stated in 10 CFR 72.42. Storage at the ISFSI will be limited to spent fuel assemblies from the NAPS Units 1 and 2 and associated materials related to receipt, storage, and transfer where the spent fuel is in the form of uranium dioxide (UO_2) clad with zirconium or zirconium alloys as specified in License Conditions 6A and 7A.

The ISFSI is located southwest of NAPS, near the center of approximately 1043 acres comprising the North Anna site. The facility will consist of 3 reinforced concrete storage pads, each of which will be designed to store up to 28 loaded casks. The facility will thus have the capacity for up to 84 TN-32 casks. However, given that each of the TN-32 casks can hold 32 fuel assemblies from a pressurized water reactor, the facility needs only 57 casks to accommodate the 1824 assemblies expected to exceed the current capacity of the NAPS spent fuel pool.

Each fuel assembly contains approximately 0.46 metric tons of uranium (MTU). Based on the projected number of fuel assemblies to be stored and the uranium content of each assembly, the licensed capacity of the North Anna ISFSI is established at 839.04 MTU. The licensed capacity for the ISFSI is described in Condition 8A of the license. The first storage pad will be constructed in the near term while the second and third pads will be constructed as needed through the life of the ISFSI. The storage pads will be surrounded by a security fence and a perimeter fence. Electricity, provided by the NAPS service system, is the only utility service necessary for ISFSI operation. Electricity is used for lighting, instrumentation, and security features but is not required for any important-to-safety functions.

The dry storage casks used at the NAPS ISFSI will be right circular cylinders. The model proposed for use at NAPS, the TN-32, is approximately 16 feet high and 8 feet in diameter, and a single cask can hold 32 assemblies from a pressurized water reactor. The casks weigh nearly 125 tons when fully loaded. The spent fuel is stored in an inert helium gas environment, and baskets within the cask hold the fuel in place. For the TN-32, radiation shielding is provided by a steel shell approximately 20 centimeters (cm) thick, and a borated resin material 11 cm thick. No radioactive materials are released from the casks under any credible accident conditions.

The casks are loaded and prepared for storage inside the NAPS Fuel and Decontamination Buildings. Casks are loaded individually under water in the spent fuel pool, then a lid is placed on top and bolted in place. The water is then removed from the cask and, after lifting the cask from the pool, the interior is vacuum dried and backfilled with helium. After the cask exterior is decontaminated, the cask is carried to the ISFSI by a special transport vehicle. Casks are placed on the pads with approximately 8 feet spacing between outer surfaces.

A description of the ISFSI site location and the ISFSI storage features, including proposed use of the TN-32 cask, limit on storage capacity, and description of the ISFSI pad are included in TS 4.1 and 4.2. The staff concludes that these TS satisfy the requirement of 10 CFR 72.44(c)(4), Design Features.

1.3 Identification of Agents and Contractors

Virginia Power is responsible for the design, engineering, and operation of the North Anna ISFSI. Site preparation and construction will be performed by Virginia Power's Site Services Department, relying on specialty subcontractors as required. Virginia Power proposed to use the TN-32 storage cask designed by Transnuclear, Inc. Virginia Power will purchase these casks from one or more contractors, who fabricate the casks under the Virginia Power Quality Assurance Program.

1.4 Material Incorporated By Reference

Several documents docketed by the NRC support the safety analyses in the North Anna ISFSI SAR and are referenced therein. Among these, the NRC finds all of the following documents suitable for reference in the North Anna ISFSI SAR:

1. Transnuclear, Inc., "TN-32 Dry Storage Cask Topical Safety Analysis Report(TSAR)," Revision 9A, December 1996.

2. North Anna Power Station Units 1 and 2, Updated Final Safety Analysis Report (UFSAR), NRC dockets 50-338 and 50-339, July 20, 1982, as updated.

3. North Anna Power Station Units 1, 2, 3 and 4, Environmental Report, March 15, 1972.

4. Safety Evaluation Report - "TN-32 Dry Storage Cask Topical Safety Analysis Report," Revision 9", November 7, 1996.

5. Virginia Power Topical Report VEP-1-5A (Updated), Operational Quality Assurance Program Topical Report, submitted July 28, 1993, (approved by NRC on February 28, 1994).

1.5 Evaluation Findings and License Conditions

The NRC staff makes the following findings regarding the general description of the ISFSI:

F1.1 The types, state, condition, and aging of radioactive materials to be stored are described in Section 3.1.1 of the North Anna ISFSI SAR. These parameters comply with the limitations given in 10 CFR 72.2 for an ISFSI.

F1.2 The proposed duration of the license is for a fixed period of 20 years, which does not exceed the limit of 20 years for an ISFSI provided by 10 CFR 72.42.

2.0 SITE CHARACTERISTICS

NRC regulations in 10 CFR 72.24(a) require that each applicant for an ISFSI license provide a description and safety assessment of the proposed ISFSI site. The assessment is to include information regarding the design bases for external events as well as an evaluation of the potential for interactions with any co-located nuclear power plant. Detailed siting evaluation factors are specified in 10 CFR Part 72, Subpart E.

2.1 Site Description

2.1.1 Geography and Demography

The North Anna site is in Louisa County in north-central Virginia, approximately 40 miles north-northwest of Richmond. The site is on a peninsula on the southern shore of Lake Anna, a reservoir created by an earthen dam approximately 5 miles southeast of the site. The ISFSI is located approximately 2000 ft southwest of the NAPS protected area and within the boundaries of the North Anna site.

The topography in the site region is characteristic of the central Piedmont Plateau, with a gently undulating surface varying between 200 and 500 feet above sea level. The regional vegetation is agricultural fields interspersed with forests.

The North Anna site comprises approximately 1043 acres, excluding the portion of Lake Anna that falls within the site boundary. The ISFSI perimeter fence sections off approximately 11 acres within the site, although the ISFSI controlled area, required by 10 CFR 72.106(a), encompasses the entire 1043 acres within the site boundary. The minimum distance from the ISFSI to the controlled area boundary is approximately 2500 feet, much greater than the 100 m minimum required by 72.106(b). The area inside the ISFSI perimeter fence will be graded level, and drainage will be provided by channels to a small creek to the south and west. Therefore, only minimal erosion potential exists at the ISFSI. No trees will stand within the ISFSI perimeter, although existing forest will remain outside the ISFSI perimeter fence. Thus, the threat of forest fire within the ISFSI is minimal.

In 1990, the resident population within 10 miles of the North Anna site was about 11,900. Projected populations within the 10-mile radius for the years 2000, 2010, 2020, and 2030 are, respectively, 14,500, 16,500, 18,600, and 20,600. A detailed discussion of population, including transient population associated with Lake Anna State Park, is presented in the North Anna ISFSI Environmental Report which was attached to the May 9, 1995 license application.

2.1.2 Land and Water Use

The area within 5 miles of the North Anna site is largely rural and characterized by farmland and wooded tracts. Nearby Lake Anna State Park is used for a variety of recreational activities, such as camping, biking, and picnicking, in addition to boating on Lake Anna. Lake Anna is used for recreation, and downstream flood control, and as a source of cooling water for the NAPS.

Seven groundwater wells provide domestic water for the North Anna site. The closest well to the ISFSI site is approximately 1500 feet to the west. The closest offsite well is in a residential area approximately 3500 feet south of the site. A tributary to Sedges Creek, which lies between this well and the ISFSI, effectively serves as a hydrologic barrier preventing groundwater movement between the ISFSI and this well.

2.1.3 Nearby Industrial, Transportation, and Military Facilities

Aside from the NAPS, there are presently no industrial, transportation, or military facilities within 5 miles of the ISFSI site. This includes manufacturing plants, chemical plants and storage facilities, military bases, airports, major water transportation routes, or oil and gas pipelines. No expansion of industrial activity within 5 miles of the site is expected within the foreseeable future. There are no mining activities within 5 miles of the site.

The nearest rail main line passes approximately 5.5 miles from the ISFSI at its closest point of approach. A spur line connects the site to the main line.

US Route 522 and Virginia Route 208, both passing within 5 miles of the site, are the major transportation routes in the area, but no data exist on the types of materials transported over these roads. Virginia Route 700 ends at the NAPS site boundary, and all industrial materials transported on this road are either destined for or originating from the NAPS.

Three airports lie within 11 miles of the site, but they serve only light aircraft.

2.1.4 Hydrology

2.1.4.1 Surface Hydrology

The preeminent surface hydrologic feature is Lake Anna, created by an earthen dam across the North Anna River, 5 miles southeast of the site. The dam is the only control structure on the North Anna River. Lake Anna extends approximately 17 miles northwest, upstream from the dam. The lake and the NAPS waste heat treatment facility have a surface area over 13,000 acres and contain approximately 100 billion gallons of water.

The headwaters of the North Anna River are in the eastern slopes of the southwestern mountains in the Appalachian Range. The North Anna watershed above the dam is 343 square miles. Downstream of the Lake Anna dam, the North Anna River meets the South Anna River to form the Pamunkey River. Through 1997, the North Anna River had a stream gauge at the bridge where Route 601 crosses the river, about 0.5 miles downstream from the dam. Previously operating gauges were about 15 miles downstream from the dam at Doswell and Hart Corner, Virginia. Table 2.4-1 of the North Anna ISFSI SAR summarizes discharge data from these stations.

The Bear Island Paper Company, 26 miles downstream from the NAPS, is the sole industrial user of water below the Lake Anna dam. No other known industrial users draw from this water source until a paper manufacturing plant located 60 miles downstream from the NAPS, after the Pamunkey River merges with the Mattaponi River to form the York River. The only known potable water withdrawal from the North Anna River is the Hanover County treatment plant, located 24 miles downstream from the NAPS.

2.1.4.2 Subsurface Hydrology

The ISFSI site lies within a fairly limited groundwater domain, bounded by a Sedges Creek tributary on the south and west, the NAPS discharge canal on the east, and Lake Anna on the north. Figure 2.4-3 in the North Anna ISFSI SAR shows the installation in relation to these boundaries. The surface soil, largely saprolite, is a weathering product of the igneous and metamorphic rocks in the region, and the soil thickness ranges from 0 to 125 feet. Groundwater exists under water table conditions, with recharge by precipitation. Water infiltrating beneath the ISFSI site exits the ground as springs within this groundwater domain, or enters Lake Anna directly. Two permanent groundwater monitoring wells are installed down-gradient (south) of the ISFSI site, and one well is installed up-gradient (north). The up-gradient well has an average water table elevation of 296.3 feet above mean sea level, while the down-gradient wells have average elevations of 289.0 feet and 280.3 feet. These averages reflect only a 3 month period of measurement, so the readings may not capture some seasonal variation. The water table gradient to the southwest of the site is approximately 0.01 feet/foot, and the gradient to the southeast is approximately 0.02 feet/foot. Groundwater infiltrating beneath the ISFSI tends to migrate toward springs in the Sedges Creek tributary, and into Lake Anna.

Water for domestic use at the NAPS is taken from seven wells in the area. The nearest well is about 1500 feet west of the ISFSI site, outside the groundwater domain containing the site. The nearest offsite water well is in a residential area approximately 3500 feet across the Sedges Creek tributary and well outside the site's groundwater domain.

2.1.5 Meteorology

The regional climate of the site is essentially continental, with warm, humid summers and cool winters. Temperatures rarely exceed 95 °F or fall below 10 °F. Average annual rainfall is approximately 44 inches, and precipitation is distributed fairly evenly throughout the seasons. July and August have the highest average rainfall because of thunderstorm activity. Nearby Richmond, Virginia, averages 37 days per year with thunderstorms. Richmond averages 14.6 inches of snow per year, but snowfalls in excess of 4 inches occur once per year on average, and accumulations rarely remain more than several days. Tornadoes are infrequent in the region. The area within 50 miles of the site experiences less than one tornado per year on average. As described in Section 2.3.1.3.2 of the North Anna Updated Final Safety Analysis Report (UFSAR), the annual probability of a tornado striking a given point within the 50 mile radius of the site is 3.25×10^{-5}, which yields a recurrence interval of 30,800 years.

Temperature data for Richmond is considered to adequately represent conditions at the NAPS. The mean daily average temperature at Richmond has a minimum of 37 °F in January, and peaks at 89 °F in July. Richmond temperature extremes are 107 °F in 1918, and -12 °F in 1940. Frequency distributions of wind speed and horizontal and vertical atmospheric stability are presented in Tables 2.3-9, 2.3-10, and 2.3-11 of the NAPS UFSAR.

2.1.6 Geology and Seismology

The ISFSI site is enclosed within the NAPS site boundary, so regional geologic investigations performed and cited during the NAPS licensing process also apply to the ISFSI. The North Anna ISFSI SAR references this earlier work, as well as geologic investigations conducted since the reactors were licensed. The site lies within the Piedmont Plateau, which is characterized by undulating topography with as much as 100 feet of relief in the site area. The Piedmont Plateau is bounded by the Atlantic Coastal Plain, 15 miles east-southeast of the site, and by the Blue Ridge Province 40 miles to the northwest. Bedrock within the Piedmont is generally metasedimentary and metavolcanic, with some plutonic granitic rocks. The bedrock is typically weathered into a saprolitic cover up to 100 feet thick.

2.1.6.1 Geologic Setting of the Site and Surrounding Region

Lithologies in the site region include the Central Virginia Volcanic-Plutonic Belt, the Ta River and Po River Metamorphic Suites, and interlayered mafic and felsic metavolcanics. The volcanic-plutonic belt includes the Falmouth Intrusive Suite and the Quantico Formation. The Falmouth Suite is strictly igneous intrusives dated between 300 and 325 million years before present (Ma). The Ordovician Quantico Formation is largely slate and porphyroblastic schist, with metamorphic grade increasing to the southwest. The Cambrian Ta River Suite contains a variety of high-grade metamorphic rocks, including amphibolite, gneiss, quartzite, and schist. As with the Quantico Formation, the grade increases to the southwest. The Po River Suite, east of the Ta River Suite, is primarily gneiss and schist, with subsidiary pegmatoid and granitoid dikes. Stratigraphic relationships suggest that the Po River Suite appears to be Proterozoic Z or Early Paleozoic in age. Figure 2.5-1 in the North Anna ISFSI SAR shows the bedrock lithology of the ISFSI site. The site is within a unit mapped as an interbedded sequence of hornblende gneiss, biotite granite gneiss, and granite gneiss, part of the Ta River Metamorphic Suite.

The site is located within a portion of the eastern North American craton that has undergone extensive tectonic activity since Precambrian time. The region has experienced both compressional and extensional deformation, resulting in a complex pattern of folding and faulting in the bedrock. There are multiple models explaining the Paleozoic tectonic history of the region, as described in North Anna ISFSI SAR Section 2.5.1.3.2 and UFSAR Section 2.5.2.4. Most recently, the Late Triassic to Early Jurassic continental rifting created numerous down-faulted basins within the Piedmont and Coastal Plain from Connecticut to Georgia. The site is on the northwest flank of a northeasterly trending, gently north-plunging antiform. Boundaries between the lithologic units at the site were affected by flexural slip during Paleozoic compressional events, and deformation along one of these boundaries formed the Zone A Chlorite Seam studied thoroughly in 1973 during NAPS construction. Details on this investigation appear in UFSAR Section 2.5.2.4. Several recent borings were drilled at the ISFSI to explore the bedrock characteristics; the findings confirmed the interpretations made during initial NAPS site investigations and revealed no new structural features. North Anna ISFSI SAR Table 2.5-1 contains details on rock quality values from the borings, and the boring logs are in Appendix 2.5A.

2.1.6.2 Specific Structural Features of Significance

The closest fault to the site is approximately 6 miles west near the town of Mineral, Virginia. The fault has no surface expression. The known fault length is approximately 1000 feet, although projections indicate it could be as long as several miles, approaching within 4.5 miles of the site.

The Hylas zone, south-southeast of the site and 15 miles west of Richmond, is a group of mylonitic rocks produced by Late Paleozoic ductile shearing. At about 220 Ma, high-angle faulting was superimposed over the Hylas shear zone. This was synchronous with the Triassic rifting along the eastern seaboard.

The Spotsylvania lineament is a northeast-trending aeromagnetic anomaly separating the Ta River metamorphic suite to the west and the Po River metamorphic suite to the east. This lineament, approximately 10 miles southeast of the NAPS, is most likely a fault formed before or during the regional metamorphism. The lineament is directly on strike with the Stafford fault system, but it is not believed to be structurally related. The minimum age of any slip along the lineament is 100 Ma.

The Stafford fault system is a series of end echelon, high-angle reverse faults displacing both the Piedmont Paleozoic rocks and the overlying Coastal Plain sediments. The fault system strikes northeast, extending more than 33 miles along the Virginia Fall Line and the northeast-trending portion of the Potomac River. In Virginia, the system is aligned with the Spotsylvania magnetic lineament. The Stafford system makes its closest approach to the site 14 miles northeast, near Fredericksburg, Virginia. Slip along the fault system began in the Early Cretaceous, and offsets as young as Late Pliocene have been reported. However, a detailed mapping and trenching study in 1976 identified the youngest slip on the fault system as pre-mid-Miocene, so the system is not considered capable by the definition of Appendix A to 10 CFR Part 100.

The Mountain Run fault zone is a northeast-trending physiographic feature, taking the form of a fault scarp in the Unionville, Virginia quadrangle. The fault zone is thought to be a suture between a Cambrian island arc and its back-arc basin against ancestral North America. Some reactivation of this zone may have occurred as recently as post-Pliocene time.

Recently, a series of extensional faults were discovered in Giles County, Virginia, about 220 miles west-southwest of the site. Seismicity related to the Giles County fault zone is ongoing, although ground motion at the NAPS from this fault zone is extremely unlikely given the distance from the site.

2.1.6.3 Site Investigations

Eight borings were drilled at the ISFSI site; locations are shown in North Anna ISFSI SAR Figure 2.5-2. In addition, seven shallow borings were drilled along the transporter route to the ISFSI pad. Boring logs showing elevation and depth of samples, penetration resistances, soil stratum description and Uniform Classification, and groundwater data are contained in North Anna ISFSI SAR Appendix 2.5A. Several undisturbed soil samples were also collected for laboratory testing. Logs of wells drilled for groundwater monitoring are also contained in Appendix 2.5A. Rock core samples were collected below levels where soil boring equipment failed to advance. Boring logs in North Anna ISFSI SAR Table 2.5-1 contain the percentage of core recovery and rock quality designation values.

Geophysical surveys and studies were performed to evaluate bedrock structure and stratigraphy in the area before licensing the NAPS, and the results are summarized in UFSAR Section 2.5.

2.1.6.4 Geologic Profiles

The typical soil profile at the ISFSI site consists of surface clay minerals chemically weathered from feldspars, micas, and mafic minerals in the parent metamorphic rock. At depth these minerals become less weathered, retaining their inter-particle bonding. There is a gradual transition from fine-grained to more granular soils with depth. In addition, the boundary between soil and rock is transitional. Rock depth in the ISFSI borings, as defined by auger or spoon refusal, ranges from 245 feet to 272 feet in elevation. The bedrock encountered in the cores confirms the previous bedrock interpretations made in 1973. No slickensides have been observed on any fractures in retrieved core, suggesting an absence of fault slip in the immediate area. North Anna ISFSI SAR Figure 2.5-3 provides a profile of soil and rock stratigraphy across the site.

2.1.6.5 Engineering Properties of Soil and Rock

A variety of tests were performed on selected soil samples, and the results are found in North Anna ISFSI SAR Appendices 2.5A and 2.5B. Specifically, these include particle size analysis, Atterberg limits, natural moisture content, moisture density determination, California bearing ratio, consolidation test, triaxial shear test, unconfined compression test, and constant head permeability. The properties of the soil samples collected during ISFSI site investigation are very similar to those documented in the UFSAR from initial NAPS site investigations. No tests were performed on rock samples collected during ISFSI site characterization. The rock physical properties are not important to ISFSI stability, as the rock lies at least 30 feet below the surface, and the incremental load on the rock from the concrete pads and storage casks will be very small. No additional dynamic analyses were performed during ISFSI investigation, since the data from borings and laboratory tests are so similar to those gathered during construction of the dam and the NAPS. Dynamic soil and rock properties for the NAPS are in Section 2.5 of the UFSAR. A shear modulus of 19,800 psi and Poisson's ratio of 0.3 were used in the design of the storage pads.

2.1.6.6 Analysis Techniques and Calculated Results

The design minimum safety factor against a soil bearing capacity failure is 3.0. The factor of safety calculated for an ISFSI pad bearing on stiff residual soil is significantly greater than 3.0. Settlement estimates were derived from immediate elastic and long-term consolidation settlement of underlying residual soil. Such estimates have a record of inaccuracy when compared with actual measured subsidence, so calculations were performed using empirical equations as well. Given the results derived using the two methods, total pad settlement is estimated to be less than 1.5 inches under a full load. The estimate assumes no more than 5 feet of overburden will be removed before construction, whereas the actual overburden removed for the first pad may be as much as 10 feet (greater overburden removal equates with less settlement). The 1.5 inch estimate is also conservative in that it assumes the total load on the pad will be placed in a single increment, whereas casks will actually be placed incrementally over several years.

2.1.6.7 Vibratory Ground Motion

The NAPS is located in the north-central portion of the Piedmont Plateau, a northeast-trending belt of metamorphic rocks extending from Alabama to New Jersey. Earthquakes occur with less frequency in this province in comparison with the Blue Ridge and Valley and Ridge Provinces to the west. Within the Piedmont Plateau and the Coastal Plain Province to the east, seismic activity tends to cluster in three areas, including the South Carolina-Georgia region, the Fall Zone in the Delaware-New Jersey area, and central Virginia. The NAPS lies on the northern boundary of the central Virginia zone of activity. The majority of this activity lies in an east-west zone 30 miles south of the NAPS. Historically, the central Virginia seismic zone has experienced 2-10 events per decade, with most earthquakes having Modified Mercalli (MM) intensity between III and V. The largest historical earthquakes affecting the NAPS site were in 1774 near the Richmond Basin (MM intensity VI-VII) and in 1875 near the Arvonia Syncline (MM VII). The 1875 event likely caused ground motion at the NAPS site of MM intensity V, in other words ground motion adequate to break windows and cause fragile objects to fall. A complete description of the seismic history of the site area is in Appendix 2C of the UFSAR.

The fault zone underlying the NAPS reactor buildings is of limited extent, and it does not meet the criteria of a capable fault found in Appendix A of 10 CFR Part 100. An extensive micro-earthquake monitoring system was deployed in the Lake Anna area in the 1970s for the purpose of studying possible micro-earthquakes associated with this fault or the impoundment of Lake Anna. A reduced monitoring effort is ongoing, and no historic seismic activity can be shown to have any direct tectonic relationship to the fault zone underlying the NAPS site.

The design earthquake ground motion for the NAPS assumes that the largest historical earthquake associated with the Arvonia Syncline occurs close to the NAPS. Such a MM intensity VII event would cause a peak horizontal acceleration of 0.12 g at a rock surface. Amplification effects increase the design acceleration to 0.18 g at the surface of saprolite greater than 15 feet thick. Eight to ten pulses of strong ground motion is a conservative estimate for the design earthquake at the NAPS. Response spectra appear in Figures 2.5-11 through 2.5-14 in the UFSAR. Additional investigations and seismic data since the licensing of the NAPS reactors do not suggest any need to modify the original design earthquake ground accelerations for the site.

2.1.6.8 Surface Faulting

No evidence suggests that any of the historic earthquakes in the Piedmont Plateau or the entire Appalachian region have caused faulting at or near the surface.

2.1.6.9 Subsurface Stability

Earthen materials encountered at the NAPS were categorized into five zones on the bases of the general structural characteristics of each. Zone IIA saprolite appeared to contain zones of soil that were potentially liquefiable. Main plant structures were partially supported by the zone IIA saprolite and partially founded on sound rock or compacted granular backfill. According to the exploratory borings performed by Dames and Moore (D&M) in 1968, the average thickness of saprolite across the NAPS site was approximately 40 feet.

The applicant did not specifically calculate factors of safety against liquefaction under the ISFSI pad. Rather, the applicant submitted an analysis of liquefaction, entitled "Soil Failure/ Liquefaction Susceptibility Analysis for North Anna Power Station (NAPS) - Seismic Margin Assessment," December 1994 (Liquefaction Report), which was performed for the NAPS site to support conclusions regarding liquefaction under the ISFSI pad.

The NUREG/CR-0098 soil spectrum normalized to 0.3g zero period acceleration was used in the liquefaction analysis for the NAPS facilities. However, since the ISFSI is a new facility, the staff determined that the appropriate licensing standards were specified in Regulatory Guide (RG) 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," which are founded on the North Anna site design earthquake (0.18 g). NUREG/CR-0098 entitled "Development of Criteria for Seismic Review of Selected Nuclear Power Plants," published in 1978, was primarily intended for the review of seismic issues for plants under the Systematic Evaluation Program.

To justify the conservatism of the liquefaction analysis using NUREG/CR-0098 and a 0.3g PGA, the applicant submitted a letter, dated December 16, 1997, which included a study comparing the amplified response spectrum values for the NUREG/CR-0098 horizontal spectrum normalized to 0.3 g PGA and the RG 1.60 horizontal spectrum with a 0.18 g PGA. Both cases used 5% damping. The study showed that the NUREG/CR-0098 response spectrum itself was less conservative than the response spectrum specified by RG 1.60. However, because of the large margin of 0.3 g over 0.18 g as seismic input, the combined amplified response spectrum values using NUREG/CR-0098 spectrum envelop those using the RG 1.60 response spectrum. Therefore, the liquefaction analysis was conservative and therefore acceptable with respect to licensing under 10 CFR Part 72.[1]

In the Liquefaction Report, the applicant assumed a Review Level Earthquake (RLE) with a peak horizontal ground acceleration of 0.3g and seismic characteristics consistent with the seismic design spectrum described in NUREG\CR-0098. The Liquefaction Report, which was generated to support the applicant's response to Generic Letter 88-20, Supplement 4, specifically evaluated liquefaction susceptibility under main plant structures such as the main steam valve house, auxiliary building, service building and turbine building and under the service water reservoir area.

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[1] No statements made in this Safety Evaluation Report regarding the use of NUREG-0098 and the applicants Liquefaction Report should be taken as a staff conclusion regarding the acceptability of the applicant's response to Generic Letter 88-20, Supplement 4, "Individual Plant Examination for External Events."

Three approaches were used in the liquefaction assessment of the soils at the NAPS site. Specifically, these included (1) a simplified procedure founded on standard penetration testing (SPT), (2) threshold shear strain analysis, and (3) cyclic triaxial testing. Approaches (1) and (2) were used for the main plant area and approach (3) was used for the Service Water Reservoir area. All the three approaches are current state-of-practice techniques. For the main plant structures, the resulting factors of safety ranged from 1.54 to 3.51 against liquefaction, showed no liquefaction damage or related effects, and showed that significant pore pressure generation was not likely to occur. For the Service Water Reservoir area, cyclic triaxial tests were performed on the undisturbed samples in the vicinity of the pump house and in the general area. The liquefaction resistance associated with these samples was used to estimate the factors of safety. The resulting factors of safety ranged from 1.51 to 1.99.

Although an evaluation of safety margins to soil liquefaction for the ISFSI pad was not specifically performed, all evaluated NAPS facilities were shown to have high factors of safety against liquefaction. Therefore, it was reasonable to conclude that liquefaction would not occur for the ISFSI.

2.2 Safety Assessment of the Site

2.2.1 Industrial and Transportation Events

The largest credible rail or highway transportation accident is the explosion of an 8,500 gallon gasoline tank truck at the closest approach of Virginia Route 652, 1.5 miles from the ISFSI site. Given the application of RG 1.91 and information provided by the applicant regarding equivalent TNT weight of gasoline, the staff agrees that the expected overpressure from such an explosion would be less than 1 psi at the ISFSI site. In the TN-32 SER, the staff previously acknowledged that the TN-32 cask is designed to withstand an overpressure of 25 psi. Thus, the staff concludes that the postulated gasoline tank truck explosion 1.5 miles from the North Anna ISFSI would have negligible effect on any TN-32 cask in use at the ISFSI.

2.2.2 Flooding

The potential for flooding of the ISFSI site is evaluated below for several flood initiating events.

2.2.2.1 Precipitation Events

The ISFSI general site grade is 311 feet above mean sea level; the top elevation of the storage pads will be 311.5 feet. The ISFSI access road west of the facility is graded from 332 feet down to 311 feet into the site. The area outside the ISFSI boundary generally slopes to the south toward a tributary of Sedges Creek, which feeds into Lake Anna. North Anna ISFSI SAR Figure 2.4-2 shows the grading plan for the ISFSI site.

During heavy precipitation events, the ISFSI site will be drained by a gradual, fine grading away from the storage pads, and a combination of earthen and concrete channels. These channels, which appear in North Anna ISFSI SAR Figure 2.4-2, are designed to accommodate runoff from a 100-year precipitation event. Hydrodynamic loading and flooding of the storage pads is not credible for the 100-year storm.

Given the elevation of the ISFSI site relative to Lake Anna, and the conservative design of the storm drainage facilities in the site area, the staff concludes that the site is flood-dry.

2.2.2.2 Probable Maximum Flood (PMF) on Streams and Rivers

As discussed in the NAPS UFSAR Section 2.4.1, the normal water level of the North Anna reservoir is 250 feet. As discussed in Section 2.4.3 of the NAPS UFSAR, and in the North Anna ISFSI SAR, the maximum calculated water level at the plant site for the PMF is 267.3 feet msl. The staff previously reviewed and found acceptable these calculated water levels as documented in the OL-SER (NUREG-0053) and in Supplement 2 to the OL-SER (NUREG-0053, Supplement 2). Accordingly, with the ISFSI grade level established at 311 feet msl, which is 60 feet above normal water level and 45 feet above PMF lake level, the staff concludes that the ISFSI site is adequately protected from the effects of floods on nearby lakes and rivers.

2.2.2.3 Potential Dam Failures (Seismically Induced)

The Lake Anna dam is the only dam on the North Anna River. The only water impoundments that may be upstream of the dam are small farm ponds. Failure of such structures would produce no noticeable effect on the Lake Anna water level. Given the elevation of the ISFSI site relative to Lake Anna and given the lack of significant upstream impoundments, the staff concludes that the ISFSI site would be unaffected by flood levels attributable to the seismically induced failure of dams.

2.2.2.4 Probable Maximum Surge and Seiche Flooding

The ISFSI site is 311 feet above mean sea level and approximately 76 miles upstream of tidal influence. Therefore, the staff concludes that flooding from a storm surge is not credible. Furthermore, given that the site is not near a semi-enclosed bay or harbor, the staff concludes that seiche flooding attributable to water oscillation is impossible.

2.2.2.5 Probable Maximum Tsunami Flooding

Given the inland location of the ISFSI site, the staff concludes that tsunami flooding is not credible.

2.2.2.6 Ice Flooding

The ISFSI site is approximately 60 feet above the normal level of Lake Anna. Given this elevation above the lake, the staff concludes that no credible buildup of ice on Lake Anna could affect the ability of the ISFSI site to drain properly.

2.2.2.7 Flooding Conclusions and Requirements

In light of the discussion in Sections 2.2.2.2 through 2.2.2.6 above, the staff concludes that the design and location of the North Anna ISFSI is adequate to preclude flooding, meets the requirements of Subpart E to 10 CFR Part 72, as it pertains to flooding, and is therefore, acceptable.

2.2.3 On-site Meteorological Measurement Program

The NAPS has a meteorological monitoring station which will provide monitoring for the ISFSI. The monitoring program is described in detail in NAPS UFSAR Section 2.3.3. The primary meteorological tower is approximately 3500 feet northeast of the ISFSI site. This distance, in addition to the intervening topography, heat sources, and service water reservoir, prevents the heat source in a fully loaded ISFSI from affecting tower readings.

The onsite meteorological data will not be used to estimate offsite effluent concentrations, as no credible mechanism for the release of airborne effluents from the ISFSI has been postulated. However, χ/Q dispersion values have been calculated, in accordance with RG 1.145, for use in the dose assessment of airborne releases during accident scenarios. These values appear in Table 2.3-1 of the North Anna ISFSI SAR. The maximum site boundary χ/Q value is in the southeast sector, 3570 feet (expressed as 1100 m in the North Anna ISFSI SAR) from the ISFSI site.

2.2.4 Groundwater Contamination

Groundwater in the local domain will not be affected by operation of the ISFSI, as the facility produces no liquid, solid or gaseous effluents. TS controls limit the external surface contamination on storage casks to minimum detectable levels using direct radiation survey methods and thus minimize the possible spread of contamination to the environment.

2.3 Evaluation Findings and License Conditions

The NRC staff reached the following findings regarding the site characteristics of the ISFSI:

F2.1 The SAR provides an acceptable description and safety assessment of the site on which the ISFSI is to be located, in accordance with 10 CFR 72.24(a).

F2.2 The proposed site complies with the criteria of Subpart E to 10 CFR Part 72, as required by 10 CFR 72.40(a)(2).

3.0 PRINCIPAL DESIGN CRITERIA

NRC regulations require, at 10 CFR 72.24(c), that each applicant for an ISFSI license provide a description of the proposed ISFSI design, including design criteria and applicable codes and standards. The presentation is to address the design criteria specified in Subpart F to 10 CFR Part 72, including any additions to or departures from the criteria in Subpart F.

3.1 Material To Be Stored

The applicant proposed to use the North Anna ISFSI to store fuel which has been used at the NAPS. The applicant further proposed that stored fuel be limited to intact fuel assemblies, which do not have gross cladding defects and which do not have visible physical damage which precludes insertion or removal from a cask. In a letter dated April 1, 1998, the applicant proposed that these limitations be included as TS 2.1.1. In a letter dated May 28, 1998, the applicant proposed that TS 2.1.1 be further revised to specifically exclude the loading of burnable poison rod assemblies and thimble plugging devices. In Table 3.1-1 of the North Anna ISFSI SAR, the applicant provided detailed information on the design of the fuel assemblies which are to be stored.

The applicant also proposed specific limits on certain design and operational variables associated with each assembly to be stored in the TN-32 cask. Specifically, the applicant proposed the following limits:

Parameter	Limit
(1) Maximum initial enrichment	$\leq$ 3.85 weight %
(2) Average burnup	$\leq$ 40,000 MWD/MTU
(3) Maximum decay heat per assembly	$\leq$ 0.847 kw/assembly
(4) Post discharge cooling time	$\geq$ 7 years
(5) Gamma source per cask	$\leq 2.31 \times 10^{17}$ photons/second
(6) Neutron source per cask	$\leq 4.83 \times 10^{9}$ neutrons/second
(7) Fuel assembly design	Westinghouse 17 x 17 Standard Westinghouse 17 x 17 Vantage 5H

The applicant proposed that the limits on these variables be documented in the Table 2.1-1 of the ISFSI TS. The applicant also proposed a TS requirement, TS 2.2, specifying the actions to be taken if one of the Functional and Operating Limits of TS 2.1.1 were violated. Those actions include obtaining NRC approval to resume loading and transport activities after the violation.

3.2 Classification of Structures, Systems, and Components (SSCs)

In 10 CFR 72.3, the term "SSCs important to safety" is defined as follows:

> Those features of the ISFSI...whose function is:
>
> (1) To maintain the conditions required to store spent fuel....safely,
>
> (2) To prevent damage to the spent fuel...during handling and storage, or
>
> (3) To provide reasonable assurance that spent fuel...can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

In Section 4.5 of the North Anna ISFSI SAR and in a letter dated May 28, 1998, the applicant stated that the casks (i.e., the TN-32 cask) and the handling equipment used during loading and unloading (cask lift beam and cask lid lifting tools) are considered important to safety. The applicant stated that the Virginia Electric and Power Company Operational Quality Assurance Program Topical Report program, discussed further in Section 16 of this SER, apply to that equipment. The applicant stated that none of the other systems including the storage pad, fence, monitors (i.e., pressure monitors), wiring, and lights perform a safety function. The applicant further stated that the transporter is not considered important to safety because the casks are designed to withstand the failure of the transporter. The applicant stated that the cask handling crane and auxiliary crane are to be included under the programmatic control of the NAPS "NUREG 0612 Heavy Loads" program.

On the basis of its review of the North Anna ISFSI SAR and previous experience with dry cask loading and the TN-32 cask, the staff concludes that the applicant has adequately identified those SSCs which are important to safety.

3.3 Design Criteria for SSCs That Are Important to Safety

In Chapters 3 and 4 of the North Anna ISFSI SAR, the applicant specified the design criteria for various SSCs associated with handling and storage of spent fuel at North Anna. Table 3.4-1 of the SAR lists the design criteria used by the applicant in selection of a cask. Table 4.2-1 summarizes the applicants proposed means for complying with the individual design criteria specified in Subpart F. The staff's evaluation of the applicant's design criteria against the requirements of Subpart F is presented below.

3.3.1 Quality Standards

The applicant proposed that various accepted design and construction standards be applied to the cask and ISFSI facility. Codes and standards used in the design and construction of the ISFSI facility are described in Section 3.4.1 of this SER. Codes and standards for the design of the cask are listed in Section 2 of the TN-32 TSAR.

The applicant proposed that the standards in its existing Quality Assurance (QA) program regarding the design, fabrication and delivery of safety-related equipment be applied to ensure that cask and ISFSI facility meet the listed standards. As described further in Section 16 of this SER, the staff finds that the applicant's existing QA program satisfies the requirements of 10 CFR Part 72. The staff concludes that the proposed standards and the application of the existing QA program to the ISFSI satisfies the requirements of 10 CFR 72.122(a).

3.3.2 Protection Against Environmental Conditions and Natural Phenomena

The applicant proposed design criteria for the cask related to seismic considerations, high ambient temperature, exposure to sunlight, and extreme winds and missiles as listed in Table 3.4-1 of the North Anna ISFSI SAR.

For solar heat load, the applicant proposed a design criteria of 800 g-cal/cm^2 for flat surfaces and 400 g-cal/cm^2 for curved surfaces. These criteria are equivalent to the criteria of 2950 BTU/ft^2 and 1475 BTU/ft^2 for flat and curved surfaces previously reviewed by the staff during its review of the TN-32 TSAR and are equivalent to the criteria for spent fuel shipping containers in 10 CFR 71.71(c) and is therefore acceptable.

For ambient temperature, the applicant proposed a criteria of -20°F to 115°F. This range bounds the range of historical recorded temperatures in the vicinity and is identical to the criteria previously reviewed by the staff during its review of the TN-32 TSAR. The criteria are therefore acceptable.

For seismic peak acceleration, the applicant proposed maximum peak acceleration values of 0.18 g for horizontal motion and 0.12 g for vertical motion. These values are predicated on the design-basis earthquake described in Section 2.5.2.6 of the NAPS UFSAR. These values are bounded by those used in the structural analysis of the TN-32 cask. The staff therefore finds the seismic peak acceleration criteria proposed by the applicant acceptable.

With regard to wind loading, the applicant proposed tornado wind design criteria of combined rotational and translational wind speed of 360 mph. This value was equal to the combined wind speed of 360 mph contained in and approved for TN-32 TSAR. The combined tornado wind speed criteria in the North Anna ISFSI SAR is equivalent to the criteria evaluated in the TN-32 TSAR and is therefore acceptable.

For wind-driven missiles, the applicant proposed to use the design-basis missiles from the NAPS UFSAR as the design-basis missiles for the North Anna ISFSI. These missiles differ from those used in the TN-32 TSAR. In a letter dated May 18, 1998, the applicant summarized the effects of the North Anna design-basis missiles with respect to three phenomena. Those phenomena are cask sliding, cask tipping and cask penetration. The summary showed that the TN-32 missile analysis bounded the consequences for the worst case North Anna design-basis missile. The staff therefore concludes that the design-basis missiles proposed by the applicant are acceptable.

With respect to flooding, the applicant described that the ISFSI site is flood free. Therefore, the applicant did not propose any additional design criteria for the ISFSI with regard to floods. As discussed in Section 2 of this SER, the staff accepts the applicant's analysis with regard to the

ISFSI site being flood dry and therefore finds that no further design criteria are necessary to protect against flooding.

With respect to snow and ice loadings, the applicant concluded that snow and ice loading did not pose a credible challenge to the spent fuel casks. The applicant presented information describing local snow and ice historical data. This data included (1)14.6 inch annual average snowfall, (2) single snow fall of greater than 4 inches occurring once per year on average and (3) 21.6 inch maximum 24 hour snowfall (as described in the NAPS UFSAR). These snowfalls are bounded by the snow and ice loadings considered in the TN-32 TSAR. The staff agrees that snow and ice loading are not of concern and that no further design criteria are necessary to protect against snow and ice loading.

In light of the above discussions regarding flooding, seismic conditions, tornado- and wind-driven missiles, snow and ice loadings, and temperature extremes, the staff concludes that the applicant has proposed sufficient design criteria for protection against environmental conditions and environmental phenomena as required by 10 CFR 72.122(b)(1) and (b)(2). The meteorological data collection facilities described in the NAPS UFSAR satisfy the requirements of 10 CFR 72.122(b)(3).

In Section 3.3.2.1 of the North Anna ISFSI SAR, the applicant proposed to use casks whose confinement integrity is ensured under credible site conditions (the TN-32) as the means for precluding the transport of radioactive material into the environment via a major water sources. The staff finds this criteria consistent with the requirement of 10 CFR 72.122(b)(4).

3.3.3 Fires and Explosion

The applicant proposed criteria to ensure that SSCs important to safety are able to perform their safety function under credible fire conditions. The applicant proposed that design features be used to ensure that a fuel fire associated with the backup diesel generator located within the ISFSI security fence is prevented from propagating to the ISFSI (i.e., to the pad and the casks). Satisfaction of this criteria is further discussed in Section 11 of this SER. The staff finds the proposed use of design features that preclude the propagation of a fire to the ISFSI important to safety SSCs consistent with the criteria of 10 CFR 72.122(c).

With regard to explosions, the applicant discussed potential sources of explosions in Chapter 2 of the North Anna ISFSI SAR. The applicant stated the siting of the ISFSI ensured that the peak overpressure from the maximum credible explosion (less than 1 psi) remained less than the design pressure of 25 psi for the TN-32 cask. The staff concludes that the combination of site location and design pressure for the selected cask are consistent with and satisfy the criteria of 10 CFR 72.122(c) with regard to explosions.

3.3.4 Sharing of Structures, Systems, and Components

To address the effect of sharing ISFSI SSCs, the applicant proposed the criteria that all ISFSI activities be performed without jeopardizing the safe shutdown capability of the North Anna Units 1 and 2 reactors. Normal power for the North Anna ISFSI is drawn from NAPS nonsafety station service system. Alarms from the cask pressure monitoring system are located in the

Central Alarm Station which also serves the NAPS facility. No water systems are provided to the ISFSI, thus none are shared with the NAPS. By letter dated April 13, 1998, the applicant described the review of and revisions to the NAPS UFSAR associated with ISFSI operation. These revisions included changes to site drawings and changes to accommodate the equipment used inside the NAPS to perform cask loading operations. Such changes to the UFSAR are subject to the provisions of 10 CFR 50.59. Given the extremely limited degree of SSC sharing between NAPS and the ISFSI described above, the staff concludes that the applicant has adequately considered sharing of SSCs in the design, consistent with the criteria of 10 CFR 72.122(d).

3.3.5 Proximity of Sites

The applicant proposed to show that, consistent with 10 CFR 72.122(e), the design and operation of the North Anna ISFSI result in minimal additional risk to public health and safety. The combined effect of operating the NAPS and the ISFSI is discussed in Section 8 of this SER.

3.3.6 Testing and Maintenance of Systems

The applicant proposed to use an cask that requires no periodic maintenance other than minor adjustment of instruments or minor touch-up of the cask outer coatings. The applicant indicated that certain periodic surveillances of the selected cask would be performed consistent with the maintenance practices described in the TN-32 TSAR. The staff finds these criteria are consistent with and satisfy the requirements of 10 CFR 72.122(f).

3.3.7 Emergency Capability

In a letter dated May 18, 1998, the applicant indicated that access to the ISFSI is adequate for emergency responders who may be required to respond to the ISFSI. This is consistent with the criteria of 10 CFR 72.122(g).

3.3.8 Confinement Barriers and Systems

10 CFR 72.122(h) requires that the spent fuel must be protected against degradation that leads to gross ruptures or the fuel must be otherwise confined such that degradation of the fuel will not pose operational problems with respect to removal from storage.

The applicant proposed to use an cask for which it considers no path for release of radioactive material to be credible under all conditions for the duration of the license. The applicant proposed to backfill the cask with helium and establish a minimum backfill pressure to protect against long-term degradation of the fuel under normal storage conditions. The cask is designed to maintain the fuel clad temperatures at acceptable levels to prevent gross ruptures.

The staff considers these criteria consistent with 10 CFR 72.122(h)(1) and (h)(5). Establishment of these criteria negates the need for ventilation criteria pursuant to 10 CFR 72.122(h)(3). Since the applicant has not proposed to store the fuel in a pool, criteria pursuant to 10 CFR 72.122(h)(2) are not applicable. The applicant proposed a continuous monitoring system for the confinement consistent with 10 CFR 72.122(h)(4). However, since the applicant proposed to use a cask whose confinement is leak tight under all credible conditions, the applicant proposed the monitoring system be considered not important to safety. The staff concludes that the design criteria proposed by the applicant are consistent with the criteria of 10 CFR 72.122(h).

3.3.9 Instrumentation and Control

The applicant proposed to use cask for which no instrument or control systems are required to perform the intended safety functions. The cask are not considered operating systems in the same sense as spent fuel pool cooling systems or ventilation systems which may require other instrumentation and control systems to ensure proper function. Hence, because of the passive nature of the cask and ISFSI design, pressure monitoring and surveillance activities are appropriate and sufficient. Such activities ensure adequate protection of the public health and safety and meet the requirements of 10 CFR 72.122(l).

3.3.10 Control Room

The applicant proposed that no control room or control area is necessary to monitor or control the safe operation of the ISFSI. To the extent that the proposed casks are designed to passively perform their safety functions under normal and accident conditions, the staff finds the applicants proposed criteria regarding the absence of an ISFSI control room is allowed by 10 CFR 72.122(j).

3.3.11 Utilities or Other Services

The applicant proposed to use casks that do not rely on utility supplies and systems (such as electrical or water systems) to ensure that safety functions are performed under normal and accident conditions. The applicant proposed to install electric power that is not important to safety for the purposes of lighting, general utility, and cask seal instrumentation. These functions are not necessary to ensure that the cask can perform its safety function. Therefore, the applicant proposed that utility systems be neither redundant nor able to withstand a single failure. To the extent that the TN-32 cask has been previously reviewed and found acceptable by the staff in this regard (TN-32 SER, Section 11.3), the staff concludes that the proposed ISFSI utility systems design criteria are consistent with 10 CFR 72.122(k).

3.3.12 Retrievability

The applicant proposed to use the TN-32 cask, which allows fuel to be unloaded in the North Anna spent fuel pool and retrieved for further packaging into transportation casks consistent with 10 CFR 72.122(l).

3.3.13 Criticality Safety

The applicant proposed a design criterion that subcriticality be maintained at all times with the assumption of a single active failure or credible passive failure. The applicant proposed that the effective neutron multiplication factor be maintained less than 0.95. The staff considers this consistent with the criteria of 10 CFR 72.124(a).

3.3.14 Methods for Criticality Control

The applicant proposed to rely on the criteria for criticality control provided for the selected cask and did not propose additional design criteria or features of its own. The staff finds use of the cask specified design criteria acceptable and consistent with 10 CFR 72.124(b).

3.3.15 Criticality Monitoring

The applicant proposed to perform all spent fuel handling under water in the spent fuel pool in accordance with the provisions of the NAPS operating license pursuant to 10 CFR Part 50 and to store the fuel dry in the selected cask. Therefore, consistent with 10 CFR 72.124(c), criticality monitoring is not required.

3.4 Design Criteria for Other SSCs Subject To Approval

3.4.1 Concrete Storage Pad

The following codes and standards are used in the design and analysis of the pad:

(1) ACI 349, "Code Requirements for Nuclear Safety Related Concrete Structures

(2) ANSI/ANS 57.9, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)"

(3) BOCA, "The BOCA National Building Code"

(4) ASCE 7, "Minimum Design Loads for Buildings and Other Structures"

Material properties were referenced to ASTM standards. The above cited codes and standards are commonly used commercial standards and are considered acceptable by the staff.

3.4.2 Transporter

Codes and Standards used in the design of the transporter include various ASTM standards as listed in Table 4.3-1 of the North Anna ISFSI SAR. These are commonly used commercial codes and are considered acceptable to the staff.

3.5 Evaluation Findings

F3.1 As described above, the North Anna ISFSI SAR (including referenced TN-32 TSAR) includes design criteria in sufficient detail to support a finding that the criteria are consistent with the criteria of Subpart F to 10 CFR Part 72, except where noted, in compliance with 10 CFR 72.24(c). This finding is predicated on a review which considered the regulatory requirements, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

4.0 INSTALLATION FUNCTION AND OPERATING SYSTEMS

4.1 Regulatory Requirements

Requirements regarding the overall function of the ISFSI and the operation of certain separate functional subsystems are detailed in the design criteria in 10 CFR 72.24, 72.40(a), 72.122(h)-(l), 72.124(c), 72.126(b)-(d) and 72.128(a). Functions and functional subsystems reviewed in this Section of the SER include those associated with receipt, preparation, loading, transfer, storage, maintenance and retrieval of the stored spent fuel.

This review was performed according to Chapter 4 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

4.2 Operation Description

In Chapter 5 of the North Anna ISFSI SAR, the applicant describes two primary operations associated with storage of spent fuel at the ISFSI. These operations are cask loading and cask unloading. Although operations to load the cask in the spent fuel pool, prepare it for storage, and transfer the cask to outside the Decontamination Building are subject to the requirements of 10 CFR Part 50 and subject to the conditions of the NAPS Part 50 operating license, those activities are integral with spent fuel dry storage activity. Thus, those activities are recounted in Chapter 5 of the North Anna ISFSI SAR and are recounted here.

The applicant's narrative description and itemized sequence of loading operations in Chapter 5 of the North Anna ISFSI SAR encompass the major tasks associated with dry cask storage including (1) receipt of the empty cask from the manufacturer, (2) preloading inspection and cask preparation, (3) transfer of the empty cask into the spent fuel pool (SFP), (4) loading and verification of spent fuel assemblies, (5) removal of the cask from the SFP and removal of water from the cask, (6) sealing, vacuum drying and helium backfill of the loaded cask, (7) decontamination of the cask exterior, (8) verification of adequate surface radiation measurements and confinement integrity and (9) transport of the cask to the ISFSI pad.

In Table 5.1-1 of the North Anna ISFSI SAR, the applicant provided a tabular flowsheet listing the significant steps needed to load a cask. The applicant also referenced the cask loading flowsheet in the specific SAR for the chosen cask which in this case is the TN-32. The staff reviewed the narrative descriptions of the cask loading operation and, on the basis of previous staff observation of TN-32 cask loading operations, concluded that they were acceptable.

The applicant also described potential unloading operations including (1) transport from the ISFSI pad to the Decontamination Building, (2) sampling of the cask atmosphere to test for fuel degradation, (3) placement of the cask into the SFP, (4) reflooding of the cask, (5) removal of the cask lid, (5) removal of the spent fuel back to the SFP and (6) removal and decontamination of the cask. In a letter dated April 14, 1997, the applicant described that it would closely monitor cask internal pressure during the reflood process. The applicant specifically stated that steps would be taken to test for indication of fuel failure before loosening the lid bolts during an unloading operation.

In light of the above, the staff concludes that the descriptions of the proposed functions and operating systems with regard to stored radioactive material from storage are acceptable and comply with 10 CFR 72.122(l).

4.3 Fuel Handling Systems

The NAPS and North Anna ISFSI include systems and components necessary to handle the storage cask during the loading phase and during transport to or from the ISFSI pad.

4.3.1 NAPS Cask Handling Equipment

As described in the NAPS UFSAR, a 125 ton capacity trolley crane is installed in the Fuel and Decontamination Buildings and is capable of lifting a loaded TN-32 cask from the spent fuel pool to the concrete surface outside the Decontamination Building. The trolley is designed to the standards of ANSI-B32.2.0-1967, "Safety Code for Overhead and Gantry Cranes and Specification for Electric Overhead Traveling Cranes for EOCI Service Class A."

As described in the applicant's letter dated April 14, 1997, a lift beam is used for lifting and moving the cask to various station areas, including to the spent fuel pool. The lift beam attaches to the 125 ton trolley crane using a pin through a hole in the crane hook. The lift beam attaches to the upper trunnions of the cask with two air-operated arms. A locking mechanism ensures that the arms remain firmly attached to the trunnions during lifts. Movement of the arms and engagement of the locking mechanism is accomplished with a remote control unit. The lift beams are made from carbon steel and stainless steel components. The carbon steel components are painted to prevent corrosion from immersion in the pool.

4.3.2 Transporter System

The applicant proposed to use a towed transporter frame vehicle to move the cask from the Decontamination Building laydown area to the ISFSI storage pad. The transporter consistent of a large A-frame assembly equipped with fixed and steerable tires as well as braking and cask lifting systems. The transporter is to be towed by a pull vehicle through the use of a towing bar assembly.

The transporter lifts the cask through use of a configuration of hydraulically driven lifting arms which lift the cask via the cask trunnions. The power unit for lifting casks is a diesel-powered unit. Flow control valves in the hydraulic system control the rate at which the cask can be lowered. Hydraulic lock valves prevent the cask from being accidentally lowered during transport. In a letter dated April 23, 1998, the applicant described that the cask is prevented from being lifted more than 15 inches above the ground surface by mechanical stops internal to the hydraulic control system. In addition, the applicant proposed TS 3.1.5, which limits the lifting height of the cask to no more than 18 inches above the ground.

With regard to functions important to safety, the TN-32 cask is analyzed for end drops of up to 18 inches and for cask handling tip over events onto a concrete storage pad. The cask was analyzed for the impact of such drops on the ability to maintain a subcritical configuration, the ability to remove fuel from the cask after the event and the ability to maintain confinement. In the TN-32 SER, the staff concluded that the cask will perform adequately for cask tipover and drops of not more than 18 inches, provided that the pad is not more than 3 feet thick, with a concrete strength not greater than 4,000 psi, and a soil modulus of elasticity not more than 40 ksi. Actual North Anna ISFSI pad conditions are evaluated in Section 11 of this SER.

Based on the applicant's proposed design features and TS controls which ensure that the cask is not lifted more than 18 inches while in the transporter, the staff concludes that the North Anna transporter will adequately ensure that the design drop analytical assumptions are satisfied. The staff further concludes that the TN-32 cask when moved with the transporter is in compliance with 10 CFR 72.128(a) with regard to ensuring adequate safety under normal and accident conditions.

4.4 Operation Support Systems

Although the TN-32 cask proposed by the applicant is designed to maintain confinement integrity under normal and accident conditions through the period of the license, the inter-seal region is monitored by a pressure monitoring system (PMS). As described in the North Anna ISFSI SAR and as further described in a letter dated May 18, 1998, the system includes two pressure switches per cask wired to provide separate inputs to a programmable logic controller (PLC). When the inter-lid pressure falls below at preset value, as a result of a leak of either the inner seal or outer seal, the PLC will provide output to an annunciator display panel via a fiber optic modem and to the NAPS Central Alarm Station (CAS) via a relay. The PLC includes self checking features that will provide indications to the annunciator panel and the CAS. The annunciator panel provides indication of which cask and which pressure switch is in an alarm state and provides indication for a faulted PLC condition. Upon loss of power to a particular pressure switch, the annunciator will show an alarm condition for the affected cask and switch. Upon loss of power to the PLC, the annunciator panel will show all pressure switches in an alarm condition. Upon loss of power to the annunciator panel, the panel will be blank. All low-pressure or loss-of-power conditions described above will cause a single ISFSI cask status alarm in the CAS. Although not important to safety itself, the PMS provides an acceptable capability to test and monitor components important to safety and satisfies the requirements of 10 CFR 72.128(a)(1) and 72.122(h)(4).

In order to minimize fuel degradation while in long-term storage, the cask cavity is evacuated and then backfilled with helium during the loading process. As described in the NAPS UFSAR, the applicant has installed a vacuum drying system and a helium system in the Decontamination Building. The vacuum system consists of two parallel vacuum pumps along with necessary filters and monitoring equipment. The helium system consists of a rack for helium bottles, regulating equipment and monitoring equipment.

Electric power is provided for area lighting, receptacles, security equipment and the PMS. The electric power supply is not considered important to safety since power is not required to satisfy any safety functions at the ISFSI. The electric power supply is not connected nor shares components with the NAPS Class 1E power system. A backup diesel generator is provided at the ISFSI to supply power in the event of an extended power loss.

The utility systems described above are not required during any accident conditions to perform a safety function. By implementing a cask design that does not rely on utility services to perform a safety function under emergency or accident conditions, the applicant has satisfied the requirements of 10 CFR 72.122(k).

4.5 Control Room or Control Area

The TN-32 cask proposed by the applicant does not require continuous surveillance and monitoring to ensure that its safety functions are performed during normal, off-normal or postulated accident conditions. Therefore, the applicant has proposed not to install a control room or control area at the ISFSI itself.

As discussed above, the applicant has indicated that the seal function of the TN-32 will be continuously monitored by pressure instruments which monitor the pressure between the inner and outer cask seals. These instruments will alarm at a local alarm panel which is located at the ISFSI site. In its submittal dated April 14, 1997, the applicant stated that an alarm at the local alarm panel will activate an alarm within the Station Security Central Alarm Station and Secondary Alarm Station. Upon receipt of an alarm, security staff will notify the Control Room Shift Supervisor who will direct operators to check the cause of the alarm including potential electronic fault, failed sensor or actual failed cask seal and will initiate appropriate corrective action.

Operation during the transport phase will be under local control by the applicant's personnel.

Normal loading and unloading operations will take place in the North Anna Fuel Building and Decontamination Building under local control in coordination with the NAPS control room staff and subject to control under the applicant's license under 10 CFR Part 50 for the NAPS facility.

On the basis of previous review of the design of the TN-32 and review of the North Anna ISFSI SAR information described above, the staff concluded that a specific control room for the ISFSI is not necessary and that operations to control and monitor cask conditions as proposed by the applicant are adequate to meet the requirements of 10 CFR 72.122(j).

4.6 Analytical Sampling

As described in the ISFSI SAR, no gaseous or liquid effluents are expected from the operation of the ISFSI during either normal or off-normal operation. Therefore, provision of means of monitoring and measuring the amount of radio nuclides in effluents during normal operation or accident conditions, to comply with 10 CFR 72.122(h)(3), are not required. Nevertheless, the applicant stated that the count room, portable instrumentation, personnel monitoring instruments and support facilities associated with the NAPS health physics lab will be available to support operation of the ISFSI. The applicant stated that the above facilities meet the guidance of Regulatory Position 4 of RG 8.8. Use of RG 8.8 facilities at NAPS to support the ISFSI will provide sampling and analysis capability for normal and off normal operation of the ISFSI over and above that required by the regulations and is therefore acceptable to the staff.

4.7 Cask Repair and Maintenance

The applicant has proposed to use the TN-32 cask which requires no scheduled maintenance during its operating life. The applicant has stated that the cask will be inspected in detail during the receipt process before loading. In addition, the applicant stated that the machine shops associated with the NAPS are available to perform any necessary minor repairs.

Once placed in service, the TN-32 cask does not require periodic maintenance other than touching up defects in the outer coatings and adjustments of the seal monitoring instruments (which are not required to ensure a safety function) on an as-needed basis.

4.8 Evaluation Findings

The NRC reached the following findings with regard to installation functions and functional subsystems:

F4.1 The North Anna ISFSI SAR includes acceptable descriptions and discussions of the projected operating characteristics, in compliance with 10 CFR 72.24(b).

F4.2 By implementing a cask design that does not rely on utility services to perform a safety function under emergency or accident conditions, and by implementing utility systems that do not share components with the NAPS, the applicant has satisfied the requirements of 10 CFR 72.122(k).

F4.3 The descriptions of the proposed functions and operating systems with regard to retrieval of stored radioactive material from storage are acceptable and comply with 10 CFR 72.122(l).

F4.4 The PMS provides an acceptable capability to test and monitor components important to safety and satisfies the requirements of 10 CFR 72.128(a)(1) and 72.122(h)(4).

F4.5 The operating procedures and schedules for operation for the ISFSI acceptably provide for control during storage operations to be accomplished from the NAPS control room facility and for control during transport to be under the local control of the applicant's operations personnel. This is considered to comply with 10 CFR 72.122(j).

5.0 WASTE CONFINEMENT AND MANAGEMENT

Requirements regarding the safe confinement and management of any radioactive waste generated by the facility and the management of the release of radioactive materials in effluents to the environment are detailed in 10 CFR Part 20 and 10 CFR 72.104, 72.106, 72.122, 72.126 and 72.128. The ISFSI must be designed to limit the levels of radioactive materials released in effluent to as low as reasonably achievable (ALARA). In addition, the design must minimize the quantity of radioactive wastes generated.

This review was performed according to Chapter 6 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

5.1 Waste Sources

As described in Chapter 6 of the North Anna ISFSI SAR, some amounts of liquid and solid radioactive wastes will be generated during loading, decontamination and other preparatory actions before storage. Contaminated spent fuel pool water used to fill the cask during the loading and unloading operations will be drained back to the spent fuel pool (SFP) before moving the cask from the fuel pool area to the decontamination area. As described in the NAPS UFSAR, SFP water contaminants are removed through a series of filters and ion exchangers connected with the fuel pit cooling and purification system.

A detergent/water mixture is used to decontaminate exterior surfaces of the cask subsequent to removing the cask from the SFP. This decontamination activity results in the generation of small amounts of liquid waste. This liquid waste is directed to the NAPS fluid waste treatment system and is subsequently transferred to the NAPS liquid waste disposal system.

During the loading, unloading and decontamination activities, a small amount of low-level solid waste may be generated as well. The solid waste would consist in part of anti-contamination clothing, rags, plastic sheeting and tape. As described in Section 11.5 of the NAPS UFSAR, such solid waste material is compacted into 55 gallon drums, and retained on the NAPS site until it is shipped for final disposal either by incineration or by burial at a disposal site. The staff concludes that use of NAPS facilities for the processing of solid and liquid wastes generated during cask loading, unloading and decontamination activities satisfies the requirements of 10 CFR 72.128(b).

During transport to the ISFSI pad and during storage at the ISFSI, no radioactive waste material is generated by the use of the TN-32 cask. The cask is a passive design, requiring no active systems to ensure adequate decay heat removal and to ensure adequate confinement. The TN-32 cask also does not require intrusive periodic maintenance. The only periodic maintenance involves examination of the cask outer surface for defects in the exterior decontamination coatings and possible maintenance of the PMS components. This passive design greatly minimizes the volume of radioactive waste that could be generated by the operation of the ISFSI. The staff concludes that the applicant's proposed use of the TN-32 cask satisfies the requirements of 10 CFR 72.128(a)(5). The solid and liquid radioactive waste management satisfies the requirements of 10 CFR 72.24(l).

5.2 Offgas Treatment and Ventilation

As described in the North Anna ISFSI SAR, potentially contaminated air and helium will be purged from the cask during vacuum drying, helium backfilling and leak testing activities. Such contaminated vented gas will be processed by the ventilation systems in the Fuel and Decontamination Buildings and subject to the requirements of 10 CFR Part 50 and the NAPS license. As described in the NAPS UFSAR, this ventilation system has in-series particulate and charcoal filter banks to scrub radioactive contaminants from the exhaust ventilation stream.

Control of radiological contamination during cask handling, loading and unloading within the NAPS Fuel and Decontamination Buildings is subject to the requirements of 10 CFR Part 50 and the NAPS license. However, for informational purposes, the applicant's measures to control contamination during these phases of operation are described below. As part of the cask loading and unloading operations, the loaded cask is lifted from the spent fuel pool to the decontamination area in the Decontamination Building. This lift is performed using the cask handling crane. Once cask decontamination is accomplished, the cask is lifted to outside the Decontamination Building using the cask handling crane. The applicant recognized that the cask crane rigging equipment (slings, cables and hook) would be immersed in the spent fuel pool during cask loading becoming potentially contaminated in the process and would traverse to the outside environment during the course of a cask loading operation. In letters dated April 23 and May 29, 1998, the applicant addressed the spread of potential contamination from the cask crane rigging equipment. The applicant proposed to construct a crane enclosure outside the Decontamination Building to shelter the cask crane from the weather thereby limiting the means by which contamination could be spread from cask handling equipment to the environment. The applicant proposed to complete construction by December 31, 1999. In the interim, the applicant proposed to use temporary measures, including procedural limitations to prevent crane use outside of the Decontamination Building during adverse weather conditions; decontamination of the crane hook, lift beam, and cables before moving the cask outside; and follow-up surveys of the outside area.

Once removed to the storage pad, the TN-32 cask is designed to be leak tight under all normal and accident conditions. Thus, no gaseous effluents are expected during storage operations at the ISFSI. The confinement capability of the ISFSI is further described in Section 10 of this SER. Cask surface contamination limits are specified in the North Anna ISFSI TS and are sufficient to limit unacceptable spread of contamination to the environment.

In light of the above, the staff concludes that the applicant has provided sufficient design features and controls to ensure the confinement of airborne radioactive particulate during normal and off-normal conditions in compliance with 10 CFR 72.122(h)(3). In addition, on the basis of the above discussion, the staff concludes that the proposed design and operation of the North Anna ISFSI satisfies the requirements of 10 CFR 72.126(d). Because no effluents are expected under normal or accident conditions, the requirements of 10 CFR 72.126(c)(1), regarding measurement and dilution of effluents, are considered not applicable.

5.3 Waste Treatment and Retention

The processing of liquid and solid radioactive wastes generated during loading and unloading and decontamination activities, described in Section 5.1 above, is subject to the requirements of 10 CFR Part 50 and the NAPS license. Use of the NAPS facility, subject to the provisions of 10 CFR Part 50, to process radioactive waste generated during all phases of ISFSI operation satisfies the requirements of 10 CFR 72.128(b).

5.4 Radiological Impact of Normal Operations

Although the North Anna ISFSI is located next to a major water resource, no liquid radioactive materials will be present at the ISFSI. As described in Section 2 of this SER, the site is not susceptible to any surface flooding. Further, as described in Sections 10 and 11 of this SER, there are no credible scenarios by which liquid or gaseous effluents could be released from the storage casks. Therefore, the staff concludes that the requirements of 10 CFR 72.122(b)(4) are met.

5.5 Evaluation Findings

F5.1 The North Anna ISFSI SAR adequately describes acceptable features of the ISFSI design and operating modes that reduce to the extent practical the radioactive waste volume generated by the installation, in compliance with 10 CFR 72.24(f) and 72.128(a)(5).

F5.2 The North Anna ISFSI design and procedures provide acceptable measures to preclude the transport of radioactive materials to the environment through aquifers, in compliance with 10 CFR 72.122(b)(4).

F5.3 Use of NAPS facilities for the processing of solid and liquid wastes generated during cask loading and decontamination activities conducted under the provisions of the NAPS 10 CFR Part 50 license, satisfies the requirements of 10 CFR 72.128(b).

F5.4 The design of the ISFSI provides acceptable means to limit to levels as low as is reasonably achievable the release of radioactive materials in effluents during normal operation and to control the release of radioactive materials under accident conditions, in compliance with 10 CFR 72.126(d).

F5.5 The waste confinement and management activities described in the SAR support a conclusion that the activities authorized by the license can be conducted without endangering the health and safety of the public, in compliance with 10 CFR 72.40(a)(13).

6.0 INSTALLATION DESIGN AND STRUCTURAL EVALUATION

Requirements regarding the safe confinement and management of any radioactive waste generated by the facility and the management of the release of radioactive materials in effluents to the environment are detailed in 10 CFR Part 20 and 10 CFR 72.104, 72.106, 72.122, 72.126 and 72.128. The ISFSI must be designed to limit the levels of radioactive materials released in effluent to as low as reasonably achievable. In addition, the design must minimize the quantity of radioactive wastes generated.

NRC staff acceptance criteria for structural design are detailed in Chapter 7 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

6.1 *Summary Description*

The applicant proposed to use an array of TN-32 casks placed on a reinforced concrete pad for storage of spent fuel from the NAPS. The staff conducted a review of the structural design of the North Anna ISFSI reinforced concrete pad as described in Section 6.3 below. The staff previously performed a detailed review of the TN-32 structural design, as summarized in Section 6.2 below. The staff did not perform a specific structural analysis of cask handling equipment such as lifting beams and the transporter vehicle. For the transporter, the staff reviewed the applicant's proposed design and administrative controls in the North Anna ISFSI application which ensured that the TN-32 cask would not be handled in excess of analyzed parameters during transport. The staff concluded that the applicant's description of the structural design for the ISFSI satisfies the requirements of 10 CFR 72.24(a), (b), (c), and (d).

6.2 Confinement Structures, Systems, and Components

The applicant has selected the TN-32 as the cask it will use upon initial licensing of the ISFSI. The detailed structural analysis of the TN-32 cask including the cask body and basket is presented in Chapter 3 and Appendices 3A, 3B, and 3C of the TN-32 TSAR. The staff performed a detailed review of the structural analysis. The staff's evaluation and conclusion are presented in Section 3 of the TN-32 SER. In the TN-32 SER, the staff made the following summary findings regarding the structural analysis of the TN-32 cask:

> [The TN-32] storage systems are designed to allow ready retrieval of spent fuel for further processing or disposal. No accident or natural phenomena events analyzed will result in damage that will prevent retrieval of the fuel.
>
> The cask is designed and fabricated so that the spent fuel is maintained in a subcritical condition under credible conditions. The configuration of the fuel is unchanged.
>
> The cask and its systems important to safety are evaluated to demonstrate that they will reasonably maintain confinement of radioactive material under normal, off normal, and credible accident conditions.
>
> The staff concludes that the structural design of the TN-32 is in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The

structural evaluation provides reasonable assurance that the TN-32 will enable safe storage of spent fuel. This finding is based on a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, accepted practices, and staff confirmatory analysis.

By letter dated May 28, 1998, the applicant submitted a revised lid bolt analysis for the TN-32 cask. The analysis was revised to correct errors identified by the cask vendor such as incorrect stress intensity values and stress comparisons, and uses the same methodology as was employed in the approved TN-32 TSAR. Therefore, the staff did not undertake a specific review of the revised analysis. The revised analysis concludes that the code allowable stresses on the bolts are not exceeded for both normal and accident conditions. As stated above, the staff previously concluded that the structural design of the TN-32 cask is in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied.

6.3 Reinforced Concrete Structures

The North Anna ISFSI includes three concrete storage pads, each 224-by-32 feet in area, on which the loaded casks will be placed. Forty feet long concrete ramps on each end of the pad are installed to enable the cask transporter to gain access to the pad. The overall area of the pad is 304 feet x 32 feet. Each storage pad is designed to accommodate 28 TN-32 casks arranged in 14 rows of two casks with a nominal center-to-center spacing of 16 feet in both directions. The pad is a nominal 24 inch thick reinforced concrete slab. The concrete is to be of the normal weight with a design compressive strength (fc') of 3000 psi. The re-bar is to be ASTM materials with a minimum yield strength (fy) equal to 60 ksi. While the pad is not classified as important to safety, it is evaluated to determine its adequacy for supporting the cask during normal operation and to ensure that the effects of the design earthquake do not place the cask in an unanalyzed condition.

6.3.1 Static Analysis

In a letter dated February 17, 1998, the applicant forwarded calculations which supported the design of the reinforced concrete ISFSI pad. The static analysis of the storage pad was performed to ensure that the pad has been designed to adequately support the static load of the stored casks. The storage pad design was analyzed using the Images-3D finite element computer program. The following codes and standards were used in the design and analysis of the pad:

(1) ACI 349, 'Code Requirements for Nuclear Safety Related Concrete Structures"

(2) ANSI/ANS 57.9, "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)"

(3) BOCA, "The BOCA National Building Code"

(4) ASCE 7, "Minimum Design Loads for Buildings and Other Structures"

Material properties were referenced to ASTM standards. The above cited codes and standards are commonly used commercial standards and are considered acceptable by the staff.

In the computer analysis, the soil stiffness was modeled as vertical translational springs placed at each node of the model. Each cask weight (250 kips) was modeled as a 50-kip load at the node directly beneath the centerline of the cask and 50 kips each at the four adjacent nodes. Loads, load combinations and design limits for the pad were in accordance with ANSI/ANS 57.9 which included wind load and tornado wind load. Loads from cask transporter were also considered. All of the cask loads and transporter loads were treated as live loads in the analysis, which carried a load factor of 1.7 in the load combinations. The load factors helped to increase the design loads and hence the design stresses for the concrete and the re-bar.

The storage pad was analyzed for five cask loading patterns in order to determine the maximum bending stress in the pad and for re-bar design. The maximum concrete stress occurred with the pad loaded with two center casks. Similarly, in evaluating the effect of cask transporter loads, the pattern with the transporter at the edge of the storage pad yielded the maximum stress in the pad among all the transporter load cases. Still, it was the loading with two center casks that produced the maximum bending stresses in the pad.

The design wind load was determined at a 100-year recurrence level in accordance with ASCE 7-88, with a basic speed of 70 mph. The design tornado wind load with a maximum speed of 360 mph was used to determine loads on the casks, cask sliding and overturning, and the effect on the pad. Both the design wind load and the design tornado wind load conditions were separately analyzed and calculated, their results were determined to be not critical.

The potential for cask sliding and overturning was also analyzed. The sliding and overturning analysis assumed a 7 feet cask diameter instead of 8 feet, the actual cask diameter. This yielded conservative results for the factors of safety against sliding and overturning.

As a result of the analyses and the calculations, the final re-bar layout is to be #10 at 12 inches each way at the top and bottom of the slab. The maximum concrete bending stress was determined to be 350 psi resulting from the load case of two casks at the pad center.

The static analysis for the North Anna ISFSI has been reviewed. The staff determined that the ISFSI pad design satisfies the design bases with an adequate margin of safety. The codes and standards used were acceptable, thus meeting the requirements of 10 CFR 72.24 (c)(3) and (c)(4). Also, the pad was designed to quality standards commensurate with its safety function. The pad was designed to accommodate normal and postulated accident conditions, and to withstand the effects of natural phenomena thus ensuring the casks meet the requirements of 10 CFR 72.122 (b)(1) and (b)(2).

The methodologies, loads and load combinations, calculations and site evaluations for the pad static analysis are in compliance with the pertinent requirements of the proposed design criteria. Therefore, the structural analysis demonstrated that the pad is capable of supporting the static cask loads.

6.3.2 Dynamic Analysis

A dynamic analysis was performed to determine the effect of the 0.18g DE on the stored casks and the concrete pad. A finite element model using the computer code SASSI was developed. The reinforced concrete slab was modeled by plate elements and the casks by rigid beams with their masses lumped at their center of gravity. Because of the symmetry of the pad, only a quarter of the pad was modeled.

The best estimate of soil profile was developed on the basis of soil boring logs underneath the pads. The soil time histories corresponding to the design earthquake motion for the NAPS were used as the seismic input for the soil-structure interaction analysis (SSI) defined at elevation 310 feet.

As described below, the applicant evaluated the potential for sliding or overturning of the casks as well as the stresses generated in the pad by seismic motion.

6.3.2.1 Cask Sliding and Overturning

From the time-history analysis, the accelerations and forces in the three directions for each node (cask) at each time increment were computed. The cask stability was analyzed using the three directional accelerations. As a result, the lowest factor of safety for sliding was slightly higher than one, and the lowest factor of safety for overturning was 1.6 contingent on the three components of accelerations. However, since the three components of the input were uncoupled, estimates of the factors of safety for sliding and overturning were re-calculated by using the 100%, 40%, 40% of the maximum responses for each direction as recommended in ASCE Standard 4-86, "Seismic Analysis of Safety-Related Nuclear Structures and Commentary *on Standard for Seismic Analysis of Safety-Related Nuclear Structures.*" The factors of safety for sliding and overturning obtained using the ASCE Standard 4-86 approach were 1.17 and 2.04 respectively, which are larger than the recommended value of 1.1 specified in NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems," and, therefore, are acceptable to the staff.

6.3.2.2 Stress Calculation

The computer module STRESS was used to calculate the seismic axial forces, in-plane shear forces and bending moments at all plate elements (pad) and in the beam elements (casks). The seismic maximum stresses attributable to each of the three components of the input motion were calculated and combined using the square-root, sum-of-squares techniques as recommended in RG 1.92. However, the moments and forces at the concrete pad were small and did not control the design of the slab.

6.3.2.3 Verification of SASSI Code

A model consisting of beam and plate elements was selected for SASSI code verification against a QA verified code. The SASSI code and the CLASSI code (a QA verified soil-structure interaction computer code) were used to analyze the same model. The results showed that for in-structure accelerations at the foundation; in-plane stresses, plate bending moments in plate elements; and the axial and shear forces, and bending moments in beam elements; both computer codes yielded very close results for the duration of the time-histories.

The approach used and the results obtained for verifying the SASSI computer code are acceptable.

6.3.3 Soil Liquefaction

Earthen materials encountered at the NAPS were categorized into five zones on the basis of general structural characteristics. Zone IIA saprolite appeared to contain zones of soil that were potentially liquefiable. NAPS main plant structures were partially supported by the zone IIA saprolite and partially founded on sound rock or compacted granular backfill. According to the exploratory borings performed by Dames and Moore (D&M) in 1968, the average thickness of saprolite across the NAPS site was approximately 40 feet.

The applicant did not specifically calculate factors of safety against liquefaction under the ISFSI pad. Rather, the applicant submitted an analysis of liquefaction, entitled "Soil Failure/ Liquefaction Susceptibility Analysis for North Anna Power Station (NAPS) - Seismic Margin Assessment," December 1994 (Liquefaction Report), which was performed for the NAPS site to support conclusions regarding liquefaction under the ISFSI pad.

The NUREG/CR-0098 soil spectrum normalized to a 0.3g zero period acceleration was used in the liquefaction analysis for the NAPS facilities. However, since the ISFSI is a new facility, the staff determined that the standards in Regulatory Guide 1.60, "Design Response Spectra for Seismic Design of Nuclear Power Plants," based on the North Anna site design earthquake (0.18g) were the appropriate licensing standards. NUREG/CR-0098 entitled "Development of Criteria for Seismic Review of Selected Nuclear Power Plants" published in 1978, was primarily intended for the review of seismic issues for plants under the Systematic Evaluation Program.

To justify the conservatism of the liquefaction analysis using NUREG/CR-0098 and a 0.3g PGA, the applicant submitted a letter, dated December 16, 1997, which included a study comparing the amplified response spectrum values for the NUREG/CR-0098 horizontal spectrum normalized to 0.3g PGA and the RG 1.60 horizontal spectrum with a 0.18g PGA.. Both cases used 5% damping. The study showed that the NUREG/CR-0098 response spectrum itself was less conservative than the response spectrum specified by RG 1.60. However, because of the large margin of 0.3g over 0.18g as seismic input, the combined amplified response spectrum values using NUREG/CR-0098 spectrum envelop those using the RG 1.60 response spectrum. Therefore, the liquefaction analysis was conservative and therefore acceptable with respect to licensing under 10 CFR Part 72.[2]

In the Liquefaction Report, the applicant assumed a Review Level Earthquake (RLE) with a peak horizontal ground acceleration of 0.3g and seismic characteristics consistent with the seismic design spectrum described in NUREG/CR-0098, "Development of Criteria for Seismic

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[2] No statements made in this Safety Evaluation Report regarding the use of NUREG-0098 and the applicants Liquefaction Report should be taken as a staff conclusion regarding the acceptability of the applicant's response to Generic Letter 88-20, Supplement 4, "Individual Plant Examination for External Events."

Review of Selected Nuclear Power Plants." The Liquefaction Report, which was generated to support the applicant's response to Generic Letter 88-20, Supplement 4, specifically evaluated liquefaction susceptibility under main plant structures such as the main steam valve house, auxiliary building, service building and turbine building and under the service water reservoir area.

Three approaches were used in the liquefaction assessment of the soils at the NAPS site. Specifically, these included (1) a simplified procedure founded on standard penetration testing (SPT), (2) threshold shear strain analysis, and (3) cyclic triaxial testing. Approaches (1) and (2) were used for the main plant area and approach (3) was used for the Service Water Reservoir area. All of the three approaches are current state-of-practice techniques. For the main plant structures, the resulting factors of safety ranged from 1.54 to 3.51 against liquefaction, showed no liquefaction damage or related effects, and showed that significant pore pressure generation was not likely to occur. For the Service Water Reservoir area, Cyclic Triaxial Tests were performed on the undisturbed samples in the vicinity of the pump house and in the general area. The liquefaction resistance associated with these samples was used to estimate the factors of safety. The resulting factors of safety ranged from 1.51 to 1.99.

Although an evaluation of safety margins to soil liquefaction for the ISFSI pad was not specifically performed, all evaluated NAPS facilities were shown to have high factors of safety against liquefaction. Therefore, it was reasonable to conclude that liquefaction would not occur for the ISFSI.

The dynamic analysis for the North Anna ISFSI has been reviewed. The staff determined that the requirements of 10 CFR 72.102 (c), (d), and (f)(1) regarding geological and seismological characteristics, and natural phenomena protection were met. In addition, the staff concluded that the requirements of 10 CFR 72.122 (b)(2) and (b)(3) regarding the ability of structures, systems and components to withstand natural phenomena were met. The factors of safety for sliding and overturning met the recommended values of 1.1 specified in NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems." The finite element modeling and computer codes used were satisfactorily benchmarked for various types of structural analyses.

The loads, load factors and load combinations, the structural analyses and the design were in general in accordance with ANSI/ANS-57.9, ASCE 7, and ACI 349.

Seismic stress combinations were consistent with RG. 1.92. The recommendations defined in ASCE 4-86, "Seismic Analysis of Safety-Related Nuclear Structures and Commentary on Standard for Seismic Analysis of Safety-Related Nuclear Structures," for combining the three directional accelerations were acceptable.

The prediction methods used for liquefaction analysis were within commonly used industrial practice. Since the NAPS site facilities were shown to have high factors of safety against liquefaction, it is reasonable to judge that liquefaction is not likely to occur for the ISFSI which is on the same site with other NAPS facilities.

6.4 Other SSCs Important to Nuclear Safety

As stated in Section 4.5 of the North Anna ISFSI SAR, certain cask handling equipment used during loading and unloading is considered important to safety because the cask is not designed to withstand their failure. The cask handling equipment under consideration is operated within the confines of the NAPS structures, and thus subject to the requirements of the NAPS license under 10 CFR Part 50, up to the point that the cask is placed in the transporter for removal to the ISFSI (i.e., to the concrete pad).

The staff did not undertake a specific structural review of the cask handling equipment used within the NAPS as part of the review of the 10 CFR Part 72 license application because it is subject to review under the provisions of the NAPS license under 10 CFR Part 50.

6.5 Findings

F6.1 The design, design bases, layout and relation to the site conditions of the ISFSI are adequately described in the North Anna ISFSI SAR and are acceptable and in compliance with 10 CFR 72.24.

F6.2 The applicant's proposed design complies with the requirements of 10 CFR Subpart F, as required by 10 CFR 72.40(a)(1).

7.0 THERMAL EVALUATION

The objective of the thermal review is to ensure that the temperatures of the stored fuel material and of SSCs important to safety remain within the allowable values or criteria for normal, off-normal, and accident conditions consistent with the regulatory requirements of Subpart F to 10 CFR Part 72. The applicant will use the TN-32 spent fuel storage cask at the North Anna ISFSI. To perform its review, the staff compared the key thermal assumptions, bounding site characteristics and environmental conditions, and cask-ISFSI interface requirements identified in the TN-32 TSAR sections applicable to the North Anna ISFSI design and environmental conditions.

This review was performed according to Chapter 8 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

7.1 Heat Removal System

The TN-32 thermal design criteria for normal conditions is specified in Section 2.3.2.2 of the TN-32 TSAR. Section 4 of the TSAR describes the heat removal system as completely passive. The decay heat is transferred from the fuel assemblies to the outer environment. The helium in the cask cavity aids in the transport of decay heat from the fuel assemblies to the cask inner wall. The TSAR considered casks stored on unenclosed concrete pads with a 16 foot center-to-center spacing.

In Chapter 4 of the TN-32 SER, the staff found that the SSCs important to safety were described in sufficient detail to enable evaluation of the effectiveness of their thermal performance. The staff also concluded that the TN-32 cask is designed with a heat removal capability having testability and reliability consistent with its importance to safety, as required by 10 CFR 72.24 (c)(3) and 72.128(a)(4).

The North Anna ISFSI is a passive installation consisting of an unenclosed concrete pad. Section 4 of the North Anna ISFSI TS specifies certain design features of the ISFSI. The TS specify that the nominal center-to-center spacing for the storage casks is 16 feet. The only design change to the TN-32 cask proposed by the applicant is the use of shims between the inner vessel flange and the outer gamma shield. This change was described in the applicant's letter dated May 18, 1998. The shims do not affect the TN-32 thermal analysis. The staff concluded that the TN-32 cask is designed with a heat removal capability having testability and reliability consistent with its importance to safety and that the North Anna ISFSI does not adversely impact the heat removal capability; in compliance with 10 CFR 72.128(a)(4).

7.2 Thermal Loads and Environmental Conditions

Section 2.1 of the TSAR describes the design-basis fuel characteristics and the design-basis external environmental conditions. The design-basis fuel characteristics include (1) an initial maximum average decay heat per spent fuel assembly of 0.847 kW (27.1 kW total per cask) and (2) a 7-year minimum cooling time. These characteristics are consistent with an initial enrichment of 3.85% and a maximum average burnup of 40,000 MWD/MTU. The bounding external environmental storage conditions are listed in Table 2.5-1 of the TN-32 TSAR.

Minimum and maximum ambient temperatures of -20°F to 115°F were assumed respectively. Maximum solar heat loads for flat and curved surfaces of 2950 and 1474 BTU/ft^2 respectively were assumed. Section 11.2.4 of the TN-32 TSAR states that the cask is designed to withstand 25 psi external pressure. Section 11.2.5 of the TSAR also describes the external conditions assumed for the TN-32 accident condition of a fire. The only fire considered is a 200 gallon fuel fire from the transporter tow vehicle. The analysis demonstrated that the assumed fire does not compromise the containment integrity of the TN-32 cask.

In Section 4 of the TN-32 SER, the staff concluded that the spent fuel cladding is protected against degradation that leads to gross ruptures by maintaining the cladding temperature for 7-year cooled PWR fuel below 348° C and by maintaining an inert helium environment. The staff found that these measures, along with the basket structural design features protect the cladding against degradation that leads to gross rupture and which will allow retrieval of spent fuel for further processing or disposal. This is in compliance with 10 CFR 72.122(h)(1) and 10 CFR 72.122(l).

The bounding external environmental storage conditions for the North Anna ISFSI are listed in Table 3.4-1 of the North Anna ISFSI SAR. The minimum and maximum assumed environmental temperatures are -20°F and 115° F which are the same as those considered in the TN-32 TSAR. Additionally, the heat loads for flat and curved surfaces (direct exposure to sunlight) are also the same as those considered in the TN-32 TSAR. With respect to fuel characteristics, Table 2.1-1 of the North Anna ISFSI TS lists the fuel functional and operating limits. These limits are the same as those considered in the TN-32 TSAR.

The ISFSI includes a backup diesel generator and its associated monitored, double walled fuel tank within the ISFSI security fence. This combustible source was not considered in the TN-32 TSAR. However, this tank has a maximum capacity of 200 gallons which is the same size as what was considered for the transporter tow vehicle fuel fire above. Additionally, Section 8.2.5 of the North Anna ISFSI SAR considers a small electrical fire at the ISFSI. This fire is bounded by the fuel fire analyzed in the TN-32 TSAR. No other combustibles or explosives are stored at the ISFSI. Since the containment integrity of the TN-32 is not breached during the postulated fire, no fire protection system other than portable fire extinguishers is located at the ISFSI. Also, the fire fighting equipment and personnel at the NAPS would be available if needed.

No explosion hazards are identified at the ISFSI. Explosion hazards attributable to vehicular traffic are discussed in Section 2 of this SER and have a minimal effect on the ISFSI, therefore no explosion detection systems are necessary.

The staff concludes that the applicant has provided an acceptable basis for the ISFSI design and location of safety-related structures and systems to minimize the effect of fire and explosions; has used noncombustible and heat resistant materials whenever practical; has provided fire detection and fire fighting systems of appropriate capacity and capability to minimize adverse effects of fire on systems important to safety; and does not require explosion detection systems. Therefore, the proposal is in compliance with 10 CFR 72.122(c).

7.3 Thermal Analysis

Section 4.4 of the TN-32 TSAR describes the model used to evaluate thermal performance. The model considers the spent fuel assemblies, the basket, the cask body, and the concrete storage pad. The concrete storage pad was modeled as a 36 inch thick cylinder extending radially 36 inches beyond the outer diameter of the bottom of the cask. The bottom of the pad is in contact with the soil and is assumed to be isothermal. The bottom of the storage cask is assumed to be in contact with the storage pad. The thermal accident scenario (fire) described in Section 11.2.5 of the TN-32 TSAR uses the same model as is used in Section 4.4 of the TN-32 TSAR.

The material properties of the cask are given in section 4.2 of the TN-32 TSAR. These reflect the accepted values of the thermal properties of the materials specified for the construction of the cask. The calculated maximum temperatures for normal and accident conditions are less than the maximum allowable temperatures specified in the cask design criteria. The calculated maximum cask cavity pressures for normal and accident conditions are below the design pressure of 100 psig specified in Section 2.2.5.3.3 of the TN-32 TSAR.

The staff's confirmatory analysis is discussed in Section 4.3.4.4 of the TN-32 SER. The TN-32 SER states that the staff's confirmatory analysis for the normal and accident storage conditions demonstrated substantial agreement with the TN-32 TSAR results. The staff also concluded that the maximum temperatures of the cask components and spent fuel clad are less than the TN-32 vendor's design criteria. Finally, the staff concluded that the cask pressure resulting from the average cavity temperature coupled with the failure of all of the spent fuel rods is less than the specified design criteria.

As described in Section 4 of the TN-32 SER, the staff found that the thermal systems and components important to safety had been analyzed and evaluated to assess their adequacy for protecting the health and safety of the public. The staff concluded that the TN-32 cask is able to safely store fuel for 20 years with an adequate margin of safety.

The North Anna ISFSI is a two-foot thick concrete pad which is bounded by the three foot thick concrete pad analyzed in the TN-32 TSAR. The applicant did not propose any design or operational changes to the TN-32 cask which affect the thermal analysis. On the basis of its review of the North Anna ISFSI SAR, the TN-32 TSAR and the TN-32 SER, the staff concludes that the description of the thermal systems and components important to safety and the evaluation of those systems satisfies the requirements of 10 CFR 72.24(d). The staff further concludes that the spent fuel cladding will be protected against degradation during the period of the license in compliance with the requirements of 10 CFR 72.122(h)(1) and that the ISFSI is designed to effectively perform its safety function effectively under credible fire and explosion conditions in compliance with 10 CFR 72.122(c).

7.4 Evaluation Findings

The following findings are predicated on the staff's review of the TN-32 TSAR and the North Anna ISFSI SAR:

F 7.1 The staff concludes that thermal SSCs important to safety are described in sufficient detail to enable an evaluation of their effectiveness; in compliance with 10 CFR 72.24(c)(3).

F7.2 The staff concludes that the site-specific fire and explosion hazards, as described in the North Anna ISFSI SAR, are acceptable and that the fire protection program's design criteria and bases are acceptable and meet the requirements of 10 CFR 72.122(c).

F7.3 The staff concludes that the spent fuel cladding is protected against degradation that leads to gross ruptures by maintaining the cladding temperature for 7-year cooled PWR fuel below 348 degrees C in a helium environment. Protection of the cladding against degradation will allow ready retrieval of spent fuel for further processing or disposal; in compliance with 10 CFR 72.122(h)(1) and 72.122(l).

F7.4 The staff concludes that the TN-32 cask is designed with a heat removal capability having testability and reliability consistent with its importance to safety, as required by 10 CFR 72.128(a)(4).

8.0 RADIATION PROTECTION EVALUATION

The regulatory requirements for having a radiation protection program commensurate with licensed activities and which provides a means for controlling radiation exposures are found in 10 CFR 20.1101, 72.24, and 72.126. Other regulatory requirements for limiting exposure to occupational workers and the offsite public are found in 10 CFR Part 20, Subpart C and Subpart D, and 10 CFR 72.104 and 72.106.

This review was performed according to Chapter 9 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

8.1 Satisfaction of ALARA Objectives

As described in the North Anna ISFSI SAR, the program to ensure that radiological doses are "as low as is reasonably achievable" (ALARA) for the North Anna ISFSI will be the same as the ALARA program for the NAPS and is referred to as the Virginia Power ALARA Program. The basic principles of the ALARA program are described in Virginia Power administrative procedures and implemented by North Anna health physics technical procedures.

The NAPS ALARA program follows the guidance in RG 8.8, "Information Relevant To Ensuring That Occupational Radiation Exposures At Nuclear Power Stations Will Be As Low As Is Reasonably Achievable," and RG 8.10, "Operating Philosophy For Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable." The ALARA program includes the following elements:

(1) Identification of specific individuals with specific responsibility for and authority to implement the ALARA program

(2) An ALARA committee with responsibility to coordinate the station ALARA program and to advise the Station Manager on matters which involve ALARA

(3) Requirements for pre-job measures which include ALARA evaluations of proposed work, pre-job meetings, and tiered levels of review contingent on projected person-rem

(4) Monitoring and controlling on-going work through an exposure tracking system, ALARA hold points, and ALARA radiation work permit re-evaluation meetings

(5) Post-job reviews of completed work

(6) An ALARA review of engineering design changes before implementation.

The site of the ISFSI was chosen because it was centrally located on the NAPS site and will thus minimize any offsite exposures. The ISFSI site is also removed from the buildings and occupied sites in order to reduce the exposure to station personnel. The layout of the ISFSI itself is designed to minimize personnel exposures. Finally, the surveillance and maintenance requirements for the cask are minimal which reduces radiological dose to station maintenance personnel.

After reviewing the above information, the staff concludes that the applicant's description of the ALARA program satisfies the requirements of 10 CFR 72.24(e).

8.2 Radiation Sources

As part of the cask loading process, the exterior surface of the cask will be decontaminated before to transfer to the ISFSI. During the storage period, the casks will not be opened after placement at the ISFSI. Therefore, the principle source of radiation from normal operations will be the direct radiation from the fuel stored in the casks.

The spent fuel to be stored at the ISFSI must have an initial enrichment ≤3.85 %, a maximum average burnup of ≤40,000 MWD/MTU, and a cooling time ≥7 years. Cask-specific analyses were performed for representative NAPS fuel. Neutron and gamma source terms for the stored spent fuel were generated using the OREST (ORIGEN II) computer code.

8.3 Radiation Protection Design Features

The ISFSI will consist of three concrete storage pads on which the loaded storage casks will be placed. The storage pads will be constructed one at a time, as needed.

Access to the ISFSI is limited to personnel needed during operations at the ISFSI. The ISFSI will be surrounded by a security fence and a perimeter fence. Types of operations to be conducted at the ISFSI include periodic inspections of the facility, placement of loaded casks, and routine security checks. The perimeter fence will have a locked gate and control of the keys will be in accordance with security and health physics polices and procedures.

Currently, the TN-32 dry storage system is the only system proposed for use at the North Anna ISFSI. The major components of the TN-32 cask include a carbon steel cylindrical containment vessel with an integrally welded carbon steel bottom closure, bolted carbon steel lid closure, steel gamma shield and borated polyester resin compound neutron shield. The evaluation of the TN-32 shielding design in the TN-32 SER states, "design of the shielding system is in compliance with 10 CFR Part 72 and the applicable design and acceptance criteria have been satisfied. The evaluation of the shielding design provides reasonable assurance that the TN-32 will enable safe storage of spent fuel." In a letter dated May 18, 1998, the applicant described a change to the TN-32 design to fill the gap between the inner vessel flange and the gamma shield with steel shims. The gap that remains between the shim and the cask components is very small (maximum 0.03") and occurs at the top of the cask. There is no line of sight path from a radiation source. Therefore, no significant increase in dose rate is expected. Given the proposed controls described above and the applicant's proposed use of the TN-32 cask, the staff concludes that the applicant has satisfied the requirements of 10 CFR 72.126(a) and 72.128(a)(2).

There is no forced ventilation of the casks. Natural air flow around the storage casks provides sufficient cooling for the spent fuel. As described in Section 11 of this SER, the TN-32 cask is not expected to leak under normal or accident conditions. Therefore, the staff concludes that airborne radioactivity monitors described in 10 CFR 72.126(c)(1) are not required at the ISFSI.

8.4 Estimated Onsite Collective Dose Assessment

Cask specific analyses were performed for representative NAPS fuel to determine the gamma and neutron doses. ANISN and DOT or similar computer codes were used by cask vendors to calculate the surface fluxes. The flux-to-dose-rate conversion factors used were from ANSI/ANS 6.1.1-1977. From the analyses, the design-basis side-surface dose rate would be 129 mrem/hr from neutron and gamma. The design-basis top surface dose rate would be 55 mrem/hr from neutron and gamma.

The dose rates at various distances from the loaded casks were calculated. For neutron doses, scattering and cask surface neutron leakage were included in the calculations. Skyshine was included in the calculations for the gamma dose. On the basis of these calculations, the maximum dose rate (neutron plus gamma) at the ISFSI fence line would range from 0.16 mrem/hr at the north fence to 1.02 mrem/hr at the east fence.

Occupational exposures to station personnel have been evaluated for ISFSI operations. The design-basis surface dose rates were used in the evaluations. The estimated dose from loading, transport and emplacement of a single cask is 1.46 person-rem. Given the experience gained by Virginia Power at the Surry Power Station ISFSI, the estimated dose from loading, transport, and emplacement is conservative, and the dose would actually be approximately 0.25 person-rem.

The annual occupational exposures from routine maintenance activities such as visual surveillance of casks operability tests, calibration and repair of instrumentation, and repair of defects was evaluated. The evaluation used the design-basis surface dose rates and assumed the ISFSI was filled to design capacity. The estimated annual exposure of maintenance activities would be 0.30 person-rem.

The estimated annual exposures from ISFSI related activities is a small percent of the average annual occupational exposure from all operations associated with operating the NAPS. There is reasonable assurance that individual exposures will be below the annual occupational limit of 5 rem specified in 10 CFR 20.1201.

The applicant proposed TS to ensure that design-basis dose rates are not exceeded and to ensure that 10 CFR Part 20 requirements are met. TS 3.3.1 provides specific limits on top and side neutron and gamma dose rates for the casks and provides an acceptable surveillance requirement. The values provided in TS 3.3.1 are consistent with the design basis and are therefore acceptable. TS 3.3.2 provides specific limits on cask exterior surface loose contamination levels and provides an acceptable surveillance requirement.

In light of the above discussion, the staff concludes that the North Anna ISFSI satisfies the requirements of 10 CFR 72.128(a)(2).

8.5 Health Physics Program

The current health physics (HP) program for the NAPS will be modified to incorporate activities at the ISFSI. The HP organization described in administrative procedures will also be responsible for health physics activities at the ISFSI. Virginia Power personnel qualifications and experience for power plant operations are adequate for ISFSI operations.

NAPS health physics equipment, instrumentation and facilities will be used for ISFSI operations and surveys. Available equipment includes count room equipment, portable radiation measuring instruments, personnel monitoring equipment, and protective equipment. The bioassay program for plant personnel in use at the NAPS will be the same for the ISFSI.

Current HP procedures for the NAPS will be revised to reflect the activities to be conducted at the ISFSI. All radiation surveys conducted at the ISFSI will be conducted in accordance with approved HP procedures in effect for the NAPS. Testing guidance, rejection criteria, and use of dosimeters will be the same for the ISFSI as for the NAPS. Requirements to have HP and ALARA procedures are specified in TS 5.4.1.i. On the basis of the above information, the staff concludes there is reasonable assurance that individual exposures will be below the annual occupational limit of 5 rem specified in 10 CFR 20.1201.

8.6 Direct Dose to the Offsite Public

As further discussed in Section 10 of this SER, there will be no gaseous or liquid radioactive effluents from normal operations of the ISFSI, so the dose to the offsite public is attributable to direct radiation from the spent fuel stored in the casks. The minimum distance from the ISFSI to the site boundary is approximately 2500 feet in the southwest sector. The nearest resident is located approximately 2800 feet away from the ISFSI. An Environmental Assessment (EA) was performed by NRC staff to evaluate the impact to the environment from construction and operation of the ISFSI. On the basis of the EA, the radiological impact to the nearest resident from routine operations would be about 10 μSv/yr (1.0 mrem/yr). The cumulative dose the nearest resident would receive from the NAPS and the ISFSI would be about 58 μSv/yr (5.8 mrem/yr), which is well below the limits specified in 10 CFR 20.1301, 10 CFR 72.104, and 40 CFR Part 190. As the estimate of the cumulative effects of the ISFSI and NAPS combined operation are well below applicable regulatory limits, the staff concludes that the proposed ISFSI satisfies the requirements of 10 CFR 72.122(e) and 72.126(d) with regard to normal operation.

Given the description of potential dose to an individual outside the controlled area from direct radiation described in the North Anna ISFSI SAR, the staff concludes that the applicant has satisfied the requirement of 10 CFR 72.24(m) for ISFSI operation.

The applicant has also proposed use of thermo-luminescent detectors (TLDs) placed on the ISFSI perimeter fence to monitor direct gamma radiation doses from the ISFSI. The applicant has proposed TS limits on the ISFSI perimeter radiation levels to ensure that regulatory requirements on radiation dose to the general public from the ISFSI are met. Proposed TS 3.3.3 includes limits on perimeter radiation levels and an acceptable surveillance requirement. The staff concludes that the use of the TLD and the periodic TS surveillance are adequate for compliance with the requirements of 10 CFR 72.126(c)(2).

8.7 Findings

F8.1 The design and operating procedures of the ISFSI provide acceptable means for controlling and limiting occupational radiation exposures within the limits given in 10 CFR Part 20 and for meeting the objective of maintaining exposures ALARA, in compliance with 10 CFR 72.24(e).

F8.2 The North Anna ISFSI SAR includes an acceptable analysis of the potential dose equivalent or committed dose equivalent to an individual outside the controlled area from direct radiation from the ISFSI in compliance with 10 CFR 72.24(m).

F8.3 The proposed ISFSI is to be on the same site as the NAPS. The cumulative effects of the combined operations of these facilities will not constitute an unreasonable risk to the health and safety of the public, in compliance with 10 CFR 72.122(e).

F8.4 The North Anna ISFSI SAR provides information showing that releases to the general environment during normal operations and anticipated occurrences will be within the exposure limit given in 10 CFR 72.104, thus satisfying the requirements of 10 CFR 72.126(d) for normal operation.

F8.5 The design of the ISFSI provides suitable shielding for radiation protection under normal and accident conditions, in compliance with 10 CFR 72.126(a) and 72.128(a)(2).

F8.6 The staff concludes that the use of the TLD and the periodic TS surveillance are adequate for compliance with the requirements of 10 CFR 72.126(c)(1) and 72.126(c)(2).

9.0 CRITICALITY

Requirements for the prevention of criticality in independent spent fuel storage installations are detailed in the design criteria in 10 CFR 72.124. That standard includes requirements that spent fuel storage systems must be designed to maintain subcritical conditions with margins of safety that account for uncertainties in the data and methods used in the criticality calculations. Storage system designs must ensure that before a criticality accident occurs, at least two unlikely, independent and concurrent or sequential changes have occurred in conditions essential to criticality. Methods of criticality control must be predicated on favorable geometry or fixed neutron absorbers or both.

NRC staff acceptance criteria for criticality control design features are detailed in Chapter 10 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

9.1 Design Features and Operations to Ensure Subcriticality

The applicant will use the TN-32 cask for storage of spent fuel at North Anna. Criticality design evaluations for the TN-32 are described in Chapter 6 of the TN-32 TSAR. The TN-32 cask incorporates several design and operational methods to prevent criticality. The design incorporates neutron absorbing material in the form of borated aluminum plates in the basket. From an operational standpoint, it is assumed that a minimum dissolved boron concentration of 2000 ppm in the spent fuel pool is present during cask loading and unloading activities. It is also assumed that operational controls are implemented to prevent fresh water from entering a cask loaded with spent fuel. In addition, it is assumed that the initial enrichment of the fuel is limited to no more then 3.85 % wt. The design analysis took into consideration these design and operational assumptions along with the geometry of the fuel inside the loaded cask.

In a letter dated January 30, 1998, the applicant proposed to load only two specific fuel assembly types, the Westinghouse 17x17 Standard and the Westinghouse 17x17 Vantage 5H, into the TN-32 casks at North Anna. The applicant proposed to include in the TS limitations on the initial enrichment (TS 2.1.1; $\leq$ 3.85 % wt) and fuel assembly design (TS 2.1.1; Westinghouse 17x17 Standard or 17x17 Vantage 5H) and on the boron concentration in the water to be placed in the cask cavity (TS 3.2.1; $\geq$ 2000 ppm). In a letter dated May 28, 1998, the applicant revised the proposed TS 3.2.1 to include a requirement for two independent samples of boron concentration associated with cask loading and unloading activities. This satisfies the requirements of 10 CFR 72.124(a).

9.2 Criticality Analysis

In the TN-32 TSAR, the criticality evaluation of the TN-32 was performed for two fuel assembly types, a Westinghouse 15x15 assembly and a Westinghouse 17x17 OFA assembly. As described in the Chapter 6 of the TN-32 SER, the staff found that for both the 15x15 and 17x17 OFA PWR assemblies, the calculated value of k_{eff}, was less than 0.95, taking into account statistical uncertainties and biases. The staff concluded that the TN-32 cask was designed to remain subcritical under all credible conditions and that the fixed neutron poisons in the cask design would remain effective for the proposed 20-year storage period. The staff concluded that the criticality design of the TN-32 cask was in compliance with 10 CFR Part 72 and that applicable design and acceptance criteria were satisfied.

In a letter dated January 30, 1998, the applicant noted it intended to load only Westinghouse 17x17 Standard and Westinghouse 17x17 Vantage 5H assemblies into the TN-32 casks. The applicant observed that further analysis by TN showed that the 17x17 Standard assembly was not bounded by the criticality analysis of the 17x17 OFA presented in the TN-32 TSAR. The results of the further analysis showed that for the 17x17 Standard assembly with fuel assemblies centered in each fuel compartment, k_{eff} = 0.9225. For the 17x17 Standard assemblies, a calculation was also performed assuming the fuel assemblies were all shifted toward the center of the cask. In this case, k_{eff} was calculated to be 0.9222. The applicant stated that the Vantage 5H model differed from the 17x17 Standard in the use of some materials for the fuel assembly hardware. For example, the 17x17 Standard design has eight Inconel grid spacers whereas the Vantage 5H assembly has six zirconium alloy spacers and two Inconel spacers. However, the applicant stated that all dimensions important to criticality (e.g., fuel pellet diameter, fuel rod diameter, fuel rod pitch and fuel stack height) were the same for the Standard and Vantage 5H assemblies. The applicant concluded that these fuel assembly differences had no effect on the criticality analysis. The staff confirmed that dimensions important to criticality were the same for the Vantage 5H and the Standard assemblies and agrees that the assemblies were the same for criticality considerations.

Given the information provided by the applicant regarding specific planned use of the TN-32 cask at North Anna and the proposed TS controls, the staff concludes that the proposed North Anna ISFSI design and operation meets the requirements of 10 CFR 72.124(a) and (b) with the exception of the requirement to periodically verify neutron absorber efficacy. The staff has granted an exemption from this requirement as detailed in Section 13 of this SER. Because the spent fuel at North Anna will be handled underwater and stored dry and packaged in a licensed configuration, pursuant to 10 CFR 72.124(c), criticality monitoring is not required.

9.3 Findings

On the basis of (1) the TS proposed by the applicant, (2) the information provided by the applicant, and (3) the analysis and review of the TN-32 cask design documented in the TN-32 TSAR and TN-32 SER, the staff reached the following findings:

F9.1 The designs and proposed use of the North Anna ISFSI, using the TN-32 storage cask and associated systems, for the handling, packaging, transfer and storage for the radioactive material to be stored acceptably ensure that the materials will remain subcritical and that, before a nuclear criticality accident is possible, at least two unlikely, independent and concurrent or sequential changes must occur in the conditions essential to nuclear criticality safety. The North Anna ISFSI SAR analyses and the submittal dated January 30, 1998, and the TN-32 TSAR analysis adequately show that acceptable margins of safety will be maintained in the nuclear criticality parameters, commensurate with uncertainties in the data and methods used in calculations. They also demonstrate safety for the handling, packaging, transfer and storage conditions in the nature of the immediate environment under accident conditions in compliance with 10 CFR 72.124(a) and (b), except for the requirement to periodically verify neutron absorber efficacy.

10.0 CONFINEMENT EVALUATION

NRC regulations at 10 CFR 72.122(h) and 72.128(a) provide requirements for confinement barriers and systems including requirements for the prevention of gross fuel ruptures, ventilation systems where necessary, monitoring of confinement integrity and retrieval of stored fuel. General requirements regarding adequacy of the description of confinement systems in the application are specified in 10 CFR 72.24. Because the proposed ISFSI is not a pool type facility, the requirements of 10 CFR 72.122(h)(2) are not applicable.

This review was performed according to Chapter 11 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

10.1 Confinement Design

The applicant has elected to use the TN-32 cask for initial licensing and storage operations at the North Anna ISFSI. The TN-32 confinement boundary includes the inner shell, the shell bottom plate and top flange, the bolted lid assembly outer plate with an inner metallic O-ring, and the bolted vent/drain port covers with inner O-rings. The only penetrations in the primary confinement are the opening for the lid assembly and the vent and drain ports. The penetrations are closed by the lid assembly outer plate and the vent/drain port covers, all of which are sealed by two metallic O-rings. The TN-32 is backfilled with helium to protect the fuel against degradation during storage. The TN-32 casks are designed, fabricated, and examined to the maximum extent practical in accordance with ASME Boiler and Pressure Vessel Code Section III, Division 1, Section NB.

In Section 3.3.2.1 and Appendix A of the North Anna ISFSI SAR, the applicant references the TN-32 confinement design. The staff concludes that this reference and the confinement description in the TN-32 TSAR satisfy the requirements of 10 CFR 72.24(c) and (d) with regard to confinement.

10.2 Confinement Monitoring

The region between the inner and outer seals of the cask lid is pressurized with helium to an initial pressure greater than the pressure inside the sealed cask. The regions between the inner and outer seals of the vent and drain ports are connected to the region between the lid seals by paths drilled into the cask lid. This is done so that in the event of an unanticipated failure of any of the inner (or primary) confinement seals, the helium will leak into the cask cavity or the vent port.

The inter-seal region is monitored by a PMS. When the interlid pressure falls below a preset value, as a result of a leak of either the inner or outer seal, the pressure switch will cause an alarm to activate at a local alarm panel and in the NAPS Central Alarm Station. Upon receipt of an alarm, security staff will notify the NAPS Control Room Shift Supervisor who will direct operators to check the cause of the alarm and will initiate appropriate corrective action.

The applicant proposed a TS requirement (TS 3.1.4) to verify seal integrity every 24 hours.

Given the above description of the PMS and proposed TS requirements, the staff concludes that the design and operation of the North Anna ISFSI is in compliance with the requirements of 10 CFR 72.122(h)(4) and therefore is acceptable. The staff also concludes that the confinement monitoring provided by the PMS is sufficient to satisfy the requirements of 10 CFR 72.122(l) as it pertains to confinement.

10.3 Confinement Analysis

A confinement analysis was provided in the TN-32 TSAR to demonstrate compliance with the applicable dose limits in 10 CFR Parts 20 and 72 and shielding requirements in 10 CFR Part 72. Under design-basis normal and accident conditions, the TN-32 provides a primary and redundant sealing confinement boundary. In addition to the credible accident conditions evaluated in the TN-32 TSAR, the TN-32 TSAR also postulated an event which assumed a breach of the cask seal barriers and removal of the closure lids and which assumed failure of both the fuel pellets and cladding such that ^{85}K, ^{129}I and tritium are released to the environment. Such an event is not considered credible for the North Anna ISFSI. The TN-32 confinement system has been evaluated to demonstrate that it will reasonably maintain confinement of radioactive material under normal, off-normal, and accident conditions. In the TN-32 SER, the staff stated that the evaluation of the TN-32 confinement system design provides reasonable assurance that the TN-32 cask will enable safe storage of spent fuel.

The North Anna ISFSI applicant has evaluated the dose from a hypothetical loss of confinement accident using site-specific information. Site-specific meteorological information, source term, and fuel characteristics were used in the calculation of the dose at the nearest site boundary. The staff reviewed the applicant's analysis of a postulated loss of confinement. For the hypothetical loss of confinement accident with the release of I^{129}, Kr^{85}, and tritium, the total effective whole body dose and thyroid dose are a small fraction of the 5 rem siting evaluation factor in 10 CFR 72.106(b).

Given the information provided in the North Anna ISFSI SAR and the TN-32 TSAR, doses to the public from normal operations and anticipated occurrences will be within the siting evaluation factor in 10 CFR 72.104. Projected releases from accident scenarios will be within the limit in 10 CFR 72.106(b). On the basis of the applicant's proposed use of the TN-32 cask and the confinement evaluation presented above, the staff concludes that the North Anna ISFSI confinement features meet the requirements of 10 CFR 72.122(h)(5). Given the sealed cask design and the staff's conclusion that confinement integrity will be maintained for the duration of the license, the staff concludes that ventilation and offgas systems discussed in 10 CFR 72.122(h)(3) are not necessary and that the design is sufficient to preclude transport of radioactive material to any major water resources as required by 10 CFR 72.122(b)(4).

10.4 Estimated Offsite Dose Assessment

As discussed above, there will be no gaseous or liquid radioactive effluents from normal operations of the ISFSI, so the dose to the offsite public is attributable to direct radiation from the spent fuel stored in the casks. The minimum distance from the ISFSI to the site boundary is approximately 2500 feet in the southwest sector. The nearest resident is located approximately 2800 feet away from the ISFSI. An assessment was performed by NRC staff to evaluate the impact to the environment from construction and operation of the ISFSI. On the basis of the assessment, the radiological impact to the nearest resident from routine operations would be about 10 μSv/yr (1.0 mrem/yr). The cumulative dose the nearest resident would receive from the NAPS and the ISFSI would be about 58 μSv/yr (5.8 mrem/yr), which is well below the limits specified in 10 CFR 20.1301, 10 CFR 72.104, and 40 CFR Part 190.

10.5 Protection of Stored Material From Degradation

After the cask is loaded with fuel, the cask lid is bolted in place engaging the double seal rings in the process. The cask is vacuum dried and back filled with helium and leak tested. The inert helium backfill is provided to prevent air inleakage to the cask cavity which could damage the fuel cladding during the period of storage. In the TN-32 TSAR, a leakage rate acceptance criteria was calculated to ensure that the helium pressure in the inner seal space was always greater than the pressure inside and outside the cask, thus preventing escape of radioactive gases or in leakage of air. The calculated leak rate was 1×10^{-5} std cc/sec. The applicant proposed a TS control on the cask seal initial leakage rate (TS 3.1.3) of 1×10^{-5} mbar-liter/sec, which is equivalent to the value calculated in the TN-32 TSAR. The staff concluded that this value is acceptable.

In the TN-32 TSAR, the vendor evaluation of cask helium pressure over a 20-year storage period assumed an initial cask cavity pressure of 2.2 atm. The applicant proposed a TS control (TS 3.1.2) on helium backfill pressure. The applicant proposed a TS limit for helium back pressure for the TN-32 cask at the North Anna ISFSI of 2230 mbar, which is equivalent to the value assumed in the TN-32 TSAR, and which the staff thus concludes is acceptable.

In Section 8.1.3 of the TN-32 TSAR, the vendor describes the vacuum drying process which ensures that all liquid water has evaporated and been removed from the cask cavity after the cask is loaded with fuel and the lid is installed. This process serves to minimize degradation of the fuel cladding while in storage. The vendor established cask vacuum pressure as a dryness criteria and established an acceptance criteria where cask pressure must be held stable at less than 10 mbar for at least 10 minutes. The applicant proposed a TS control (TS 3.1.1) on vacuum drying pressure with more conservative limiting values (less than 3 mbar for ten minutes) than described in the TN-32 TSAR. The staff concluded the applicant's TS drying controls are acceptable.

Given the applicant's proposed use of the TN-32 cask as designed and as described in the TN-32 TSAR, and given the acceptable TS controls proposed by the applicant, the staff concludes that the proposed North Anna ISFSI complies with the requirements of 10 CFR 72.122(h)(1).

10.6 Evaluation Findings

F10.1 The design and proposed operation of the ISFSI include acceptable measures that preclude the transport of radioactive materials to major water resources in accordance with 10 CFR 72.122(b)(4).

F10.2 The design and proposed operation of the ISFSI provide acceptable measures for protection of the cladding of the material to be stored, in compliance with 10 CFR 72.122(h)(1).

F10.3 The design of the ISFSI provides the capability for continuous monitoring of the effectiveness of confinement, in compliance with 10 CFR 72.122(h)(4).

F10.4 The design and proposed procedures of the ISFSI provide for packaging the material to be stored without the release of radioactive materials to the environment or radiation exposures in excess of Part 20 limits, for the duration of the license, in compliance with 10 CFR 72.122(h)(5).

F10.5 The ISFSI includes the TN-32 cask as its important to safety confinement system which warrants monitoring over anticipated ranges for normal and off normal operation. The PMS satisfies the requirements of 10 CFR 72.122(l) with respect to confinement.

F10.6 The North Anna ISFSI SAR demonstrates that releases to the general environment during normal operations and anticipated occurrences will be within the exposure limit given in 10 CFR 72.104, and that releases to the general environment resulting from design-basis accidents and accident level events and conditions will be within the exposure limits given in 10 CFR 72.106, thus satisfying the requirements for accident conditions as specified by 10 CFR 72.126(d) and 72.128(a)(3).

F10.7 The SAR includes an acceptable analysis of the potential dose equivalent or committed dose equivalent to an individual outside the controlled area from direct radiation from the ISFSI in compliance with 10 CFR 72.24(m).

11.0 ACCIDENT ANALYSIS

11.1 Introduction

The staff reviews the accident analysis to ensure that off-normal events and postulated accidents and conditions have been identified, and their potential safety consequences considered to meet the following regulatory requirements; 10 CFR 20.1201, 72.24, 72.26, 72.40(a)(13), and Subparts E and F to 10 CFR Part 72. The applicant proposes to use the TN-32 spent fuel storage cask at the North Anna ISFSI. Therefore, the TN-32 TSAR key assumptions, bounding site characteristics, environmental conditions, and cask/ISFSI interface requirements applicable to the accident analyses review are compared to the ISFSI design and environmental conditions.

This review was performed using the acceptance criteria listed in Chapter 12 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

11.2 Off-Normal Events and Conditions

Off-normal conditions are Design Event II as defined in ANSI/ANS 57.9-1984. These events can be expected to occur with moderate frequency or on the order of once per year. The applicant established that the North Anna ISFSI site parameters are within the bounds of the TN-32 TSAR. The staff concurs that all off-normal conditions and their potential safety consequences were considered.

11.2.1 Loss of Electric Power

The North Anna ISFSI SAR identifies one off-normal event which is loss of electric power to the ISFSI. This event was also assessed in the TN-32 TSAR. There were no differences between the ISFSI SAR and the TN-32 TSAR with respect to the effects, consequences, and radiological impacts of a loss-of-power event.

The power is used only for area lighting, receptacles, security equipment and the PMS. The PMS monitors the cask seal integrity; it is not used to maintain cask seal integrity. The cask seal integrity, which is verified during loading operations as specified in the North Anna ISFSI TS, is not affected by a loss of power. Thus, a temporary interruption of the PMS function is of no safety consequence.

Loss of power could be caused by natural phenomena or an undefined disturbance in the non-safety-related North Anna electric power system. A power loss to the ISFSI would be detected and indicated at the North Anna Central Alarm Station via the ISFSI Cask Status Alarm. Maintenance personnel are available at the North Anna site to restore normal power following any loss of power caused by onsite problems. In addition, a backup diesel generator is available to provide power to affected ISFSI equipment upon a loss of normal power.

There is no adverse impact on the cask integrity from a loss-of-power event, since power is not relied on for maintaining cask integrity. Since cask integrity is maintained, there are no radiological or safety effects or consequences.

11.2.2 One Set of Seals and PMS Fail Simultaneously

During the staff's review of the TN-32 TSAR, the TN-32 vendor provided a supplemental analysis of an event in which one set of cask seals for a single cask is assumed to fail simultaneously with a failure of the PMS on that same cask. The results of that analysis are described in Sections 7.3.4, 10.3.4.1, and 11.3.1.2 of the TN-32 SER. This event was evaluated to assess the importance of the PMS. In the TN-32 SER, site boundaries are assumed to be at 100 and 200 meters from the ISFSI. It was assumed that the failed seals and PMS would be repaired or replaced upon detection of this event.

The analysis assumptions and resulting radiological effects and consequences are discussed in Sections 7.3.4 and 10.3.4.1 of the TN-32 SER. The staff found that the dose at the postulated site boundary from this event is negligible compared to the regulatory limits in 10 CFR 72.104(a).

The applicant did not repeat this analysis for the North Anna site. However, the staff notes that the distance from the North Anna ISFSI to the site boundary is approximately 770 meters (2500 ft). Therefore the analytical results presented in the TN-32 SER for this event are conservative for the North Anna ISFSI and no further analysis is required for the North Anna ISFSI.

11.3 Accident-Level Events and Conditions

Accident level events and conditions are Design Events III and IV as defined in ANSI/ANS 57.9-1984. They include natural phenomena and human-induced low-probability events. The applicant established that the North Anna ISFSI site parameters are within the bounds of the TN-32 TSAR, or provided additional analyses to demonstrate design adequacy. The staff concurs that all accident-level events and conditions and those other events being bounded, have been identified and all potential safety consequences considered.

11.3.1 Earthquake

Sections 2.5.2, 3.2.3, and 8.2.1 of the North Anna ISFSI SAR describe the design earthquake which has a ground acceleration of 0.18 g in the horizontal direction and 0.12 g in the vertical direction. The TN-32 TSAR evaluated the TN-32 cask response to an earthquake with the same ground acceleration as the NA ISFSI design earthquake.

There are no radiological or safety effects or consequences resulting from this event. Section 4.2.1.4 of the North Anna ISFSI SAR evaluated the ISFSI response to the design earthquake. The concrete pad remains intact and the cask does not slide, tip over or become damaged. Therefore, the fuel is not damaged and the confinement integrity is maintained for the design earthquake.

11.3.2 Wind and Tornado Missiles

Section 8.2.2.1 of the North Anna ISFSI SAR evaluated the natural phenomena design-basis wind (DBW) and design-basis tornado (DBT) accidents. The wind loads were determined using

ASCE 7-88 and the DBW frequency is once every 100 years. The DBW is shown on North Anna ISFSI SAR Figure 2.3-3 and is 80 mph. The DBT, described in Sections 2.3.1 and 3.2.1.1, occurs less than once every 30,800 years, has a rotational wind velocity of 300 mph, a translational velocity of 60 mph and a pressure drop of 3 psi in 3 seconds.

The ISFSI and cask design criteria are discussed in Section 3 of this SER. The ISFSI is an unenclosed concrete pad, therefore there are no structures that could collapse onto the cask. The applicant has proposed sufficient design criteria for protection against the wind and tornado missile environmental phenomena as required by 10 CFR 72.122. The concrete pad is not damaged and the cask does not slide or tip over.

In a letter dated May 18, 1998, the applicant provided the results for an analysis of the North Anna DBT missiles. The analysis demonstrated that the containment integrity is maintained during these events but minor damage to the cask exterior and neutron shield may be sustained. However, the consequences of minor damage to the neutron shield are bounded by the consequences of the loss of all the neutron shield analyzed in the TN-32 TSAR and found to be below the regulatory limits in 10 CFR 72.106(b); refer to Section 11.3.7 below. If damage to the neutron shield was found or suspected, the cask would be repaired or unloaded.

11.3.3 Flood

Flooding is not a credible design-basis event for the North Anna ISFSI. The ISFSI site is flood-dry since it is 45 feet above the Probable Maximum Flood elevation for Lake Anna. Additionally, the storm drainage design of the ISFSI site is designed to accommodate a 100-year precipitation event. Refer to Section 2.2 of this SER for a discussion of flooding events. The North Anna ISFSI meets the requirements of 10 CFR Subpart E with respect to flooding.

11.3.4 Explosion

No explosion hazards are identified at the ISFSI. Explosion hazards attributable to vehicular traffic are discussed in Chapter 2 of this SER and have a negligible effect on the ISFSI. The TN-32 cask is designed to withstand an external pressure of 25 psi, which is greater than any overpressure from the identified vehicular traffic explosion hazards. The largest credible rail or highway transportation accident is the explosion of an 8,500 gallon gasoline tank truck at the closest approach of Virginia Route 652, 1.5 miles from the ISFSI site. Given the application of RG 1.91 and the information provided by the applicant regarding equivalent TNT weight of gasoline, the staff agrees that the expected overpressure from such an explosion would be less than 1 psi at the ISFSI site. In the TN-32 SER, the staff previously acknowledged that the TN-32 cask is designed to withstand an overpressure of 25 psi. Thus, the staff concludes that the postulated gasoline tank truck explosion 1.5 miles from the North Anna ISFSI would have a negligible effect on any TN-32 cask in use at the ISFSI, the fuel is not damaged and that the containment integrity of the TN-32 cask is maintained. Therefore, there are no radiological safety effects or consequences.

11.3.5 Fire

Fire accidents are discussed in Section 7 of this SER. The hypothetical fire accidents considered have a minimal effect on the ISFSI. The containment integrity of the TN-32 cask is not breached, although the neutron shielding may be damaged. As described in Section 11.3.7 below, the boundary dose was evaluated for a single cask without any neutron shielding and found to comply with 10 CFR 72.106(b). If damage to the neutron shield was found or suspected, the cask would be repaired or unloaded.

11.3.6 Storage of Unauthorized Fuel Assembly

Section 8.2.6 of the North Anna ISFSI SAR evaluated the storage of an unauthorized fuel assembly as a result of operator error or failure of fuel handling operation administrative controls. The SAR considered loading of an unirradiated fuel assembly and loading of damaged assemblies.

The applicant stated that loading of an unauthorized assembly with gross cladding defects would not cause further damage to the clad or release of radioactive material. Loading of an unauthorized fuel assembly with gross structural damage is assumed to be prevented by administrative controls. Loading of an unauthorized unirradiated assembly is bounded by the criticality evaluation in the TN-32 TSAR which considers that all fuel assemblies are unirradiated and demonstrates subcriticality is maintained.

The North Anna ISFSI SAR includes specifications on the fuel assembly parameters for fuel that is to be stored in the casks. The North Anna ISFSI SAR describes the administrative steps that will be taken to verify that only authorized fuel assemblies are loaded into the cask. The identity of each fuel assembly is checked again before installing the cask lid. Since there are multiple checks before sealing the lid and removing the cask from the spent fuel pool, unauthorized fuel in the cask after removal from the spent fuel pool was not evaluated. The staff concurs that the administrative controls are sufficient to preclude a loading error that remains undetected until the cask is removed from the spent fuel pool.

11.3.7 Loss of Neutron Shield

Total loss of the neutron shielding is not considered credible but is evaluated for one cask in Chapter 5 of the TN-32 TSAR and Chapters 5 and 10 of the TN-32 SER. The staff found that the resulting dose meets the requirements of 10 CFR 72.106(b). The minimum distance from the North Anna ISFSI to the site boundary is approximately 770 meters (2500 feet), and the maximum dose rate from the accessible cask surfaces 1 meter from the cask (neutron shielding and outer shell removed) is approximately 400 mrem/hr. This event would result in an annual dose at the site boundary of less than 0.01 rem which is a small fraction of the siting evaluation factor of 5 rem. Therefore, the North Anna ISFSI is in compliance with 10 CFR 72.106(b) under loss of neutron shield accident conditions.

11.3.8 Seal Leakage

The TN-32 cask has redundant seals and a PMS to detect a decrease in pressure.

Simultaneous failure of one set of seals and the PMS was evaluated above and found to be in compliance with 10 CFR Part 72. Loss of both sets of seals is not a credible event and is bounded by the loss of confinement barrier evaluated in Section 11.3.11 below.

11.3.9 Bottom-End Drop

The cask handling accidents inside the Fuel and Decontamination Buildings are addressed in the NAPS UFSAR. The bottom-end drop was evaluated in Section 8.2.9 of the ISFSI SAR as the only credible handling accident outside the Fuel and Decontamination Buildings.

Sections 3 and 11 of the TN-32 TSAR qualify the cask for a bottom-end drop deceleration of 50 g. In the TN-32 SER, the staff accepts, for an 18-inch drop, a maximum deceleration of 50 g if the storage pad bounding parameters are limited to (1) a thickness of 3 feet, (2) a concrete strength of 4 ksi, and (3) a soil modulus of 40 ksi. The North Anna concrete storage pad parameters differ from those listed above. The depth of the concrete pad is 2 feet, the concrete strength 5.06 ksi, and soil modulus 30 ksi. In a response to staff's request for additional information, the applicant performed an as-built reconciliation analysis of pad parameters. The staff reviewed the assumptions made in the analysis and agreed with the conclusion that the reduced pad thickness and increased concrete strength or elastic modulus effectively cause a net reduction in pad flexural rigidity, thereby lowering the applicable cask deceleration g-loads.

In a letter dated April 23, 1998, the applicant described the mechanical stops in the transporter lifting mechanism which limit the lifting height to 15 inches. In addition, the applicant proposed TS control to limit cask lifting height to 18 inches. These design and administrative controls ensure that the consequences of the cask drop accident are limited to those previously analyzed and accepted by the staff.

On the above basis, the staff concurs that, for the North Anna ISFSI application, the TN-32 cask will not experience a bottom-end drop deceleration greater than the level the cask has been evaluated in the TN-32 TSAR. This ensures that cask confinement and spent fuel retrievability from the basket will not be compromised after a bottom-end cask drop accident.

11.3.10 Tip-Over

As discussed in Section 6 of this SER, the applicant evaluated the potential for cask tip-over and determined that conservative factors of safety exist against cask overturning. However, the consequences of cask tip-over were evaluated in the TN-32 TSAR. The TN-32 TSAR analyzes the cask for tipover as a bounding condition during handling operations. For the most severely stressed regions, the fuel compartment was analyzed for a quasi-static force of 88 g at the basket top and 52 g at the basket center. These forces envelop the corresponding g-loads resulting from a staff confirmatory analysis in which the storage pad bounding parameters are limited to (1) a thickness of 3 feet, (2) a concrete strength of 4 ksi, and (3) a soil modulus of 40 ksi. The North Anna concrete storage pad parameters differ from those listed above. The depth of the concrete pad is 2 feet, the concrete strength 5.06 ksi, and soil modulus 30 ksi. In a response to staff's request for additional information, the applicant performed an as-built reconciliation analysis of pad parameters. The staff reviewed the assumptions made in the analysis and agreed with the conclusion that the reduced pad thickness and increased concrete strength or elastic modulus will effectively cause a net reduction in pad flexural rigidity, thereby lowering the applicable cask deceleration g-loads.

On the above basis, the staff concurs that, for the North Anna ISFSI application, the TN-32 cask will not experience tipover deceleration g-loads greater than the levels for which the cask has been evaluated in the TN-32 TSAR. This ensures that cask confinement and spent fuel retrievability from the basket will not be compromised after a hypothetical cask tipover accident. There could be localized damage to the neutron shield. The staff concurred with the TSAR conclusion that the increased site boundary dose is below the requirements of 10 CFR 72.106(b) even if total loss of the neutron shield for a single cask is assumed as discussed in Section 11.3.7 above.

11.3.11 Loss of Confinement Barrier

As discussed in Section 10 of this SER, the loss of the confinement barrier is considered a non-credible event. The loss of the confinement barrier is evaluated as a non-mechanistic event in Section 8.2.10 of the North Anna ISFSI SAR. For the hypothetical loss of confinement accident with the release of I^{129}, Kr^{85}, and tritium, the total effective whole body dose and thyroid dose are a small fraction of the 5 rem siting evaluation factor in 10 CFR 72.106(b).

11.3.12 Borated Water Replaced by Fresh Water

Section 6.4 of the TN-32 TSAR evaluated fresh water replacing the borated water in the TN-32 cask cavity. The criticality model assumed 1.8 weight percent U-235 instead of 3.85 weight percent U-235 (i.e., spent fuel instead of fresh fuel) and the borated aluminum plate thickness was increased from 0.04 inches thick to 0.075 inches thick. The maximum calculated keff $+2\sigma$ is 0.9441. Including bias, the maximum calculated keff is 0.9523. While this calculation demonstrates acceptable results for this accident, the North Anna ISFSI TS also include requirements for two independent samples of boron concentration for water that is being added to the cask cavity.

11.4 Evaluation Findings

The following findings are predicated upon the staff's review of the TN-32 TSAR and the North Anna ISFSI SAR:

F11.1 The staff concludes that the SAR includes acceptable analyses of the design and performance of SSCs important to safety under off-normal and accident scenarios. The analyses show acceptable maximum levels of possible impact on public health and safety resulting from potential off-normal conditions and accident-level events during the life of the ISFSI, and acceptable capability of SSCs for the prevention of accidents and the mitigation of the consequences of accidents and accident-level conditions; in compliance with 10 CFR 72.24(d).

F11.2 The staff concludes that the analyses of off-normal and accident-level events and conditions and reasonable combinations of these and normal conditions show that the design of the ISFSI will acceptably meet the related requirements without endangering the health and safety of the public, in compliance with 10 CFR 72.40(a)(13) and 72.122(b).

F11.3 The staff concludes that the analyses of design-basis accidents and anticipated occurrences show that releases of radiation to the general environment will be below the exposure limits of 10 CFR 72.106 and 72.104, respectively; and in compliance with 10 CFR 72.126(d).

F11.4 The staff concludes that the applicant has provided a systematic approach to the identification of off-normal and accident level events that is thorough and comprehensive such that there is reasonable assurance that the analyses and results bound all credible accident scenarios.

F11.5 The staff concludes that before a criticality accident is possible, at least two, unlikely, independent and concurrent or sequential changes have to occur in the conditions essential to nuclear criticality safety and therefore the proposed ISFSI complies with 10 CFR 72.124(a).

12.0 CONDUCT OF OPERATIONS

The objective of the conduct of operations review is to ensure that the applicant has the appropriate infrastructure to manage, test, and operate the ISFSI and to conduct effective training for ISFSI operation consistent with the requirements of 10 CFR Part 72.

This review was performed according to Chapter 13 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

12.1 Organizational Structure and Technical Qualification

Virginia Power is a regulated utility that has assembled an organization and installed a management system for operating the NAPS. Virginia Power has proposed to use the same organization and management system for the ISFSI, with modifications necessary to accommodate the needs of the ISFSI. Elements of the applicant's organization and individual responsibilities are described in VEP-1-5A (Updated) "Operational Quality Assurance Program Topical Report." (Updated). In TS 5.1.1, the North Anna plant manager is designated overall responsibility for ISFSI operation and is required to approve, before implementation, each proposed test, experiment or modification to systems that affect nuclear safety. TS 5.2.1 provides general requirements for assigning and defining lines of authority and responsibility and specifically requires that responsibilities assigned to individual positions or organization be documented. The staff concludes that the North Anna ISFSI SAR and TS include an acceptable plan for the conduct of operations, in compliance with 10 CFR 72.24(h). The staff also concludes that the application includes an acceptable description of the applicant's operating organization, delegations of responsibility and authority and the minimum skills and experience qualifications relevant to the various levels of responsibility and authority, in compliance with 10 CFR 72.28(c).

TS 5.3.1 requires that each member of the facility staff meet or exceed minimum qualification requirements ANS 3.1-1979 for comparable positions with exceptions as specified in the QA Program Topical Report. The Superintendent of Radiological Protection is required to meet or exceed the qualifications of RG 1.8 -1975.

In the License Application, the applicant described its experience with nuclear facility operations which include construction and operation of the North Anna and Surry Power Stations and Surry ISFSI dating back into the late 1960s. The staff acknowledges this significant experience. Given the applicant's previous experience, as well as the satisfactory nature of the information provided in the SAR and supplemental submittals, the staff concludes that the applicant has demonstrated acceptable technical qualifications to engage in the proposed activities, in compliance with 10 CFR 72.28(a).

12.2 Pre-Operational Testing and Operation

In Section 9.2 of the North Anna ISFSI SAR, the applicant described the scope and objectives of its pre-operational testing program. The applicant described planned testing of physical facilities including the cask pressure monitoring system, electrical systems, and communications and security systems. The applicant also described the operational testing that is to be done for each cask design, including loading and unloading operations. In addition, each new cask design is subjected to testing with the transporter to ensure proper function of the transporter. In a letter dated April 14, 1997, the applicant stated that preoperational testing acceptance criteria are the same as those that will be used during loading, transport and unloading operations and include TS acceptance criteria where applicable. The applicant also stated that when preoperational testing is completed, procedures or equipment are modified on the basis of lessons learned from the testing. Given the above, the staff concludes that the SAR and supplemental submittals include an acceptable description of the program covering preoperational testing and initial operations, in compliance with 10 CFR 72.24(p).

12.3 Training Programs

Pursuant to 10 CFR 72.192, the applicant must establish a program of training, proficiency testing and certification of ISFSI personnel. In its license application, the applicant stated that it planned to maintain an adequate complement of trained certified personnel before the receipt of spent fuel for storage. In Section 9.1.3 and 9.3 of the SAR, the applicant described the personnel qualification and training programs which will serve to ensure an adequate complement of trained personnel are available. In its submittal of May 29, 1998, the applicant supplemented the SAR information with draft training modules and job performance measures. The staff concludes that these submittals satisfy the requirements of 10 CFR 72.192.

As described by the applicant, the existing North Anna training and qualification programs have been augmented with information and training procedures pertinent to design and operation of the ISFSI. Elements of ISFSI training are provided to operations personnel who are assigned duties associated with spent fuel dry cask storage such as cask crane operation, cask transport cask loading and testing. In the submittal dated May 29, 1998, the applicant described, through draft training modules and program guides, the information that is provided to employees in training for ISFSI activities. The training program includes information related to the TN-32 design, basic cask operation, transport operation, and the ISFSI layout, TS, and SAR. The training program also incorporates job performance measures for on-the-job training for cask functional areas including crane operation, cask handling, cask preparation, spent fuel loading, cask lid handling, cask closure, storage preparation, and transport activities.

Pursuant to 10 CFR 72.190, the applicant ensures that operation of equipment and controls important to safety is limited to personnel trained and certified under the training and qualification program described above. The applicant implements this requirement through its spent fuel dry cask storage qualification and evaluation plan. The plan specifies the classroom, and job performance measures that must be completed before an individual's participation in dry cask storage activities. The plan identifies management responsibilities for implementation of the plan.

Pursuant to 10 CFR 72.194, the applicant ensures that the physical condition and general health of personnel certified to operate equipment and controls important to safety are not such as might cause errors that would endanger other plant personnel or public health and safety. By letter dated May 29, 1998, the applicant described how this requirement is implemented through station administrative procedures. These procedures specify medical surveillance requirements for broad groups of employees. Employees involved in spent fuel handling and cask handling are covered by these administrative controls. The controls are adequate to satisfy the requirements of 10 CFR 72.194.

In light of the above, the staff finds that the applicant's training and certification program meets the requirements of 10 CFR Part 72, Subpart I (Sections 72.190, 72.192 and 72.194). Further, the staff concludes that the applicant will have and maintain an adequate complement of trained and certified installation personnel before receipt of spent fuel for storage, in compliance with 10 CFR 72.28(d).

12.4 Normal Operation

Normal activities to store spent fuel from the NAPS at the North Anna ISFSI include fuel loading and handling activities inside NAPS facilities. Activities inside the NAPS facilities are subject to the requirements of the NAPS license including the NAPS TS as specified in License Condition 16 of the ISFSI license. Notwithstanding, certain procedures and processes to be used by the applicant in loading and transporting spent fuel out of the NAPS were considered by the staff in addition to the procedures and controls associated solely with the North Anna ISFSI.

12.4.1 Record Keeping

The applicant described procedures and processes for record keeping related to the inventory, disposal and transfer of spent fuel. In a letter dated April 23, 1998, the applicant stated that accountability records for all fuel assemblies transferred to, stored in or removed from the ISFSI will be maintained for as long as the fuel assemblies are stored on the North Anna site and for 5 years after its transfer off the site. The applicant specifically stated that such records will include information on (1) fuel manufacturer, (2) date of delivery to the station, (3) reactor exposure history, (4) burnup, (5) calculated special nuclear material content, (6) inventory control number, (7) pertinent data on discharge and storage at the reactor, transfer to the ISFSI, storage at the ISFSI and disposal, and (8) other information as may be required by TS. This satisfies the requirements of 10 CFR 72.72(a).

The applicant stated that records of the current physical inventory at the ISFSI will be retained until the ISFSI license is terminated. This satisfies the requirements of 10 CFR 72.72(b). The applicant stated that material control and accounting procedures will be retained until the ISFSI license is terminated. This satisfies the requirements of 10 CFR 72.72(c).

In a letter dated April 29, 1998, the applicant requested an exemption from the requirement of 10 CFR 72.72(d) to maintain records in duplicate at physically separate locations. The staff has reviewed and approved this exemption as discussed in detail in Section 13 of this SER. In a letter dated April 23, 1998, the applicant stated that records of spent fuel transferred out of the ISFSI will be preserved for a period of 5 years after the date of transfer. This satisfies the remaining requirements of 10 CFR 72.72(d).

12.4.2 Administrative Procedures

In the North Anna ISFSI SAR, the applicant committed to develop and implement administrative procedures to provide instruction regarding various matters including personnel conduct and control, organization and responsibility. The commitment to establish and implement administrative control procedures is captured in TS 5.4.1.a. TS 5.4.1.e, 5.4.1.g, 5.4.1.j, 5.4.1.m, 5.4.1.n, and 5.4.1.o require procedures for administrative matters such as design control and facility modifications, control of special processes, special nuclear material accountability, records management, the TS Bases Control Program and the Radioactive Effluent Control Program. TS 5.5.1 specifies the requirements for changing the TS Bases.

12.4.3 Health Physics Procedures

In the North Anna ISFSI SAR, the applicant stated that health physics procedures are used to implement the radiation protection plan. The applicant stated that procedures have been developed and implemented for various matters including monitoring employee exposure, radiation surveys of work areas, radiation monitoring of maintenance activities and records maintenance. The applicant committed to revise existing procedures as needed to address ISFSI operation before it begins. The applicant stated that revised procedures will address cask loading, unloading, transport, and maintenance. The applicant stated that all work inside the ISFSI will be controlled by radiation work permit. The commitment to have health physics procedures for the ISFSI, including ALARA practices, is identified in TS 5.4.1.i.

TS 5.5.2 provides for the programmatic controls required by 10 CFR 72.44(d) for environmental monitoring and effluent reporting. As the ISFSI is not expected to release any effluents under normal or accident conditions, the requirements of 10 CFR 72.44(d)(1) are not necessary. However, Technical Specification 3.1.3 and 3.1.4 establish leakage rate testing and seal integrity requirements that effectively limit release of radioactive material below the limits of 10 CFR Part 20 and 10 CFR 72.104 and therefore satisfy the requirements of 10 CFR 72.44(d)(1).

12.4.4 Maintenance Procedures

In the North Anna ISFSI SAR, the applicant stated that procedures will be developed to control the performance of preventative and corrective maintenance. The commitment to have maintenance procedures for the ISFSI is identified in TS 5.4.1.h.

12.4.5 Operations Procedures

In the North Anna ISFSI SAR, the applicant committed to developing and implementing operating procedures for cask handling, including loading, unloading, sealing, transporting and storage. The applicant also committed to develop and implement procedures for responding to annunciator alarms associated with the casks. The commitment to have procedures for routine operations and annunciator response are captured in TS 5.4.1.b and 5.4.1.c, respectively.

12.5 Findings

F12.1 The SAR and supplemental submittals include an acceptable plan for the conduct of operations, in compliance with 10 CFR 72.24(h).

F12.2 The SAR and supplemental submittals include an acceptable description of the program covering preoperational testing and initial operations, in compliance with 10 CFR 72.24(p).

F12.3 The SAR and supplemental submittals include an adequate description of acceptable technical qualifications, for the applicant to engage in the proposed activities, in compliance with 10 CFR 72.28(a).

F12.4 The application and supplemental submittals include an acceptable description of a personnel training program to comply with Subpart I to 10 CFR Part 72.

F12.5 The application includes an acceptable description of the applicant's operating organization, delegations of responsibility and authority and the minimum skills and experience qualifications relevant to the various levels of responsibility and authority, in compliance with 10 CFR 72.28(c).

F12.6 The application includes an acceptable program to have and maintain an adequate complement of trained and certified installation personnel before receipt of spent fuel for storage, in compliance with 10 CFR 72.28(d).

F12.7 The applicant's description of record keeping processes that satisfy the requirements of 10 CFR 72.72 except in regard to duplicate record storage. An exemption has been granted from the requirement in 10 CFR 72.72(d) for duplicate record storage.

F12.8 In light of the information provided by the applicant as discussed in this Section, and given the individual staff conclusions documented in this Section, the staff concludes that the applicant is qualified by reason of training and experience to conduct the operations covered by the regulations in 10 CFR 72, in compliance with 10 CFR 72.40(a)(4). The staff further concludes that the application is considered to provide acceptable assurance with regard to the management, organization, and planning for preoperational testing and initial operations, that the activities authorized by the license can be conducted without endangering the health and safety of the public in compliance with 10 CFR 72.40(a)(13).

13.0 TECHNICAL SPECIFICATIONS

Requirements to include TS in the license application are detailed in 10 CFR 72.26. Detailed requirements on the information that must be included in TS are specified in 10 CFR 72.44. The TS define operating limits and controls that ensure safe operation of the North Anna ISFSI.

NRC staff acceptance criteria for TS are described in Chapter 14 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

13.1 Functional and Operating Limits

Functional and operating limits are those limits on fuel handling and storage conditions necessary to protect the integrity of the stored fuel, to protect employees against occupational exposure and to guard against the uncontrolled release of radioactive materials. The functional and operating limits included in the North Anna TS are listed in Table 13-1. The table lists the section of this SER which documents the acceptability for each functional and operating limit.

Table 13-1

TS ITEM	FUNCTIONAL/OPERATING LIMIT	ASSOCIATED SER SECTION
2.1	Fuel to be stored at the ISFSI	3.1
2.2	Functional and Operating Limit Violations	3.1

On the basis of an extensive review of the application, the staff concludes that the functional and operating limits listed in Table 13-1 are those necessary to protect the integrity of the stored fuel, to protect employees against occupational exposure and to guard against the uncontrolled release of radioactive materials. The staff therefore concludes that the North Anna ISFSI TS are in compliance with 10 CFR 72.44(c)(1)(I).

13.2 Limiting Conditions/Surveillance Requirements

Limiting conditions for operation are the lowest functional capability or performance levels of equipment required for safe operation. Surveillance requirements provide for inspection and test activities to ensure that the necessary integrity of required systems is maintained, confirmation that operation of the ISFSI is within the required functional and operating limits, and confirmation that the limiting conditions required for safe storage are met. The Limiting Conditions and Surveillance Requirements included in the North Anna TS are listed in Table 13-2. The table also lists the section of this SER which documents the acceptability for each limiting condition or surveillance requirement.

Table 13-2

TS ITEM	LIMITING CONDITION	ASSOCIATED SURVEILLANCE REQUIREMENT	ASSOCIATED SER SECTION
3.1.1	SSSC Cavity Vacuum Drying Pressure	3.1.1.1	10.5
3.1.2	SSSC Helium Backfill Pressure	3.1.2.1	10.5
3.1.3	SSSC Helium Leak Rate	3.1.3.1	10.5
3.1.4	SSSC Seal Integrity	3.1.4.1	10.1
3.1.5	SSSC Maximum Lifting Height	3.1.5.1	4.3.2
3.2.1	Dissolved Boron Concentration	3.2.1.1, 3.2.1.2	9.1
3.3.1	SSSC Average Surface Dose Rates	3.3.1.1	8.4
3.3.2	SSSC Surface Contamination	3.3.2.1	8.2
3.3.3	ISFSI Perimeter Radiation	3.3.3.1	8.6

On the basis of its review of the application, the staff concludes that the limiting conditions listed in Table 13-2 specify the lowest functional capability for that equipment required for safe operation. In addition, the staff concludes that the surveillance requirements listed in Table 13.2 provide for necessary inspection and testing, confirm operation within appropriate functional and operating limits and confirm that limiting conditions for safe storage are met. The staff therefore concludes that the North Anna ISFSI TS are in compliance with 10 CFR 72.44(c)(2) and (c)(3).

13.3 Design Features

The Design Features portions of the TS includes items that would have a significant effect on safety if altered or modified such as materials of construction or geometric arrangements. The Design Features included in the North Anna TS are listed in Table 13-3. The table also lists the section of this SER which documents the acceptability for each design feature.

Table 13-3

TS ITEM	DESIGN FEATURE	ASSOCIATED SER SECTION
4.1	Site	1.2
4.2	Storage Features	1.2

On the basis of an extensive review of the application, the staff concludes that the design features listed in Table 13-3 are those, which if altered, would have a significant effect on safety. The staff therefore concludes that the North Anna ISFSI TS are in compliance with 10 CFR 72.44(c)(4).

13.4 Administrative Controls

The Administrative Controls portion of the TS includes controls on the organization and management, record keeping, review and audit and reporting processes necessary to ensure that the operation involved in storage of spent fuel at the ISFSI are performed in a safe manner. The Administrative Controls included in the North Anna TS are listed in Table 13-4. The table also lists the section of this SER which documents the acceptability for each design feature TS.

Table 13-4

TS ITEM	ADMINISTRATIVE CONTROL	ASSOCIATED SER SECTION
5.1	Responsibility	12.1
5.2	Organization	12.1
5.3	Facility Staff Qualifications	12.1
5.4	Procedures	12.4
5.5	Programs	12.4

On the basis of an extensive review of the application, the staff concludes that the administrative controls listed in Table 13-4 are those necessary to ensure that the operation involved in storage of spent fuel at the ISFSI are performed in a safe manner. The staff therefore concludes that the North Anna ISFSI TS are in compliance with 10 CFR 72.44(c)(5) and (d).

13.5 Changes to Submitted Documents

In the original application regarding the North Anna ISFSI, the applicant proposed a set of TS. However, the staff undertook an initiative to reformat the proposed TS to adopt the conventions and customs developed through the NRC's Technical Specifications Improvement Program (TSIP). The TSIP led to the development of an improved set of standard TS for each of the five operating reactor vendor types. These improved TS are documented in NUREG-1430, NUREG-1431, NUREG-1432, NUREG-1433, and NUREG-1434. In reformatting the proposed North Anna ISFSI TS, the staff adopted the tabular format, the logic conventions, and the use and applications rules contained in the operating reactor improved TS.

The staff forwarded the draft reformatted TS to the applicant in a letter dated December 4, 1997. The applicant reviewed the staff's proposal and made several modifications. The applicant resubmitted proposed TS in the revised format in a letter dated April 1, 1998.

The applicant made several additional revisions to the draft TS in a letter dated May 28, 1998. The staff, in issuing the final TS with the license, revised proposed TS 5.5.2 to correctly reference 10 CFR 72.44(d). The staff review of the proposed TS described in Section 13.1 - through 13.4 above includes consideration of all revisions to the proposed TS through June 19, 1998.

13.6 License Conditions

10 CFR 72.44 states that each license issued under 10 CFR Part 72 shall include license conditions which may derive from the SAR, which may pertain to design, construction and operation or which the Commission may include as it determines is appropriate. In addition, 10 CFR 72.44 specifies certain license conditions which apply to each license issued under 10 CFR Part 72 whether or not they are explicitly stated in the license. Those conditions are specified in 10 CFR 72.44(b)(1) through (b)(6) and are binding on the North Anna license, but are not explicitly restated in the North Anna ISFSI license.

Each of the explicit license conditions in the North Anna license are briefly described in the table below.

LICENSE CONDITION	DESCRIPTION	ASSOCIATED SER SECTION
6A	Nature of Material Stored at ISFSI	1.2
7A	Chemical Form of Stored Material	1.2
8A	Maximum Amount of Stored Material	1.2
9	Authorized Use and Authorized Cask	1.1
10	Authorized Place of Use	N/A
11	Technical Specifications	13
12	Physical Security Plan Controls	15.5
13	Quality Assurance Program Controls	16.3
14	Emergency Plan Controls	14.3
15	Design Construction and Operation in Accordance with Commission Regulations	N/A
16	Relation to Part 50 License	12.4
17	Exemptions Issued With License	13.7

13.7 Exemptions

By letter dated April 29, 1998, pursuant to the provisions of 10 CFR 72.7, the applicant requested exemptions from the requirements of 10 CFR 72.44(d)(3) and 72.72(d). The applicant requested permission to submit a single effluent release report encompassing the NAPS and the North Anna ISFSI, by May 1 of each year, instead of submitting a separate report for the ISFSI within 60 days of January 1 of each year, as required by 10 CFR 72.44(d)(3). Additionally, the applicant requested to maintain a single set of spent fuel storage records at a records storage facility that meets the standards of ANSI N.45.2.9-1974 instead of maintaining duplicate records at separate locations as required by 10 CFR 72.72(d). Separately, the staff identified the need for an exemption to 10 CFR 72.124(b) to ensure that the North Anna ISFSI license is consistent with the staff's conclusion that the TN-32 storage cask does provide a positive means to verify the neutron absorber continued efficacy.

The staff evaluated the public health and safety and environmental impacts of the proposed exemption and determined that granting the exemptions would not result in any significant impacts as follows:

- Duplicate Record Storage (10 CFR 72.72(d))

  The applicant stated that, pursuant to 10 CFR 72.140(d), the Virginia Power Operational Quality Assurance (QA) Program Topical Report will be used to satisfy the QA requirements for the ISFSI. The QA Program Topical Report states that QA records are maintained in accordance with commitments to ANSI N45.2.9-1974. ANSI N45.2.9-1974 allows for the storage of QA records in a duplicate storage location sufficiently remote from the original records or in a records storage facility subject to certain provisions designed to protect the records from fire and other adverse conditions. The applicant seeks to streamline and standardize record keeping procedures and processes for the NAPS and the North Anna ISFSI spent fuel records. The applicant states that requiring a separate method of record storage for ISFSI records diverts resources unnecessarily.

  The staff considered the applicant's request and determined that granting the proposed exemptions from the requirements of 10 CFR 72.72(d) is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest. The staff approves the exemption, subject to the following conditions:

  (1) Virginia Power may maintain records of spent fuel and high-level radioactive waste in storage either in duplicate as required by 10 CFR 72.72(d), or alternatively, a single set of records may be maintained at a records storage facility that satisfies the standards set forth in ANSI N45.2.9-1974.

  (2) All other requirements of 10 CFR 72.72(d) shall be met.

- Annual Effluent Release Report (10 CFR 72.44(d)(3))

  The applicant is preparing to operate the North Anna ISFSI as described in the application dated May 9, 1995, subject to issuance of an NRC license pursuant to 10 CFR Part 72. The applicant is implementing the necessary processes and procedures to operate the ISFSI and seeks to have those processes make efficient use of resources. With regard to annual effluent release reporting, the applicant already prepares and submits effluent release reports for the NAPS by May 1 of each year pursuant to the NAPS TS. The NAPS effluent release report provides the same type of data and is generated by the same applicant program as would the annual effluent release report for the ISFSI. The applicant states that submittal of separate reports for the NAPS and the ISFSI, as would be required without the exemption from 10 CFR 72.44(d)(3) would entail duplication of report preparation and verification data.

  The staff considered the applicant's request and determined that granting the proposed exemptions from the requirements of 10 CFR 72.44(d)(3) is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest. The staff approves the exemption, subject to the following conditions:

  (1) Virginia Power shall submit an annual report, addressing the previous calendar year, as required by 10 CFR 72.44(d)(3), no later than May 1 of each year. This report may be included in the NAPS Effluent Release Report submitted under the North Anna 10 CFR Part 50 license.

  (2) All other requirements of 10 CFR 72.44(d)(3) shall be met.

- Neutron Poison Effectiveness Verification (10 CFR 72.124(b))

  With regard to verification of neutron poison efficacy, the exemption is necessary to ensure that the licensing process for the North Anna ISFSI takes into account previous staff conclusions (TN 32 SER) that fixed neutron poisons in the TN-32 storage cask will remain effective over the 20-year period of the license. Periodic verification of neutron poison effectiveness is not practicable for the TN-32 cask and, consistent with the staff's conclusion described above, is not necessary.

  The staff considered the exemption and determined that granting the proposed exemption from the requirements of 10 CFR 72.124(b) is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest. The staff approves the exemption, subject to the following conditions:

  (1) Virginia Power is not required to periodically verify the effectiveness of the neutron absorber material used in the TN-32 storage cask.

  (2) All other requirements of 10 CFR 72.124(b) shall be met.

For these exemptions, an Environmental Assessment and Finding of No Significant Impact has been prepared and published in the Federal Register (63 FR 33100).

13.8 Findings

F13.1 As described above, the staff concludes that the TS for the North Anna ISFSI are in compliance with the requirements of 10 CFR 72.44(c) and (d).

F13.2 Pursuant to 10 CFR 72.7 and as specified in Section 13.7, exemptions to the requirements of 10 CFR 72.44(d)(3), 72.72(d), and 72.124(b) are granted.

14.0 EMERGENCY PLANNING

Requirements for a description of plans for coping with emergencies are included in 10 CFR 72.24. Detailed requirements for emergency planning are specified in 10 CFR 72.32 and include provisions for classifying events, detecting, assessing and mitigating events, assigning responsibilities, communicating information and exercises.

This review was performed according to Chapter 13 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

14.1 Evaluation

Paragraph (c) of 10 CFR 72.32 specifies that for an ISFSI located on the site of or within the exclusion area of a nuclear power reactor licensed for operation by the Commission, the emergency plan required by 10 CFR 50.47 shall be deemed to satisfy the requirements of 10 CFR 72.32. The applicant does have an Emergency Plan for the NAPS which has been deemed to satisfy the requirements of 10 CFR 50.47 and Appendix E of that Part. The NRC approved the North Anna Emergency Plan (NAEP) by letter dated July 22, 1996. From time to time, the applicant has revised the NAEP pursuant to 10 CFR 50.54(q). On the basis of having an approved emergency plan, the staff concludes that the applicant meets the requirements of 10 CFR 72.32(c) and thus satisfies the requirements of 10 CFR 72.32.

Notwithstanding the provisions of 10 CFR 72.32(c), the staff reviewed the changes the applicant made to the approved plan to incorporate consideration of the ISFSI. These changes are described in Section 9.5 of the North Anna ISFSI SAR. In a letter dated January 23, 1998, the applicant submitted Revision 21 of the NAEP which included the changes described in the SAR. In a letter dated April 13, 1998, the applicant committed to make several additional administrative changes to the NAEP regarding the ISFSI. The staff reviewed the following changes or change commitments related to the ISFSI:

(1) Site Description: The applicant committed to revise Section 2.1 of the NAEP to include a description of the ISFSI in the overall site description.

(2) Types and Classification of Accidents: The applicant revised Table 4.1 and Appendix 10.11 of the NAEP to include two ISFSI events classified as Notification of Unusual Event. These events are (1) cask seal leakage and (2) cask drop or handling mishap. Given the very low consequences of a loss of cask confinement, the staff concludes that the Notification of Unusual Event classification is appropriate for these events.

(3) Reference to Part 72 Requirements: The applicant committed to revise Section 2.2 of the NAEP to incorporate reference to the emergency planning requirement of 10 CFR 72.32(c).

(4) Exclusion Area Map: The applicant committed to revise the Exclusion Area Map in Appendix 10.3 to depict the location of the ISFSI.

The staff concludes these changes enhanced the implementation of Emergency Plans with respect to the ISFSI and are acceptable. The staff also concludes that the SAR description of the Emergency Plan satisfies the requirements of 10 CFR 72.24(k).

14.2 Findings

F14.1 Given the existence of an approved North Anna Emergency Plan which meets the requirements of 10 CFR 50.47, pursuant to 10 CFR 73.32(c), the requirements of 10 CFR 72.32 are met.

14.3 License Condition

Because the Emergency Plan for the ISFSI is founded on a program that was approved pursuant to 10 CFR Part 50, the staff has imposed a license condition requiring that, before termination of the Part 50 license, the applicant must obtain staff approval of a stand-alone ISFSI Emergency Plan that satisfies the requirements of 10 CFR 72.32.

15.0 PHYSICAL PROTECTION

Requirements for a description of the physical protection design features and program are specified in 10 CFR 72.24(o). Requirements for physical protection for the ISFSI are specified in Subpart H to 10 CFR Part 72 and include requirements for the physical security plan, physical security design features and contingency plan. In Subpart H to Part 72, the regulations make reference to applicable requirements of Part 73 to further specify ISFSI physical security requirements.

In a letter dated January 29, 1998, the applicant submitted a Physical Security Plan encompassing the existing North Anna and Surry Power Stations, the existing Surry ISFSI and the proposed North Anna ISFSI. In a separate letter dated January 29, 1998, the applicant submitted a letter that itemized the individual requirements in Part 73 applicable to an ISFSI and described how it plans to comply with those requirements at the North Anna ISFSI. By letter dated October 2, 1997, the applicant submitted the Nuclear Security Personnel Training and Qualification Plan for Surry and North Anna Power Stations, Revision 1.

15.1 Threat

The proposed North Anna ISFSI will be located within the owner-controlled area of the operating NAPS site, but within a separate protected area (PA). The protection strategy for the ISFSI is currently predicated on protecting the site from radiological sabotage including the use of explosives to breach the casks and disperse material, in conjunction with the relevant sections of 10 CFR Parts 72 and 73.

15.2 Physical Security Plan

The ISFSI at North Anna will be an unmanned facility that will store spent fuel in a dry cask storage configuration within its own protected area. When authorized activities are required within the ISFSI, security force members from the operating reactor site will be utilized to support these operations. The physical security plan commitments for the ISFSI are located within a separate chapter of the North Anna operating reactor Physical Security Plan. All activities associated with the ISFSI day-to-day operation (response to alarm annunciations, searches, patrols, access control, etc.) are supported by the security organization at the reactor site since activities will be minimal and have no impact on the security program at the operating reactor site. The security procedures for the ISFSI are built upon the applicable procedures used for the operating reactor site and those specific procedures that apply to the ISFSI site. The procedures provide additional detailed information that support the commitments within the security plan.

In reviewing the physical security plan submittals, the staff noted that it contained adequate design provisions for physical security, a safeguards contingency plan, provisions for guard training, and provisions for tests, inspections and audits. The staff thus concluded that the applicant met the provisions of 10 CFR 72.180. The staff also concluded that the Safeguards Contingency Plan satisfied the requirements of 10 CFR 72.184 and that the design information satisfied the requirements of 10 CFR 72.182.

15.3 Physical Safeguards Security Systems

The ISFSI security systems are founded on a modified version of the 10 CFR 73.55 requirements as described in the applicant's letter dated January 29, 1998. The site will have a protected area barrier fence that totally surrounds the spent fuel storage site. An intrusion detection system (IDS) will be positioned in proximity to the protected area barrier so that unauthorized attempts to enter the site will result in an alarm annunciation at a security alarm station. To determine what has caused the alarm, the site protected area will have closed circuit television (CCTV) for assessment purposes. The CCTV is positioned to give full coverage of the protected area barrier and interior areas of the ISFSI. On either side of the protected area barrier, there will be isolation zones which will remain clear of objects so that CCTV assessment is not hindered. The site will be illuminated so that assessment of unauthorized activities can be determined during the hours of darkness. The lighting levels will be sufficient to assess all activities within the protected area and the exterior isolation zones. Unescorted access to the ISFSI will be limited to authorized individuals who are issued a company picture badge. Visitors will be escorted by a trained individual who has authorized access to the ISFSI. Before entry into the ISFSI, personnel, vehicles, and packages entering the protected area will be searched for unauthorized devices that could be used for radiological sabotage. Tests of the security system equipment will be conducted to determine system effectiveness in accordance with performance and operability requirements. Periodic patrols of the ISFSI will be conducted and arrangement with the local law enforcement agency (LLEA) will be made to support the site should unauthorized activities occur. On the basis of the information described above, the staff concludes that, pursuant to 10 CFR 72.180, the applicant satisfies the applicable requirements of 10 CFR Part 73 for an ISFSI.

15.4 Findings

F15.1 Pursuant to 10 CFR 72.180, the applicant has developed a physical security plan that satisfies the requirements in 10 CFR Part 73 which are applicable to an ISFSI.

F15.2 On the basis of the information provided by the applicant as described above, the staff concludes that the applicant has committed to a protective strategy with objectives to protect the site against the threat of radiological sabotage and that the applicant has satisfied the requirements of Subpart H to 10 CFR Part 72. The staff further concludes that the storage of spent fuel at this site is not inimical to the common defense and security.

15.5 License Conditions

A condition has been included in the license which ensures that changes to the physical security plan, guard training plan and portions of the safeguards contingency plan are made in accordance with the requirements of 10 CFR 72.186.

16.0 QUALITY ASSURANCE

Requirements for a description of the quality assurance (QA) program are specified in 10 CFR 72.24. Detailed requirements for the quality assurance program are specified in Subpart G to 10 CFR Part 72 and include requirements applying to design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, maintenance, inspection, testing, operation, repair and modification of systems structures and components that are important to safety.

This review was performed according to Chapter 15 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

16.1 Evaluation

Paragraph (b) of 10 CFR 72.140 states that each licensee shall establish, maintain and execute a quality assurance program satisfying each of the applicable criteria of Subpart G. Paragraph (d) of 10 CFR 72.140 states that a Commission approved quality assurance program which satisfies the applicable criteria of Appendix B of Part 50 and which is established, maintained and executed with regard to an ISFSI will be accepted as satisfying the requirements of 10 CFR 72.140(b).

In Chapter 6 of the North Anna ISFSI license application and Chapter 11 of the North Anna ISFSI SAR, the applicant stated that the governing document for the 10 CFR 50 Appendix B quality assurance program was VEP-1-5A (Updated) "Operational Quality Assurance Program Topical Report." In a letter dated February 28, 1994, the NRC found that the program described in VEP-1-5A (Updated) satisfied the requirements of 10 CFR 50 Appendix B. In the North Anna ISFSI license application and in Section 11.1 of the North Anna ISFSI SAR, the applicant stated that VEP-1-5A (Updated) would be applied to all activities associated with the ISFSI considered important to safety and that no changes to VEP-1-5A were required for the ISFSI activities.

In a letter dated April 9, 1998, the applicant submitted Revision 33 to the NAPS SAR, which included a revision to VEP-1-5A (Updated). This revision clarified the position description for various North Anna management positions by noting responsibilities for the ISFSI.

Given the existing approved QA program that satisfies Appendix B to 10 CFR Part 50 and the applicant's stated intent to apply that program to the ISFSI, and the clarification included in the submittal dated April 9, 1998, the staff concludes that the applicant has met the conditions of 10 CFR 72.140(d) and, therefore, satisfies the requirements of 10 CFR 72.140(b). The staff also concludes that the description of the QA program in the SAR satisfies the requirements of 10 CFR 72.24(n).

16.2 Findings

As stated above, given the existing approved QA program that satisfies Appendix B to 10 CFR Part 50 and the applicant's stated intent to apply that program to the ISFSI, the staff concludes that the applicant has met the conditions of 10 CFR 72.140(d) and, therefore, satisfies the requirements of 10 CFR 72.140(b). The staff also concludes that the description of the QA program in the North Anna ISFSI SAR satisfies the requirements of 10 CFR 72.24(n).

16.3 License Condition

Because the quality assurance for the ISFSI is founded on a program that was approved pursuant to 10 CFR Part 50, the staff has imposed a license condition requiring that, before termination of the Part 50 license, the applicant must obtain staff approval of a stand-alone ISFSI QA program that satisfies the requirements of Subpart G to 10 CFR Part 72.

17.0 DECOMMISSIONING

Requirements related to decommissioning of an ISFSI are identified in 10 CFR 72.30 and 72.130. 10 CFR 72.30 provides requirements for a site-specific decommissioning plan, including decontamination of the site and facilities, disposal of residual radioactive materials after all spent fuel has been removed, the decommissioning funding plan, and the cost estimate for decommissioning

10 CFR 72.130 provides requirements for decommissioning and states, in part, that the ISFSI shall be designed for decommissioning. Among the items to be addressed under this part are the provisions to facilitate decontamination of equipment, the provisions to minimize the quantity of radioactive wastes and contaminated equipment and the provisions to facilitate the removal of radioactive wastes and materials at the time of permanent decommissioning.

This review was performed according to Chapter 16 of NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities."

17.1 Decommissioning Plan and Decommissioning Facilitation

In the license application and North Anna ISFSI SAR, the applicant described potential dispositioning of the stored spent fuel at the time of decommissioning of the ISFSI similar to those described in the TN-32 TSAR. The TSAR states that the cask with its load of spent fuel could be placed in a transportation overpack. The TSAR also indicates that the spent fuel in the cask could be unloaded and placed in a licensed transportation package for shipment to a subsequent storage facility or repository. The applicant did explicitly state in Section 4.6 of the North Anna ISFSI SAR that the spent fuel pool would remain functional until the ISFSI is decommissioned, thereby preserving the wet transfer option. The method by which the North Anna spent fuel is removed from the ISFSI is beyond the scope of this safety evaluation. However, the staff believes that either loading of the loaded cask into a future licensed overpack or unloading of the spent fuel from the cask into a licensed transportation package are reasonable assumptions regarding the dispositioning of the fuel before the decommissioning of the ISFSI and are acceptable with regard to the requirements in 10 CFR 72.130 that the facility be designed for decommissioning.

At decommissioning, the cask components will be both contaminated and activated. With regard to decontamination, the applicant and vendor both indicated in the TN-32 TSAR that loose surface contamination could be removed with high-pressure water sprays. The vendor also described that fixed surface contamination could be removed using chemical etching or electro-polishing. Upon successful decontamination, the applicant stated that cask components could be cut up for scrap, or if any components remain contaminated, such components could be shipped as low-level waste to a low-level waste facility.

With regard to activation of cask components, the applicant referenced the TN-32 TSAR discussion of the issue. Section 2.4 of the TN-32 TSAR describes the cask vendor's evaluation of activation. The TN-32 vendor assumed that (1) the cask contained 32 design-basis PWR assemblies, (2) the neutron flux remained constant over the 20-year service life of the cask and (3) the neutron spectrum was the same as in a pressurized water reactor. The vendor calculated that the total activity associated with activation after 20 years amounted to less than 0.08 Ci per cask. The specific activity of various isotopes in the cask components were compared to the Class A waste limits of 10 CFR 61.55. The specific activity was shown to be a small fraction of the Class A waste limits. Therefore, the applicant concluded that, after surface decontamination, the cask could be scrapped. In the TN-32 SER with regard to activation of cask components, the staff agreed with the calculated activity in the TN-32 cask components and agreed with the conclusions that calculated activity is a negligible fraction of the limits for Class A waste.

The applicant stated that, because of the leak-tight design of the cask, no residual contamination of the storage pad is expected. The applicant did not specifically quantify activation of the storage pad as a result of neutron flux from the stored fuel. However, in its submittal dated April 14, 1997, the applicant stated that, given the low neutron flux from the bottom of the cask relative to the cask interior, and given the low activation potential of the concrete, very little activation of the concrete will occur. The staff agrees that no contamination of the storage pad, fence, or peripheral structures is expected. The also staff agrees that, because of the material used in the construction of the storage pad and the low neutron flux, the specific activity in the pad materials will be a negligible fraction of the limits for Class A waste in 10 CFR 61.55

Site specific decontamination procedures will have to be developed at the time of decommissioning. Other than procedure development, the staff notes that there are no other site specific considerations in the decontamination and activation analysis beyond those evaluated in the TN-32 SER. The staff therefore concludes that the applicant's description of proposed decontamination processes for the cask components are acceptable with regard to the requirements in 10 CFR 72.130 that the facility be designed for decontamination.

17.2 Decommissioning Funding

Virginia Power provided a decommissioning plan in the license application and a description of the plan in Section 4.6 of the North Anna ISFSI SAR. Additional information was provided by the applicant in a letter dated April 14, 1997.

Decommissioning funding assurance for the North Anna ISFSI is addressed in 10 CFR 72.30(c)(5), which in turn references the provisions of 10 CFR 50.75(e) for those ISFSI applicants that are "electric utilities." The co-owners, each of which meets the NRC definition of "electric utility," have chosen to use the external sinking fund method of assuring that funds will be available to decommission the North Anna ISFSI.

Virginia Power projects that the ISFSI will be licensed for 20 years, with operation beginning in 1998. Total decommissioning cost, which will be expended at the time of North Anna reactor facility decommissioning, is estimated to be $16 million. Both Virginia Power and ODEC maintain master trust accounts for their respective shares of all decommissioning related activities, including ISFSI decommissioning. Each co-owner intends to continue to make annual trust fund contributions until necessary funds are accumulated at the time of permanent shutdown of the NAPS facility. The Virginia State Corporation Commission and the Federal Energy Regulatory Commission have approved rate allowances for North Anna decommissioning costs including ISFSI costs. In a letter dated January 28, 1998, the applicant stated that subaccounts have been established for the Company's nuclear decommissioning trusts to separately track the amounts related to the North Anna ISFSI.

For the above reasons, the co-owners are expected to have adequate funds in their external trust accounts to successfully complete decommissioning the North Anna ISFSI. The staff therefore concludes that the co-owners have provided reasonable assurance that the funds will be available in the amounts needed to decommission the North Anna ISFSI.

The staff concludes that the decommissioning financial information included in Virginia Power's application comply with the relevant provisions of 10 CFR 72.22(e), 72.30(c)(5), and 50.75(e), and that, therefore, the co-owners have demonstrated reasonable assurance that funds will be available to decommission the North Anna ISFSI in a manner that protects the public health and safety.

17.3 Record Keeping

In a letter dated April 23, 1998, the applicant stated that the following records related to decommissioning will be retained until the North Anna site is released for unrestricted use:

(1) records of spills or other unusual occurrences involving the spread of contamination in and around the ISFSI

(2) as-built drawings and modifications of structures and equipment at the ISFSI

(3) a list in a single document and updated no less than every two years of all areas designated and formerly designated as restricted areas as defined by 10 CFR 20.1003, and all areas outside the restricted area requiring documentation per item (1) above

(4) records of the cost estimate performed for the decommissioning funding plan and the funding method used for ensuring the availability of funds.

The staff reviewed the above commitments by the applicant and concluded that they satisfy the requirements of 10 CFR 72.30(d).

17.4 Findings

F17.1 The staff has reviewed the proposed Decommissioning Plan documentation submitted by the applicant for the North Anna ISFSI facility in accordance with the "Standard Review Plan for Spent Fuel Dry Storage Facilities," and the description of the plan in the North Anna ISFSI SAR. The staff has determined that the decommissioning plan submitted by the applicant provides reasonable assurance that the decommissioning issues for the North Anna ISFSI facility have been adequately characterized, so that the site will ultimately be available for unrestricted use for any private or public purpose. The staff therefore concludes that the proposed decommissioning plan complies with 10 CFR Part 72 requirements.

F17.2 The staff has reviewed the decommissioning funding plan documentation submitted by the applicant for the North Anna ISFSI facility in accordance with the "Standard Review Plan for Spent Fuel Dry Storage Facilities." The staff has determined that the decommissioning funding plan submitted by the applicant is sufficient to provide reasonable assurance that costs related to decommissioning, as characterized by the proposed decommissioning plan, have been adequately estimated. The staff, therefore, concludes that the cost estimate in the decommissioning funding plan complies with 10 CFR Part 72 requirements.

F17.3 The staff has reviewed the financial assurance documentation submitted by the applicant, as part of the decommissioning funding plan for the facility, in accordance with the "Standard Review Plan for Spent Fuel Dry Storage Facilities. The staff has determined that the financial assurance mechanisms submitted by the applicant are sufficient to provide reasonable assurance that adequate funds will be available to decommission the facility, so that the site will ultimately be available for unrestricted use for any private or public purpose. The staff therefore concludes that the financial assurance mechanisms in the decommissioning funding plan comply with 10 CFR Part 72.

18.0 CONCLUSIONS

Pursuant to Subpart C to 10 CFR Part 72, the Commission is to issue a license after determining that the application meets (1) the standards and requirements of the Atomic Energy Act; (2) the regulations of the Commission; and (3) the requirements for issuance of a license identified in 10 CFR 72.40(a).

18.1 Satisfaction of Required Contents of Application

The license application documentation includes technical information, provided in the North Anna ISFSI SAR and documents referenced therein and in the supplemental submittals listed in the license, which is considered to comply with the requirements for its content stated in 10 CFR 72.24. The license application includes TS with supporting bases and justifications. The specifications are listed in Appendix A of the North Anna ISFSI license. The TS are considered adequate to meet the requirements of 10 CFR 72.26.

The license application contains descriptions of the applicant's technical qualifications. The applicant's statements of technical qualification are considered to meet the requirements of 10 CFR 72.28.

18.2 Satisfaction of Requirements for Issuance of License

In accordance with 10 CFR 72.40(a)(1), the NRC staff finds that the applicant's proposed ISFSI design complies with the general design criteria contained in Subpart F to 10 CFR Part 72, with the exception of 10 CFR 72.124(b). An exemption from the requirements of 10 CFR 72.124(b) has been granted as discussed in Section 13 of this SER.

In accordance with 10 CFR 72.40(a)(2), the NRC staff finds that the applicant's proposed ISFSI site complies with the requirements of Subpart E of 10 CFR Part 72.

The North Anna ISFSI is located on the same site as the NAPS which is another NRC-licensed nuclear facility. In accordance with 10 CFR 72.40(a)(3), on the basis of information presented in Section 4 (regarding sharing of systems) and Section 8 (regarding radiological dose), the license application documentation is considered to provide acceptable evidence that the proposed site and installation location at the site will not pose an undue risk to the safe operation of the North Anna ISFSI or the NAPS.

In accordance with 10 CFR 72.40(a)(4), the North Anna ISFSI SAR and other documentation submitted in support of the application are considered to provide adequate and acceptable evidence that the applicant has the training and experience necessary to conduct operation of the North Anna ISFSI and to conduct associated activities.

In accordance with 10 CFR 72.40(a)(5), the North Anna ISFSI SAR and other documentation submitted in support of the application are considered to provide adequate and acceptable evidence that the operating procedures proposed by the applicant provide adequate and acceptable provisions for protection of health and minimization of danger to life and property.

In accordance with the requirements of 10 CFR 72.40(a)(7), the SAR and supporting information submitted as part of the application are considered to provide adequate and acceptable evidence that the applicant has a quality assurance program for the North Anna ISFSI which complies with Subpart G to 10 CFR Part 72.

In accordance with 10 CFR 72.40(a)(8), the submitted application includes an acceptable description of the detailed measures for physical protection, including description of the design features and physical security plan with design for physical protection, safeguards contingency plan, and guard training plan, as required by Subpart H to 10 CFR Part 72, and in compliance with 10 CFR 72.24(o).

In accordance with 10 CFR 72.40(a)(9), the SAR and other documentation submitted in support of the application include the applicant's program for training, proficiency testing, and certification of ISFSI personnel and demonstrates the applicant's personnel training program complies with Subpart I to 10 CFR 72.

In accordance with 10 CFR 72.40(a)(10), the SAR, proposed decommissioning plan with provisions for financing, and other documentation submitted in support of the application, provide reasonable assurance that the decontamination and decommissioning of the ISFSI at the end of its useful life will provide adequate protection to the health and safety of the public.

In accordance with 10 CFR 72.40(a)(11), the emergency plan described in the application is considered acceptable to comply with 10 CFR 72.32(c).

In accordance with 10 CFR 72.40(a)(13), and in light of the information in (1) the application, (2) the North Anna ISFSI SAR, (3) the North Anna ISFSI Environmental Report, and (4) the applicant's supplemental submittals, there is reasonable assurance that the activities authorized by a license to construct and operate the North Anna Independent Spent Fuel Storage Installation can be conducted without endangering the health and safety of the public and that these activities will be conducted in compliance with the conditions of the license, and the Commission's Regulations (10 CFR Parts 72, 20, 50, and 73).

In accordance with 10 CFR 72.40(a)(14), the documentation submitted with the application and review of the character and experience of the applicant provide sufficient information for the NRC staff to conclude that there is reasonable assurance that the issuance of the license for the North Anna ISFSI will not be inimical to the common defense and security.