APPENDIX 4B POOL AND POOL CONFINEMENT FACILITIES

The pool and pool confinement facilities provide a capability that may be essential to the conduct of independent spent fuel storage installation (ISFSI) and monitored retrievable storage installation (MRS) loading for storage and unloading functions and that may be needed for retrievability. The pool and pool confinement facilities are considered to include those systems important to safety that provide for wet transfer, loading, unloading, and temporary holding or long-term storage of spent nuclear fuel (SNF), high-level radioactive waste (HLW), and other radioactive materials associated with SNF or HLW storage. Other ISFSI or MRS equipment that may be used within and outside the pool facility, or that are used for lifting or transfer within the facility but are not installed cranes or conveyance systems, are addressed as structures, systems, and components (SSCs) important to safety or "other" SSCs.

The safety function of the pool and associated equipment is to maintain the SNF assemblies in a safe and subcritical array during all credible storage conditions and to provide a safe means of loading the assemblies into shipping casks.

The ISFSI and MRS pools and pool facilities should be designed as though they were to be in constant use for in-pool storage and wet transfer for the life of the ISFSI or MRS license. However, it is anticipated that the actual use of the ISFSI or MRS pool facility may differ from the use of the SNF pool at a reactor facility. Therefore, the SAR should thoroughly describe the limited or part-time use of the pool. The use status of the pool facility may have a major impact on the generation of radioactive and other waste. The design may also need to provide for conversion to standby mode or decontamination and decommissioning while the rest of the ISFSI or MRS remains in use for dry storage.

4B.1 Description of Pool Facilities

Regulations at Title 10 of the *Code of Federal Regulations* (10 CFR) 72.24(a), 72.24(b), 72.40(a)(3), and 72.106(a)(b)(c) address the descriptive information to be included in a license application. The application must describe pool facilities in sufficient detail to support a detailed review and evaluation. This includes text, descriptions, drawings, flow diagrams, figures, tables, and specifications to fully define the systems and features of the pool facilities.

The NRC accepts use of existing pool and pool confinement facilities that are licensed under 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," for an ISFSI or MRS, if concerns for possible sharing of SSCs between separately licensed facilities are satisfied (10 CFR 72.3, "Definitions," (included with the definition of an ISFSI), 72.24(a), 72.40(a)(3), and 72.122(d)). The existing pool and pool confinement facilities may continue to be licensed under 10 CFR Part 50, or they may be relicensed as elements of a wet storage or dry storage ISFSI, as appropriate.

4B.2 Design Criteria

The regulatory requirements given in 10 CFR 72.24(c)(1), (c)(2), and (c)(4); 10 CFR 72.40(a)(1); 10 CFR 72.120(a)(b); 10 CFR 72.122 (a)(b)(c)(d)(f)(g)(h)(i)(j)(k)(l); 10 CFR 72.128(a)(b); 10 CFR 72.236(b)(e)(f)(g)(k) identify acceptable design criteria.

Design criteria for important to safety facilities in 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related

Greater Than Class C Waste," are fully applicable to pool and pool confinement facilities. Pool and pool confinement facilities should meet the criteria for structural integrity for similar facilities constructed at a power reactor, which must comply with 10 CFR Part 50. These criteria are principally as stated in 10 CFR Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," General Design Criterion (GDC) 61, "Fuel Storage and Handling and Radioactivity Control." Some portions of GDC 62, "Prevention of Criticality in Fuel Storage and Handling," and GDC 63, "Monitoring Fuel and Waste Storage" apply. GDC 2, "Design Bases for Protection Against Natural Phenomena," 4, "Environmental and Dynamic Effects Design Bases," and 5, "Sharing of Structures, Systems, and Components," apply to the design of pool facilities. See NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LRW Edition," Sections 9.1.2, "New and Spent Fuel Storage," and 9.1.3, "Spent Fuel Pool Cooling and Cleanup System," for specific acceptance criteria, which derive from 10 CFR Part 50, Appendix A.

The intended usage of the pool and pool facilities may be used in the development of design requirements. Should the intended usage be long-term storage of SNF, the NRC accepts design of elements of the pool facility in accordance with American National Standards Institute (ANSI)/American Nuclear Society (ANS) 57.2, "Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants." Should the intended usage be short term or primarily to facilitate wet transfer operations, the NRC accepts design of elements of the pool facility in accordance with ANSI/ANS 57.7, "Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type)." Regardless of whether ANSI/ANS 57.2 or ANSI/ANS 57.7 is used, it should be noted that 10 CFR 72.2, "Scope," requires that SNF be aged for at least 1 year after discharge from the core.

The NRC accepts design of the pool liquid containment structures, systems, and components (SSCs) as required for Quality Group B (as described in Regulatory Guide (RG) 1.26, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants") that are licensed under 10 CFR Part 50. This quality group requires design to not less than the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Valve (B&PV) Code, Section III, "Rules for Construction of Nuclear Facility Components," Division 1, Subsection NC.

The NRC accepts the design of ISFSI and MRS pool facility cooling and makeup water systems (as required) for Quality Group C, as described in RG 1.26. This quality group requires design to not less than the requirements of ASME B&PV Code Section III, Division 1, Subsection ND.

The NRC accepts the guidance for reactor facility pools provided by RG 1.13, "Spent Fuel Storage Facility Design Basis," for ISFSI and MRS pool facilities. RG 1.13 lists the following principal criteria for pool facility design:

- prevent loss of water from the pool that would uncover the radioactive material
- protect the radioactive material from mechanical damage
- provide capability for limiting the potential offsite exposures in the event of a significant release of radioactivity from the subject materials

4B.3 Review Procedures

4B.3.1 Description of Pool Facilities

Review the descriptive material in Chapter 1 of the SAR and the descriptive information in Chapter 3 of the SAR. Ensure that the text descriptions, drawing figures, tables, flow diagrams, and specifications included in the application fully define the pool facilities.

Review the description of SSCs important to safety and verify that there is enough detail to proceed with the evaluation of the structural integrity and functional suitability. The configurations should be defined by drawings and fabrication specifications. Ensure that the specifications include references to the codes that govern the design details. Verify that the combination of the drawings, specifications, appropriate codes and standards, and supporting calculations are sufficient.

A pool and pool confinement facilities involve a broader range of components and systems than the confinement structures. However, the staff anticipates a diversity of pool facilities ranging from existing conventional pools designed under 10 CFR Part 50 requirements to site-specific designs used for limited, short-duration, wet-transfer operations. The facilities may contain some of the following elements that will require verification of structural integrity:

- pool structure, structural supports, and components that form the primary hydraulic confinement, water level control, cooling, and clean-up systems, such as piping, valves, pumps, filters, monitoring stations, and feeders
- pool components that provide for positioning the radioactive materials within the pool to ensure subcriticality (racks), accessibility, and compatibility with lifting interfaces
- pool components that ensure against improper movement of transfer or storage casks during wet-loading and unloading operations
- secondary hydraulic containment that precludes releases to the surface or subsurface environment that might result from leaks or rupture of elements of the primary hydraulic containment, including equipment and floor drainage system
- SSCs associated with lifting, loading, unloading, transfer, or other handling of ISFSI or MRS vessels, transfer or transportation casks, other shielding vessels, or radioactive material to be stored
- enclosure(s) of the pool and operations that involve loading, unloading, and handling of the subject radioactive materials and other SSCs forming structural elements of the confinement boundary
- emergency power capability necessary to maintain safe conditions and monitor radioactivity
- internal waste collection or confinement, demineralized water makeup system, and compressed air system for cask dewatering system (if used)
- SSCs providing compartmentalization and secondary confinement boundaries within (or coincident with) a pool facility's tertiary confinement barrier, such as for control room,

electrical and machinery rooms, cask system component holding and inspection, personnel changing and showers, personnel decontamination and monitoring, health physics, and technical and administrative spaces.

Other ISFSI or MRS equipment that may be used within and outside the pool facility or that is used for lifting or transfer within the facility, but is not installed in the facility, such as cranes or conveyance systems, is addressed as “other SSCs important to safety” or “other SSCs.”

Coordinate with the confinement review, Chapter 9 of this SRP, to verify that the SAR clearly identifies the confinement boundaries associated with the pool and pool facilities.

4B.3.2 Design Criteria

For each of the SSCs being reviewed, determine what the design criteria and design bases are from the SAR. Confirm that the design criteria comply with acceptance criteria as outlined in Section 4.5.2.2 of this SRP.

Depending on the type of usage, that is, long-term storage or short-term wet transfer, verify that the appropriate criteria are applied. ANSI/ANS 57.2 is appropriate for long-term, as well as short-term storage, whereas ANSI/ANS 57.7 may be more appropriate for short-term storage or wet-transfer operations.

Verify that the following sections of NUREG-0800 (Section 9.1.2) are adequately addressed:

- GDC 2—as it relates to structures housing the facility and that the facility is capable of withstanding the effects of natural phenomena such as earthquakes, tornadoes, and hurricanes

- GDC 4—as it relates to structures housing the facility and that the facility is capable of withstanding the effects of environmental conditions and external missiles such that safety functions are not precluded

- GDC 5—as it relates to shared SSCs

- GDC 61—as it relates to the facility design for fuel storage and handling of radioactive materials

- GDC 62—as it relates to the prevention of criticality of the fuel by means of physical systems.

4B.3.3 Material Properties

Coordinate with the thermal review, Chapter 5 of this SRP, to verify that the material properties used in the structural analysis are appropriate for the load conditions and that the appropriate temperature at which the stress limits are defined is consistent with service temperatures. For each of the SSCs being reviewed, determine what structural materials are specified (e.g., reinforced concrete, steel), and verify that the material properties conform to the accepted design codes and standards. Section 4.5.2.2 of this SRP gives references to acceptable codes. Review structural and other materials, and verify that they will produce no significant chemical or galvanic action or cause corrosion degradation that could adversely affect the safety function.

4B.3.4 Structural Analysis

Confirm that the design analysis includes codes and standards, design documentation, and design conditions for (1) the SNF storage and cask handling pools; (2) the SNF cask and fuel assembly handling systems; (3) SNF storage racks; (4) fuel pool water makeup, cooling, and cleanup systems; (5) heating, ventilating, and air conditioning equipment; (6) fuel-storage buildings; and (7) electrical power, instrumentation and control, and communications, as described in ANSI/ANS 57.2 and ANSI/ANS 57.7, as appropriate.

If ANSI/ANS 57.2 is used, verify that the SSCs meet the following GDC from Appendix A to 10 CFR Part 50:

- GDC 2—Confirm that regulatory position C.2 of RG 1.13, applicable portions of RG 1.29 and RG 1.117, and appropriate paragraphs of ANSI/ANS 57.2 are met.

- Review supporting documentation and appropriate staff confirmatory calculations and verify that position C.2 of RG 1.13 is met. Position C.2 states that the pool facility should be designed to keep tornado winds and missiles generated by tornado winds from causing significant loss of watertight integrity of the fuel storage pool and to prevent tornado-driven missiles from contacting the fuel stored in the pool.

- GDC 4—Confirm that regulatory position C.2 of RG 1.13, RG 1.115, “Protection Against Low-Trajectory Turbine Missiles,” and 1.117, as well as appropriate paragraphs of ANSI/ANS 57.2 are met.

- GDC 5—Confirm that SSCs important to safety are capable of performing the required safety function.

- GDC 61—Confirm that regulatory positions C.1 and C.4 of RG 1.13 and appropriate paragraphs of ANSI/ANS 57.2 are met.

- Review supporting calculations or independent staff confirmatory calculations and verify that regulatory positions C.1 and C.4 of RG 1.13 are satisfied. Position C.1 states that the fuel storage facility, including its structures and facilities (with some exceptions in regulatory position C.6), should be designed to Category I seismic requirements. Position C.4 states that a controlled leakage building should enclose the fuel pool. It should be equipped with an appropriate ventilation and filtration system to limit the potential release of radioactive materials. Although the building does not need to be designed to withstand extremely high winds, leakage should be suitably controlled during fuel-transfer operations. The ventilation and filtration system should be based on the assumption that the cladding of all the fuel rods in one fuel bundle might be breached.

- GDC 62—Confirm that regulatory positions C.1 and C.4 of RG 1.13 and appropriate paragraphs of ANSI/ANS 57.2 are met.

- Confirm that the handling of heavy loads (e.g., a SNF storage cask or SNF shipping cask) conforms to the guidance given in NUREG-0612.

Drop of a confinement cask may include secondary effects with safety implications, such as: deformation of interior structural SSCs that may preclude ready retrievability of the stored

materials, structural damage and possible rupture of the pool (without loss of coolant that would uncover the fuel), damage to radioactive materials in the pool, and damage to the transfer cask, radiation shielding, or both. Secondary effects may also involve analyses addressed under the other structural evaluation categories such as the pool and pool facilities, reinforced concrete structures, and other SSCs important to safety.

RG 1.120, "Fire Protection Guidelines for Nuclear Power Plants," provides guidance for fire protection, where applicable, to some confinement systems such as the SNF pool area.

4B.4 Evaluation Findings

F4B.1 The SAR and docketed materials adequately describe the ISFSI structures, and therefore meet the requirements in 10 CFR 72.24(b) with respect to technical information.

F4B.2 The SAR and docketed materials describe the design of the ISFSI structures in sufficient detail to support findings in 10 CFR 72.40, "Issuance of License," for the term requested in the application, including the design criteria pursuant to Subpart F, the design bases, and the relation of the design to the design criteria and utilizes applicable codes and standards, and therefore meets the requirements in 10 CFR 72.24(c)(1), (c)(2), and (c)(4) with respect to technical information.

F4B.3 The SAR and docketed material contain information relative to materials of construction, general arrangement, dimensions of principal structures, and descriptions of all SSCs important to safety in sufficient detail to support a finding that the ISFSI will satisfy the design bases with an adequate margin of safety, and therefore meets the requirements in 10 CFR 72.24(c)(3) with respect to technical information.

F4B.4 The SAR and docketed material contain an analysis and evaluation of the design and performance of SSCs important to safety, with the objective of assessing the impact on public health and safety resulting from operation of the ISFSI, and therefore meet the requirements in 10 CFR 72.24(d) with respect to technical information.

F4B.5 The SAR identifies the SSCs important to safety whose functional adequacy or reliability had not been demonstrated for that purpose or cannot be demonstrated by reference to performance data in related applications or to widely accepted engineering principles, and the applicant has provided a satisfactory schedule showing how safety questions will be resolved before the initial receipt of SNF, HLW, or reactor-related GTCC waste, as appropriate, for storage at the ISFSI, and therefore meets the requirements in 10 CFR 72.24(i)

F4B.6 The SAR and docketed materials adequately describe the design criteria for the SSCs important to safety and other SSCs, and therefore meet the requirements in 10 CFR 72.120(a).

F4B.7 Any reactor-related GTCC waste that is stored is in a durable solid form with demonstrable leach resistance, and therefore meets the requirements in 10 CFR 72.120(b)(3).

F4B.8 Each SSC important to safety is designed to the quality standards commensurate with the important to safety of the function to be performed, and therefore meets the requirements in 10 CFR 72.122(a).

F4B.9 The SSCs important to safety are designed to withstand the normal and off-normal conditions associated with the site and can withstand postulated accidents, and therefore meet the requirements in 10 CFR 72.122(b)(1).

F4B.10 The SCCs important to safety are designed to withstand the natural phenomena associated with the site without impairing their capability to perform their intended safety functions (with consideration for the most severe natural phenomena reported for the site and in the appropriate combination of normal and accident conditions), and therefore meet the requirements in 10 CFR 72.122(b)(2)(i).

F4B.11 All ISFSI structures are designed to prevent massive collapse or dropping of heavy objects onto an SSC important to safety, and therefore meet the requirements in 10 CFR 122(b)(2)(ii).

F4B.12 SSCs important to safety are designed and located to continue to perform their safety functions effectively under credible fire and explosion exposure conditions, and therefore meet the requirements in 10 CFR 72.122(c).

F4B.13 SSCs important to safety are not shared between the ISFSI and other facilities, or have been shown that such sharing does not impair the capability of either facility to perform its safety functions, including the ability to return to a safe condition in the event of an accident, and therefore meet the requirements in 10 CFR 72.122(d).

F4B.14 Storage systems are designed to allow ready retrieval of SNF, HLW, and reactor-related GTCC waste for further processing or disposal, and therefore meet the requirements in 10 CFR 72.122(l).

F4B.15 SNF handling, packaging, transfer, and storage systems are designed to ensure subcriticality, in that at least two unlikely, independent, and concurrent or sequential changes must occur before a nuclear criticality accident ensues. The margins of safety of these systems are adequate for the nature of the immediate environment under accident conditions, and therefore meet the requirements in 10 CFR 72.124(a).

F4B.16 SSCs important to safety are designed to provide favorable geometry or permanently fixed neutron absorbing materials, as applicable, and therefore meet the requirements in 10 CFR 72.124(b).

F4B.17 SSCs important to safety that contain SNF, HLW, reactor-related GTCC waste, and other related radioactive waste are designed to ensure adequate safety with respect to suitable shielding and confinement under normal and accident conditions, and therefore meet the requirements in 10 CFR 72.128(a)(2) and (a)(3).

4B.5 References

10 CFR Part 50, “Domestic Licensing of Production and Utilization Facilities.”

10 CFR Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste.”

American National Standards Institute (ANSI)/American Nuclear Society (ANS) 57.2-1983; W1993 (W=Withdrawn), “Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants.”

ANSI/ANS 57.7-1988; R1997; W2007 (R=Reaffirmed, W=Withdrawn), “Design Criteria for an Independent Spent Fuel Storage Installation (Water Pool Type).”

American Society of Mechanical Engineers (ASME) Boiler and Pressure (B&PV) Code, 2015.
Section III, “Rules for Construction of Nuclear Facility Components.”
Division 1, “Metallic Components”; Subsection NC and ND

Regulatory Guide 1.13, “Spent Fuel Storage Facility Design Basis.”

Regulatory Guide 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive Waste-Containing Components of Nuclear Power Plants.”

NUREG/CR-6322, “Buckling Analysis of Spent Fuel Basket,” UCRL-ID-119697, Lawrence Livermore National Laboratory, May 1995.