U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

9.1.2 NEW AND SPENT FUEL STORAGE

REVIEW RESPONSIBILITIES

Primary - Organization responsible for the review of new and spent fuel storage and handling

Secondary - Organization responsible for the review of chemical engineering issues

I. AREAS OF REVIEW

Nuclear reactor plants include facilities for the storage of new and spent fuel assemblies. The safety functions of the new fuel storage vault, new fuel storage racks, spent fuel pool, and spent fuel storage racks are to maintain the fuel assemblies in a safe and subcritical array during all credible storage conditions and to provide a safe means of loading the spent fuel assemblies into shipping or storage casks.

Review of the new and spent fuel storage facilities covers the new fuel vault, the new fuel storage racks, spent fuel storage pool, spent fuel storage racks, spent fuel pool liner, equipment storage pits, and structure housing these systems for compliance with 10 CFR 20.1101(b), 10 CFR 50.68, and General Design Criteria (GDCs) 2, 4, 5, 61, and 63 of Appendix A of 10 CFR Part 50.

This Standard Review Plan (SRP) section addresses the capability of the new and spent fuel storage facilities to maintain the fuel in a safe and subcritical array during all anticipated operating and accident conditions.

The specific areas of review are as follows:

1. The quantity of new and spent fuel to be stored.

2. The effects of design loads and forces on the new and spent fuel storage racks, new fuel storage vault, spent fuel storage pool, and pool liner plate.

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3. The capability to withstand and protect against natural phenomena (e.g., safe shutdown earthquake (SSE), design-basis tornado).

4. The effectiveness of natural coolant circulation through the spent fuel storage racks and the ability of new fuel racks to drain fluids if the new fuel storage facility is intended for dry storage or to be flooded if the new fuel storage facility is intended for wet storage.

5. The ability to detect and contain spent fuel pool liner leaks.

6. The configuration of the new fuel vault, the spent fuel storage pool, and their handling areas to preclude accidental falls of heavy objects on the new and spent fuel.

7. The ability to provide both radiological shielding for personnel by maintaining adequate water levels in the spent fuel pool and adequate shielding for the new fuel if recycled fuel is used.

8. The use of design features to maintain an adequate coolant inventory in the spent fuel pool and in the new fuel vault (if wet storage is used) under accident condition (e.g., weirs and gates, absence of unnecessary drains, proper piping penetration levels, etc.).

9. The use of appropriate monitoring systems to detect spent fuel pool water levels, pool temperature, and building radiation levels. Also, dry storage facilities for new fuel are reviewed for appropriate criticality monitors or means to ensure an adequate degree of subcriticality.

10. Safety implications related to sharing (for multi-unit) facilities.

11. A secondary review by the organization responsible for chemical engineering issues evaluates the materials of construction in the new and spent fuel storage facilities. This secondary review evaluates the compatibility and chemical stability of the materials wetted by the water in the spent fuel pool and, if applicable, in the new fuel vault and evaluates potential mechanisms that alter the dispersion of any strong fixed neutron absorbers.

    A. Compatibility and chemical stability of the materials in the components wetted by water in the spent fuel pool and in the new fuel vault. If the possibility for corrosion mechanisms is detected, the existing programs for preventing or minimizing corrosion are reviewed for their applicability to control corrosion.

    B. The reactivity of fuel in the spent fuel pool is controlled by plates or inserts attached to spent fuel racks containing neutron poison dispersed in a matrix. In some environments, the matrix may degrade and release the neutron poison, resulting in some reduction of neutron absorbing properties of the panels. The licensee should have a program for monitoring the effectiveness of the neutron poison present in the neutron absorbing panels.

12. Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC). For design certification (DC) and combined license (COL) reviews, the staff reviews the applicant's proposed ITAAC associated with the structures, systems, and components (SSCs) related to this SRP section in accordance with SRP Section 14.3, "Inspections, Tests, Analyses, and Acceptance Criteria." The staff recognizes that the review of ITAAC cannot be completed until after the rest of this portion of the application has been reviewed against acceptance criteria contained in this SRP section. Furthermore, the staff reviews the ITAAC to ensure that all SSCs in this area of review are identified and addressed as appropriate in accordance with SRP Section 14.3.

13. COL Action Items and Certification Requirements and Restrictions. For a DC application, the review will also address COL action items and requirements and restrictions (e.g., interface requirements and site parameters).

For a COL application referencing a DC, a COL applicant must address COL action items (referred to as COL license information in certain DCs) included in the referenced DC. Additionally, a COL applicant must address requirements and restrictions (e.g., interface requirements and site parameters) included in the referenced DC.

Review Interfaces

Other SRP sections interface with this section as follows:

1. Section 3.10: review of the seismic qualification of Category I instrumentation.

2. Section 3.11: review of equipment qualification.

3. Sections 3.2.1 and 3.2.2: review of the acceptability of the seismic and quality group classifications for system components.

4. Section 3.4.1: review of flood protection.

5. Sections 3.5.1.1, 3.5.1.2, and 3.5.1.3: review of the protection against internally-generated missiles.

6. Sections 3.5.1.4, 3.5.1.5, 3.5.1.6, and 3.5.2: review of the protection against externally-generated missiles.

7. Sections 3.3.1, 3.3.2, 3.4.2, 3.5.3, 3.7.1 through 3.7.4, 3.8.4, and 3.8.5: review of the acceptability of the design analyses, procedures, and criteria for the ability of seismic Category I structures housing the system and supporting systems to withstand the effects of such natural phenomena as the SSE, the probable maximum flood, and tornadoes and tornado missiles.

8. Section 6.6: review for whether in-service inspection requirements are met for system components.

9. Section 9.1.1: review of the acceptability of the design as to criticality prevention.

10. Section 9.1.3: review of the spent fuel pool's water level control, cleanup, and cooling systems.

11. Section 9.1.4: review of the spent fuel storage facility's light load handling system.

12. Section 9.1.5: review of the spent fuel storage facility's heavy load handling system and the provisions prevent the spent fuel cask from falling into the spent fuel pool.

13. Section 9.5.1: review of fire protection.

14. Sections 12.3 - 12.4: review of the adequacy of the radiation monitoring system.

15. Section 16.0: review of technical specifications.

16. Chapter 17: review of quality assurance.

The specific acceptance criteria and review procedures are contained in the referenced SRP sections.

II. ACCEPTANCE CRITERIA

Requirements

Acceptance criteria are based on meeting the relevant requirements of the following Commission regulations:

1. GDC 2 of Appendix A to 10 CFR Part 50 as to structures housing the facility and the facility itself withstanding the effects of natural phenomena like earthquakes, tornadoes, and hurricanes.

2. GDC 4 as to structures housing the facility and the facility itself withstanding the effects of environmental conditions, externally-generated missiles, internally-generated missiles, pipe whip, and jet impingement forces of pipe breaks so safety functions are not precluded.

3. GDC 5 as to shared structures, components and systems (SSCs) important to safety performing required safety functions.

4. GDC 61 as to the facility design for fuel storage and handling of radioactive materials.

5. GDC 63 as to monitoring systems for detecting conditions that could cause the loss of decay heat removal capabilities for spent fuel assemblies, detecting excessive radiation levels, and initiating appropriate safety actions.

6. 10 CFR 20.1101(b) as to radiation doses kept as low as reasonably achievable (ALARA).

7. 10 CFR 50.68 as to criticality monitoring or design to preclude criticality accidents.

8. 10 CFR 52.47(b)(1), which requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations.

9. 10 CFR 52.80(a), which requires that a COL application contain the proposed inspections, tests, and analyses, including those applicable to emergency planning, that the licensee shall perform, and the acceptance criteria that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, the facility has been constructed and will operate in conformity with the combined license, the provisions of the Atomic Energy Act, and the NRC's regulations.

SRP Acceptance Criteria

Specific SRP acceptance criteria acceptable to meet the relevant requirements of the NRC's regulations identified above are as follows for the review described in this SRP section. The SRP is not a substitute for the NRC's regulations, and compliance with it is not required. However, an applicant is required to identify differences between the design features, analytical techniques, and procedural measures proposed for its facility and the SRP acceptance criteria and evaluate how the proposed alternatives to the SRP acceptance criteria provide acceptable methods of compliance with the NRC regulations.

1. Acceptance for meeting the relevant aspect of GDC 2 is based on compliance with positions C.1 and C.2 of Regulatory Guide (RG) 1.13 and applicable portions of RG 1.29, and RG 1.117. For the spent fuel storage facility, additional guidance acceptable for meeting this criterion is found in American Nuclear Society (ANS) 57.2,

paragraphs 5.1.1, 5.1.3, 5.1.12.9, and 5.3.2. For the new fuel storage facility, additional guidance acceptable for meeting this criterion is found in ANS 57.3, paragraphs 6.2.1.3(2), 6.2.3.1, 6.3.1.1, 6.3.3.4, and 6.3.4.2.

2. Acceptance for meeting the relevant aspect of GDC 4 is based on positions C.2 and C.3 of RG 1.13, and RG 1.115 and 1.117.

3. GDC 5 is met by sharing the SSCs important to safety between the units in a manner that does not degrade the performance of their safety functions.

4. Acceptance for meeting the relevant aspect of GDC 61 for the spent fuel storage facility is based on compliance with positions C.4, C.6, C.10, C.11 and C.12 of RG 1.13 and the appropriate paragraphs of ANS 57.2. Acceptance for meeting this criterion for the new fuel storage facility is based on compliance with the appropriate paragraphs of ANS 57.3. Acceptance is also based on meeting the fuel storage capacity requirements noted in subsection III.1 of this SRP section. The following design considerations are evaluated:

   A. Provisions for periodic inspections of components important to safety.

   B. Suitable shielding for radiation protection, including adequate water levels.

   C. Appropriate containment and confinement systems.

   D. Residual heat removal capability by effective coolant flow through the storage racks for spent fuel assemblies.

   E. Prevention of reduction in fuel storage coolant inventory under accident conditions.

5. Acceptance for meeting the relevant aspect of GDC 63 for spent fuel storage is based on compliance with position C.7 of RG 1.13 and paragraph 5.4 of ANS 57.2. Acceptance for meeting this criterion for the dry storage of new fuel is based on radiation monitoring pursuant to 10 CFR 70.24 or acceptable prevention of an increase in effective multiplication factor (K_{eff}) beyond safe limits as described in 10 CFR 50.68.

6. In meeting the requirements of 10 CFR 20.1101(b), positions C.2.f(2) and C.2.f(6) of RG 8.8 are the bases for acceptance with respect to provisions for decontamination. For spent fuel storage, paragraph 5.1.5 of ANS 57.2 and appropriate positions of RG 1.13 are the bases for acceptance. For new fuel storage, paragraphs 6.3.3.7 and 6.3.4 of ANS 57.3 are the bases for acceptance.

7. 10 CFR 50.68 allows the applicant to follow the guidelines of 10 CFR 70.24 for criticality monitors or the guidelines described therein for significant margins of subcriticality.

Technical Rationale

The technical rationale for application of these acceptance criteria to the areas of review addressed by this SRP section is discussed in the following paragraphs:

1. GDC 2 requires that nuclear power plant SSCs important to safety be designed to withstand the effects of such natural phenomena as earthquake, tornado, hurricane, flood, tsunami, and seiche without loss of capability to perform their safety functions. The design of these SSCs also must reflect appropriate combinations of the effects of accidents and natural phenomena.

   The functions of the new and spent fuel storage facilities are to maintain new and spent fuel in a safe and subcritical array during all anticipated operating and accident conditions and to limit offsite exposures in the event of significant release of radioactive

materials from the fuel. The spent fuel storage facility also must keep spent fuel assemblies adequately cooled during all anticipated operating and accident conditions. GDC 2 requirements verify whether SSCs of the new and spent fuel storage facilities (e.g., the spent fuel pool, new and spent fuel storage racks, and pool liner) will withstand the effects of natural phenomena that might occur at the plant site. Designing the storage pool and fuel storage racks to meet seismic Category I requirements provides reasonable assurance that earthquakes will not cause a substantial coolant loss, a reduction in margin to criticality, or damage to the fuel assemblies.

GDC 2 requirements provide assurance that natural phenomena will not prevent maintenance of a subcritical configuration and adequate cooling of the stored fuel.

2. GDC 4 requires that SSCs important to safety be designed to accommodate the effects of, and be compatible with, the environmental conditions of anticipated operating and accident conditions. This requirement includes protection against dynamic effects, including those of missiles, pipe whipping, and discharging fluids caused by equipment failures and from events and conditions outside the nuclear power unit.

   GDC 4 requires for new and spent fuel storage facilities a controlled and protected environment for the new and spent fuel and all SSCs necessary for safety. The spent fuel pool liner, the new and spent fuel assemblies, and the fuel storage racks must be protected from dynamic effects, including turbine and tornado missiles. Adequately thick spent fuel pool walls and adequate water levels usually provide the necessary protection from dynamic effects for SSCs within the pool. The new fuel and its storage racks also must be protected from dynamic effects to provide reasonable assurance that a substantial margin to criticality is maintained.

   GDC 4 requirements provide assurance that the new and spent fuel storage facilities will contain radioactive materials and maintain a subcritical configuration that can be cooled adequately in all environmental conditions, even after exposure to dynamic effects like missiles.

3. GDC 5 requires that SSCs important to safety not be shared among nuclear power units unless such sharing can be shown not to significantly impair their ability to perform safety functions, including, in an accident in one unit, an orderly shutdown and cooldown of the remaining units.

   GDC 5 requires that the fuel storage facility at multiple-unit sites either not be shared among the units or that shared SSCs be designed so an accident at one facility will not significantly impair the ability of the remaining facility to protect new and spent fuel.

   GDC 5 requirements provide assurance that SSC sharing will not impair the safety functions of the new and spent fuel storage facilities.

4. GDC 61 requires that the fuel storage system be designed for adequate safety under anticipated operating and accident conditions. The system must be designed with (1) the capability for appropriate periodic inspection and testing of components important to safety, (2) suitable shielding for radiation protection, (3) appropriate containment, confinement, and filtering capability, (4) residual heat removal that reflects the safety importance of decay heat and other residual heat removal, and (5) the capability to prevent a significant reduction in fuel storage coolant inventory under accident conditions.

   GDC 61 requires that the new and spent fuel storage facilities provide for inspection of the facilities, protection of the new and spent fuel, cooling for the spent fuel, shielding for the workers, and containment of the radioactivity. Provisions for inspection and testing are necessary to verify that there is no corrosion of the spent fuel pool liner or new and spent fuel storage racks, no buildup of crud or debris that may obstruct coolant flow in wet storage facilities, and no degradation of any strong fixed neutron absorbers.

Containment is provided by the spent fuel pool liner, liner leakage collection, and appropriate floor sumps. Provisions for removing decay heat from the spent fuel are by (1) design of spent fuel storage racks for adequate coolant flow, (2) maintenance of adequate spent fuel pool water levels, and (3) design of the spent fuel pool and storage racks to seismic Category I criteria. Prevention of significant reduction in spent fuel pool coolant inventory under accident conditions is by elimination of pool penetrations below coolant levels necessary for shielding and by anti-syphon devices and check valves on piping that could be a source of coolant draining; furthermore, gates and weirs should separate the spent fuel storage pool from adjacent fuel-handling areas. Suitable shielding from spent fuel is provided by water levels at least 3 meters (10 feet) above the top of the stored fuel assemblies. There must also be appropriate shielding in the new fuel storage facility if recycled fuels are used.

GDC 61 requirements for the new and spent fuel storage facilities provide assurance of adequate cooling of stored fuel, appropriate confinement of radioactive materials, and adequate radiation shielding for personnel.

5. GDC 63 requires appropriate systems in fuel storage and radioactive waste systems and handling areas to detect conditions that may cause loss of residual heat removal capability and excessive radiation levels and to initiate appropriate safety actions.

   GDC 63 for spent fuel storage facilities requires spent fuel pool water level, pool temperature, and pool building radiation monitoring to protect personnel, to prevent significant offsite radiation doses, and to detect conditions that could cause loss of decay heat removal capabilities. For the dry storage of new fuel, either criticality accident monitors pursuant to 10 CFR 70.24 or an acceptable method of preventing an increase in K_{eff} beyond safe limits may be used pursuant to 10 CFR 50.68.

   In addition, alarms and communications systems must alert personnel and provide for communications between fuel handling machines, refueling machines, and the control room. If necessary to limit offsite dose consequences from a fuel handling accident or pool boiling, instrumentation should automatically place the spent fuel facility ventilation system in a mode to reduce the offsite release of radioactive material.

   GDC 63 requirements provide assurance that loss of residual heat removal capability and high radiation levels will be detected and that the release of radioactive materials to the environment will be prevented.

6. 10 CFR 20.1101(b) requires the licensee to use, to the extent practicable, procedures and engineering controls based on sound radiation protection principles to achieve ALARA occupational doses and doses to the public.

   This SRP section describes staff positions and ANS guidance for the new fuel storage vault, new fuel storage racks, spent fuel pool, spent fuel storage racks, and the containing facility meant to achieve radiation doses in compliance with the ALARA principle. Controlled drainage for the spent fuel pool limits the spread of contamination from leakage of the pool liner. Smooth and non-porous surfaces for all components in contact with contaminated coolant (e.g., spent fuel pool liner and storage racks) avoid unnecessary buildup of radioactive material. Appropriate shielding of spent fuel and new recycled fuels also ensures compliance with the ALARA principle.

   10 CFR 20.1101(b) requirements provide assurance that components of the new and spent fuel storage facilities will generate radiation doses that comply with the ALARA standard.

7. 10 CFR 50.68 requires provisions either to monitor for criticality accidents pursuant to 10 CFR 70.24 or to follow its guidelines to ensure K_{eff} will not increase beyond safe limits.

10 CFR 50.68 as to the dry storage of fuel ensures an adequate degree of subcriticality or adequate criticality monitors. The applicant may provide radioactivity monitors as specified in 10 CFR 70.24, administrative controls and/or design features to prevent flooding of the dry storage area, or analysis to show that K_{eff} does not exceed 0.95 if the storage area is flooded with unborated water and that K_{eff} does not exceed 0.98 if the storage area is filled with an optimum moderator (e.g., fire extinguishing foam), assuming fuel of the maximum reactivity. SRP Section 9.1.1 provides the guidance necessary for criticality evaluation in the new and spent fuel storage areas.

10 CFR 50.68 requirements ensure that criticality accidents will not endanger the safety of personnel.

III. REVIEW PROCEDURES

The reviewer will select material from the procedures described below, as may be appropriate for a particular case.

These review procedures are based on the identified SRP acceptance criteria. For deviations from these acceptance criteria, the staff should review the applicant's evaluation of how the proposed alternatives to the SRP criteria provide an acceptable method of complying with the relevant NRC requirements identified in Subsection II.

Upon request from the primary reviewer, the interfacing review branches provide input for the areas of review stated in Subsection I of this SRP section. The secondary review branch provides an input routinely for areas of review of this SRP section. The primary reviewer uses such input as required to complete this review procedure.

1. The SAR is reviewed to determine whether the design bases and facility description section indicate the storage capacity of the design.

   The minimum storage capacity in the spent fuel storage pool should equal or exceed the amount of spent fuel from five years of operation at full power plus one full-core discharge. Due to insufficient away-from-reactor storage capacity, the industry trend has been to use high-density storage racks. The reviewer evaluates high-density storage case by case. Low-density storage should be used, at a minimum, for the most recently discharged fuel to enhance the capability to cool it.

2. The SAR information on the facility design criteria, safety evaluation, system description, and layout drawings for the new fuel vault, spent fuel pool, the containing building, and the new and spent fuel storage racks is reviewed to verify whether:

   A. The new fuel vault, new fuel storage racks, spent fuel storage racks, pool, and pool liner are capable of withstanding all design loads. This review is coordinated, as necessary, with the primary reviewer for SRP Section 3.8.4.

   B. The new and spent fuel storage racks are designed so a fuel assembly can be inserted only in a design location. The design also should prevent placement of fuel assemblies in the adjacent regions external to the racks.

   C. Nonsafety-related SSCs not designed to seismic Category I standards located in the vicinity of the new and spent fuel storage facilities are reviewed for whether their failure would cause an increase in K_{eff} to more than the maximum allowable. The SAR description section, the general arrangement and layout drawings, and the tabulation of seismic design classifications for structures and systems are reviewed for whether this condition is met. An SAR statement establishing this condition as a design criterion is acceptable at the construction permit (CP) review stage.

D. Design calculations should show that the new and spent fuel storage racks and any anchorages can withstand the maximum fuel handling equipment uplift forces without an increase in K_{eff} or damage to the watertight integrity of the spent fuel pool liner. An SAR statement that excessive forces cannot be applied due to the design of the fuel handling equipment is acceptable with justification. The evaluation procedures of SRP Sections 9.1.4 and 9.1.5 validate this statement.

E. The load handled by the light load handling system, as addressed in SRP Section 9.1.4, with the potential to cause the greatest damage to stored fuel should be used in the fuel handling accident evaluation.

The provisions for protecting the new fuel storage area from loads dropped by the heavy load handling system are covered under SRP Section 9.1.5.

F. Sharing of storage facilities in multi-unit plants will not decrease the ability to remove decay heat from the spent fuel or maintain new and spent fuel in a subcritical array.

G. The materials wetted in the spent fuel pool, (e.g., spent fuel racks, fixed neutron poison, and the spent fuel pool liner) and, if applicable, the new fuel vault are chemically compatible and stable. The review also verifies whether there are potential mechanisms to alter the dispersion of any strong fixed neutron absorbers. The secondary reviewer provides input for this review.

H. The spent fuel pool coolant water level can be maintained at a safe level for cooling and shielding. The design should include:

i. Weirs and gates separating the spent fuel storage areas from handling areas to prevent the accidental draining of the coolant to levels inadequate for fuel cooling or radiation shielding. The bottoms of any gates should be above the top of the fuel assemblies, and the volume of the adjacent fuel-handling areas should be limited so that leakage into these areas while drained would not reduce the coolant inventory to less than 3 meters (10 feet) above the top of the fuel assemblies.

ii. Absence of drains, permanently connected mechanical or hydraulic systems, and other features that by failure or improper operation could reduce coolant levels to inadequacy for cooling the spent fuel and all piping penetration locations above minimum shielding depth.

I. The thermal-hydraulic analysis of the flow through the spent fuel racks is adequate for decay heat removal from the spent fuel assemblies during all anticipated operating and accident conditions. Furthermore, the analysis should show adequate natural circulation of the coolant during all anticipated operating conditions, including full core-offloads during refueling, to prevent nucleate boiling for all fuel assemblies.

J. The new fuel storage racks include openings at the bottom to facilitate drainage if intended for dry storage or flooding if intended for wet storage.

K. Detection and collection of spent fuel pool liner leaks incorporated into the design with capability to collect pool liner leaks (e.g. drains and sumps) to prevent uncontrolled releases of radioactive material to the environment and to keep radiation exposure as low as reasonably achievable for personnel.

L. If new fuel is intended to be stored dry, adequate drainage for the new fuel storage vault to prevent accumulation of any liquid moderators. The drain system should be sized to handle the maximum flow from the rupture of the

largest water pipe in the area. Backflow into the vault through the drain system should be prevented.

M. If necessary to limit offsite dose consequences from a fuel-handling accident or from spent fuel pool boiling, an air filtration system designed to meet the requirements of RG 1.52.

N. If the spent fuel storage facility is designed to allow boiling during accident conditions the spent fuel pool liner and containing structure should withstand the high temperatures of the boiling coolant.

O. Appropriate monitoring systems included in the design. For spent fuel storage, monitoring systems should detect pool water levels, pool temperatures, and pool building radiation levels. Alarms should be both local and in a continuously manned location. Guidance acceptable to the staff for spent fuel monitoring requirements is in position C.7 of Regulatory Guide 1.13. For dry storage of new fuel assemblies, the dry fuel storage facility should have one of the following pursuant to 10 CFR 50.68:

i. Criticality monitors as specified in 10 CFR 70.24.

ii. Administrative controls and/or design features to prevent flooding.

iii. K_{eff} not more than 0.95 if the storage area is flooded with unborated water and not more than 0.98 if the storage area is filled with an optimum moderator (e.g., fire extinguishing foam), assuming fuel of the maximum reactivity. SRP Section 9.1.1 provides the necessary guidance for criticality evaluation in the new and spent fuel storage areas.

Criticality monitors are not required for the underwater storage of fuel pursuant to 10 CFR 70.24, but there should be area radiation monitoring equipment for spent fuel storage pursuant to GDC 63.

3. The reviewer determines whether the safety function of the facility will be maintained, as required, if the facility is subjected to adverse natural phenomena of earthquakes, tornadoes, hurricanes, and floods. In this determination, the reviewer considers the following points:

A. The facility design basis and criteria and the component classification tables are reviewed for whether the new and spent fuel storage facilities including the new fuel storage vault, spent fuel storage pool, pool liner, and new and spent fuel racks are classified and designed to seismic Category I requirements.

B. If the spent fuel pool liner plate is not designed and constructed to seismic Category I requirements, the spent fuel pool liner plate is reviewed for whether a failure of the liner plate as a result of an SSE will not cause any of the following:

i. Significant releases of radioactivity due to mechanical damage to the fuel.

ii. Significant loss of water from the pool which could uncover the fuel and lead to release of radioactivity due to heat-up.

iii. Loss of ability to cool the fuel due to flow blockage caused by a complete section or portion of the liner plate falling on the fuel racks.

iv. Damage to safety-related equipment as a result of pool leakage.

v. Uncontrolled release of significant quantities or radioactive fluids to the environs.

C. The essential portions of the new and spent fuel storage facilities are reviewed for protection from the effects of floods, hurricanes, tornadoes, and internally- or externally-generated missiles. Flood protection and missile protection criteria are addressed in the SRP Chapter 3 sections listed in the Review Interfaces subsection of this SRP section. The reviewer utilizes the information in those SRP sections, as appropriate, to validate the analyses presented. The reviewer accepts a statement to the effect that the storage facility is located in a seismic Category I structure that is missile-and flood-protected.

4. The safe handling of spent fuel assemblies necessitates the underwater transfer of spent fuel between plant areas including the spent fuel cask loading area. The SAR is reviewed for a statement in the design basis and facility description section that a separate spent fuel shipping cask loading area is adjacent to the spent fuel pool. The reviewer verifies whether the loading area is designed to maintain the safety function of the spent fuel pool during accident conditions and natural phenomena. In addition, the reviewer verifies whether the design includes the following:

   A. The fuel transfer canal and cask loading area should be capable of isolation from the fuel pool by gates and weirs. An SAR statement that the design includes these features is acceptable. The reviewer uses engineering judgment to verify whether the means provided meet the stated intent.

   B. As to the handling of heavy loads (e.g., the spent fuel shipping cask) in the vicinity of the spent fuel storage pool, the reviewer must establish and verify in SRP Section 9.1.5 that one of the alternative approaches described in Section 5 of NUREG-0612 has been satisfied. If Sections 5.1.1 and 5.1.6 of NUREG-0612 have not been met, the SAR safety evaluations, results of design calculations, and the general arrangement and layout drawings should show that the spent fuel cask loading area is designed to withstand the loads from falling heavy objects, including the shipping cask, is not part of the storage pool floor, and, if breached by a falling object, would not cause loss of fuel pool water to an unacceptable level.

5. For reviews under 10 CFR Part 50, the procedures for CP application review for whether the design criteria and bases and the preliminary design meet the acceptance criteria of Subsection II of this SRP section. For the review of the operating license application, the review procedures and acceptance criteria verify whether the initial design criteria and bases are implemented appropriately in the final design. The operating license review verifies whether the content and intent of the technical specifications prepared by the applicant agree with requirements for system testing, minimum performance, and surveillance developed from the staff's review.

6. For review of a DC application, the reviewer should follow the above procedures to verify that the design, including requirements and restrictions (e.g., interface requirements and site parameters), set forth in the final safety analysis report (FSAR) meets the acceptance criteria. DCs have referred to the FSAR as the design control document (DCD). The reviewer should also consider the appropriateness of identified COL action items. The reviewer may identify additional COL action items; however, to ensure these COL action items are addressed during a COL application, they should be added to the DC FSAR.

   For review of a COL application, the scope of the review is dependent on whether the COL applicant references a DC, an early site permit (ESP) or other NRC approvals (e.g., manufacturing license, site suitability report or topical report).

7. For review of both DC and COL applications, SRP Section 14.3 should be followed for the review of ITAAC. The review of ITAAC cannot be completed until after the completion of this section.

IV. EVALUATION FINDINGS

The reviewer verifies that the applicant has provided sufficient information and that the review and calculations (if applicable) support conclusions of the following type to be included in the staff's safety evaluation report. The reviewer also states the bases for those conclusions.

The new and spent fuel storage facilities include the new and spent fuel storage racks, the spent fuel storage pool, the new fuel storage vault, and equipment storage pits. After review of the applicant's proposed DC, design bases, and safety classification for the new and spent fuel storage facilities and the provisions necessary to maintain a subcritical array and prevent uncontrolled releases of radiation, the staff concludes that the design of the spent fuel storage facility and supporting systems complies with NRC regulations in 10 CFR 20.1101(b), 10 CFR 50.68, and GDCs 2, 4, 5, 61, and 63.

This conclusion is based on the following findings:

1. The applicant has met the requirements of GDC 2 by compliance with positions C.1 and C.2 of RG 1.13 and with applicable portions of RGs 1.29 and 1.117. For the spent fuel storage facility, acceptance is also based on compliance with ANS 57.2, paragraphs 5.1.1, 5.1.3, 5.1.12.9, and 5.3.2. For the new fuel storage facility, acceptance is also based on compliance with ANS 57.3, paragraphs 6.2.1.3(2), 6.2.3.1, 6.3.1.1, 6.3.3.4, and 6.3.4.2.

2. The applicant has met the requirements of GDC 4 for environmental and missile protection design basis by compliance with position C.2 and C.3 of RG 1.13 and the applicable portions of RGs 1.115 and 1.117.

3. The applicant has met the requirements of GDC 5 because the failure of any portion of the shared new and spent fuel storage facilities will not impair the ability of plant systems to perform safety functions.

4. The applicant has met the requirements of GDC 61 for new and spent fuel provisions for inspections, shielding, containment, residual heat removal, coolant flow through wet storage racks, and prevention of loss of coolant by compliance with positions C.4, C.6, C.10, C.11, and C.12 of RG 1.13, the appropriate paragraphs of ANS 57.2, and the appropriate paragraphs of ANS 57.3.

5. The applicant has met the requirements of GDC 63 for monitoring the status of the stored spent fuel by compliance with position C.7 of RG 1.13 and paragraph 5.4 of ANS 57.2. Monitoring systems can detect the loss of decay heat removal capabilities or excessive radiation levels and initiate appropriate safety actions.

   The applicant has also met, by either radiation monitoring pursuant to 10 CFR 70.24 or an analysis the staff has found acceptable, the requirements of GDC 63 for monitoring the status of the dry storage of new fuel to prevent an increase in K_{eff} beyond safe limits from flooding of the dry fuel storage area as pursuant to 10 CFR 50.68.

6. The applicant has met the requirements of 10 CFR 20.1101(b) as to ALARA radiation exposures by compliance with positions C.2.f(2) and C.2.f(6) of RG 8.8 and paragraphs 5.1.5 and 5.1.7.1 of ANS 57.2.

7. The applicant has met the requirements of 10 CFR 50.68 for the dry storage of new fuel by appropriate criticality monitoring, by administrative controls and/or design features that prevent flooding, or by an analysis that shows that the dry storage facility will maintain the degree of subcriticality specified in 10 CFR 50.68 even if flooded.

For DC and COL reviews, the findings will also summarize the staff's evaluation of the requirements and restrictions (e.g., interface requirements and site parameters) and COL action items relevant to this SRP section.

In addition, to the extent that the review is not discussed in other SER sections, the findings will summarize the staff's evaluation of the ITAAC, including design acceptance criteria, as applicable.

V. IMPLEMENTATION

The staff will use this SRP section in performing safety evaluations of DC applications and license applications submitted by applicants pursuant to 10 CFR Part 50 or 10 CFR Part 52. Except when the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the staff will use the method described herein to evaluate conformance with Commission regulations.

The provisions of this SRP section apply to reviews of applications submitted six months or more after the date of issuance of this SRP section, unless superseded by a later revision.

VI. REFERENCES

1. 10 CFR 20.1101, "Radiation Protection Programs," U.S. Nuclear Regulatory Commission.

2. 10 CFR Part 50, Appendix A, GDC 2, "Design Bases for Protection Against Natural Phenomena," U.S. Nuclear Regulatory Commission.

3. 10 CFR Part 50, Appendix A, GDC 4, "Environmental and Dynamic Effects Design Bases," U.S. Nuclear Regulatory Commission.

4. 10 CFR Part 50, Appendix A, GDC 5, "Sharing of Structures, Systems, and Components," U.S. Nuclear Regulatory Commission.

5. 10 CFR Part 50, Appendix A, GDC 61, "Fuel Storage and Handling and Radioactivity Control," U.S. Nuclear Regulatory Commission.

6. 10 CFR Part 50, Appendix A, GDC 63, "Monitoring Fuel and Waste Storage," U.S. Nuclear Regulatory Commission.

7. 10 CFR 50.68, "Criticality accident requirements," U.S. Nuclear Regulatory Commission.

8. 10 CFR 52.47, "Contents of applications," U.S. Nuclear Regulatory Commission.

9. 10 CFR 52.97, "Issuance of combined licenses," U.S. Nuclear Regulatory Commission.

10. 10 CFR 70.24, "Criticality accident requirements," U.S. Nuclear Regulatory Commission.

11. RG 1.13, "Spent Fuel Storage Facility Design Basis."

12. RG 1.29, "Seismic Design Classification."

13. RG 1.115, "Protection Against Low-Trajectory Turbine Missiles."

14. RG 1.117, "Tornado Design Classification."

15. NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants."

16. Generic Communication: Bulletin 84-03, "Refueling Cavity Water Seal."

17. Generic Communication: Bulletin 94-01, "Potential Fuel Pool Draindown Caused by Inadequate Maintenance Practices at Dresden Unit 1."

18. ANS 57.2/ANSI N210-1976, “Design Objectives for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Stations,” American Nuclear Society/American National Standards Institute.

19. ANSI/ANS-57.3-1983, “Design Requirements for New Fuel Storage Facilities at Light Water Reactor Plants,” American Nuclear Society/American National Standards Institute.