U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 9.1.1 NEW FUEL STORAGE

REVIEW RESPONSIBILITIES

Primary - Auxiliary and Power Conversion Systems Branch (APCSB)

Secondary - Mechanical Engineering Branch (MEB)
Structural Engineering Branch (SEB)
Materials Engineering Branch (MTEB)
Reactor Systems Branch (RSB)
Core Performance Branch (CPB)
Radiological Assessment Branch (RAB)

I. AREAS OF REVIEW

Nuclear reactor plants include storage facilities for the dry storage of new fuel. The quantity of new fuel to be stored varies from plant to plant, depending upon the specific design of the plant and the individual refueling requirements. The safety function of the storage facility is to maintain the new fuel in a subcritical array during all credible storage conditions. The APCSB reviews the new fuel storage facility design including the fuel assembly storage racks and storage vault.

1. The facility design is reviewed with respect to the following:
   a. The quantity of fuel to be stored.
   b. The design and arrangement of the storage racks for maintaining a subcritical array during all storage conditions.
   c. The degree of subcriticality, and the supporting analysis and associated assumptions.
   d. The effects of external loads and forces on the new fuel storage racks and vault (e.g., safe shutdown earthquake, crane uplift forces).
   e. The effects of sharing in multi-unit complexes, and failures of other plant equipment close to the new fuel storage facility.

Secondary reviews are performed by other branches and the results used by the APCSB to complete the overall evaluations of the system. The secondary reviews are as follows: The SEB determines the acceptability of the design analyses, procedures, and criteria used to establish the ability of facility structures to withstand the effects of natural phenomena such as the safe shutdown earthquake (SSE), the probable maximum flood (PMF), and tornado missiles. The MEB reviews the seismic qualification of components and

confirms that components, piping, and structures are designed in accordance with applicable codes and standards. The RSB determines that the assigned seismic and quality group classifications for facility components are acceptable. The MTEB verifies, upon request, the compatability of the materials of construction with service conditions. The CPB verifies, upon request, that the k_{eff} of loaded storage racks is acceptable. The RAB reviews the adequacy of the shielding design and the radiation monitoring system.

II. ACCEPTANCE CRITERIA

Acceptability of the new fuel storage facility design as described in the applicant's safety analysis report (SAR), including related sections of Chapters 2 and 3 of the SAR, is based on specific general design criteria and regulatory guides, and on independent calculations and staff judgments with respect to facility functions and component selection. Listed below are specific criteria related to the storage facility.

1. The design of the new fuel storage facility is acceptable if the integrated design is in accordance with the following criteria:
   a. General Design Criterion 2, as related to the ability of structures housing the facility and the facility components to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, and floods, as established in Chapters 2 and 3 of the SAR.
   b. General Design Criterion 3, as related to protection against fire hazards.
   c. General Design Criterion 4, with respect to structures housing the facility and the facility components being capable of withstanding the effects of external missiles and internally-generated missiles, pipe whip, and jet impingement forces associated with pipe breaks, such that safety functions will not be precluded.
   d. General Design Criterion 5, as related to shared systems and components important to safety being capable of performing required safety functions.
   e. General Design Criterion 61, as related to the facility design for fuel storage, including the following elements:
      (1) The capability for periodic testing of components important to safety.
      (2) Shielding for radiation protection.
      (3) Provisions for containment or confinement.
   f. General Design Criterion 62, as related to the prevention of criticality by physical systems or processes utilizing geometrically safe configurations.
   g. General Design Criterion 63, as it relates to monitoring systems provided to detect excessive radiation levels.
   h. Regulatory Guide 1.29, as related the seismic design classification of facility components.
   i. Fuel storage capacity and criticality limits as discussed in III.1 and III.2 below.

An additional basis for determining the acceptability of the facility is the degree of similarity of the design with that for previously reviewed plants with satisfactory operating experience.

III. REVIEW PROCEDURES

The procedures below are used during the construction permit (CP) application review to determine that the design criteria and bases and the preliminary design meet the acceptance

criteria given in Section II of this plan. For operating license (OL) applications, the review procedures and acceptence criteria are utilized to verify that the initial design criteria and bases have been appropriately implemented in the final design as set forth in the final safety analysis report. The review procedures given are for a typical storage system. Any variance of the review, to adjust to a proposed unique design, is such as to assure that the facility design conforms to the criteria in Section II. The reviewer selects and emphasizes material from this review plan as may be appropriate for a particular case.

1. The quantity of new fuel to be stored onsite forms the basis for the design capacity of the vault and the number of storage racks provided. The SAR is reviewed to determine that the facility description section has stated the storage capacity provided by the design. The SAR's for recent light water reactor applications have stated that the storage space provided is consistent with the number of new fuel assemblies used during the refueling cycle. In general, storage capacity for at least one-third of a core is usually provided for each unit of a plant (e.g., 1/3 core for single unit design and 2/3 core for a dual unit design).

2. The information provided in the SAR pertaining to criticality safety of the new fuel storage facility is evaluated based in part on previously approved facilities or on independent calculations by CPB upon request. The facility design criteria, safety evaluation, system description, and the layout drawings for the storage vault and racks are reviewed to verify that:
   a. Criticality information (including the associated assumptions and input parameters) in the SAR must show that the spacing between fuel assemblies in the storage racks is sufficient to maintain the array, when fully loaded and flooded with nonborated water, in a subcritical condition, i.e., k_{eff} of less than about 0.95. Furthermore, the design of the new fuel storage racks will be such that the K_{eff} will not exceed 0.98 with fuel of the highest anticipated enrichment in place assuming optimum moderation. Credit may be taken for neutrons absorbing materials. An independent criticality analysis will not be performed when the design of the storage racks and physical characteristics of the fuel (e.g., enrichment, rod size, number of rods, spacing, and shims) is the same, or is demonstrated in the SAR to be less reactive than those of similar facilities which have been licensed.
   b. The design is such that a fuel assembly cannot be inserted anywhere in the racks other than in the design locations and provisions for drainage are made in the vault design.
   c. Failures of systems or structures not designed to seismic Category I standards and located in the vicinity of the new fuel storage facility will not cause a decrease in the degree of subcriticality provided. Reference to the SAR description section and the general arrangement and layout drawings will be necessary, as well as the tabulation of seismic design classifications for structures and systems. A statement in the SAR establishing the above condition as a design criterion is acceptable.
   d. Design calculations should show that the storage racks and the anchorages can withstand the maximum uplift forces available from the crane without an increase in k_{eff}. A statement in the SAR that excessive forces cannot be applied due to the

design of the crane handling system is acceptable if justification is presented. The evaluation procedures identified in Standard Review Plan 9.1.4 are used to validate this statement.

e. The vault and racks have been designed to preclude damage from dropped heavy objects.

f. Sharing of a storage facility in multi-unit plants does not result in any added potential for increasing the k_{eff} of the storage array.

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

a. The facility design basis and criteria, and the component classification tables presented in the SAR are reviewed to verify that the new fuel storage facility, including the storage vault and racks, have been classified and will be designed to seismic Category I requirements.

b. The essential portions of the new fuel racks and storage vault are reviewed to verify that protection from the effects of floods, hurricanes, tornadoes, and internally or externally generated missiles is provided. Flood protection and missile protection criteria are discussed in the standard review plans for Chapter 3 of the SAR. The reviewer utilizes the procedures of those review plans, as appropriate, to assure that the analyses presented are valid. A statement to the effect that the storage will be located in a seismic Category I structure that is designed to withstand the effects of tornado missiles and floods or that components of the system will be located in individual rooms that will withstand the effects of both flooding and missiles is an acceptable commitment at the CP stage.

4. The evaluations of the new fuel storage facility that are carried out by the secondary review branches are done according to the procedures and criteria in standard review plans for their areas of responsibility.

IV. EVALUATION FINDINGS

The reviewer verifies that the information provided and his review support, conclusions of the following type, to be included in the staff's safety evaluation report:

"The new fuel storage facility includes the fuel assembly storage racks, the concrete storage vault that contains the storage racks, and auxiliary components. The scope of review of the new fuel storage facility for the _____ plant, includes layout drawings, piping and instrumentation diagrams, and descriptive information for the facility and the supporting systems that are essential to the safe operation of the facility. [The review has determined the adequacy of the applicant's proposed design criteria and design bases for the new fuel storage facility regarding the provisions necessary to maintain a subcritical array during normal, abnormal, and accident conditions. (CP)] [The review has determined that the applicant's analysis of the design of the new fuel storage facility and supporting systems is in conformance with the proposed design criteria and design bases. (OL)]

"The basis for acceptance in the review has been conformance of the applicant's designs, design criteria, and design bases for the new fuel storage facility and its supporting systems to the Commission's regulations as set forth in the general design criteria, and to applicable regulatory guides, branch technical positions, and industry standards.

"The staff concludes that the design of the new fuel storage facility conforms to all applicable regulations, guides, staff positions, and industry standards, and is acceptable."

V. REFERENCES

1. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

2. 10 CFR Part 50, Appendix A, General Design Criterion 3, "Fire Protection."

3. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Missile Design Bases."

4. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."

5. 10 CFR Part 50, Appendix A, General Design Criterion 61, "Fuel Storage and Handling and Radioactivity Control."

6. 10 CFR Part 50, Appendix A, General Design Criterion 62, "Prevention of Criticality in Fuel Storage and Handling."

7. 10 CFR Part 50, Appendix A, General Design Criterion 63, "Monitoring Fuel Waste and Storage."

8. Regulatory Guide 1.29, "Seismic Design Classification."

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SRP 9.1.2