# 9.0 Auxiliary Systems

## 9.1 Fuel Storage and Handling

The New Fuel Storage Facility (NFSF), Spent Fuel Storage Facility (SFSF), and associated handling systems and equipment are designed to accommodate both new fuel assemblies and spent fuel assemblies.

### 9.1.1 Criticality Safety of New and Spent Fuel Storage and Handling

#### 9.1.1.1 Design Bases

New and spent fuel storage facilities are located in the Fuel Building which is part of the Nuclear Island and is on a common basemat with the Reactor Building and the Safeguard Buildings. The design of the Fuel Building is described in Section 3.8.4.1.2.

The U.S. EPR spent fuel storage racks must provide a minimum spent fuel storage capacity of ten calendar years of plant operation plus one full core load. Based on the limiting core design, spent fuel storage racks must provide a minimum of 945 storage cells.

The Region 1 rack design incorporates a flux trap and fixed neutron absorbers and is able to store irradiated and unirradiated fuel in the water filled spent fuel pool and new (unirradiated) fuel in the new fuel storage room. The Region 2 rack is a high density design developed for long term storage of cooled irradiated fuel and new (unirradiated) fuel in select locations. Using these two configurations, the fuel storage racks safely store a maximum of 1247 fuel assemblies in the spent fuel pool. Using the Region 1 rack design, the New Fuel Storage Facility safely stores a maximum of 120 new fuel assemblies.

New and spent fuel assemblies are maintained in a subcritical array during all credible storage and handling conditions in accordance with GDC 62 and 10 CFR 50.68. Criticality is prevented through the use of geometrically safe configurations, as well as the presence of soluble boron. Details of the spacing between assemblies (assembly pitch) and the spacing between the racks and the walls are provided in Technical Report TN-Rack.0101, “U.S. EPR New and Spent Fuel Storage Rack Technical Report” (Reference 4). Adequate spacing is provided to prevent criticality during earthquakes or other natural phenomena. In addition, criticality is prevented for the new fuel storage room assuming flooding of the new fuel storage room with optimum moderation.

The U.S. EPR design complies with guidance from ANSI/ANS 57.1 (Reference 1) and ANSI/ANS 57.3 (Reference 2) with regards to criticality prevention for fresh fuel storage and handling. In addition, the U.S. EPR complies with ANSI/ANS 57.2 (Reference 3) and RG 1.13 with regard to criticality prevention for spent fuel storage and handling.

In lieu of the installation of a criticality monitoring system, design and analysis requirements specified in 10 CFR 50.68(b) are followed to prevent criticality.

For the new fuel storage racks, the maximum $k_{eff}$ must not exceed 0.95 at a 95 percent probability, 95 percent confidence level when flooded with unborated water, and must not exceed 0.98 at a 95 percent probability, 95 percent confidence level assuming optimum moderation.

For the spent fuel storage racks, with credit for soluble boron, the maximum $k_{eff}$ must not exceed 0.95 at a 95 percent probability, 95 percent confidence level when flooded with borated water, and must be less than 1.0 at a 95 percent probability, 95 percent confidence level when flooded with unborated water.

All criticality safety analyses are calculated using the maximum fuel assembly reactivity (five percent U-235 enrichment by weight). Validation of the criticality analysis codes is discussed in Reference 4.

#### 9.1.1.2 Facilities Description

The NFSF includes the new fuel assembly storage racks, the concrete storage area containing those storage racks, and auxiliary components. The SFSF includes the spent fuel storage racks, the spent fuel storage pool containing those racks, and the associated equipment storage areas. The design and layout of the NFSF and SFSF are described in Section 9.1.2.

#### 9.1.1.3 Safety Evaluation

The fuel is maintained in a subcritical condition in normal and credible abnormal conditions by using minimum assembly separation, integral neutron absorbing material, and soluble boron (for abnormal conditions). The criticality control design confirms that the effective multiplication factor ($k_{eff}$) of the storage rack configuration is no greater than an upper subcritical limit (USL) for the most reactive configuration. The USL includes an administrative safety margin of 0.005. The criticality safety analysis for the new and spent fuel racks is provided in Reference 4.

A boron dilution analysis demonstrates that the dilution of the SFP below the boron concentration required for subcriticality is not credible due to the quantity of unborated water required. The undetected addition of 448,500 gallons of unborated water to the SFP is required to dilute the SFP such that the subcriticality limit ($k_{eff}$ less than or equal to 0.95) is exceeded. This volume of water movement would be easily detected by pool level alarms, floor sump level alarms, and visible observation of spillover by operators. If a dilution event is detected, boron could be added to the SFP by the reactor boron and water makeup system (RBWMS) or by other means.

The new and spent fuel storage racks consist of a structural metal and boron carbide-aluminum metal matrix composite (MMC) neutron absorber.

### 9.1.1.4 References


1. ANSI/ANS-57.1-1992; R1998; R2005 (R=Reaffirmed): "Design Requirements for Light Water Reactor Fuel Handling Systems," American National Standards Institute/American Nuclear Society, 2005.

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

3. ANSI/ANS-57.2-1983: "Design Requirements for Light Water Reactor Spent Fuel Storage Facilities at Nuclear Power Plants," American National Standards Institute/American Nuclear Society, 1983.

4. TN-Rack 0101, Revision 0, "U.S. EPR New and Spent Fuel Storage Rack Technical Report," AREVA Transnuclear Inc., December 2009.


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