B 3.7 PLANT SYSTEMS

B 3.7.15 Spent Fuel Assembly Storage

BASES

BACKGROUND

In the two region poison fuel storage rack (Refs. 1 and 2) design, the spent fuel pool is divided into two separate and distinct regions. Region 1, with 286 storage positions, is designed and generally reserved for temporary storage of new or partially irradiated fuel. Region 2, with 1177 storage positions, is designed and generally used for normal, long term storage of permanently discharged fuel that has achieved qualifying burnup levels.

The McGuire Region 1 spent fuel storage racks are composed of individual cells made of stainless steel. These racks utilize Boral, a boron carbide aluminum cermet, as the neutron absorber material. The cells within a module are interconnected at six locations along the length of the cell using spacer plates to form an integral structure. Depending on the criticality requirements, some cells have a Boral wrapper on all four sides, some on three sides and some on two sides. The Region 1 racks will store the most reactive fuel (up to 5.00 weight percent Uranium-235 enrichment) without any burnup limitations.

Boral is a thermal neutron poison material composed of boron carbide and 1100 alloy aluminum. Boron carbide is a compound having a high boron content in a physical stable and chemically inert form. The 1100 alloy aluminum is a lightweight metal with high tensile strength, which is protected from corrosion by a highly resistant oxide film. Boron carbide and aluminum are chemically compatible and ideally suited for long-term use in a spent fuel pool environment.

The McGuire Region 2 spent fuel storage racks contain Boraflex neutron-absorbing panels that surround each storage cell on all four sides (except for peripheral sides). It has been observed that after Boraflex receives a high gamma dose from the stored irradiated fuel ($>10^{10}$ rads) it can begin to degrade and dissolve in the wet environment. Thus, the B4C poison material can be removed, thereby reducing the poison worth of the Boraflex sheets. This phenomenon is documented in NRC Generic Letter 96-04, “Boraflex Degradation in Spent Fuel Pool Storage Racks”.

To address this degradation, the McGuire spent fuel storage racks (both Regions) have been analyzed taking credit for soluble boron as allowed in Reference 3. The methodology ensures that the spent fuel rack multiplication factor, k_{eff}, is less than or equal to 0.95 as recommended in ANSI/ANS-57.2-1983 (Ref. 4) and NRC guidance (Ref. 5). The spent fuel storage racks are analyzed to allow storage of fuel assemblies with enrichments up to a maximum nominal enrichment of 5.00 weight percent Uranium-235 while maintaining $k_{eff} \leq 0.95$ including uncertainties, BACKGROUND (continued)

tolerances, biases, and credit for soluble boron. Soluble boron credit is used to offset off-normal conditions and to provide subcritical margin such that the spent fuel pool k_{eff} is maintained less than or equal to 0.95. The soluble boron concentration required to maintain k_{eff} less than or equal to 0.95 under normal conditions is at least 800 ppm. In addition, sub-criticality of the pool ($k_{eff} < 1.0$) is assured on a 95/95 basis, without the presence of the soluble boron in the pool. The criticality analysis performed for Region 2 shows that the regulatory subcriticality requirements are met for fuel assembly storage within an allowable storage configuration, when the criteria for fuel assembly type, initial enrichment, burnup, and post-irradiation cooling time, as specified in LCO 3.7.15, are satisfied. No credit is taken for the Boraflex neutron absorber panels in Region 2. The criticality analysis performed for Region 1 shows that the acceptance criteria for subcriticality are met for unrestricted storage of unirradiated fuel assemblies with enrichments up to a maximum nominal value of 5.00 weight percent Uranium-235.

The storage criteria for fuel stored in Region 2 of the spent fuel pool is based upon criticality analysis that was performed in accordance with the criteria of 10 CFR 50.68(b). The fuel storage requirements are defined as a function of enrichment, burnup, cooling time and fuel type. The following are the fuel types considered in the criticality analyses:

MkBI – This generic fuel type represents the old Oconee 15x15 MkB2, MkB3, and MkB4 fuel assembly designs, which used Inconel spacer grids in the active fuel area. 300 of these assemblies, which operated in the Oconee reactors, were transshipped to McGuire.

W-STD – This is the standard 17x17 Westinghouse fuel design which was used in the initial cycles (batches 1-3) of both the McGuire reactors. At that time the W-STD design had Inconel grids.

W-OFA – This is the 17x17 Westinghouse “Optimized Fuel Assembly” design, which had thin rods, Zircaloy grids, and a low total uranium loading. This design was deployed for batches 4 through 9 in both McGuire units.

MkBW – This is the standard 17x17 Framatome (B&W) fuel design which was modeled after the standard Westinghouse product. The MkBW design contains Zircaloy grids. This fuel type (without axial blankets) was used for batches 10 through 13 in both McGuire reactors.

MkBWb1 – This is the same design as the standard MkBW, but it employs solid, 6-inch, 2.00 wt % U-235 axial blankets at the top and bottom of the active fuel zone. This fuel type was used in McGuire Unit 1, batches 14 to 16, and McGuire Unit 2, batch 14.

MkBWb2 – – This is also the same design as the standard MkBW, but it employs solid, 6-inch, 2.60 wt % U-235 axial blankets at the top and bottom of the active fuel zone. This fuel type was used in McGuire Unit 2, batch 15.

W-RFA – This is the advanced 17x17 Westinghouse fuel design. It is similar to the MkBW assembly design, and contains Zircaloy grids, but uses annular, 6-inch, 2.60 wt % U-235 axial blankets at the top and bottom of the active fuel zone. This fuel type has been chosen for McGuire Unit 1, batches 17 to present, and McGuire Unit 2, batches 16 to present."

APPLICABLE SAFETY ANALYSES

Most accident conditions do not result in an increase in reactivity of the racks in the spent fuel pool. Examples of these accident conditions are the drop of a fuel assembly on top of a rack, the drop of a fuel assembly between rack modules (rack design precludes this condition), and the drop of a fuel assembly between rack modules and the pool wall. However, three accidents can be postulated which could result in an increase in reactivity in the spent fuel storage pools. The first is a drop or placement of a fuel assembly into the cask loading area. The second is a significant change in the spent fuel pool water temperature (either the loss of normal cooling to the spent fuel pool water which causes an increase in the pool water temperature or a large makeup to the pool with cold water which causes a decrease in the pool water temperature) and the third is the misloading of a fuel assembly into a location which the restrictions on location, enrichment, burnup and decay time is not met.

For an occurrence of these postulated accidents, the double contingency principle discussed in ANSI N-16.1-1975 and the April 1978 NRC letter (Ref. 6) can be applied. This states that one is not required to assume two unlikely, independent, concurrent events to ensure protection against a criticality accident. Thus, for these postulated accident conditions, the presence of additional soluble boron in the spent fuel pool water (above 800 ppm required to maintain k_{eff} less than or equal to 0.95 under normal conditions) can be assumed as a realistic initial condition since not assuming its presence would be a second unlikely event.

Calculations were performed to determine the amount of soluble boron required to offset the highest reactivity increase caused by either of these postulated accidents and to maintain k_{eff} less than or equal to 0.95. It was found that a spent fuel pool boron concentration of 1600 ppm was

APPLICABLE SAFETY ANALYSES (continued)

adequate to mitigate these postulated criticality related accidents and to maintain k_{eff} less than or equal to 0.95. Specification 3.7.14 ensures the spent fuel pool contains adequate dissolved boron to compensate for the increased reactivity caused by these postulated accidents.

Specification 4.3.1.1 c. requires that the spent fuel rack k_{eff} be less than or equal to 0.95 when flooded with water borated to 800 ppm. A spent fuel pool boron dilution analysis was performed which confirmed that sufficient time is available to detect and mitigate a dilution of the spent fuel pool before the 0.95 k_{eff} design basis is exceeded. The spent fuel pool boron dilution analysis concluded that an unplanned or inadvertent event which could result in the dilution of the spent fuel pool boron concentration to 800 ppm is not a credible event.

The configuration of fuel assemblies in the spent fuel pool satisfies Criterion 2 of 10 CFR 50.36 (Ref. 7).

LCO

a

Unrestricted storage of fuel assemblies within Region 1 of the spent fuel pool is allowed provided that the maximum nominal Uranium-235 enrichment is equal to or less than 5.00 weight percent. This ensures the k_{eff} of the spent fuel pool will always remain $\leq$ 0.95, assuming the pool is flooded with water borated to 800 ppm.

b

The restrictions on the placement of fuel assemblies within Region 2 of the spent fuel pool, which have accumulated burnup greater than or equal to the minimum qualified burnups and which have decayed greater than or equal to the minimum qualified cooling time in Table 3.7.15-1 in the accompanying LCO, ensures the k_{eff} of the spent fuel pool will always remain $\leq$ 0.95, assuming the pool to be flooded with water borated to 800 ppm. Fuel assemblies not meeting the criteria of Table 3.7.15-1 may be stored in accordance with Figure 3.7.15-1 per the initial enrichment, burnup and decay time criteria specified by Tables 3.7.15-2 and 3.7.15-3 for restricted/filler storage configuration. Another acceptable storage configuration is described by Figure 3.7.15-2 for fuel assemblies that satisfy the initial enrichment, burnup and decay time criteria specified in Table 3.7.15-4 for Checkerboard storage.

APPLICABILITY

This LCO applies whenever any fuel assembly is stored in the spent fuel pool.

ACTIONS

A.1

Required Action A.1 is modified by a Note indicating that LCO 3.0.3 does not apply.

When the configuration of fuel assemblies stored in the spent fuel pool is not in accordance with the LCO, the immediate action is to initiate action to make the necessary fuel assembly movement(s) to bring the configuration into compliance.

If unable to move irradiated fuel assemblies while in MODE 5 or 6, LCO 3.0.3 would not be applicable. If unable to move irradiated fuel assemblies while in MODE 1, 2, 3, or 4, the action is independent of reactor operation. Therefore, inability to move fuel assemblies is not sufficient reason to require a reactor shutdown.

SURVEILLANCE REQUIREMENTS

SR 3.7.15.1

This SR verifies by administrative means that the fuel assembly is in accordance with the configurations specified in the accompanying LCO.

REFERENCES

1. UFSAR, Section 9.1.2.
2. Issuance of Amendments, McGuire Nuclear Station, Units 1 and 2 (TAC NOS. MC0945 and MC0946), March 17, 2005.
3. 10 CFR 50.68, “Criticality Accident Requirements”.
4. American Nuclear Society, “American National Standard Design Requirements for Light Water Reactor Fuel Storage Facilities at Nuclear Power Plants,” ANSI/ANS-57.2-1983, October 7, 1983.
5. Nuclear Regulatory Commission, Memorandum to Timothy Collins from Laurence Kopp, “Guidance on the Regulatory Requirements for Criticality Analysis of Fuel Storage at Light Water Reactor Power Plants,” August 19, 1998.
6. Double contingency principle of ANSI N16.1-1975, as specified in the April 14, 1978 NRC letter (Section 1.2) and implied in the proposed revision to Regulatory Guide 1.13 (Section 1.4, Appendix A).
7. 10 CFR 50.36, Technical Specifications, (c)(2)(ii).