5.4.10 Fuel Assemblies with Stainless Steel Replacement/Dummy Rods Dose Rate Evaluation

A dose rate evaluation for the HI-STORM 100S Version B containing the MPC-32 and the MPC-68 is performed to determine the impact of storing fuel assemblies with irradiated stainless steel replacement or dummy rods. Replacement rods would be present in repaired assemblies, when individual damaged fuel rods are replaced with stainless steel rods so they can be reintroduced into the core. Dummy rods would be stainless steel rods that are part of the initial assembly configuration. In both cases, the steel rod would be replacing a fuel rod. The analyses are performed using a number of conservative assumptions:

- All 32 design basis PWR assemblies and all 68 design basis BWR assemblies are assumed to contain stainless steel rods, with 4 rods in each PWR assembly and 2 rods in each BWR assembly, resulting in a total of 128 rods in the PWR assemblies in a basket, and 134 rods in the BWR assemblies in a basket. This is considered conservative since replacement or dummy rods are typically only present in a smaller number of assemblies at any plant.
- For the analyses, it is assumed that the stainless steel rods are irradiated in the same neutron flux and for the same time period as the design basis PWR and BWR UO2 fuel rods. For the replacement rods this is a conservative approach since those would be irradiated for a shorter time than the fuel rods, hence experiencing a lower level of irradiation than the fuel rods.
- Analyses are performed for the design basis burnup, enrichment and cooling time combinations, i.e. the same as those listed for the tables in Section 5.1. This is extremely conservative because of the low cooling time assumed for all assemblies, specifically those on the periphery of the basket. For a realistic loading configuration a regionalized loading would be selected where shorter cooled and lower burned assemblies would be placed on the periphery for ALARA purposes. Further, based on the potential dose rate effect of such assemblies and ALARA considerations, assemblies with steel rods would be allocated and loaded in the cells in the inner areas of the basket, not on the periphery. In this case the radiation from the steel rods would be shielded by the outer assemblies that do not contain any such rods, which would significantly reduce or even eliminate any impact on external dose rates.
- In the analyses, for simplification, the calculated source terms for the steel rods are simply added to the source term of the fuel assemblies, i.e. while the steel rods replace fuel rods, the source terms from fuel is not reduced for that.
- Rods are considered solid stainless steel rods with the cobalt content consistent with the discussions in Section 5.2. Other rod materials with lower cobalt content, such as zirconium, are therefore bounded by the analyses performed for the steel rods.

The dose rates at several locations, adjacent to and at 1 meter, from the HI-STORM containing the MPC-32 are presented in Table 5.1.11 and Table 5.1.14, respectively. The dose rates for the HI-STORM containing the MPC-68 are presented in Tables 5.1.13 and Table 5.1.16. The dose rates at the same locations are calculated for the condition with steel rods present in all assemblies, and for the same design basis burnup, enrichment and cooling time combinations. The dose rates with the 4 irradiated stainless steel replacement rods in the design basis PWR assembly are calculated to be approximately 10% higher for the MPC-32, and the dose rates with the 2 irradiated stainless steel replacement rods in the design basis BWR assembly are calculated to be approximately 33%

higher the MPC-68, compared to those shown in the tables in Section 5.1. The presence of such rods can therefore increase external dose rates for individual casks, specifically when they would be present in assemblies with low cooling times that are placed on the periphery of the basket. Hence the following should be considered when storing assemblies with such rods:

- The preferred cell locations for fuel assemblies with replacement or dummy steel rods is in the center of the basket, specifically if the assemblies only have a short cooling time.
- Site specific dose and dose rate analyses performed under 10CFR72.212 should include considerations for the presence of such rods. Note that for a given site, based on the total number of such rods and the selected location of the corresponding assemblies in the baskets the overall dose or dose rate effect may be negligible.

In summary, based on the results of the analyses, and following the considerations stated above, fuel assemblies containing irradiated replacement or dummy rods are acceptable for storage. Further, based on the significant conservatisms listed above in analyzing the effect of such rods, all doses and dose rates in this and other chapters that do not explicitly include considerations for such rods are still considered appropriate and bounding.