UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 28, 2019

Mr. Brian Seawright
Licensing Engineer
Holtec International
1 Holtec Blvd
Camden, NJ 08104

SUBJECT: CERTIFICATE OF COMPLIANCE NO. 9261, REVISION NO. 12, FOR THE MODEL NO. HI-STAR 100 PACKAGE

Dear Mr. Seawright:

As requested by your letter dated September 21, 2018, as supplemented on June 27, 2019, enclosed is the Certificate of Compliance No. 9261, Revision No. 12, for the Model No. HI-STAR 100 package. Changes made to the enclosed certificate are indicated by vertical lines in the margin. The staff's safety evaluation report is also enclosed.

The approval constitutes authority to use the package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of Title 49 of the *Code of Federal Regulations* Part 173.471. If you have any questions regarding this certificate, please contact Pierre Saverot of my staff at (301) 415-7505.

Sincerely,

/RA/

John McKirgan, Chief
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9261
EPID No. L-2018-LLA-0253

Upon removal of Enclosure 3, this document is uncontrolled.

Enclosures:
1. Certificate of Compliance No. 9261, Rev. No. 12
2. Safety Evaluation Report
3. Registered Users

cc w/encls 1 & 2: R. Boyle, DOT
J. Shuler, DOE, c/o L. Gelder
Registered Users

SUBJECT: CERTIFICATE OF COMPLIANCE NO. 9261, REVISION NO. 12, FOR THE MODEL NO. HI-STAR 100 PACKAGE, DOCUMENT DATE: <u>August 28, 2019</u>

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EPID: Closes L-2018-LLA-0253

ADAMS Package No.: ML19239A189
Letter Accession No. ML19239A191
CoC Accession No.: ML19239A190
RU: ML19239A192

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DATE:	05/01/2019		05/17/2019		08/22/2019		03/14/2019		05/21/2019		08/22/2019	
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SAFETY EVALUATION REPORT
Docket No. 71-9261
Model No. HI-STAR 100
Certificate of Compliance No. 9261
Revision No. 12

SUMMARY

By letter dated September 21, 2018, Holtec International (Holtec) submitted an amendment request for the Model No. HI-STAR 100 Transportation Package to (i) revise the licensing drawing for the MPC-24 fuel basket, (ii) make changes to the application to update acceptable MPC-32 fuel assemblies with different cooling time, burnup and enrichment combinations, (iii) update the structural side drop analysis to address an MPC-32 condition where the basket supports may vary from alignment with the cross panels of the fuel basket, (iv) qualify the trunnions handling limits to the maximum weight of the package, and (v) allow manufacturing variations to be included in the transportation of the BW 15x15 fuel assemblies.

The misalignment of the basket supports was a manufacturing deviation for a Diablo Canyon MPC. The change in weight is changing the structural qualification of the trunnions to the maximum possible weight that may loaded during operations. This was an internal finding from the applicant where the package, lifted from the pool during loading operations, had a maximum weight slightly larger than the structural analysis of the trunnions initially documented in the previous application (251,952 lbs compared to 250,000 lbs).

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the applicant's amendment request and found that the package meets the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71.

1.0 GENERAL INFORMATION

The Model No. HI-STAR 100 package is a canister based spent fuel transportation system with a design that relies on the geometry of the fuel basket, fuel enrichment limits, and poison plates for criticality safety, with burnup credit being also implemented for criticality safety of the package with certain PWR fuel canisters. The NRC staff reviewed Chapter 1 of the revised application and did not find any change made by the applicant for this amendment that could affect the previous evaluations. Therefore, the NRC staff finds that previous reviews and their associated findings for this package remain applicable.

The staff concludes that the information presented in this section of the application provides an adequate basis for the evaluation of the Model No. HI-STAR 100 package against 10 CFR Part 71 requirements for each technical discipline.

2.0 STRUCTURAL EVALUATION

2.1 Structural Evaluation

The staff reviewed the proposed changes in this amendment request to verify that the applicant has performed an adequate structural evaluation to demonstrate that the package, as proposed, continues to meet the requirements of 10 CFR Part 71. The applicant has made no changes affecting the existing structural design basis and acceptance criteria as a result of the proposed changes No. 1, 2, 4, 5, 7. The staff's structural review focused primarily on (i) proposed change No. 3 to update the side drop analysis allowing a condition where the fuel basket is misaligned with its supports and (ii) proposed change No. 6 to increase the handling weight limit of the trunnions to the maximum weight of the cask.

Proposed change No. 3 would allow a condition for the fuel basket panels of the MPC-32 to be misaligned with the basket supports. The staff reviewed the application and the finite element models which present a sensitivity study of the MPC-32 side drop. The staff noted that only the 30-ft drop scenario was analyzed for the potential misalignment because this condition had the smallest safety margins on the fuel basket.

When comparing the safety margins of the MPC-32 for both accident conditions (Table 2.7.4) and normal conditions (Table 2.6.8), the accident condition safety margin is shown to be the most limiting. The sensitivity study performed by the applicant involves a finite element analysis of an MPC-32 with a fuel basket that is laterally misaligned by 0.1823 inches at two off-center basket support locations. The model is analyzed for the impact of the 30-foot side and corner drops since these free drop hypothetical accident conditions were previously shown to be the most limiting of the test conditions required by 10 CFR Part 71. As such, the finite element analysis of these accident conditions is sufficient to assess the misaligned MPC for both normal and hypothetical accident conditions.

The results of the analysis demonstrate acceptable structural performance of the misaligned fuel basket MPC with little difference in the minimum safety margins of stresses from those of the previously analyzed MPC with an aligned fuel basket. So, the misaligned fuel basket is confirmed to be acceptable since the most limiting drop condition (accident condition) is shown to be above the safety margins.

The staff required the applicant to insert a note in the drawing to indicate that any misalignment of the MPC-32 fuel basket and supports shall not exceed the analyzed misalignment. The staff concludes that an MPC-32 with the analyzed misalignment of the fuel basket and its supports continues to satisfy the requirements for hypothetical accident conditions and normal conditions of transport in 10 CFR Part 71.

Proposed change No. 6 would increase the maximum lifted weight using the overpack top flange lifting trunnions. The staff reviewed the application and the associated calculations for the overpack. The applicant provided calculations to qualify the lifting trunnions for the increased maximum lifting weight and revised the weights, lifting devices, and operating procedures described in the application. The staff concludes that the calculations for the trunnions and the revisions to the application demonstrate that the increased maximum lifted weight of the HI-STAR 100 package satisfies the requirements for lifting standards of 10 CFR Part 71.45(a).

Based on review of the statements and representations in the application, the NRC staff concludes that the changes to the structural design have been adequately described and

evaluated and that the package has adequate structural integrity to meet the requirements of 10 CFR Part 71.

2.2 Evaluation Findings

The staff has reviewed the package structural design description and concludes that the contents of the application satisfies the requirements of 10 CFR 71.31(a)(1) and (a)(2) as well as 10 CFR 71.33(a) and (b). The staff has reviewed the structural codes and standards used in the package design and finds that they satisfy the requirements of 10 CFR 71.31(c). The staff has reviewed the lifting system for the package and concludes that they satisfy the standards of 10 CFR 71.45(a) for lifting attachments. The staff reviewed the application and finds that the package was evaluated by subjecting a model to the specific tests, or by another method of demonstration acceptable to the Commission and therefore satisfies the requirements of 10 CFR 71.41(a). The staff reviewed the structural performance of the packaging under the normal conditions of transport proscribed in 10 CFR 71.71 and concludes that there will be no substantial reduction in the effectiveness of the packaging that would prevent it from satisfying the requirements of 10 CFR 71.51(a)(1) and 10 CFR 71.55(d)(2). The staff has reviewed the structural performance of the packaging under the hypothetical accident conditions proscribed in 10 CFR 71.73 and concludes that the packaging has adequate structural integrity to satisfy the subcriticality, containment, and shielding requirements of 10 CFR 71.51(a)(2) and 10 CFR 71.55(e).

2.3 Conclusion

Based on the staff's review of the statements and representations in the application, the staff concludes that the Model No. HI-STAR 100 package meets the requirements of 10 CFR Part 71.

3.0 THERMAL EVALUATION

The NRC staff reviewed the proposed changes by the applicant for this amendment and found that they do not present new information related to the thermal performance of the package nor do any changes relate to previous thermal evaluations reviewed by NRC staff. Therefore, the NRC staff finds that previous reviews and their associated findings for this package remain applicable.

4.0 CONTAINMENT EVALUATION

The staff concludes that there is no change to the containment design of the package and that the package design meets the containment requirements of 10 CFR Part 71.

5.0 SHIELDING EVALUATION

The staff reviewed the amendment request to verify that the shielding design has been described and evaluated under NCT and HAC, and that the package meets the external radiation requirements in 10 CFR Part 71. The staff conducted its review using the guidance described in Section 5 ("Shielding Review") of NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel."

The purpose of this amendment request was to modify the allowable package contents in the MPC-32 canister, by increasing the maximum allowable fuel assembly burnup to 45,000 MWD/MTU. This expansion is only for the new loading patterns involving PWR assemblies in the MPC-32. The allowable fuel assemblies must meet one of four categories, as listed in the

CoC conditions: 1) MPC-32 with design basis Zr-based clad fuel, with Zr incore spacers, without non-fuel hardware; 2) MPC-32 with design basis Zr-based clad fuel, with non-Zr incore spacers, without non-fuel hardware; 3) MPC-32 with design basis Zr-based clad fuel, with non-Zr incore spacers, with non-fuel hardware; and 4) MPC-32 with design basis Zr-based clad fuel, with Zr incore spacers, with non-fuel hardware.

Table 45.8.1 shows the analyzed loading patterns requested for this amendment request, also adding the following non-fuel hardware devices: Burnable Poison Rod Assemblies (BPRAs), Thimble Plug Devices (TPDs), Rod Cluster Control Assemblies (RCCAs), Wet Annular Burnable Absorbers (WABAs), Neutron Source Assemblies (NSAs), and Instrument Tube Tie Rods (ITTRs). Axial Power Shaping Rods (APSRs) are excluded. The approach used by the applicant for analyzing the non-fuel hardware is described in Chapter 5 of the HI-STORM 100 FSAR Rev. II, Report HI-2002444. Technical justifications and analyses are provided in Report HI-951322, "*HI-STAR 100 Shielding Design and Analysis for Transport and Storage,*" and in the shielding evaluation in Chapter 5 of the application.

<u>BPRA, TPD, RCCA, WABA, NSA, and ITTR</u>

Some PWR non-fuel hardware and neutron sources are authorized for transportation in the HI-STAR 100 System with the MPC-32. Table 7.A.1 of the application lists the authorized types and quantity of non-fuel hardware devices that are authorized for transportation in the MPC-32. The allowable combinations of non-fuel hardware burnup and post-irradiation cooling time are provided in Table 7.A.14 of the application. In Section 5.4.2 of the application, the applicant requested to include BPRAs, TPDs, and RCCAs in the allowable contents for the HI-STAR 100 package with the MPC-32, with these items loaded in a PWR fuel assembly. The non-fuel hardware also includes WABAs, NSAs, and ITTRs. RCCAs include similar control components, including Control Rod Assemblies (CRAs) and Control Element Assemblies (CEAs).

RCCAs are discussed in Appendix 31 and in Chapter 5 of the application. According to the applicant, two configurations were evaluated for RCCAs , showing that Configuration 1 (10% RCCA insertion) bounds Configuration 2 (fully removed RCCA) from a radiation level perspective. Thus, the shielding calculations in Appendix 31 are only performed for Configuration 1. Table 45.4.5 of Report HI-951322 provides the RCCA Co-60 activities used for the current analyses. WABAs are discussed in Appendix 17 of Report HI-951322. Appendix 31 of the proposed revision of the application states that WABA dose rates are bounded by BPRA dose rates. Thus, explicit calculations were not performed for fuel assemblies loaded with WABAs into the MPC-32. The radiation levels for spent fuel assemblies with BPRAs were used to bound the spent fuel assemblies with WABAs.

NSAs are discussed in Appendix 39 of the application. According to the applicant, by the time NSAs are stored in the MPC, the primary neutron sources will have been decaying for many years since they were first inserted into the reactor (typically greater than 10 years). For the Cf-252 source, with a half-life of 2.64 years, this means a significant reduction in the source intensity; while the Po-210-Be source, with a half-life of 138 days, is virtually vanished. A comparison of the NSA masses to the bounding BPRA in Appendix 17 of the application, indicates that the BPRA is bounding in the active fuel zone while the NSA is slightly higher than the BPRA in the top portion. However, the applicant concluded that the total activation of an NSA is bounded by the total activation of a BPRA. Furthermore, only a single NSA is permitted in the MPC-32 and can only be in a center basket location.

On these bases, the staff found it to be acceptable that the NSA is bounded by the total activation of a BPRA based on the facts that the Sb-Be source produces neutrons from a gamma-n reaction in the beryllium, where the gamma originates from the decay of neutron-activated antimony. The very short half-life of Sb-124, 60.2 days, however results in a complete decay of the initial amount generated in the reactor within a few years after removal from the reactor. The production of neutrons by the Sb-Be source through regeneration in the MPC is orders of magnitude lower than the design-basis fuel assemblies. Therefore Sb-Be sources do not contribute any noteworthy amount to the total neutron source in the MPC-32.

The applicant states that, in the shielding analysis, it assumed that the source term in each basket cell included the source terms from a BPRA, TPD and RCCA in each inner region location and the source terms from a BPRA and TPD in each outer region location. Fuel assemblies containing BPRAs, TPDs, WABAs, water displacement guide tube plugs, orifice rod assemblies, or vibration suppressor inserts, with or without ITTRs, may be loaded in any fuel basket location. Fuel assemblies containing NSAs may only be loaded in fuel package locations 13, 14, 19 and/or 20 (see Figure 45.8.1). Fuel assemblies containing CRAs, RCCAs, or CEAs may only be loaded in fuel basket locations 7, 8, 12-15, 18-21, 25 and/or 26.

As stated above, the applicant assumed each inner region basket cell has a BPRA, TPD and RCCA and each outer region basket cell has a BPRA and TPD. The staff finds that this approach is conservative since a fuel assembly cannot have more than one non-fuel hardware device at the same time. The applicant used SAS2H and ORIGEN-S to calculate the radiation source term for the TPDs and BPRAs. The bounding TPD was determined to be the Westinghouse 17x17 guide tube plug. In the ORIGEN-S calculations the cobalt-59 impurity level was assumed to be 0.8 mg/kg for stainless steel and 4.7 mg/kg for inconel. These calculations were performed by irradiating the appropriate mass of steel and inconel using the flux calculated for the design basis B&W 15x15 fuel assembly. The mass of material in the regions above the active fuel zone was scaled by the appropriate scaling factors listed in Table 5.2.10 of the HI-STORM 100 FSAR in order to account for the reduced flux levels above the fuel assembly. The total curies of cobalt were calculated for the TPDs and BPRAs as a function of burnup and cooling time. For burnups beyond 45,000 MWD/MTU, the applicant assumed, for the purpose of the calculation, that the burned fuel assembly was replaced with a fresh fuel assembly every 45,000 MWD/MTU. This was achieved in ORIGEN-S by resetting the flux levels and cross sections to the 0 MWD/MTU condition after every 45,000 MWD/MTU.

The applicant stated that the non-fuel hardware devices of BPRA, TPD, RCCA, WABA, NSA and ITTR were evaluated for loading in HI-STAR 100 with MPC-32 during transportation. Explicit shielding calculations are performed for BPRAs, TPDs, and RCCAs. The information is taken from Chapter 5 of the HI-STORM 100 Final Safety Analysis Report (FSAR), HI-2002444, Revision 12. The Co-60 non-fuel hardware activities are provided in Chapter 5 of the HI-STORM 100 Final Safety Analysis Report, HI-2002444, Revision 12, and are based on the non-fuel hardware burnup and cooling time combinations stated in Table 2.1.25 of the HI-STORM 100 Final Safety Analysis Report, HI-2002444, Revision 12, and Appendices 17 and 31 of the application.

For the current analyses used to ensure that the package meets the regulatory radiation level limits, the applicant proposed the cooling times for the non-fuel hardware that are given in Table 45.4.1. The applicant proposes to add a constant cooling time of 12 years for non-fuel hardware to lower the Co-60 activities. The NFH was already part of the MPC-32 contents; however, to accommodate the changes to the SNF contents and ensure the dose rate limits are met, the applicant added an additional 12 years to the cooling times for the NFH. The staff

examined the dose rates calculations performed by the applicant, which include non-fuel hardware with the addition of 12 years of cooling times. The burnup-cooling time combinations of the design basis non-fuel hardware for the current analyses are provided in Table 45.4.1 of Appendix 45 of the application. Table 45.4.2 shows the design basis BPRAs and TPDs. Table 45.4.3 shows the design basis Cobalt-60 activities for BPRAs and TPDs. Table 45.4.4 shows the description of design basis control rods assembly configurations for source terms calculations. Table 45.4.5 shows the design basis sources terms for control rods assembly configurations. Tables 45.4.6 and 45.4.7 in Appendix 45 of the proposed application provide the design basis fuel hardware information used for this analysis.

Maximum Allowable Fuel Assembly Burnup

The applicant states that there is a potential to experience radiation levels peaking at the side of the cask as a result of azimuthal variations. The applicant had analyzed the effect of these azimuthal variations by calculating “peak-to-average ratios” for source term components for the MPC-24. The effect of peaking was calculated on the surface of the overpack adjacent to the pocket trunnion and dose locations 2a and 3a in Figures 5.1.1 of the HI-STAR 100 application. The effect of peaking was also analyzed at 2 meters from the overpack at location 2 and at the axial height of the impact limiter. Dose locations 2a and 2 encompass 14 axial segments that range from the pocket trunnion to the top of the Holtite. The highest dose rate of these 14 axials segments were chosen as the value for dose locations 2a and 2. Based on the analyses, location 2 was determined to be the peak dose rate location. The effect of these azimuthal variations is determined by calculating “peak-to-average ratios” for source term components. Then, those ratios are used to calculate the “maximum dose rates”. The peak-to-average values calculated for the MPC-24 were used for the MPC-32.

According to the applicant, the peaking outside the HI-STAR 100 for the MPC-32 will be similar to the peaking outside the HI-STAR 100 for the MPC-24 due to the fact that the fuel assemblies in the MPC-24 are not as closely positioned to each other as in the MPC-32. Also, both the MPC-24 and the MPC-32 transport PWR fuel with the only significant difference being that the MPC-24 basket has flux traps, which the applicant states do not significantly influence the shielding effectiveness of the system. Furthermore, the azimuthal variation in the MPC-32 basket is expected to be similar to the MPC-24 basket. The detail of the “peak to average ratio” methodology is described in Appendix 35 of the application.

Section 5.5 of the application, Regulatory Compliance, presents results which take into account peaking due to radiation streaming or azimuthal variation, and the newly added loading patterns (maximum burnup, minimum enrichment and minimum cooling times) are provided in Table 45.8.1 of the application.

Tables 45.8.5 through 45.8.7 of the application provide normal surface, normal 2 m, and accident 1 m dose rates, respectively, for the HI-STAR 100 with the MPC-32 for the newly added loading pattern when the incore spacers are zircaloy and no non-fuel hardware device is loaded. Tables 45.8.8 through 45.8.10 of the application provide normal surface, normal 2 m, and accident 1 m dose rates, respectively, for the HI-STAR 100 with the MPC-32 for the newly added loading pattern when the incore spacers are non-zircaloy and no non-fuel hardware device is loaded.

Tables 45.8.11 through 45.8.13 of the provide normal surface, normal 2 m, and accident 1 m dose rates, respectively, for the HI-STAR 100 with MPC-32 for the worst case of the newly added loading patterns when the incore spacers are non-zircaloy and non-fuel hardware device

is loaded. The information to determine the worst-case loading pattern (burnup level and cooling time) is provided in Section 5.4 of application.

Tables 45.8.14 through 45.8.16 provide total normal surface, normal 2 m, and accident 1 m dose rates, respectively, for the HI-STAR 100 with MPC-32 for all newly added loading patterns when the incore spacers are non-zircaloy and non-fuel hardware device is loaded.

The applicant provided additional dose rate results, for different burnup, initial enrichment, and cooling time combinations in Section 5.4 of the application.

The staff reviewed the method presented in Section 5.4.1, "*Streaming Through Radial Steel Fins and Pocket Trunnions*", and found the approach acceptable based on the fact that the attenuation of neutrons through steel is substantially less than the attenuation of neutrons through the neutron shield. It is possible to have neutron streaming through the channels which could result in a localized dose rate peak. The same could not be true for photons; however, it would result in a localized reduction in the photon dose.

The staff found that the method of the "peak-to-average ratio" acceptable based on the analysis performed by the applicant and reviewed by the staff. With respect to the applicant's arguments for applying the results of the MPC-24 for this method to the MPC-32, the staff found this approach acceptable, based on the fact that the fuel assemblies in the MPC-24 are not as closely positioned to each other as in the MPC-32.

Maximum Dose Rates

1. Dose Location on the surface of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with zircaloy incore spacers without non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 20 Year Cooling (mrem/hr)	133.57	1000.00 200.00
45,000 MWD/MTU, 3.2 wt.% U-235, 24 Year Cooling Initial Enrichment (mrem/hr)	132.06	1000.00 200.00

2. Dose Location at two meters of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with zircaloy incore spacers without non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 20 Year Cooling (mrem/hr)	8.37	10.00
45,000 MWD/MTU, 3.2 wt.% U-235, 24 Year Cooling Initial Enrichment (mrem/hr)	7.84	10.00

3. Dose Location at one meter of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with zircaloy incore spacers without non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 20 Year Cooling (mrem/hr)	476.21	1000.00
45,000 MWD/MTU, 3.2 wt.% U-235, 24 Year Cooling Initial Enrichment (mrem/hr)	503.28	1000.00

4. Dose Location on the surface of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with non-zircaloy incore spacers without non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 24 Year Cooling (mrem/hr)	109.08	1000.00 200.00
45,000 MWD/MTU, 3.2 wt.% U-235, 26 Year Cooling Initial Enrichment (mrem/hr)	120.54	1000.00 200.00

5. Dose Location at two meters of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with non-zircaloy incore spacers without non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 24 Year Cooling (mrem/hr)	7.98	10.00
45,000 MWD/MTU, 3.2 wt.% U-235, 26 Year Cooling Initial Enrichment (mrem/hr)	8.08	10.00

6. Dose Location at one meter of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with non-zircaloy incore spacers without non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 24 Year Cooling (mrem/hr)	416.20	1000.00
45,000 MWD/MTU, 3.2 wt.% U-235, 26 Year Cooling Initial Enrichment (mrem/hr)	472.52	1000.00

7. Dose Location on the surface of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with non-zircaloy incore spacers with non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 25 Year Cooling (mrem/hr)	128.02	1000.00 200.00
45,000 MWD/MTU, 3.2 wt.% U-235, 27 Year Cooling Initial Enrichment (mrem/hr)	139.27	1000.00 200.00

8. Dose Location at two meters of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with non-zircaloy incore spacers with non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 25 Year Cooling (mrem/hr)	8.97	10.00
45,000 MWD/MTU, 3.2 wt.% U-235, 27 Year Cooling Initial Enrichment (mrem/hr)	9.09	10.00

9. Dose Location at one meter of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with non-zircaloy incore spacers with non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 25 Year Cooling (mrem/hr)	408.68	1000.00
45,000 MWD/MTU, 3.2 wt.% U-235, 27 Year Cooling Initial Enrichment (mrem/hr)	461.94	1000.00

10. Dose Location on the surface of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with zircaloy incore spacers with non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 25 Year Cooling (mrem/hr)	150.08	1000.00 200.00

11. Dose Location at two meters of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with zircaloy incore spacers with non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 25 Year Cooling (mrem/hr)	8.93	10.00

12. Dose Location at one meter of the HI-STAR 100 System for Normal Conditions MPC-32 design basis zircaloy clad fuel with zircaloy incore spacers with non-fuel hardware.

Configurations	Maximum Total Dose Rates (mrem/hr)	10CFR71.47 Limit (mrem/hr)
45,000 MWD/MTU, 3.6 wt% U-235 Enrichment, 25 Year Cooling (mrem/hr)	491.96	1000.00

The staff reviewed the information provided by the applicant. The applicant referenced five documents to support the basis for this shielding evaluation:

1. DCPP Design Input Transmittal, DIT 50032610-04-00, February 2015.
2. Dose Evaluation for the ISFSI at Diablo Canyon Power Station, HI-2002563, Revision 10.
3. HI-STORM 100 Final Safety Analysis Report, HI-2002444, Revision 12.
4. Spent Nuclear Fuel Source Terms, HI-2022847, Revision 9.
5. HI-STAR 100 SAR, HI-951251, Revision 19.

The staff used the ORIGEN-ARP code in SCALE 6.1 to confirm some of the source terms presented in this amendment request. Using the data presented in Table 45.8.1, the staff was able to confirm that the applicant performed the shielding analysis using the bounding source terms. The staff examined all of the documents pertinent to the changes proposed in this application. The staff examined the maximum dose rates presented in Tables 45.8.5 through 45.8.17 of the application for the new loading pattern and content specifications. The staff verified that the maximum dose rates were under the regulatory limits established in 10 CFR Part 71.

Based on the dose rate results, the staff found it acceptable to increase the maximum allowable fuel assembly burnup to 45,000 MWD/MTU for PWR fuel assemblies. The dose rate analyses were done for the existing approved spent fuel assembly types (no new assembly types were added to the package contents) and used the bounding assembly type (B&W 15x15). Based on the results of the maximum radiation levels for the design basis fuel assembly, the staff concludes that the use of the “peak-to-average ratios” approach assures that the selected PWR fuels in the MPC-32 will satisfy the requirements establish in 10 CFR 71.47 and 71.51. Tables 45.8.5 through 45.8.17 of the application, which show the NCT package surface, NCT 2 m, and HAC 1 m radiation levels, for the HI-STAR 100 with the MPC-32 for the newly added loading patterns and contents specifications were examined by the staff. All radiation levels for NCT and HAC satisfy the limits in 10 CFR 71.47 and 10 CFR 71.51.

Based on the results of the radiation levels including the non-fuel hardware, the staff concludes that the proposed cooling times for the non-fuel hardware will help ensure the radiation levels

remain under the regulatory limits established in 10 CFR 71. The staff also found the increasing the cooling time will allow the non-fuel hardware to lower the Co-60 activity. Thus, the non-fuel hardware will be bound by the design basis non-fuel hardware. Therefore, the staff finds this cooling time requirement to be acceptable for the contents to which it applies.

Based on its review of the information and representations in the application and the staff's independent analyses, the staff has reasonable assurance that the package with the proposed contents changes satisfies radiation level limits of 10 CFR Part 71.

6.0 CRITICALITY EVALUATION

The objective of this criticality safety review is to determine if the Model No. HI-STAR 100 transportation package, loaded with the new MPC-24 canister design and the shorter B&W 15x15 spent fuel assemblies, remains subcritical under normal conditions of transport, hypothetical accident conditions, as well as during loading and unloading operations.

The only change affecting the criticality evaluation of the package is the reduction of the length of the poison plate in the MPC-24 fuel basket by one inch (1") for the B&W 15x15 PWR fuel assemblies, that are shorter than the current authorized PWR fuel designs. The other requested changes of this amendment request, i.e., changes to the authorized burnup, enrichment and cooling time combinations, do not affect the result of the criticality safety evaluation because the criticality safety analysis for the Model No. HI-STAR 100 package with the MPC-24 fuel basket does not take burnup credit and there is no change to the maximum allowable enrichment.

The applicant states that the length of the neutron absorbers is reduced to a 154-7/8" minimum (one inch shorter than previously required from the licensing drawings) and occupies a height between 2.88" and 157.75" from the baseplate of the MPC. The fuel design parameters given in Table 1.2.16 of the application show that the fuel region of the B&W 15x15 fuel assembly starts from 8.4" above the end fit and has a maximum length of 141.8". The total fuel assembly length, including non-fuel hardware, is 170.985". To ensure that the fuel region is covered by the poison plate, the MPC-24 design for the B&W 15x15 fuel assembly requires a 4.875" spacer at the bottom of each fuel cell in the MPC-24 canister. The applicant states that no upper fuel spacer is needed. The applicant further states that the length of the neutron absorber is aligned with the active fuel region of the stored fuel assemblies at all times.

The staff verified the dimensions of the fuel and the poison plates and finds that the total length of the lower spacer and the fuel is 175.86" (5.875+170.985) and the maximum height of the fuel cell of the MPC-24 is 176.75" (176.5+0.25) based on the licensing drawing No. 3926, sheet 2. With the bottom spacer, the fuel region starts from the bottom is 13.275" (4.875"+8.4"). The top of the fuel region is 155.075" (13.275" + 141.8"). The fuel region is restricted to the poison region. The staff also finds that the gap between the top of the fuel assembly and the top lid is only 0.89" which prevents the fuel from sliding out of the region of the poison plates. Therefore, this arrangement assures that the fuel region is always enveloped within the poison plate.

The staff reviewed the criticality safety analysis for the HI-STAR 100 package and finds that the new MPC-24 basket design loaded with the shorter B&W 15x15 fuel is bounded by the MPC-24 basket with full length fuel and poison plate because the shorter B&W 15x15 fuel contained less fuel and therefore, less fissile material mass and all other parameters remain unchanged. On this basis, the staff determined that the package design, as amended, continues to meet the regulatory requirements of 10 CFR 71.55 and 71.59.

In lieu of a specific condition in the CoC requiring the use of a 4.875” spacer in the MPC-24 containing the B&W 15x15 fuel with a 141.8” active fuel length, the applicant revised a note on Drawing 3926 where the shorter Metamic panel length is discussed.

The staff followed the guidance provided in NUREG-1617, “Standard Review Plan for Transportation Packages for Spent Nuclear Fuel” during its review.

7.0 PACKAGE OPERATIONS

The package operating procedures describe the general procedures for loading and unloading of the package. Changes were made to this Section to reflect the correction of editorial errors, updates to licensing drawings and revision numbers, and also clarification of procedure terminology.

There was nothing that initially changed in Chapter 7 for the misalignment topic subject of this amendment request. The applicant added a note to the drawing that states that two basket supports (90 degrees apart) may have a misalignment no greater than 0.1823” with the fuel basket panels.

The loading configuration above the pool for Table 2.2.3 follows the current procedural steps in Section 7.1.3.1. The cask is lifted from the pool loaded with fuel with the MPC lid in place for shielding but without the closure plate installed. The closure plate is installed later as described in Section 7.1.4. This is after the MPC is drained, dried, and backfilled. Since this followed the current operating procedures, there was no need to update Chapter 7.

Based on these findings, the staff concludes that the operating procedures both meet the requirements of 10 CFR Part 71 and are adequate to assure the package will be operated in a manner consistent with its evaluation for approval.

CONDITIONS

The conditions specified in the CoC have been revised to incorporate several changes as indicated below:

Item No. 3.b and the references section have been revised to identify Holtec application, Revision No. 20, dated June 27, 2019.

Condition No. 5(a)(3) has been revised to include Revised licensing drawings for the MPC 24 and MPC 32.

Condition No. 11 was modified to authorize continued use of Revision No. 11 for approximately one year.

The expiration date of the certificate was not modified.

CONCLUSION

Based on the statements and representations in the application, as supplemented, and the conditions listed above, the staff concludes that the Model HI-STAR 100 package design has

been adequately described and evaluated and that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9261, Revision No. 12, on August 28, 2019.