Revised Summary of Proposed Changes (SOPC) for LAR 9373-1 Based on RAI Responses

Proposed Change #1

Revise loading Configuration 3 (Table 7.C.5) for MPC-37 to include the following options for fuel assembly class 16x16C: a) 2 Damaged Fuel Containers (DFCs) containing fuel debris (up to 37 rods per DFC), 10 DFCs containing damaged fuel and 25 undamaged fuel assemblies; b) 1 DFC can be loaded fuel debris (up to 57 fuel rods), 11 DFCs containing damaged fuel and 25 undamaged fuel assemblies; c) 12 DFCs containing fuel debris (up to 11 rods per DFC) and 25 undamaged fuel assemblies.

Reason for Proposed Change #1

Provide more flexibility in loading Configuration 3 for allowable contents for transportation.

Justification for Proposed Change #1

Criticality analysis of revised loading Configuration 3 was performed and the results of these analyses have been added to Chapter 6 (Paragraph 6.2.5.2 and Subsection 6.B.5.3) of the HI-STAR 190 SAR. The analyses show that the k_{eff} is less than 0.95 for all added options for assembly class 16x16C in Configuration 3. Revised Configuration 3 is provided in Appendix 7.C of the SAR.

Thermal design is not affected by proposed change, as DFC placement in limited number of basket cells is bounded by all-basket cells populated with DFCs evaluated in Thermal Chapter 3, Sections 3.3.1 and 3.3.6.

This proposed change is bounded by the shielding analysis provided in HI-STAR 190 SAR Chapter 5 since the stated DFCs with fuel debris or damaged fuel contain less fission products and other activated materials than undamaged fuel assemblies. Furthermore, fuel reconfiguration is evaluated conservatively in Chapter 5.

This proposed change does not result in any increase in the loading (weights and pressures) on and the temperatures of cask, MPC and fuel basket beyond those used in the various design basis structural evaluations presented in Chapter 2 of the SAR. The structural adequacy (during handling operations and under hypothetical drop accidents) of DFC's is demonstrated in Holtec reports HI-2156649 and HI-2177733. Additional discussion is added in Sections 2.5, 2.6 and 2.7 of the HI-STAR 190 SAR (Proposed Revision 2A).

The DFCs are not part of the containment boundary, therefore the containment boundary continues to meet leaktight acceptance criteria.

Proposed Change #2

Add Guide Tube Anchors (GTAs) as Non-Fuel Hardware (NFH) to Appendix 7.C. Revise definition of Non-Fuel Hardware (NFH) with addition of ITTRs and GTAs.

Reason for Proposed Change #2

Expand options of non-fuel hardware permissible for transportation in the HI-STAR 190. Supports ALARA objective by reducing quantity of spent fuel assemblies on plant sites.

Justification for Proposed Change #2

Guide Tube Anchors (GTAs) are non-irradiated non-fuel hardware installed in the guide tubes post irradiation in the nuclear reactor, prior to lifting of irradiated fuel assemblies susceptible to Stress Corrosion Cracking (SCC) in the guide tube joints. Instrument Tube Tie Rods (ITTRs) (currently authorized for transport in the HI-STAR 190 package) serve the same function, though installed in instrument tube rods. As such, from a licensing perspective, and in accordance with Regulatory Issue Summary (RIS) 2013-11 which includes as an enclosure Used Fuel Storage and Transportation Issue Closure Form No. I-10-01 “PWR Fuel Top Nozzle Stress Corrosion Cracking” [1], GTAs fit into the category of ITTRs as permanently installed modification to an assembly post-irradiation. Post-installation, GTAs are considered assembly components or contents of the package.

To be considered as acceptable contents for a transport package, according to [1], GTAs shall be defined in the SAR that is referenced in the CoC, with appropriate supporting analyses or evaluations in the technical areas of structural, criticality, shielding, thermal, and containment. Evaluations are provided in these technical areas below to support the addition of GTAs as permissible contents of the HI-STAR 190 package, and belonging in the category of ITTRs for licensing purposes.

GTAs, like ITTRs are considered part of the assembly [1]. Since GTAs are inserted in the guide tubes of the assembly, the overall dimensions of the assemblies are met. The conservative weight used for the fuel assembly in the structural analyses of fuel basket, MPC and overpack per Appendix 7.C (Table 7.C.1) bound the weight of the assembly with GTAs installed. Therefore, an assembly with GTAs installed shall meet the assembly specifications in Appendix 7.C; specifically, the dimensional and weight requirements of an assembly. Assemblies modified by the addition of GTAs, and meeting the dimensional and weight acceptance criteria in the Appendix 7.C of the SAR, including assembly weight and overall length are acceptable for transport in the HI-STAR 190 package, with no further structural evaluations due to the reasons provided in next paragraph. It is also noted that there are no fuel assembly or NFH handling operations involved in loading of MPC’s into HI-STAR 190 transportation casks.

The design basis structural evaluations performed in Sections 2.5, 2.6 and 2.7 of the SAR for fuel basket, MPC and overpack use bounding fuel assembly weights (including DFC's, GTA's, ITTR's, fuel debris and non-fuel hardware) per Appendix 7.C (Table 7.C.1), bounding loaded MPC and overpack weights per Table 2.1.11, bounding CG heights per Table 2.1.12, bounding MPC and overpack internal pressures per Table 2.1.1, and temperatures bounding those in Tables 3.1.1, 3.1.3, 3.1.4 and 3.2.10. There is no increase in loads (weights and pressures), CG heights or temperatures listed in those tables due to the proposed change. Therefore, no new structural analyses are performed in support of this proposed change.

As justified herein HI-STAR 190 thermal evaluation is not affected by including GTAs requested in the proposed change. Since GTAs are a part of the fuel assembly that are installed post-irradiation in a nuclear reactor, similar to ITTRs, the GTAs are not a source of heat in the assembly. Therefore an

assembly containing an installed GTA shall continue to generate the same quantity of heat as generated prior to installation of the GTA. The presence of the GTAs permanently installed on the assembly therefore has no impact on the thermal analysis of the HI-STAR 190 package with fuel assemblies meeting Appendix 7.C of the HI-STAR 190 SAR.

GTAs are installed post-irradiation of the fuel assembly in a nuclear reactor. GTAs are not activated and not considered a source of radiation in the HI-STAR 190 package, and may be considered extra material for shielding purposes (although not credited), similar to ITTRs. Therefore, similar to ITTRs, assemblies with GTAs may be stored in any location in the MPC.

GTAs presence in a guide tube reduces the quantity of water in the system. Therefore, as discussed in Subsection 6.3.9, moderation is reduced and margin to criticality limit may be increased, similar to ITTRs, hence GTAs are acceptable from the criticality safety perspective.

Addition of GTAs to assemblies has no impact on the structural integrity of the containment boundary, and they continue to meet the leaktight criteria in accordance with ANSI N14.5.

Related changes to the SAR are made to the glossary, Chapter 5 and Appendix 7.C.

[1] Used Fuel Storage and Transportation Issue Closure Form , Issue Number I-10-01, “PWR Fuel Top Nozzle Stress Corrosion Cracking”, dated 4/17/12.

Proposed Change #3

Add new heat load Pattern 7 to Table 7.C.7 for MPC-37 that covers damaged fuel assemblies with decay heat up to 1.1 kW/assembly.

Reasons for Proposed Change #3

The current decay heat load patterns for the MPC-37 allow loading damaged fuel assemblies with decay heat up to 0.84 kW. The new pattern increases the damaged fuel assemblies decay heat limit, thus giving the user additional loading flexibility for the MPC-37.

Justification for Proposed Change #3

Analyses and evaluations support the inclusion of this decay heat load pattern for the MPC-37. The proposed changes to Chapter 3 of the SAR include the description of the models, analysis, and results pertaining to the decay heat load limits for MPC-37. Heat load Pattern 7 is provided in Appendix 7.C of the SAR.

Thermal analyses have been performed for new heat load Pattern 7, and the results show that Loading Pattern 7 is bounded by the design basis heat load in Pattern 1. The PCT is below the ISG-11 Rev. 3 limits, specifically 86^{o}C below the limits. The cavity pressure is below the design basis limit for Pattern 1.

The temperatures and pressures in the HI-STAR 190 for heat load Pattern 7 are bounded by the design basis pattern (Pattern 1). The design basis structural evaluations performed in Sections 2.5, 2.6 and 2.7 of the SAR for fuel basket, MPC and overpack use bounding MPC and overpack internal pressures per Table 2.1.1, and temperatures bounding those in Tables 3.1.1, 3.1.3, 3.1.4 and 3.2.10. There is no increase in pressures and temperatures in those tables. Therefore, no new structural analyses are performed in support of this proposed change.

The dose rates from heat load Pattern 7 are bounded by the maximum dose rates in Section 5.1 of the SAR. Thus the dose rates for Pattern 7 do not exceed the 10 CFR 71.47 limit for normal conditions and the 10 CFR 71.51 limit for accident conditions.

Since the temperatures and pressures in HI-STAR 190 for heat load Pattern 7 are bounded by the design basis (Pattern 1). This change has no effect on the containment boundary structural integrity and seals are not compromised. Therefore the currently approved containment leaktight criteria continues to be met.

Since criticality does not utilize or credit any of the heat load loading configurations, there is no effect on criticality.

Proposed Change #4

Reduced the minimum cooling time requirements for Neutron Source Assemblies (NSAs) from a current maximum of 14 years (630 GWD/MTU) to 7 years cooling time, independent of NSA burnup, for a cask loaded with CE 16x16 fuel assemblies (Table 7.C.8(b)). Additional restrictions on number and types of non-fuel hardware (NFH) devices and/or loading patterns are included.

Reason for Proposed Change #4

The current cooling time requirements for NSAs may cause undue burden to some users by requiring radioactive materials to remain at the plant sites for extended periods of time. The proposed change lowers the NSA cooling time requirements and thereby increases the inventory of NSAs at higher burnups that are available for transport in the HI-STAR 190 system after 7 years.

Justification for Proposed Change #4

Shielding analysis is performed for the reduced cooling time (7 years) for a loaded NSA but with additional restrictions on number and types of non-fuel hardware (NFH) devices and/or loading patterns. It concludes that the dose rates after 7 years of cooling for a loaded NSA are below the maximum dose rates provided in Chapter 5 of the SAR and regulatory dose rates limits per 10 CFR 71.47 for normal conditions and 10 CFR 71.51 for accident conditions. Loading of NSAs with this reduced cooling time is restricted per Appendix 7.C of the SAR.

As discussed in Subsection 6.3.10, the reactivity of a fuel assembly is not affected by the presence of a neutron source, hence NSAs have been neglected in the criticality calculations and the proposed change has no impact on criticality safety. Changes are documented in Chapter 5 and Appendix 7.C of the SAR.

The design basis structural evaluations performed in Sections 2.5, 2.6 and 2.7 of the SAR for fuel basket, MPC and overpack use bounding MPC and overpack internal pressures per Table 2.1.1, and temperatures bounding those in Tables 3.1.1, 3.1.3, 3.1.4 and 3.2.10. There is no increase in pressures and temperatures listed in those tables due to the proposed change. Therefore, no new structural analyses are performed in support of this proposed change.

The proposed change does not compromise the containment boundary structural integrity and seals. Therefore the HI-STAR 190 system leaktight criteria continues to be met. The reduced cooling time for NSA does not impact thermal margin as CoC requires aggregate fuel and non-fuel hardware decay heat meet permissible limits.

Proposed Change #5

Increase the allowable activity limit for APSRs loaded with CE 16x16 fuel assemblies with higher cobalt-60 activity. Additional restrictions on number and types of non-fuel hardware (NFH) devices and/or loading patterns are included.

Reason for Proposed Change #5

Increases population of APSRs available for transport in the HI-STAR 190. Reduce the burden on some users that requires radioactive materials to remain at the plant sites for extended periods of time.

Justification for Proposed Change #5

Shielding analysis is performed for the reduced cooling time (7 years) for APSRs, and concludes that even with the APSR activities higher than design basis APSR activities, the dose rates are below the maximum dose rates provided in Chapter 5 of the SAR, and regulatory dose rates limits per 10 CFR 71.47 for normal conditions and 10 CFR 71.51 for accident conditions.

As discussed in Section 6.B.0, the presence of inserts is considered in a conservative way, i.e. only the reactivity effect on the spent fuel isotopic composition due to fuel irradiation has been applied, while the criticality calculations for MPC-37 have been performed with no inserts. Therefore, the reduced cooling time of APSRs has no impact on criticality safety.

The design basis structural evaluations performed in Sections 2.5, 2.6 and 2.7 of the SAR for fuel basket, MPC and overpack use bounding fuel assembly weights (including DFC's, GTA's, ITTR's, fuel debris and non-fuel hardware) per Appendix 7.C (Table 7.C.1), bounding loaded MPC and overpack weights per Table 2.1.11, bounding CG heights per Table 2.1.12, bounding MPC and overpack internal pressures per Table 2.1.1, and temperatures bounding those in Tables 3.1.1, 3.1.3, 3.1.4 and 3.2.10. There is no increase in loads (weights and pressures), CG heights or temperatures listed in those tables due to the

proposed change. Therefore, no new structural analyses are performed in support of this proposed change.

The containment boundary is not impacted by this change and structural integrities are maintained. Containment leaktight criteria continues to apply. The reduced cooling time for the APSR has no impact on the thermal margin as CoC requires aggregate fuel and non-fuel hardware decay heat meet permissible limits

Related changes were made to Chapter and 5 and Appendix 7.C of the SAR.

Proposed Change #6

Delete Condition 8(d) from the CoC and add to Appendix 7.C (Table 7.C.5 Note 2) of the SAR. Modify this condition to allow insertion of control rods that exceed 8 inches for CE 16x16 fuel assemblies.

Reason for Proposed Change #6

During the reactor operation at full power some control rods may be inserted more than 8 inches from the top of the active length for part of the fuel irradiation history or even for entire irradiation period for CE 16x16 fuel assemblies. This proposed change expands the permissible content conditions for MPC-37 and increase a number of loaded fuel assemblies irradiated under the CRs for transport in the HI-STAR 190.

Justification for Proposed Change #6

Criticality analyses performed in Chapter 6 (Paragraphs 6.B.2.2.2 and 6.B.5.2.1) of the SAR confirmed that for CE 16x16 assemblies under a full length control rod bank during full power, control rod insertion is permitted up to 33.3 inches from the top of the active length, but such assemblies can be only loaded up to 9 regular cells of the regionalized basket loading configurations, while the design basis spent undamaged fuel assemblies are placed in the remaining regular cells. For CE 16x16 assemblies under a part-length control rod bank, control rod insertion is permitted up to 41.7 inches during full power, and such assemblies can be loaded into all regular cells of the regionalized basket loading configurations. For all other assemblies, control rod insertion shall not exceed eight inches from the top of the active fuel during full power operation.

For shielding, the effect of discharged assemblies with APSR exposure on dose rates is insignificant, as the effect is analyzed in in Appendix 5.C. Also, the source terms for APSRs with higher activity are discussed in Subparagraph 5.2.3.2.2.

The design basis structural evaluations performed in Sections 2.5, 2.6 and 2.7 of the SAR for fuel basket, MPC and overpack use bounding fuel assembly weights (including DFC's, GTA's, ITTR's, fuel debris and non-fuel hardware) per Appendix 7.C (Table 7.C.1), bounding loaded MPC and overpack weights per Table 2.1.11, bounding CG heights per Table 2.1.12, bounding MPC and overpack internal pressures per Table 2.1.1, and temperatures bounding those in Tables 3.1.1, 3.1.3, 3.1.4 and 3.2.10. There is no increase in loads (weights and pressures), CG heights or temperatures listed in those tables due to the

proposed change. Therefore, no new structural analyses are performed in support of this proposed change.

Proposed change does not impact thermal design as fuel heat which is a function of max in-core burnup is not affected. Containment boundary integrity is not impacted by change. Leaktight acceptance criteria continues to apply.

Changes are made to the CoC, and Chapter 6 and Appendix 7.C of the SAR (Revision 2).

Proposed Change #7

Add new DFC design to SAR (drawing no. 11107R1). See Enclosure 3 to Holtec letter 5024010 for description of changes to Rev. 0 of the drawing.

Reason for Proposed Change #7

New enhanced DFC design with slightly wider opening and top/bottom details to facilitate assembly placement.

Justification for Proposed Change #7

The new DFC design has been structurally qualified for all loading conditions (handling operations and hypothetical accident conditions) in Holtec report HI-2177733. Additional discussion is added in Subsection 2.5.5 of SAR.

Addition of new DFC design does not result in any increase in the loading (weights and pressures) on and the temperatures of cask, MPC and fuel basket beyond those used in the various design basis structural evaluations presented in Chapter 2 of the SAR. Therefore, the design basis structural calculations for cask, MPC and fuel basket are not revisited for this proposed change.

The DFC tube ID is bounded by the value used in the criticality calculations. Therefore, the considered amount of damaged fuel/fuel debris at the optimum condition is still conservative and the proposed DFC design has no impact on criticality safety.

The new DFC design has no impact on shielding analysis since DFC material is not credited in the evaluation. Structural integrity of Containment Boundary components are not impacted by this change. Containment leaktight criteria continues to apply. Thermal evaluation of new design is evaluated in SAR Chapter 3, Sections 3.3.1 and 3.3.6.

The storage locations for the new design are the same storage locations for the currently approved DFC design for the HI-STAR 190.

Clarifications and editorial changes

- Editorial corrections to charpy absorbed energy and lateral expansion impact testing values. Clarifications made to align impact testing acceptance criteria with the ASME Code Section III Subsection NF. Editorial changes are made to Table 8.1.8 of the HI-STAR 190 SAR (Revision 2). Related editorial changes are made to Chapter 2 of the SAR.
- Editorial changes to Appendix 7.D of HI-STAR 190 SAR (Revision 2) to replace F-37 with MPC-37. This is a correction to an editorial mishap that occurred during the development process for the initial version of the SAR.
- Editorial changes to Appendix 1.A (Section 1.A.3.2) of the HI-STAR 190 SAR (Revision 2) that replaces "Condition" with "Criterion" as described and intended in the section for the various safety criteria that must be met for the MPC to serve as a leak-tight pressure vessel and a competent Fuel Package.
- Editorial revision to Appendix 1.A, Section 1.A.3.2 that replaces required MPC leak-tight and competent Fuel Package safety Criterion 5 "Protection from Extremely Low Fuel Cladding Temperatures that may Cause Brittle Fracture While in Storage and during Transportation" with "Monitoring the Integrity of HBF". The previous requirement to meet the minimum HBF cladding temperature limit specified in Chapter 8 was an editorial mishap, as there is no minimum cladding temperature limit in Chapter 8 nor the HI-STAR 190 SAR in general. The revised criterion is to measure the cask surface temperatures and cask surface dose rates before and after shipment to match the description in Chapter 8 of the HI-STAR 190 SAR.