August 8, 2005

Mr. Dale E. James
Acting Director
Nuclear Safety Assurance - ANO
Entergy Operations, Inc.
1448 S. R. 333
Russellville, AR 72802

SUBJECT: EXEMPTION FROM 10 CFR 72.212 AND 72.214 FOR DRY SPENT FUEL STORAGE ACTIVITIES - ARKANSAS NUCLEAR ONE (TAC NO. L23826)

Dear Mr. James:

This is in response to your letter dated March 21, 2005, requesting an exemption from the requirements of 10 CFR 72.212(a)(2) and 10 CFR 72.214, pursuant to 10 CFR 72.7 for the Arkansas Nuclear One, Unit 1 (ANO-1) and Unit 2 (ANO-2), facility. Entergy Operations, Inc. (Entergy), as the holder of an operating nuclear power reactor 10 CFR Part 50 license, is permitted to store spent nuclear fuel under the general license provision of 10 CFR 72.210. As a general licensee, Entergy is storing spent nuclear fuel in an approved Holtec International (Holtec) HI-STORM 100 Storage System, as codified in 10 CFR 72.214, and is therefore bound to the requirements of the Certificate of Compliance (CoC) issued for the HI-STORM 100 Storage System. Specifically, with respect to your submittal, you are requesting exemption from Appendix B, Section 2.1 of the Holtec HI-STORM 100 Storage System CoC (72-1014), Fuel Specifications and Loading Conditions. This exemption would allow Entergy to continue to store already loaded damaged spent fuel in the HI-STORM 100 Storage System, specifically, using the Multi-Purpose Canister (MPC) -32 design, at the ANO Independent Spent Fuel storage Installation.

We understand that you requested the exemption to permit continued storage of damaged spent fuel in the MPC-32 to reduce occupational exposure, reduce the generation of contaminated waste, and minimize the risk of possible fuel handling accidents and heavy load handling accidents that would result from the unloading of the affected MPCs to restore compliance with the HI-STORM 100 Storage System CoC and regulatory requirements. Additionally, discharge of the spent fuel from the affected MPCs would result in inadequate storage capacity in the ANO Unit 2 Spent Fuel Pool and could impact the ability to move fuel for the next refueling outage.

The U.S. Nuclear Regulatory Commission (NRC) staff performed a safety evaluation of the proposed exemption. The NRC also considers exemption from the requirements of 10 CFR 72.212(b)(2)(i) and 10 CFR 72.212(b)(7) applicable to the request and has weighed these regulations in its review. The enclosed safety evaluation concludes that the requested changes will not compromise the performance of the HI-STORM 100 Storage System used at ANO or increase the potential for dose to members of the public. In your letter dated March 21, 2005, you included technical justification and attached Holtec Report No. HI-2053369, “Justification for ANO Exemption Request for Loading of Damaged Fuel,” as the bases for approval of the request. Subsequently, at the request of the staff, on May 10, 2005, you provided a copy of Holtec Report No. HI-2012771, Appendix O, “MPC-32 with Assembly Class 16x16A with Damage to Fuel Rods” in support of your application. The staff determined that the information

submitted provided an adequate basis to grant the exemption. Although storage of the potentially damaged fuel is permitted by the granting of this exemption, NRC reminds you of the requirement, pursuant to 10 CFR 71.87(a), that prior to transport a licensee must verify the contents are appropriate for the transport packaging. In so far as damaged fuel may not be authorized as approved contents for transportation in the relevant package by the Certificate of Compliance, ANO should maintain proper records to ensure transport regulations are met. The staff may review in future inspections the loading documentation/manifests, for the specific serial numbered MPCs involved, and verify that these casks have been identified as containing damaged fuel whose fuel assemblies were not placed in a damaged fuel container (DFC).

The NRC staff evaluated the public health and safety and environmental impacts of the proposed exemption and determined that granting the exemption would not result in any significant impacts. For this action, an Environmental Assessment and Finding of No Significant Impact have been prepared and published in the Federal Register (70 FR 43463, July 27, 2005). A copy of the Federal Register Notice was provided to you by letter dated July 20, 2005. Based on the foregoing considerations, the staff has determined that granting the proposed exemption from the provisions of 10 CFR 72.212(a)(2), 72.212(b)(2)(i), 10 CFR 72.212(b)(7), and 10 CFR 72.214 is authorized by law, will not endanger life or property or the common defense and security, and is otherwise in the public interest. Accordingly, the exemption from the requirements of 10 CFR 72.212(a)(2), 10 CFR 72.212(b)(2)(i), 10 CFR 72.212(b)(7), and 10 CFR 72.214 is granted and is effective immediately. Specifically, storage of damaged fuel assemblies AKC401, AKC504, AKD001, AKF103, and AKF110 is permitted in a cask design (MPC-32 serial numbers 001, 002, 003, and 009) not approved for storage of damaged fuel under the provisions of 10 CFR 72 Subpart K and under terms and conditions not set forth in the CoC.

If you have any questions, please contact me or Christopher M. Regan of my staff at 301-415-8500. Any future correspondence related to this action should reference Docket 72-13 and TAC No. L23826.

Sincerely,

/RA/

William Ruland, Deputy Director
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket Nos.: 72-13 (50-313 and 50-368)

Enclosure: Safety Evaluation

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William Ruland, Deputy Director
Spent Fuel Project Office
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Docket Nos.: 72-13 (50-313 and 50-368)

Enclosure: Safety Evaluation
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Dockets	NRC File Center	PUBLIC	NMSS r/f	SFPO r/f
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Arkansas Nuclear One

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SAFETY EVALUATION REPORT
Docket No. 72-13
Arkansas Nuclear One - Units 1 and 2
Independent Spent Fuel Storage Installation

Summary

By letter dated March 21, 2005, Entergy Operations, Inc. (Entergy or the licensee) requested the U.S. Nuclear Regulatory Commission (NRC) grant an exemption to 10 CFR 72.212(a)(2) and 72.214 requirements. Specifically, Entergy requested an exemption from the requirements in Certificate of Compliance (CoC) No. 1014, Appendix B, Section 2.1, Fuel Specifications and Loading Conditions, for the Holtec International (Holtec) HI-STORM 100 Storage System. The NRC also considers exemption from the requirements of 10 CFR 72.212(b)(2)(i) and 10 CFR 72.212(b)(7) applicable to the request and has weighed these regulations in its review. The licensee's reason for the request was to reduce occupational exposure, reduction in the generation of contaminated waste, and to minimize the risk of possible fuel handling accidents and heavy load handling accidents resulting from unloading of the affected Multi-Purpose Canisters (MPCs) to restore compliance with the HI-STORM 100 Storage System CoC and regulatory requirements.

The NRC has evaluated the technical issues associated with this exemption and concluded that the proposed exemption does not pose an increased risk to the public health and safety.

Evaluation

The applicant requested an exemption from 10 CFR 72.212(a)(2) and 72.214 to allow the storage of damaged spent fuel in the HI-STORM 100 Storage System, specifically, using the MPC-32 design. This exemption was requested after the applicant determined that five spent fuel assemblies that may have damaged fuel pins were loaded into four spent fuel storage casks. This determination was based on a secondary review of Arkansas Nuclear One (ANO) preliminary results of ultrasonic testing (UT) data evaluations which resulted in reclassification of ANO Unit 2 fuel assemblies; AKC401, AKC504, AKD001, AKF103, and AKF110, as being suspect of containing a damaged fuel pin. Due to the fact that the size of the defects could not be determined based on the UT and visual examinations performed, the defects were conservatively assumed by the licensee to be greater than pinhole leaks or hairline cracks and therefore considered damaged. The identified fuel assemblies were loaded into MPC-32 serial numbers 001, 002, 003, and 009 in November and December of 2004. Cask number 001 contains two fuel assembles with each of the assemblies containing one damaged fuel pin. Cask numbers 002, 003, and 009 each contain only one fuel assembly with a single damaged fuel pin. Damaged fuel is not approved for storage in the MPC-32 design used at ANO. The fact that the fuel assemblies may contain damaged fuel pins was discovered after loading and sealing the MPC-32s and the exemption was requested to avoid the need to unload the four canisters. The subject five fuel assemblies were reclassified as damaged on December 20, 2004. The exemption request applies to storage operations only and does not address the implications of transportation activities under 10 CFR Part 71.

Structural Evaluation

The staff reviewed the consequences of up to two damaged fuel pins, each in a separate fuel assembly, loaded into an MPC-32 evaluated by Holtec for impact on the structural capability of the HI-STORM 100 Storage System. There are no expected geometry reconfigurations in the fuel assemblies that could be anticipated from the damage level described for the identified spent fuel assemblies. No expected geometry reconfigurations would result in significant revision to the loading conditions relative to the internal fuel mass and its distribution considered under the various design conditions. The existence of possible damaged fuel pins prior to the closure of the MPC-32 and their impact on the design pressure of the MPC-32 has been considered by Holtec and the conclusion is that there will be no relevant impact on the existing design pressures. Damaged fuel, if identified as such, when loaded into a MPC-32 is placed in a damaged fuel container (DFC) before loading into the MPC-32 fuel basket. The ANO damaged fuel was not placed into a DFC before loading. The Holtec analysis was performed for damaged fuel placed in a DFC, however, the conclusions reached by Holtec bound the MPCs used by ANO containing the damaged fuel with respect to design pressures. The thermal effects of the potentially damaged fuel pins have been evaluated by Holtec and found to not have an effect on the heat transfer mechanisms and thus would not have an impact on the structural loadings or the resulting temperature dependent metallic structural materials.

The NRC staff has reviewed the structural evaluation and the basis of the conclusions reached by Holtec and supported by Entergy for the ANO Independent Spent Fuel Storage Installation (ISFSI) regarding this exemption request. Based on its review of the representations, determinations and information provided by the applicant, the staff finds that the as-loaded potentially damaged fuel consisting of a single fuel pin in each of five fuel assemblies (ANO Combustion Engineering 16x16A fuel), with only two assemblies in a single MPC-32, can remain as loaded spent nuclear fuel without any significant effects on the structural performance of the ANO HI-STORM 100 MPC-32 Storage System and will continue to meet the structural requirements of 10 CFR Part 72.

Thermal Evaluation

The thermal evaluation included consideration of the temperature effects on fuel cladding, pressure effects on the MPC, and helium flow blockage within the basket. The staff agrees that the damaged fuel pins would not likely reconfigure their geometry under design basis storage loadings. This is because the damaged fuel pin is depressurized with no appreciable hoop stress in the cladding. Also, the defects are considered relatively small (i.e. not appreciably affecting the strength of the cladding) because the fuel was not originally classified as damaged from operational records and the fuel could be handled normally. Therefore the staff believes the residual structural integrity of the damaged fuel pin will preserve the pin's geometry. If the pin's geometry does not change there will be no effect on the thermal performance of the fuel assembly.

Pressure effects on the MPC are not an issue because the canister has already been evaluated for a quantity of postulated pin failures much greater than the damaged pins. Also, since the damaged pins have already been depressurized prior to loading into the MPC, their internal gases would not contribute to the gas inventory and consequently the pressure in the MPC. Therefore, the current pressure analysis in the Holtec HI-STORM 100 Storage System Final Safety Analysis Report would be bounding for the MPC loaded with damaged fuel.

Since the HI–STORM 100 Storage System uses internal natural convection flow to remove the heat from the fuel pins, any blockage of that cooling flow could raise the cladding temperature in that assembly. Previously, the staff stated the reasons why reorientation of the damaged fuel pin is unlikely, but in the extremely unlikely event that the one damaged spent fuel pin does fail and becomes rubblized (broken into pieces), the staff considered the possible consequences. To significantly raise the temperature of the intact fuel pins in an assembly containing a damaged pin, the rubble would have to be distributed over the area of a grid spacer and restrict the natural convection flow of the MPC fill gas (helium). Since the ANO 16x16 Combustion Engineering fuel assembly pin pitch is 0.0506 inches and the pin diameter is 0.382 inches the spacing between the fuel pins is about 1/8th of an inch. The staff feels that these small openings between the intact fuel pins would filter any significant quantities of the rubblized fuel pin from migrating between the fuel pins, thus preventing complete coverage of the grid spacer and effectively inhibiting helium flow.

The licensee stated that since the fuel assemblies with the damaged pins are located near the periphery of the fuel basket, these assemblies experience temperatures significantly lower than the peak cladding temperatures near the center of the fuel basket. Contrary to this statement Figure 4.4.19 of the HI-STORM 100 Storage System FSAR, Revision 1, shows that the point of the perimeter fuel assemblies nearest the center (approximately 18.5 inches from the basket center) is at a temperature of approximately 95% of the peak cladding basket temperature. Essentially, the radial location of the damaged fuel assemblies will have a temperature approximately only 5% less than the fuel cladding temperature at the center of the fuel basket. Natural convective heat transfer relies on helium flow through both the inner basket and outer basket regions (the region where the damaged fuel assemblies are located). Natural convection accounts for more than 5% heat removal capacity of the cask. Given that a blockage of the helium flow in an damaged fuel assembly could reduce the amount of heat removal capacity of the cask, there is a potential that the peak cladding temperatures in the basket could be exceeded. However, considering the MPCs were loaded to well below their maximum thermal capacity thereby resulting in cladding temperatures well below temperature limits, and that the likelihood of the fuel pins rubblizing and migrating in such a way as to completely cover the grid spacer and blocking helium is very low, the staff concludes that the damaged fuel may remain as-loaded.

The NRC staff has reviewed the thermal evaluation and the basis of the conclusions reached by Holtec and supported by Entergy for the ANO ISFSI regarding this exemption request. Based on its review of the representations, determinations and information provided by the applicant, the staff finds that the as-loaded potentially damaged fuel consisting of a single fuel pin in each of five fuel assemblies (ANO Combustion Engineering 16x16A fuel), with only two assemblies in a single MPC-32, can remain as loaded spent nuclear fuel without any significant effects on the thermal performance of the ANO HI-STORM 100 MPC-32 Storage System and will continue to meet the thermal requirements of 10 CFR Part 72.

Shielding Evaluation

The staff reviewed the impact on direct radiation dose of the subject exemption request to permit loaded damaged spent nuclear fuel to remain in the MPC-32. Attachment 2 of the applicant's submittal dated March 21, 2005, Holtec Report No. HI-2053369, "Justification for ANO Exemption Request for Loading of Damaged Fuel," addressed direct radiation dose from the loaded casks. Analyses contained in Chapter 5 of the HI-STORM FSAR, Revision 2, dated March 5, 2004, by simulating collapsed damaged fuel assemblies in the MPC-24 or MPC-68,

indicated that dose rates would remain below limits specified in the CoC. Additionally, analysis results showed offsite annual dose would also remain below limits specified in the CoC for damaged fuel stored in these MPCs. The potential relocation of the fuel contained in two pins, in two fuel assemblies, contained in one MPC-32 would be much less than the assumed relocation of fuel in damaged assemblies described in the FSAR analysis, thus the effect on dose would be expected to be commensurately less. The dose surveys performed on each cask prior to placing them in service demonstrated that the casks satisfied the HI-STORM 100 Storage System dose rate requirements specified in the CoC.

Given that UT identified a potential problem with an (one) inner pin in each of five assemblies, and at most two of these assemblies were loaded in a single MPC-32, the dose surveys confirm the expected result that the dose rates outside the HI-STORM overpack are within the limits specified in the CoC.

The staff reviewed the impact on effluent radiation dose of the subject exemption request to permit loaded damaged spent nuclear fuel to remain in the MPC-32. Attachment 2 of the applicant's submittal dated March 21, 2005, addressed effluent radiation dose from the loaded casks. The normal condition effluent radiation dose evaluation in the HI-STORM 100 Storage System FSAR, Revision 2, bounds the case considered here. The FSAR calculation assumes a 1% pin rupture, which is much greater than the, at most, two damaged pins stored in the ANO MPC-32 containers.

The amount of potentially damaged fuel in the casks under consideration here is bounded by the amount of damaged fuel assumed in the FSAR effluent radiation dose evaluation. Therefore, storing this fuel in the MPC-32 casks has no impact on the predicted offsite radiation effluent dose.

The staff reviewed the shielding aspects of accident analyses relevant to the subject exemption request to permit loaded damaged spent nuclear fuel to remain in the MPC-32. Attachment 2 of the applicant's submittal, dated March 21, 2005, also addressed the shielding aspect of accidents for the loaded casks. Holtec analyzed a HI-TRAC Transfer Cask handling accident, a tip-over, a fire, and a tornado with respect to shielding performance and determined that there would be no adverse consequences from continued storage of the as-loaded damaged fuel in the HI-STORM 100 MPC-32 Storage System at the ANO facility.

The NRC staff has reviewed the shielding evaluation and the basis of the conclusions reached by Holtec and supported by Entergy for the ANO ISFSI regarding this exemption request. Based on its review of the representations, determinations and information provided by the applicant, the staff finds that the as-loaded potentially damaged fuel consisting of a single fuel pin in each of five fuel assemblies (ANO Combustion Engineering 16x16A fuel), with only two assemblies in a single MPC-32, can remain as loaded spent nuclear fuel without any significant effects on the shielding performance of the ANO HI-STORM 100 MPC-32 Storage System and will continue to meet the shielding requirements of 10 CFR Part 72.

Criticality Evaluation

The staff reviewed the applicants criticality evaluation for the subject exemption request to permit loaded damaged spent nuclear fuel to remain in the HI-STORM MPC-32 casks at the ANO facility. The applicant's criticality analysis is based on its determination that no more than one fuel pin per assembly is damaged and no more than two fuel assemblies with a damaged

fuel pin are in any one storage canister. This determination was made after secondary review of preliminary ultrasonic data evaluations of the fuel assemblies after the fuel had been loaded into the canisters.

Except for the simulated fuel pin damage, the criticality analysis provided by the applicant used the same basic set of assumptions and methods, including the Monte Carlo N Particle (MCNP) code, that were approved for previous analyses of the HI-STORM 100 Storage System. The storage casks in question were loaded with fuel assemblies of the 16x16A class described in the HI-STORM 100 Storage System FSAR, Revision 2. The criticality calculations were performed for fuel with 5.0 wt% enrichment and a soluble boron level of 1900 parts per million in the water flooding the cask. These conditions meet the limits in the Technical Specifications for loading and unloading the MPC-32 with this class of fuel.

The applicant's calculational model assumed three different configurations of damaged fuel. These models are:

1) One damaged fuel pin being removed and replaced by borated water in each fuel assembly in the canister. The location of the damaged fuel pin was varied over five places in the assembly lattice including places next to a water hole, in the middle of other fuel pins, and at the edge of the assembly.

2) Replacing one fuel pin in each assembly in the canister with active fuel that completely fills the lattice cell of that pin to approximate the relocation of a fractured pin to another place in the assembly lattice.

3) Segmenting a bounding number of four fuel pins into pellet sized fragments and relocating this total fissile mass to an open volume within the canister. The spacing of the fragments was varied to determine the optimum condition which maximized k_{eff} of the fragment array.

The applicant reported results that compared the modeled cases with the k_{eff} of a canister full of 32 undamaged fuel assemblies. In the first model above, the values of k_{eff} decreased for all locations of the missing fuel pin. In the second model above, the value of k_{eff} had a maximum increase of 0.25% but remained below the acceptance limit. For the third model above, the maximum value of k_{eff} was below 0.44. Thus, the applicant's results were within the acceptable limits for all cases.

The applicant's analysis was reviewed and found to be acceptable based on the information provided. Staff performed independent confirmatory calculations with the KENO Va module in the SCALE 4.4a suite of codes developed by Oak Ridge National Laboratory. Calculations were performed for the first and second model configurations that the applicant used. The locations of the missing pin and relocated pin were different from that assumed by the applicant. Staff's results showed trends that had good agreement with that found by the applicant. In all cases, the staff's results were below the acceptable limits on k_{eff}. Confirmatory calculations were not performed on the applicant's third model because of the low value of k_{eff} found by the applicant and the low probability of the configuration assumed.

The NRC staff has reviewed the criticality evaluation and the basis of the conclusions reached by Holtec and supported by Entergy for the ANO ISFSI regarding this exemption request. Based on its review of the representations, determinations and information provided by the applicant, the staff finds that the as-loaded potentially damaged fuel consisting of a single fuel

pin in each of five fuel assemblies (ANO Combustion Engineering 16x16A fuel), with only two assemblies in a single MPC-32, can remain as loaded spent nuclear fuel without any significant effects on the criticality performance of the ANO HI-STORM 100 MPC-32 Storage System and will continue to meet the criticality safety requirements of 10 CFR Part 72.

Conclusion

Based on the information presented in the Entergy exemption request, and the staff's review of the representations, determinations and information provided by the applicant, the staff has reasonable assurance that permitting the damaged fuel to remain loaded in the Holtec HI-STORM 100 MPC-32 Storage System will not pose an increased risk to the public health and safety and is acceptable.