Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802
Tel 479-858-4704

Stephenie L. Pyle
Manager, Regulatory Assurance
Arkansas Nuclear One

0CAN101403

October 2, 2014

ATTN: Document Control Desk
Director, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: Request for Exemption from Holtec International Certificate of Compliance (CoC) (72-1014) Fuel Specification and Loading Conditions
Arkansas Nuclear One – Units 1 and 2
Docket Nos. 50-313, 50-368, and 72.13
License Nos. DPR-51 and NPF-6

Dear Sir or Madam:

Pursuant to 10 CFR 72.7, "Specific Exemptions", Entergy Operations (Entergy) requests an exemption from the requirements of 10 CFR 72.212(a)(2) and 10 CFR 72.212(b)(11) for Arkansas Nuclear One (ANO). The regulations require, in part, compliance to the terms and conditions of the Holtec International (Holtec) Certificate of Compliance (CoC) (72-1014). Specifically, an exemption is requested from Appendix B, Section 2.1 of the Holtec CoC (72-1014), "Fuel Specifications and Loading Conditions."

In accordance with the requirements of Amendment 5 of the Holtec CoC, Appendix B, Section 2.1, "Fuel Specifications and Loading Conditions," for the HI-STORM 100 System, a damaged fuel assembly is not authorized for loading into the Model 24 Multi-Purpose Canister (MPC-24). On September 12, 2014, ANO determined during cask drying operations for MPC-24-060, which had been loaded with ANO Unit 1 (ANO-1) spent fuel, that a loaded fuel assembly previously classified as intact may contain a fuel rod with cladding damage greater than a pinhole leak or hairline crack, and that the assembly would need to be conservatively reclassified as damaged. Upon this determination, the MPC, with affected fuel assembly, was placed in a safe condition via completion of the drying, backfilling, and closure welding operations for the MPC. The NRC Operations Center was notified of the event within 24 hours. The MPC subject to this exemption request remains in the Transfer Cask (i.e., the HI-TRAC) in the Spent Fuel Pool (SFP) Cask Loading Pit work platform.

An assessment of the effect a damaged fuel rod would have on the storage configuration of a fuel assembly in the HI-STORM 100 system was performed. Based on this assessment, loading a damaged fuel assembly in the subject Holtec MPC-24 results in no impact to safety, and all functions of the DFS cask are maintained. This assessment did not consider the requirements for the MPC to be transported off-site. While loading of damaged fuel into an MPC-24 is not currently permitted by the Holtec CoC, it is Entergy's position that unloading the affected MPC to restore compliance is not in the best interest of safety. Rather, an exemption should be granted to allow completion of transport and transfer activities of the affected MPC to the designated onsite storage location. Unloading the subject MPC would subject personnel to a significant amount of unnecessary radiological dose, generate contaminated waste, increase the risk of a potential fuel handling accident, and increase the risk of a potential heavy load handling event. Additionally, offloading the subject cask will reduce the number of available spaces in the SFP in advance of and during the next outage. Therefore, an exemption to allow the MPC, which contains a fuel assembly conservatively classified as damaged, to be placed in onsite storage is requested.

Entergy requests approval of this exemption request by November 4, 2014. The requested date would permit transfer of MPC-24-060 to storage and out of the SFP area prior to the beginning of refueling preparations and receipt of new fuel supporting the ANO-1 January 2015 refueling outage. The requested date also permits ANO, Unit 2 (ANO-2) to begin performing dry cask loading activities required to be completed prior to the ANO-2 September 2015 refueling outage in support of full core off-load capability, receipt of new fuel for the outage, and to reperform the airflow test that is currently listed as a previous NRC inspection Unresolved Item. Finally, the requested date is needed to support installation of new SFP level indication required to meet commitments related to Diverse and Flexible Coping Strategies (FLEX). Note that the ANO units share dry cask loading work areas and equipment.

This letter contains no new commitments.

Details of Entergy need and justification for the issuance of an exemption are included in Attachments 1, 2, and 3. Attachment 3 is requested to be withheld from public disclosure in accordance with 10 CFR 2.390 because it contains proprietary Holtec business information that falls within Exemption 4 of the Freedom of Information Act (FOIA) 5 USC Sec. 552(b)(4), the Trade Secrets Act, 18 USC Sec. 1905, and 10 CFR 9.17(a)(4). The respective affidavit is included in Attachment 4 of this letter.

Should you have any questions concerning this submittal, please contact me.

Sincerely,

ORIGINAL SIGNED BY STEPHENIE L. PYLE

SLP/rwc

Attachments:

1. Request for Exemption to Permit Storage of Spent Fuel Classified as Damaged in Holtec MPC-24-060 Cask Design at Arkansas Nuclear One
2. Holtec Report No. HI-2146265, “Justification for ANO Exemption Request for Loading of Damaged Fuel in an MPC-24”
3. Appendix Z to Holtec Report No. HI-2012771, “MPC-24 with Assembly Class 15x15D with Damage to Fuel Rods” - PROPRIETARY
4. Affidavit Pursuant to 10 CFR 2.390 for Appendix Z to Holtec Report No. HI-2146265, “MPC-24 with Assembly Class 15x15D with Damage to Fuel Rods”

cc: Mr. Marc L. Dapas
Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
1600 East Lamar Boulevard
Arlington, TX 76011-4511

NRC Senior Resident Inspector
Arkansas Nuclear One
P. O. Box 310
London, AR 72847

U. S. Nuclear Regulatory Commission
Attn: Ms. Andrea E. George
MS O-8B1
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

Attachment 1

0CAN101403

Request for Exemption to Permit Storage of Spent Fuel Classified as Damaged in Holtec MPC-24-060 Cask Design at Arkansas Nuclear One

Request for Exemption to Permit Storage of Spent Fuel Classified as Damaged in Holtec MPC-24-060 at Arkansas Nuclear One

1.0 Request for Exemption

Pursuant to 10 CFR 72.7, "Specific Exemptions", Entergy Operations, Inc. (Entergy) requests an exemption from the requirements of 10 CFR 72.212(a)(2) and 10 CFR 72.212(b)(11) for Arkansas Nuclear One (ANO). The regulations require, in part, compliance to the terms and conditions of the Holtec International (Holtec) Certificate of Compliance (CoC) (72-1014), Amendment 5. Specifically, an exemption is requested from Appendix B, Section 2.1, of the CoC, "Fuel Specifications and Loading Conditions."

2.0 Background

At approximately 0732 on September 12, 2014, the Control Room Emergency Ventilation System (CREVS) actuated, placing the ANO, Units 1 and 2 (ANO-1 and ANO-2) Control Rooms on emergency recirculation. At the time of the CREVS actuation, dry cask loading activities were in progress for MPC-24-060, the 4th (and final) canister loading of fuel from the ANO-1 spent fuel pool (SFP) of the 2014 ANO-1 Dry Fuel Storage (DFS) loading campaign.

Forced Helium Dehydration (FHD) drying operations of the MPC-24-060 canister had commenced the previous day, September 11, 2014, at approximately 0200 CDT. On September 12, 2014, at approximately 0715 CDT, approximately 29 hours into the drying evolution, the FHD system operators reduced FHD and MPC internal pressure from approximately 50 psig to 15 psig in transition to the next phase of the drying process. Shortly after completion of the pressure reduction evolution, ANO-1 Control Room Operators contacted DFS supervision inquiring as to what evolutions were in progress in the SFP area and stated that the Control Rooms had isolated on high radiation detected by the CREVS. DFS Operators were contacted by DFS supervision and instructed to stabilize the FHD and MPC in a safe condition until the source of the Control Room isolation could be determined. In accordance with DFS procedures, the FHD Operators stabilized the MPC at 15 psig and initiated no additional pressure changes until notified.

Investigation of the source of the CREVS isolation signal by Control Room Operators determined that the only relevant station activity ongoing at the time was the FHD drying operations. A sample of the helium vented from the MPC was obtained and transported to Chemistry for analysis. The analysis indicated the presence of Krypton (Kr)-85 at a level of 1.566E-03 uci/cc, representative of a cladding defect in one or more fuel pins within the MPC. The MPC internal pressure was subsequently raised to 50 psig to ensure sufficient helium mass to maintain fuel temperature within acceptable range while further evaluation of the condition progressed.

All fuel assemblies which had been loaded into MPC-24-060 were verified by Reactor Engineering to meet the respective intact status (a CoC requirement) as part of the proceduralized selection process. Intact fuel is defined as fuel without known or suspected cladding defects greater than pinhole leaks or hairline cracks, and which can be handled by normal means. Each assembly's intact status is based on in-mast sipping and/or ultrasonic

testing (UT) performed subsequent to the final operating cycle. Results of the sipping and ultrasonic test campaign are maintained in a comprehensive engineering report used to verify assembly status during the fuel selection process for DFS cask loading. Review of the report and references (individual sipping and/or UT traces) presented no indication of a fuel rod breach in the subject fuel assemblies. Additionally, all fuel to be loaded into an MPC is visually examined for indications of rod or assembly damage, or other potential issues. None of the subject assemblies contained visible rod or assembly anomalies. As a result, all of the assemblies loaded into MPC-24-060 were originally classified as intact.

Given the presence of Kr-85 in the MPC and the prevalence of grid-to-rod fretting in the cycles of operation relevant to the subject assemblies (that may produce defects larger than a pinhole), the fuel loaded into MPC-24-060 was conservatively reclassified as damaged with respect to the CoC requirements for Fuel Specifications and Loading Conditions. Discussions with the DFS cask vendor, Holtec, followed to aid in verifying that the cask remained in an acceptable condition while evaluations continued.

Holtec recommended that ANO finish the FHD drying process and backfill to the CoC Technical Specification requirements while monitoring for any additional leakage (increasing Kr-85 levels). ANO concurred with Holtec's assessment and completed the drying and backfill process, electing to complete the closure welding of the MPC (i.e., closure welding and Non-Destructive Examination of the port cap covers and closure ring), placing the MPC in a fully contained and passive cooling condition.

MPC-24-060 currently remains in the Transfer Cask (i.e., the HI-TRAC) located in the ANO-1 SFP cask loading pit suspended from the work platform. Monitoring of the MPC by DFS personnel is currently performed at least daily. This includes recirculation of the HI-TRAC/MPC annulus for approximately 30 minutes. MPC lid temperature has remained steady at approximately 196 °F and HI-TRAC/MPC annulus temperatures have remained steady at approximately 130 °F to 135 °F. Radiation Protection personnel also perform a weekly survey of the HI-TRAC, which includes contamination, gamma radiation, and neutron radiation. This survey and its frequency is denoted on the survey coversheet to ensure the survey is completed on a weekly basis. The radiological conditions of the MPC have not changed during this period of monitoring.

3.0 Technical Considerations

The HI-STORM 100 system is designed to mitigate the effects of design basis accidents that could occur during storage. Design basis accidents account for human-induced events and the most severe natural phenomena reported for the site and surrounding area. Postulated accidents analyzed include tornado winds and tornado generated missiles, design basis earthquake, design basis flood, accidental cask drop, lightning effects, fire, explosions, and other incidents. Considering the specific design requirements for each accident condition, the design of the HI-STORM 100 cask system using an MPC-24 basket design, would prevent loss of containment, shielding, and criticality control. The loading of damaged fuel rods has no impact on the structural aspects of the containment boundary. Dose surveys performed indicate that the cask satisfies the dose requirements defined in the CoC. Without the loss of containment, shielding, or criticality control, the risk to public health and safety from the continued storage of the damaged fuel rods is not compromised. By permitting the continued

storage of damaged fuel rods using the HI-STORM 100 system, MPC-24, there will be no additional occupational exposure due to unloading activities, and offsite dose rates will remain well within the 10 CFR Part 20 limits. Therefore, Entergy has concluded that an acceptable safety margin is maintained and that there are no significant environmental impacts as a result of storing damaged fuel rods in the HI-STORM 100, MPC-24 at the ANO facility.

The following is summary information from Holtec Report No: HI-2146265, Justification for ANO Exemption Request for Loading of Damaged Fuel. This report, in its entirety, is included in Attachment 2 of this letter. Attachment 3 contains Appendix Z to the Attachment 2 Holtec report.

Any potential relocation of the damaged fuel rods in the MPC has a small or negligible effect on the reactivity (k_{eff}) of the system, and the maximum k_{eff} remains well below 0.95. This is predominantly due to the fact that the number of damaged fuel rods is expected to be small. During storage operation, the MPC is internally dry, resulting in a low k_{eff} and large reactivity margins. For unloading operations, where the MPC is flooded, confirmatory calculations for possible configurations were performed and confirm that the effect of fuel relocation on the k_{eff} of the system is small, even if the MPC is flooded with unborated water.

The presence of damaged fuel rods does not have any actual impact on the temperatures and pressures within the HI-STORM system. All cooling mechanisms will continue to perform as designed with no reduction in efficacy under all previously evaluated conditions of storage (normal, off-normal and accident).

Movement of the cask through the remaining transport and transfer steps to storage on the pad does not cause any safety concerns. The damaged fuel rods have no impact on the structural ability of the cask or the MPC to withstand pressure loads due to tornado winds, flood, or explosion events.

The postulated relocation of the fuel from a small number of rods would have a negligible effect on the source distribution within the cask and similarly would not have an effect on the dose contribution at the site boundary. Chapter 7 of the HI-STORM Final Safety Analysis Report (FSAR) demonstrates that there is no credible leakage under normal conditions since the MPC meets the criteria specified in Interim Staff Guidance (ISG) 18. Therefore, the damaged fuel assemblies stored in the MPC will have no impact on the offsite radiation dose.

Postulated accident scenarios were reviewed with respect to the structural, thermal, and shielding performance of the HI-STORM 100 system. The reviews conclude that no adverse consequences would result from stored damaged fuel in the ANO MPC-24-060.

In summary, an MPC-24/HI-STORM 100 storage system (MPC-24-060) where fuel rod damage discovered after loading has been evaluated against the licensing basis analysis. The evaluation has determined that storage in the current configuration is safe and justified.

Note that the attached report also concludes that the MPC may be safely unloaded (fuel placed back in the SFP), if required.

4.0 Regulatory Considerations

Appendix B, Section 1.0, of the Holtec CoC (72-1014), Amendment 5, defines a damaged fuel assembly, in part, as one with greater than pinhole leaks or hairline cracks. At least one of the fuel assemblies contained n MPC-24-060 is currently assumed to meet the damaged fuel assembly criteria. This section of the CoC also defines an intact fuel assembly as a fuel assembly without known or suspected cladding defects greater than pinhole leaks or hairline cracks, and which can be handled by normal means.

Based on known information, the fuel sipping or UT, and visual examinations performed on the assemblies prior to loading into the MPC failed to detect a flaw that could have precluded an intact classification.

Appendix B, Section 2.1, of the Holtec CoC (72-1014), "Fuel Specifications and Loading Conditions," states, in part, that fuel assemblies shall meet the applicable limits specified in Table 2.1-1. Table 2.1-1, which contains the fuel assembly limits for the MPC-24 states, in part, that storage is allowed for up to 24 intact fuel assemblies and that damaged fuel assemblies are not authorized for loading into the MPC-24. Therefore, loading of the suspect assemblies into the MPC-24 assembly casks would violate Appendix B, Section 2.1, of the CoC, assuming one or more fuel rods are not intact.

While loading of the damaged fuel into MPC-24-060 is not allowed by the CoC, it is Entergy's and Holtec's position that unloading of the MPC to restore compliance is not prudent. Unloading of the MPC would subject personnel to a significant amount of unnecessary dose, generate additional contaminated waste, increase the risk of a potential fuel handling accident, and increase the risk of a potential heavy load handling event.

The specific requirements for granting exemptions to 10 CFR Part 72 licensing requirements are set forth in 10 CFR 72.7, Specific Exemptions, which reads as follows:

> *The Commission may, upon application by any interested person or upon its own initiative, grant such exemptions from the requirements of the regulations in this part as it determines are authorized by law and will not endanger life or property or the common defense and security and are otherwise in the public interest.*

Entergy has reviewed 10 CFR 72 and determined that an exemption to a portion of 10 CFR 72.212(a)(2) and 10 CFR 72.212(b)(11) are necessary to allow continued processing and storage of MPC-24-060 containing a damaged fuel assembly with one or more rods potentially having greater than a pinhole leak. 10 CFR 72.210 issues a general license to store spent fuel in an Independent Spent Fuel Storage Installation (ISFSI) at reactor sites as long as the Part 50 reactor license remains in effect. 10 CFR 72.212(a)(2) limits the storage of spent fuel to casks approved in 10 CFR 72, Subpart K. 10 CFR 72.212(b)(11) states that the casks "are approved for storage under the conditions specified in their Certificates of Compliance." Since loading of the damaged fuel into MPC-24-060 is not in accordance with the conditions currently described in the Holtec CoC, an exemption to 10 CFR 72.212(a)(2) and 10 CFR 72.212 (b)(11) may be granted to allow loading in variance with the CoC.

As discussed in the Holtec report (Attachment 2 of this letter), the requested exemption to allow storage of the damaged fuel in the MPC-24-060 has low safety significance and therefore, will not endanger life and property or the common defense and security. It is also in the public's interest to grant an exemption, since unloading the cask will result in increased radiological dose to plant workers, increase the risk of contamination, increase the risk of a potential fuel handling accident, and increase the risk of a potential heavy load handling event.

While 10 CFR 72.7 does not specify a presentation of "special circumstances" similar to those required for 10 CFR 50 exemptions, Entergy's exemption request can be elucidated by using two of the special circumstances identified in 10 CFR 50.12. The applicable special circumstances are discussed below:

10 CFR 50.12(a)(2)(ii) *- Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose.*

The underlying purpose of 10 CFR 72.212 is to allow reactor licensees to utilize dry fuel storage casks that have previously been found to be safe and appropriately analyzed for use by the cask designer, the cask user, and the NRC. As described above, the storage of the subject damaged fuel assemblies has been found to be non-safety significant.

10 CFR 50.12(a)(2)(iii) *- Compliance would result in undue hardship or other costs that are significantly in excess of those contemplated when the regulation was adopted, or those incurred by others similarly situated.*

Discharge of the conservatively classified damaged fuel assembly from storage in the MPC will result in inadequate storage capacity in the ANO-1 SFP post 1R25 (refueling outage). Recovery of storage space in the SFP could be significantly hindered due to double handling of ANO-1 fuel in addition to material and schedule conflicts with ANO-2 DFS activities to the extent that ANO Unit-1 core offloads could be jeopardized.

As stated previously, offloading the MPC will result in increased radiological dose to plant workers, increase the risk of contamination, increase the risk of a potential fuel handling accident, and increase the risk of a potential heavy load handling event.

Pursuant to 10 CFR 71.87(a), prior to transport a licensee must verify the contents are appropriate for the transport packaging. Damaged fuel may not be authorized as approved contents for transportation in the MPC-24 by the CoC. ANO maintains detailed records, available for inspection, to ensure transport regulations are met. The specific serial numbered MPC involved has been identified as containing damaged fuel (i.e., the fuel assemblies were not placed in a damaged fuel container).

5.0 Summary

In conclusion, Entergy requests an exemption from the requirements of 10 CFR 72.212(a)(2) and 10 CFR 72.212(b)(11) for ANO. Specifically, an exemption is requested from Appendix B, Section 2.1, of the Holtec CoC (72-1014), "Fuel Specifications and Loading Conditions," Amendment 5. While loading of the damaged fuel into MPC-24-060 is not currently allowed by the CoC, it is Entergy's and Holtec's position that unloading of the affected MPC to restore compliance is not prudent. As discussed above, the requested exemption to allow storage of fuel assemblies, which subsequent to selection for loading were conservatively re-classified as damaged, has low safety significance and, therefore, will not endanger life or property or the common defense and security. Unloading of the subject MPC would subject personnel to a significant amount of unnecessary dose, increase the risk of contamination, increase the risk of a possible fuel handling accident, and increase the risk of a possible heavy load handling accident.

Entergy requests approval of this exemption request by November 4, 2014. The requested date would permit transport and transfer of MPC-24-060 to storage and out of the SFP area prior to the beginning of refueling preparations and receipt of new fuel supporting the ANO-1 January 2015 refueling outage. The requested date also permits ANO-2 to begin performing dry cask loading activities required to be completed prior to the ANO-2 September 2015 refueling outage in support of full core off-load capability, receipt of new fuel for the outage, and to re-perform the airflow test that is currently listed as a previous NRC inspection Unresolved Item. Finally, the requested date is needed to support installation of new SFP level indication required to meet commitments related to Diverse and Flexible Coping Strategies (FLEX). Note that the ANO units share dry cask loading work areas and equipment.

This request is similar to that approved for ANO previously in NRC Safety Evaluation Report (SER) dated September 8, 2005, "Exemption from 10 CFR 72.212 AND 72.214 for Dry Spent Fuel Storage Activities – Arkansas Nuclear One (TAC No. L23826)," (0CNA090502) (ML052510724). Note that ANO records specify the aforementioned September 8, 2005, date for this previous SER; however, the ADAMS document associated with the listed ML number indicates a date of August 8, 2005.

Attachment 2

0CAN101403

Holtec Report No: HI-2146265, Justification for ANO Exemption Request for Loading of Damaged Fuel in an MPC-24

HOLTEC
INTERNATIONAL

Holtec Center, One Holtec Drive, Marlton, NJ 08053
Telephone (856) 797- 0900
Fax (856) 797 - 0909

JUSTIFICATION FOR ANO EXEMPTION REQUEST FOR DAMAGED FUEL IN AN MPC-24

FOR

ANO

Holtec Report No: HI-2146265

Holtec Project No: 1104

Sponsoring Holtec Division: NPD

Report Class : SAFETY RELATED

Table of Contents

Summary of Revisions

Revision 0: Initial Issue

1. INTRODUCTION

1.1 Statement of Purpose

This report documents the evaluation of a MPC-24/HI-STORM 100 storage system (MPC-24-060) at Arkansas Nuclear One (ANO) containing one or more damaged fuel assemblies each not in a damaged fuel container (DFC). This evaluation only addresses storage conditions for the HI-STORM 100 CoC Amendment 5 [3] issued under 10CFR72. A technical review of all relevant disciplines against the HI-STORM 100 FSAR [2] was conducted and some calculations were performed to justify the currently loaded configuration. This report provides the results of the review and calculations with the intent for use in supporting an exemption request to be submitted by ANO. This report is directly based on Holtec Report HI-2053369, Rev. 1 [4], which addresses a similar condition that occurred at ANO in 2004/2005. Specifically, criticality evaluations performed for that report are utilized here, with appropriate justification of their applicability.

1.2 Initiating Event and Expected Extent of Fuel Damage

During drying operation for the MPC, using the Forced Helium Dehydration system (FHD), a Kr-85 release was detected and traced back to the MPC. Analyses of the helium in the FHD confirmed the presence of Kr-85 at that time. Helium samples taken at a later time indicated only small trace amounts of Kr-85, indicating that larger amounts of Kr-85 were only released during a short period of time. Note that all assemblies in the MPC had been inspected prior to loading and no cladding defects larger than a pinhole leak or hairline crack had been found. Also, the assemblies are considered structurally sound, and do not have any structural defects that could be expected to result in cladding being damaged. Based on all this, the most likely scenario for the Kr-85 release is a single breached rod cladding in one of the assemblies in the canister. A small number of breached rods is also possible, but less likely. But there appears to be no reason to assume damage on a larger scale. Specifically, the number of breached rods should be well below 1%, which is used in some analyses for normal conditions in the safety evaluations. With 208 rods per assembly, and 24 assemblies in the MPC, this 1% equates to 50 rods, which is well above the single breached rod likely in this case. Further, the breach in any rod, while larger than a pinhole leak or hairline crack, is still expected to involve only a small portion of the rod. This is based on the fact that the breach does not only release the Kr-85, but also the internal rod pressurization from helium, and therefore essentially reduces the stress in the cladding that resulted in the breach to zero. Finally, based on absence of any relevant structural defects in the assemblies, and that only small cladding breaches are expected, it is unlikely that significant numbers of fuel pellets have been released from the cladding to relocate to different sections of the assembly of the canister.

With respect to the different evaluations in this report note that they all may use different assumptions with respect to the number of rods damaged and nature of that damage. In some cases these may go far beyond the reasonably expected conditions, in order to provide assurance of safety appropriate for the specific discipline.

2. TECHNICAL REVIEW AND JUSTIFICATION

2.1 Criticality Assessment

This section contains an assessment of the impact of the damaged fuel rods on the reactivity (maximum k_{eff}) of the MPCs. Normal, off-normal and accident conditions are considered, as well as storage conditions and unloading operations.

2.1.1 Normal Condition of Storage

Significant damage to some fuel rods could potentially result in an increase in reactivity due to the possible relocation of fuel pellets. However, Section 6.1 of the HI-STORM FSAR [2] states that "The HI-STORM 100 System for storage (concrete overpack) is dry (no moderator), and thus, the reactivity is very low (k_{eff}<0.52)." Under normal conditions of storage, there is therefore a large safety margin to the regulatory limit of k_{eff} of 0.95. The effect of the assumed damage on the reactivity would be very small compared to this safety margin, due to the small number of suspected rods compared to the total number of rods in each MPC and limited potential displacement of fuel pellets. In summary, it can be concluded that the reactivity remains well below the regulatory limit, and that the system is therefore safe from a criticality perspective under normal storage conditions even under the assumption of significant damage to some fuel rods.

2.1.2 Unloading of the MPC

As stated before, significant damage to some fuel rods could potentially result in a relocation of fuel pellets. During and after the reflooding of the MPC, this could lead to an increase in reactivity. However, based on the expected small number of damaged rods per MPC, the reactivity effect will be negligible or very small, and would easily be accommodated by the existing margins in the calculations. Nevertheless, evaluations were performed and are documented in [1] to confirm this conclusion. The evaluations address two potential configurations: relocation of fuel within the assembly, and relocation of fuel outside of the assembly and basket. The evaluations are performed for fuel with 4.1 wt% ^{235}U enrichment and fresh (non-borated) water, consistent with the requirement for loading and unloading fuel of assembly class 15x15D in the MPC-24 as specified in the HI-STORM CoC Amendment 5 [3]. Note that the assemblies loaded into MPC-24-060 have enrichments ranging from 2.95 to 4.05 wt% ^{235}U, with an average of about 3.6 wt% ^{235}U [6]. The results of the analyses are therefore bounding.

2.1.3 Relocation of Fuel within the Assembly

Relocation of fuel pellets within an assembly will lead to sections of the assembly with less fuel than the intact assembly, while other sections of the assembly will have more fuel than the intact assembly. For simplification, both conditions are evaluated separately. This is also conservative,

since the reactivity effects of increasing and reducing fuel would tend to offset each other to some extent. Also, evaluations are performed assuming the specific condition to be present in all 24 assemblies in the MPC. To simulate less fuel, a single fuel rod, or up to two fuel rods in each assembly are removed and replaced by water. To simulate more fuel, a single fuel rod in each assembly is replaced by a square rod of fuel which has approximately three times the amount of fuel per unit length. The fuel cladding is neglected in the latter case. The condition is applied to various fuel rod locations in the assembly, including locations on the periphery of the assembly, adjacent to a guide tube, and in a location completely surrounded by intact fuel rods. The results of the evaluations are summarized as follows:

- Removing a single fuel rod in each assembly results in an increase in the k_{eff} value of up to 0.0039 delta-k, with the largest value found when the rod is removed near the center of the assembly, whereas removing the rod on the periphery has a negligible effect. Removing two fuel rods together that had the highest effect when removed singly, the increase is about 0.0045 delta-k. But even in this case, the maximum k_{eff} value is still well below 0.95.
- Increasing the amount of fuel in each assembly results in a slight increase in k_{eff} of about 0.0021 delta-k when the damaged rod is located on the corner of the assembly, and a slight reduction in k_{eff} otherwise.

2.1.4 Relocation of Fuel Outside the Fuel Assembly and Basket

If any of the damaged fuel would relocate outside of the fuel assemblies, it could potentially accumulate in an area of the basket where no neutron poison plates are present. Despite the fact that no substantial release of fuel pellets from breached rods is expected (see Section 1.2), it is assumed that all pellets from a total of two fuel rods would fall out of the assemblies, and then accumulate in an area where no neutron poison is present. To evaluate this assumed condition, a simple geometry is analyzed, consisting of an array of fuel fragments in a large body of un-borated water. All other materials, i.e. MPC, basket and fuel assemblies are neglected. The spacing of the fragments is varied to determine the optimum moderation condition. The calculations of these configurations show a k_{eff} that is very low, with highest value below 0.7. This confirms that fuel fragments accumulating outside of the fuel assemblies and basket in the MPC during unloading are not a criticality concern, even if the MPC is flooded with pure un-borated water.

2.1.5 Off-normal and Accident Conditions

As discussed in Chapter 6 and Chapter 11 of the HI-STORM FSAR [2], there is no credible or postulated off-normal or accident condition which has any effect on the criticality control features of the system. The discussion of criticality safety under normal conditions of storage and during unloading above is therefore directly applicable to any off-normal and accident condition.

2.1.6 Summary

In summary, any potential relocation of the damaged fuel rods in the MPC has a small or negligible effect on the k_{eff} of the system, and the maximum k_{eff} remains well below 0.95. This is predominantly due to the fact that the number of damaged fuel rods is expected to be small (see Section 1.2). During storage operation, the MPC is internally dry, resulting in a low k_{eff} and large reactivity margins. For unloading operations, where the MPC is flooded, confirmatory calculations for possible configurations were performed in [1] and confirm that the effect of fuel relocation on the k_{eff} of the system is small, even if the MPC is flooded with pure un-borated water.

2.2 Thermal Assessment

The damaged fuel rods in the MPC would only be a small fraction of the total number of fuel rods (well below 1% as discussed in Section 1.2). The presence of such a small amount of damaged fuel rods would not have a significant impact on the thermal performance of the HI-STORM System. For the purposes of this assessment, however, it is assumed that the presence of damaged fuel rods could **potentially** impact thermal performance. As such, it is necessary to evaluate what impact, if any, the presence of up to two damaged fuel rods will have on the **actual** thermal performance.

2.2.1 Actual Impacts on Temperature

First, the actual impact on the temperatures in the HI-STORM System will be addressed. The MPC is backfilled with helium, which provides cooling for fuel assemblies through conduction and natural circulation. The damage to the rods is such that the rods remain in their correct physical positions within the fuel assembly. The performance of the conduction heat transfer mechanism is dependent on the fuel geometry, so this mechanism would not be impacted by the presence of the damaged fuel rods. The performance of the natural convection heat transfer mechanism is dependent on the hydraulic resistance of the fuel assemblies, which is also dependent on the fuel geometry. As the fuel geometry is not changed, this mechanism would also not be significantly impacted by the presence by the damaged fuel rods. Further, the total heat load in the MPC-24-060 is only about 15 kW, which is significantly lower than the allowable heat load of 34 kW (uniform loading) [3]. Therefore, the normal condition design temperatures specified in Table 2.2.3 of the HI-STORM FSAR [2] will not be exceeded as a result of the presence of damaged fuel rods.

It should also be noted that the MPCs containing the damaged fuel rods were not vacuum dried but were instead demoisturized using the Forced Helium Dehydrator (FHD) System. Unlike vacuum drying, which subjects the fuel to large temperature rises that could have led to further degradation of the damaged fuel cladding, the FHD System thermostatically controls the

temperature within the MPC to below normal storage levels. This further reduces the potential for additional cladding damage on the affected rods.

Because the cooling mechanisms that remove heat from the fuel assemblies and reject it to the ambient are, as described in the preceding paragraphs, undiminished by the presence of the damaged fuel rods, there would be no reduction in these mechanisms under any (normal, off-normal and hypothetical accident ambient) condition of storage.

2.2.2 Actual Impacts on Pressure

Next, the actual impact on the pressures in the HI-STORM System will be addressed. Because the damaged rod(s) have been breached prior to closing of the MPC and placement into dry storage, the rod fill gas and any gaseous fission products have been released already. As such, there is no possibility for additional rod fill gas or gaseous fission products to be released into the MPC. The internal free volume of a few fuel rods is negligible compared to the free volume within an MPC, so the presence of the damaged rods will have a negligible impact on MPC internal pressures. Therefore, the normal condition design pressures specified in Table 2.2.1 of the HI-STORM FSAR [2] will not be exceeded as a result of the damaged fuel rods.

Under off-normal and accident pressure conditions which result from fuel rod ruptures that release additional gases into the sealed MPC, the amount of rod fill gas and gaseous fission products will be slightly reduced as the damaged rods have been breached prior to placement into dry storage. Therefore, the off-normal and hypothetical accident condition design pressures specified in Table 2.2.1 of the HI-STORM FSAR [2] will not be exceeded as a result of the damaged fuel rods.

It is noted that the continuing radioactive decay of the fuel pellets would result in the production of additional amounts of gaseous fission products in the future. The amounts of any such gases would, however, be negligible compared to the amount of gases in an undamaged rod. The production of this small amount of gas will be bounded by the 1% fuel rod rupture condition evaluated as a normal event in the HI-STORM 100 FSAR [2].

2.2.3 Effects of Continued Degradation of the Rods' Integrity

The current condition of the damaged fuel rods is expected to be, as discussed in Section 1.2, such that the fuel assembly geometry is basically intact (i.e., the fuel pellets are still contained within the cladding). Two previously discussed conditions preclude further degradation of the damaged fuel rods under normal conditions. First, the heat load of the canister is well below the limit, resulting in lower temperatures and larger margin to the temperature limit. This results in lower thermal stresses in all fuel rods. Second, the rods fill gas and gaseous fission products will have already been released from the damaged rods. This results in equal pressure both within and outside of the damaged fuel rods, totally eliminating hoop stress in the fuel cladding. The relatively low thermal stresses and the complete lack of hoop stress make propagation of the

existing fuel rod damage highly unlikely. Nevertheless, the impact of a small number of fuel pellets or pieces of fuel cladding becoming dislodged from the damage fuel rods is considered.

If a fuel pellet or piece of fuel cladding were to block one of the rod-to-rod interstitial spaces, the impact on the thermosiphon natural convection heat transfer mechanism would be miniscule. This is due to the large number of such interstitial spaces within a single fuel assembly (there are 196 in the 15x15 array fuel assembly). Each interstitial space is connected to the four adjacent spaces, so helium could easily flow around any such localized blockage. The contact between any such dislodges fuel pellet and the surrounding fuel rods would still allow for effective removal of heat from the fuel pellet.

If a fuel pellet or piece of fuel cladding were to fall completely out of the fuel assembly and into the bottom mouseholes region of the fuel basket, the impact on the thermosiphon natural convection heat transfer mechanism would be similarly negligible. The mouseholes consist of a 3/8" high by 4" wide rectangular opening topped by a 4" diameter semicircular opening. None of the rectangular openings in the entire fuel basket are credited in the thermal analysis, so that the deposition of any fuel-related debris such as crud would be bounded. The size of the neglected rectangular openings is larger than the possible dislodged fuel pellets or cladding pieces. A fuel pellet in contact with the baseplate would efficiently reject heat to the baseplate through conduction and would continue to be cooled by the thermosiphon natural convection flow through the mouseholes.

There would not be an expected effect of corrosion to the MPC from fuel pellets being in contact with the stainless steel MPC surface in the dry, cool, and inert environment.

2.2.4 Summary of Thermal Assessment

In summary, the presence of damaged fuel rods does not have any actual impact on the temperatures and pressures within the HI-STORM System. All cooling mechanisms will continue to perform as designed with no reduction in efficacy under all previously evaluated conditions of storage (normal, off-normal and accident).

2.3 Structural Assessment

The damaged fuel rods have no significant effect on the structural performance of the HI-STORM 100 System. The reasons for this conclusion are as follows. First, the damaged fuel rods have no physical effect on the HI-STORM overpack or the HI-TRAC transfer cask since they do not come in contact with the stored fuel. In addition, there were no visual indications of fuel assembly damage so the damaged fuel rods do not impact the MPC fuel basket. As explained in Section 2.2, the normal, off-normal, and accident condition pressures and temperatures specified in HI-STORM FSAR [2] Tables 2.2.1 and 2.2.3 are not exceeded as a result of the damaged fuel rods. The stresses in the overpack and the transfer cask due to normal and off-normal handling events remain as calculated in the HI-STORM FSAR [2], since the dead weight of the loaded casks and their centers of gravity are unaffected by the damaged fuel rods.

Likewise, the impact decelerations experienced by the cask as a result of a handling accident or a hypothetical tip-over event are not increased, and the stability of the cask under the design basis environmental phenomena (i.e., tornado winds, earthquake, etc.) continues to be assured. Based on this evaluation as well as the criticality evaluations detailed above, continued movement of the cask through the remaining transfer steps to storage on the pad does not cause any safety concerns. Finally, the damaged fuel rods have no impact on the structural ability of the cask or the MPC to withstand pressure loads due to tornado winds, flood, or accident explosions.

2.4 Radiological Assessment

2.4.1 Shielding - Direct Radiation Dose

Chapter 5 of the HI-STORM FSAR [2] has demonstrated that storing damaged fuel assemblies in the MPC-24 or MPC-68 has little impact on the external dose rates. This analysis was performed by simulating collapsed damaged fuel assemblies, a far more conservative condition than expected in MPC-24-060.

The postulated relocation of the fuel from a small number of rods would have a negligible effect on the source distribution within the cask and similarly would not have an effect on the dose contribution at the site boundary.

2.4.2 Shielding - Effluent Radiation Dose

Chapter 7 of the HI-STORM FSAR [2] demonstrates that there is no credible leakage under normal conditions since the MPC meets the criteria specified in Interim Staff Guidance (ISG) 18 [5]. This provides further evidence that the damaged fuel assemblies stored in the MPC have no impact on the offsite radiation dose.

2.5 Operations Assessment

Section 8.3 of the HI-STORM FSAR [2] covers the unloading of the HI-STORM 100 system in the spent fuel pool. Should it become necessary to unload the MPCs at the ANO plant that contain damaged fuel, the operations that could possibly be affected are more specifically discussed in Section 8.3.3 – Preparation for Unloading. The condition of the damaged fuel inside the MPC is unknown and therefore it is assumed that loose fuel pellets could potentially be lying on the bottom of the MPC. The only actions that this situation would affect are the cool down operations and the filling of the MPC with water.

The cool down operations are accomplished by circulating helium in through the drain port, up through the MPC, and out through the vent port. The cool down can be done using the Forced Helium Dehydrator or the Helium Cooling and Circulating Skid. Either way, loose fuel pellets will not inhibit the flow of helium as they could not physically clog any of the MPC ports.

Although fuel pellets could fall into the sump and temporarily block the flow path through the drain line, the high velocity cooling helium would blow the debris away from the end of the drain line. Filling the MPC with water through the drain line will also flush any debris away from the drain. Therefore the damaged fuel will not adversely affect the cool down operations.

The filling of the MPC with water is done in basically the same way as the cool down process except that only a water supply is connected to the drain port and a vent line is connected to the vent port of the MPC. Similarly the flow of water into the MPC from the drain line nor the escape of gases from the vent port could not possibly become blocked by loose fuel pellets, therefore no adverse effects to the water fill process will result from loose fuel pellets in the MPC.

Unloading of the MPC is thus unaffected by the condition of having damaged fuel which could consist of loose fuel pellets located in the MPC.

2.6 Accident Assessments

Chapter 11 of the HI-STORM FSAR [2] presents the evaluation of the HI-STORM 100 System for the effects of off-normal and postulated accident conditions. The presence of damaged fuel in the MPC has been considered with respect to each of these conditions and is found to have insignificant impact on their evaluations.

2.6.1 Off-Normal Conditions

Per Section 11.1 of the HI-STORM FSAR [2], the structural performance of the HI-STORM 100 System is affected by the following conditions:

Off-normal pressures
Off-normal environmental temperatures
Leakage of one seal
Off-normal handling of HI-TRAC
Off-normal load combinations

The thermal performance of the HI-STORM 100 System, as stated in Section 11.1 of the HI-STORM FSAR [2] is affected by the following conditions:

Off-normal pressures
Off-normal temperatures
Partial blockage of air inlets

All of the above conditions are shown in the HI-STORM FSAR [2] to produce stresses, pressures, and temperatures which are within allowable values. Therefore, as explained in previous sections of this report, damaged fuel inside the MPC will have no impact on the performance of the HI-STORM 100 System.

2.6.2 Accidents

The following postulated accident scenarios were reviewed with respect to the structural performance of the HI-STORM 100 System to determine that no adverse consequences would result from stored damaged fuel in the ANO MPC-24-060:

HI-TRAC Transfer Cask handling accident
HI-STORM Overpack handling accident
Tip-over
Tornado
Flood
Earthquake
100% fuel rod rupture
Explosion
Burial under debris
Extreme environmental temperature

The following postulated accident scenarios were reviewed with respect to the thermal performance of the HI-STORM 100 System to determine that no adverse consequences would result from stored damaged fuel in the ANO MPC-24-060:

HI-TRAC Transfer Cask handling accident
Tip-over
Fire
Partial blockage of MPC basket vent holes
Tornado
Flood
100% fuel rod rupture
Confinement boundary leakage
100% blockage of air inlets
Burial under debris
Extreme environmental temperatures

The following postulated accident scenarios were reviewed with respect to the shielding performance of the HI-STORM 100 System to determine that no adverse consequences would result from stored damaged fuel in the ANO MPC-24-060:

HI-TRAC Transfer Cask handling accident
Tip-over
Fire
Tornado

The confinement boundary leakage accident was reviewed with respect to the confinement function of the HI-STORM 100 System to determine that no adverse consequences would result from stored damaged fuel in the ANO MPC-24-060.

3. SUMMARY

An MPC-24/HI-STORM 100 storage system (MPC-24-060) where fuel rod damage has occurred after loading has been evaluated against its licensing basis analysis. The evaluation has determined that storage in the current configuration is safe and justified.

4. REFERENCES

[1] HI-2012771 Rev 18, *HI-STORM 100 and HI-STAR 100 Additional Criticality Calculations*, Holtec International.

[2] HI-2002444 Rev 7, HI-STORM 100 Final Safety Analysis Report.

[3] HI-STORM 100 Certificate of Compliance No. 1014, Amendment 5.

[4] HI-2053369, Rev. 1, *Justification for ANO Exemption Request for Loading of Damaged Fuel*, Holtec International

[5] Interim Staff Guidance-18 Rev 1, The US Nuclear Regulatory Commission, October 3, 2008.

[6] Entergy EN-DC-215, Rev. 5, for MPC-24-060

Attachment 4

0CAN101403

Affidavit Pursuant to 10 CFR 2.390 for Appendix Z to Holtec Report No. HI-2146265 "MPC-24 with Assembly Class 15x15D with Damage to Fuel Rods"

AFFIDAVIT PURSUANT TO 10 CFR 2.390

I, Kimberly Manzione, being duly sworn, depose and state as follows:

(1) I have reviewed the information described in paragraph (2) which is sought to be withheld, and am authorized to apply for its withholding.

(2) The information sought to be withheld is Appendix Z to Holtec Report HI-2012771 Rev 18. This Appendix contains Holtec Proprietary information.

(3) In making this application for withholding of proprietary information of which it is the owner, Holtec International relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC Sec. 552(b)(4) and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10CFR Part 9.17(a)(4), 2.390(a)(4), and 2.390(b)(I) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 4). The material for which exemption from disclosure is here sought is all "confidential commercial information", and some portions also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by Holtec's competitors without license from Holtec International constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

c. Information which reveals cost or price information, production, capacities, budget levels, or commercial strategies of Holtec International, its customers, or its suppliers;

d. Information which reveals aspects of past, present, or future Holtec International customer-funded development plans and programs of potential commercial value to Holtec International;

e. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs 4.a, 4.b and 4.e above.

(5) The information sought to be withheld is being submitted to the NRC in confidence. The information (including that compiled from many sources) is of a sort customarily held in confidence by Holtec International, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by Holtec International. No public disclosure has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence. Its initial designation as proprietary information, and the subsequent steps taken to prevent its

unauthorized disclosure, are as set forth in paragraphs (6) and (7) following.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within Holtec International is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his designee), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside Holtec International are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information classified as proprietary was developed and compiled by Holtec International at a significant cost to Holtec International. This information is classified as proprietary because it contains detailed descriptions of analytical approaches and methodologies not available elsewhere. This information would provide other parties, including competitors, with information from Holtec International's technical database and the results of evaluations performed by Holtec International. A substantial effort has been expended by Holtec International to develop this information. Release of this information would improve a competitor's position because it would enable Holtec's competitor to copy our technology and offer it for sale in competition with our company, causing us financial injury.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to Holtec International's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of Holtec International's comprehensive spent fuel storage technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology, and includes development of the expertise to determine and apply the appropriate evaluation process.

The research, development, engineering, and analytical costs comprise a substantial investment of time and money by Holtec International.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

Holtec International's competitive advantage will be lost if its competitors are able to use the results of the Holtec International experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to Holtec International would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive Holtec International of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing these very valuable analytical tools.

AFFIDAVIT PURSUANT TO 10 CFR 2.390

STATE OF NEW JERSEY)

) ss:

COUNTY OF BURLINGTON)

Kimberly Manzione, being duly sworn, deposes and says:

That she has read the foregoing affidavit and the matters stated therein are true and correct to the best of her knowledge, information, and belief.

Executed at Marlton, New Jersey, this 24th day of September, 2014.

Kimberly Manzione
Acting Licensing Manager
Holtec International

Subscribed and sworn before me this 24th day of September, 2014.

MARIA C. MASSI
NOTARY PUBLIC OF NEW JERSEY
My Commission Expires April 25, 2015