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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Clinton Power Station, Unit 1
Facility Operating License No. NPF-62
NRC Docket No. 50-461

Subject: Additional Information Supporting the Request for License Amendment Related to Onsite Spent Fuel Storage Expansion

References:

(1) Letter from Keith R. Jury (AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission, "Request for Technical Specification Change to Support Onsite Spent Fuel Storage Expansion," dated August 18, 2004

(2) Letter from Keith R. Jury (AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission, "Additional Information Supporting the Request for License Amendment Related to Onsite Spent Fuel Storage Expansion," dated May 13, 2005

(3) Letter from Keith R. Jury (AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission, "Affidavit for Withholding of Global Nuclear Fuel Proprietary Information in Support of Onsite Spent Fuel Storage Expansion," dated May 25, 2005

(4) Letter from Keith R. Jury (AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission, "Additional Information Supporting the Request for License Amendment Related to Onsite Spent Fuel Storage Expansion," dated June 14, 2005

(5) Letter from Keith R. Jury (AmerGen Energy Company, LLC) to U. S. Nuclear Regulatory Commission, "Revised No Significant Hazards Consideration Supporting the Request for License Amendment Related to Onsite Spent Fuel Storage Expansion," dated August 17, 2005

In Reference 1, AmerGen Energy Company, LLC (AmerGen) requested a change to the Technical Specifications for Clinton Power Station (CPS), Unit 1, to reflect the addition of fuel storage capacity in the fuel cask storage pool and increased fuel storage capacity in the spent fuel pool. Specifically, the proposed expansion will increase the total storage space at CPS from 2,512 to 4,159 fuel assemblies. This extra capacity is expected to allow operation without loss of full core discharge capability until the 15th refueling outage (i.e., C1R15) in the year 2016.

The NRC requested additional information in support of their review of the proposed changes in Reference 1 and AmerGen provided the requested information in References 2, 3, 4, and 5. In follow-up conference calls between AmerGen and the NRC on July 21, August 11, October 6, and October 12, 2005, the NRC requested additional information related to the spent fuel pool heat load and heavy load drop analyses and the need for a CPS Metamic coupon sampling program. The requested information is provided in the attachments to this letter. Attachment 1 provides the results of the spent fuel pool heat load and rack drop analyses. Attachment 2 provides a summary of the Metamic coupon surveillance program AmerGen has committed to implement.

The regulatory commitments contained in this letter are provided in Attachment 3.

AmerGen has reviewed the information supporting a finding of no significant hazards consideration that was previously provided to the NRC in Reference 5. The supplemental information provided in this submittal does not affect the bases for concluding that the proposed license amendment does not involve a significant hazards consideration.

If you have any questions concerning this letter, please contact Mr. Timothy A. Byam at (630) 657-2804.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 24th day of October 2005.

Respectfully,

Keith R. Jury

Keith R. Jury
Director – Licensing and Regulatory Affairs
AmerGen Energy Company, LLC

Attachments:
1. Heat Load and Rack Drop Analysis Results Supporting the Request for License Amendment Related to Onsite Spent Fuel Storage Expansion
2. Clinton Power Station Metamic Coupon Sampling Program Summary
3. Commitments

ATTACHMENT 1

Heat Load and Rack Drop Analysis Results Supporting the Request for License Amendment Related to Onsite Spent Fuel Storage Expansion

Heat Load Analysis:

The NRC requested additional clarification on the responses provided, in the AmerGen letter dated June 14, 2005, to questions concerning the differences in decay heat and peak pool temperatures between the current analysis and the analysis performed to support the spent fuel pool expansion project. Specifically, the questions concerned how the maximum decay heat load and peak pool temperatures could be less, following the expansion of the spent fuel pool storage capacity, than the current values.

There are two factors that account for the observed differences in decay heat and peak pool temperatures; (1) the fuel transfer rate, and (2) the decay heat calculation method. Both of these factors result in a net reduction in the maximum decay heat load, which consequently yields a reduced peak pool temperature as there has been no change in heat exchanger performance or cooling water temperature.

1. Effect of Fuel Transfer Rate

The Clinton Power Station (CPS) Updated Safety Analysis Report (USAR) analysis uses a fuel transfer rate to the spent fuel pool of six assemblies per hour for the entire core offload. Under this assumption, the entire core of 624 assemblies would be offloaded in 104 hours. Given an in-core hold time of 24 hours prior to removing the first fuel assembly, the core offload would be completed 128 hours after reactor shutdown. This is the point in time where the maximum decay heat load of 46.2 MBtu/hr occurs.

Because of the configuration of the CPS fuel storage pools, it is not physically possible to achieve a transfer rate of six assemblies per hour for more than 160 assemblies. The upper containment pool has a capacity of 160 fuel assemblies and, once it is filled, fuel assemblies must be transferred to the Fuel Building using the inclined fuel transfer system (IFTS). Transfer of fuel assemblies from the upper containment pool to the Fuel Building is limited to approximately four assemblies per hour using the IFTS. Thus, after the first 160 assemblies are transferred, the rate must slow to four assemblies per hour.

In recent refueling outages, fuel handlers have approached a transfer rate of six assemblies per hour for the first 160 assemblies. For conservatism, it was considered prudent to increase the assumed transfer rate to seven assemblies per hour for the new analyses supporting the license amendment request for the new racks. At the same time, it was recognized that assuming seven assemblies per hour for the entire offload was overly conservative. It was decided to assume a transfer rate of seven assemblies per hour for the first 160 assemblies and then four assemblies per hour for the remaining assemblies. This bounds the physical capabilities of the actual plant equipment. Using this revised assumption, the entire core of 624 assemblies would be completely offloaded in approximately 138.8 hours. Compared to the analysis reflected in the current USAR, the occurrence of the maximum decay heat load is delayed by about 34.8 hours.

The effect of this delay can be estimated from the analysis for the new racks. At 128 hours after shutdown, the time where the current USAR analysis gave the maximum decay heat load, a single fuel assembly has a heat generation rate of 62,288 Btu/hr. At 162.8 hours after shutdown, the time where the new analysis gives the maximum decay heat load, a single fuel assembly has a heat generation rate of 56,189 Btu/hr. This represents a reduction of 9.8%, or on the order of 3.8 MBtu/hr for all 624 assemblies in the full core, attributable to the change in the transfer rate.

2. <u>Effect of Decay Heat Calculation Method</u>

The USAR analysis used ANSI/ANS 5.1, "Decay Heat Power in Light Water Reactors," with an additional two standard deviations (2σ) added to bound measurement uncertainties. Without the addition of the extra 2σ, ANSI/ANS 5.1 would be expected to yield results similar to NRC Auxiliary Systems Branch (ASB) Technical Position 9-2 (ASB 9-2), "Residual Decay Energy for Light-Water Reactors for Long-Term Cooling."

The expected agreement between ANSI/ANS 5.1 and ASB 9-2 is significant, as Holtec has performed a comparison between ASB 9-2 and computer code ORIGEN2 that was used to evaluate the CPS spent fuel storage expansion decay heat. This comparison of ASB 9-2 and ORIGEN2 was performed in 1995 for fuel from Millstone Unit 1, a BWR plant, so it is expected to be similar to the CPS fuel and operating conditions. The attached figure shows the comparison, which was performed for cooling times between 2 and 20 years. For cooling times on the order of years, ASB 9-2 significantly overestimates decay heat rates relative to ORIGEN2. This helps limit the increase in the background decay heat (i.e., from previously discharged fuel assemblies) that results from the increase in the number of stored fuel assemblies.

If qualitative extrapolation is applied at 2 and 20 years of cooling, the decay heats from ORIGEN2 are on the order of 14% and 20% lower, respectively, than those from ASB 9-2. While the reduction in the decay heat difference certainly does not change linearly with cooling time, we can estimate that a reduction at very low cooling times on the order of 4% to 5% is not unrealistic. As noted above, since the fuel transfer rate change accounts for approximately 3.8 MBtu/hr of the observed decay heat difference, the remainder (about 2.4 MBtu/hr) is due to the decay heat calculation methodology. This represents a reduction in decay heat of approximately 5%.

3. <u>Time to Boil and Boil-off Rate</u>

There are also two factors that account for the observed differences in time to boil and boil off rate; (1) pool decay heat load, and (2) thermal inertia of the pool. The boil off rate is a function of a single parameter, pool decay heat. Once the pool temperature reaches 212°F, water is converted into vapor at the following rate.

$$m = \frac{Q}{h_{fg}}$$

where: m is the boil off rate,
Q is the pool decay heat load, and
h_{fg} is the heat of vaporization of water.

The reduced pool decay heat, as discussed above, reduces the boil off rate.

The time to boil is a function of both of these factors. These two factors have a linear effect (i.e., a 10% change in the factor would change the time to boil by 10%). The reduction in decay heat load would tend to increase the time to boil, but this is offset in the new analysis by the use of a more conservative lowerbound thermal capacity that credits only a portion of the water in the fuel pool and takes no credit for the thermal inertia of the fuel, racks or liner.

Heat Load and Rack Drop Analysis Results Supporting the Request for License Amendment Related to Onsite Spent Fuel Storage Expansion

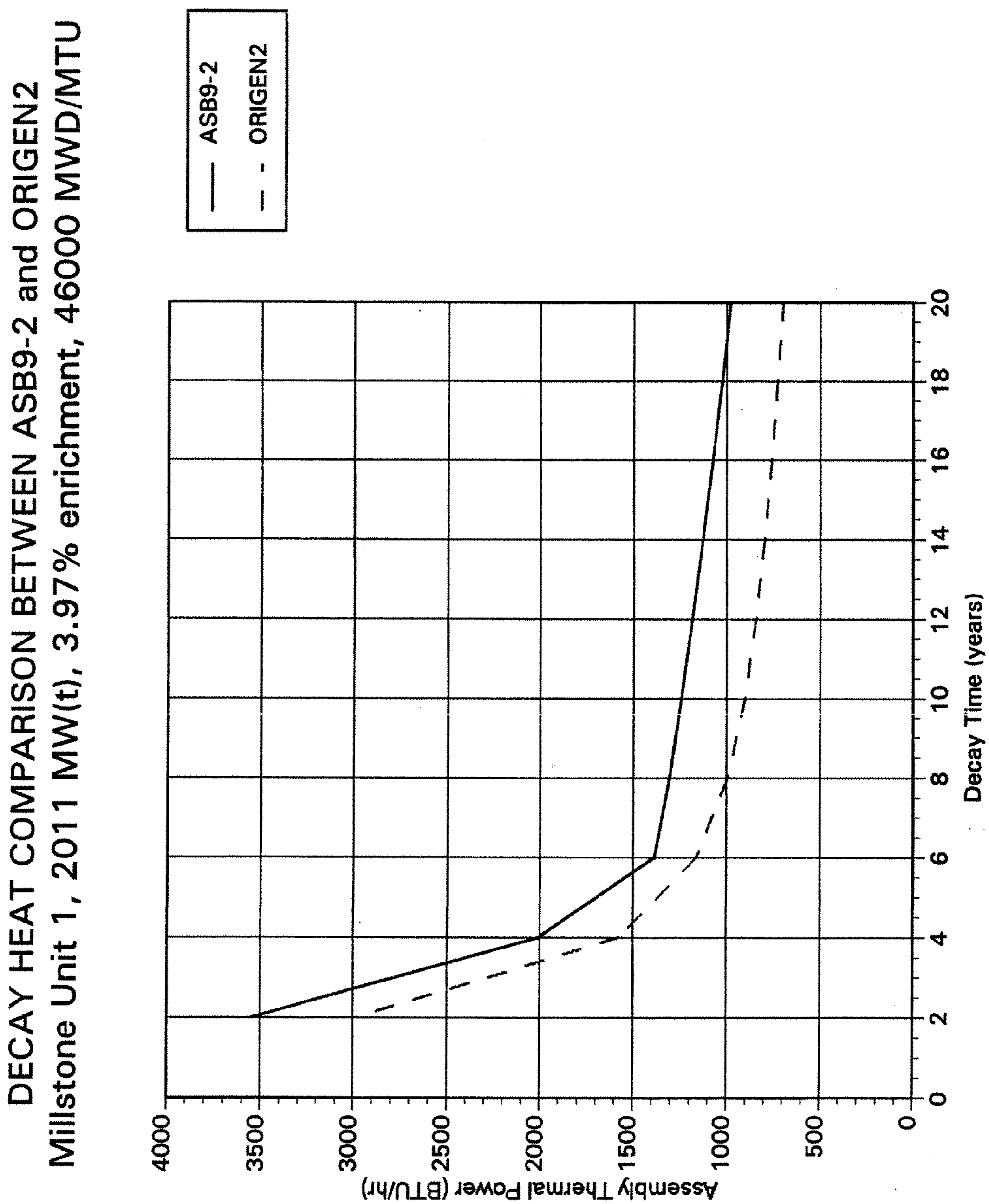

FIGURE WS-1011

Heat Load and Rack Drop Analysis Results Supporting the Request for License Amendment Related to Onsite Spent Fuel Storage Expansion

Rack Drop Analysis:

The new racks to be installed in the CPS spent fuel pool and cask storage pool will be handled by a temporary crane that is not single failure proof. To meet the regulatory requirements for the CPS rerack project, a calculation was performed to analyze a rack drop event postulated to occur during the rack installation process. The rack drop analysis was performed in accordance with the guidelines in the "OT Position for Review and Acceptance of Spent Fuel Storage and Handling Applications," dated April 1978 with an addendum dated 1979.

The finite element method was used to carry out the impact analysis for the postulated rack drop accident. LS-DYNA, a commercial computer code developed by the Livermore Software Technology Corporation and independently validated by Holtec, was used to numerically simulate the impact event. The analysis methodology has been applied to drop analyses for numerous rerack projects licensed by the NRC.

The rack was assumed to drop in a vertical orientation and remain vertical until impact. This vertical orientation is consistent with the rack lifting orientation and is conservative since the impact of this drop developed the greatest kinetic energy and thus the greatest potential damage to the pool structure. The center of gravity of the rack in this configuration falls farther than other possible (i.e., tilted) orientations and initial impact of the four pedestals provides a very small impact area. The rack was assumed to drop from a height of 4 feet above the surface of the pool water and the total weight assumed for the analysis included the weight of the rack and rack lifting tools.

The LS-DYNA model used for the rack drop analysis was developed with some conservative simplifications. The flexible rack cells, which would otherwise absorb a significant amount of impact energy in a rack drop event, are not explicitly modeled in the analysis. To maximize the potential damage to the liner, the pedestal/liner impact interface was assumed to be directly above the intersection of two perpendicular leak chases with minimum support from the concrete. In addition, only the top 6 feet of concrete was considered in the slab model with fixed bottom surface. The actual slab is more than 9 feet thick and supported on grade.

The rack drop analysis indicates that after initial impact with the floor of the spent fuel pool the rack starts to bounce back and the maximum impact force was determined to be approximately 4.1×10^5 pounds-force. It is evident from the analysis that the pedestal experiences local damage due to the uneven support provided by the underlying concrete at the leak chase intersection. Although the analysis indicated that the liner was dented, its structural integrity was maintained in the postulated drop event with the maximum plastic strain below the failure limit of the material. Therefore, the postulated rack drop event will not result in the loss of pool water. Finally, the concrete slab underneath the liner will experience some local damage. Cracks will develop on the slab surface with the maximum vertical deformation of the concrete surface expected to be approximately 1.47 inches. In conclusion, the postulated rack drop event over the CPS pools will not result in unacceptable consequences.

Clinton Power Station
Metamic Coupon Sampling Program Summary

Metamic is a metal matrix composite (MMC) consisting of a matrix of 6061 aluminum alloy reinforced with Type 1 ASTM C-750 boron carbide. Metamic is characterized by extremely fine aluminum (325 mesh or better) and B_4C powder. The high performance and reliability of Metamic derives from the small B_4C particle size and the uniformity of its distribution. The aluminum and boron carbide powders are mixed and solidified into a metal matrix composite structure by the powder metallurgy process. The powder blending process uses no binders or other additives that could adversely influence Metamic's performance. This approach yields excellent homogeneity and a porosity-free material. After blending, the powders are isostatically compacted into a green billet under high pressure and are vacuum sintered to near theoretical density. The resulting billet is extruded and subjected to cleaning by glass-beading. This cleaning process removes the very small steel particles that could otherwise become sites promoting pitting. Subsequently, the cleaned billet is processed through multiple rolling operations to produce sheet stock of the required thickness and thickness tolerance.

Fabrication qualification and acceptance testing will provide a value for the B-10 areal density for each Metamic panel and any coupon taken from the panel material. The areal density will be provided by the manufacturer as a guaranteed minimum value or a given value with a confidence range. AmerGen will review the fabrication qualification and acceptance test data to determine whether the value provided is acceptable for pre-characterization. If this value is determined not to be acceptable, AmerGen may decide to perform attenuation testing of a baseline coupon prior to installation in the CPS spent fuel pool.

Historically, Boraflex coupons have exhibited degradation and Boral coupons have exhibited blisters and swelling. All of these neutron absorbing material coupon events were identified by changes in physical property. Subsequent neutron attenuation testing was performed to determine if the neutron absorption capability of the coupon had been diminished. Based on this historical perspective and the composition of Metamic, a change in physical property (i.e., length, width, thickness, or mass) of the Metamic coupon would be coincident with and provide an indication of a potential change in neutron absorption capability.

The purpose of the Metamic coupon sampling program is to characterize certain physical and chemical properties of the Metamic sample coupon from the Clinton Power Station (CPS) spent fuel storage pool. The primary objective is to provide data necessary to confirm the capability of the poison material in the racks to continue to perform its intended function.

The coupon samples will contain 25% boron carbide, which is consistent with the boron carbide content used in the new CPS spent fuel storage racks. Each coupon is nominally 8 inches long, 4 inches wide, and 0.075 inches thick. Each coupon will be enclosed in a stainless steel jacket that is representative of the sheathing used on the Metamic in the spent fuel storage racks and then mounted on the coupon tree. The coupon tree holds 10 coupons.

Clinton Power Station
Metamic Coupon Sampling Program Summary

The CPS Metamic coupon sampling program will be implemented as part of the station preventive maintenance program. The coupon tree will be placed in the spent fuel pool at a location that will ensure a representative gamma dose to the coupons. The program will require a coupon to be removed from the spent fuel pool for testing after 2, 4, 8, 12, 20, 28, and 36 years. If no failures of test acceptance criteria are identified after the first 5 coupons are pulled and tested, the test intervals may be evaluated for possible extension. After testing, coupons will be returned to the coupon tree to support long term testing as required. If additional testing is required after the original 10 samples have been tested once, sample testing will begin again with the first sample withdrawn.

The coupon sampling program is intended to monitor the change in physical properties of the absorber material. Prior to initial installation in the spent fuel pool environment, each coupon is pre-characterized. The physical characteristics presented below are documented for each coupon and included in the documentation package for the coupon tree. The coupons, when initially measured, are in a post-manufactured state and have not been irradiated or exposed to a spent fuel pool environment. These measurements define the baseline for the coupons.

Upon removal from the spent fuel pool in accordance with the sampling program, the measurements to be performed include the following.

- Visual observation and photography
  - Observe for visual indications such as bubbling, blistering, cracking, or flaking
  - Photograph both sides of exposed coupon to document coupon condition
- Dimensional measurements
  - Length
  - Width
  - Thickness
- Weight

The results from the above measurements and physical observations will be recorded and evaluated for any physical or visual change relative to the pre-characterized data. In the event there is a physical (i.e., measurement) or visual change outside of the following allowable tolerances, then the program will dictate that neutron attenuation testing be performed on the coupon to confirm neutron attenuation capabilities:

Length & Width: +/-0.125 inches
Thickness: +/-0.07 inches
Mass: +/- 5%

In addition to the above measurements and observations of the coupon physical characteristics, a neutron attenuation test will be performed on a coupon sample after 4, 12 and 20 years to confirm neutron attenuation capabilities of the Metamic material. This testing will be performed regardless of whether the physical measurements taken at these intervals are within the allowable tolerances or not.

ATTACHMENT 2

Clinton Power Station
Metamic Coupon Sampling Program Summary

This sampling program will regularly monitor the Metamic coupons' critical parameters, which have historically indicated degradation in other neutron absorbing materials. Coupon changes outside of the prescribed physical acceptance criteria will result in additional testing activities that will directly assess the neutron attenuation capabilities of the Metamic compound. In addition, periodic testing of the neutron attenuation capabilities of the coupon material will provide a correlation between the neutron absorption capabilities and the physical characteristics of the coupons. AmerGen has concluded that this sampling program provides an efficient and effective means to monitor the condition of the Metamic compound and to detect any potential degradation that could lead to a potential change in neutron absorption capability.

ATTACHMENT 3

Commitments

LIST OF COMMITMENTS

The following table identifies those actions committed to by AmerGen Energy Company, LLC (AmerGen), in this document. Any other statements in this submittal are provided for information purposes and are not considered commitments.

COMMITMENT	Due Date/Event
(1) Incorporate into the Clinton Power Station Preventive Maintenance Program a Metamic Coupon Sampling Program. This sampling program will include periodic physical measurements, visual observations and neutron absorption measurements at a frequency defined in Attachment 2 to this letter.	Prior to installing coupon sample tree in spent fuel pool