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Your ref: Docket No. 52-006
Our ref: DCP/NRC2442

April 21, 2009

Subject: AP1000 Response to Request for Additional Information (SRP 9)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on SRP Section 9. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in this response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

Enclosure 1 provides the response for the following RAI(s):

RAI-SRP9.1.2-CIB1-01 R3

Questions or requests for additional information related to the content and preparation of this response should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

A handwritten signature in black ink, appearing to read 'Robert Sisk'.

Robert Sisk, Manager
Licensing and Customer Interface
Regulatory Affairs and Standardization

/Enclosure

1. Response to Request for Additional Information on SRP Section 9

cc: D. Jaffe - U.S. NRC 1E
E. McKenna - U.S. NRC 1E
P. Buckberg - U.S. NRC 1E
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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 9

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Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.1.2-CIB1-01
Revision: 3

Question:

In a letter dated June 30, 2006, Westinghouse submitted APP-GW-GLR-029, Rev. 0, "Spent Fuel Storage Rack Criticality Analysis," Technical Report Number 65 (TR 65) (Reference 1). In order to ensure compliance with General Design Criterion 4, NUREG-0800, the NRC staff reviewed TR 65 using the guidelines in SRP 9.1.2 to verify that the materials wetted in the spent fuel pool, (e.g., spent fuel racks, fixed neutron poison, and the spent fuel pool liner) and, if applicable, the new fuel vault are chemically compatible and stable. The staff also verified whether there are potential mechanisms to alter the dispersion of any strong fixed neutron absorbers

The AP1000 DCD, Rev. 16, Section 9.1.2.3, states that the neutron absorbing poison material used in the rack design has been qualified for the storage environment. DCD Section 9.1.6.4 references TR 65 as fulfilling a combined license applicant information item that required a confirmatory criticality analysis for the spent fuel racks, as described in subsection 9.1.2.3. The analysis was also required to address the degradation of integral neutron absorbing material in the spent fuel pool storage racks as identified in GL-96-04, and assess the integral neutron absorbing material capability to maintain a 5-percent subcriticality margin. However, the neutron absorbing material is not specifically identified or described in the DCD, nor is the testing to qualify the material for the environment described in the DCD.

The staff has reviewed the information included in TR 65. TR 65 identifies the neutron absorber material in the spent fuel storage racks as Metamic, a metal matrix composite material consisting of a Type 6061 aluminum (Al 6061) alloy matrix reinforced with boron carbide (B_4C). TR 65 Section 2.4.8 describes testing to qualify the Metamic material for spent fuel rack service, including short and long-term elevated temperature tests, accelerated corrosion and radiation tests, mechanical properties and neutron transmission testing. The staff has previously issued a Safety Evaluation Report (SER) approving a topical report supporting the use of the Metamic material in spent fuel racks in an operating plant (Reference 2). The operating plant subsequently submitted a license amendment request to use the Metamic material in the spent fuel pool (Reference 3) that was approved via a SER issued by the NRC staff (References 4, 5). The staff notes that the same generic vendor report supporting the application to use Metamic in the operating plant is referenced in TR 65. The SER for the license amendment at the operating plant (Reference 4) placed conditions on the use of the Metamic material; specifically, implementation of a coupon sampling program to ensure consistent performance with the laboratory qualification testing.

The Metamic absorber material is relied upon in the TR 65 criticality analysis to maintain the required 5% subcriticality margin. While TR 65 Section 2.4.8 indicates that no significant loss of neutron absorbing capacity is expected for the Metamic material based on the testing conducted, the Metamic material is a new material with very little operating experience in the

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spent fuel pool environment. Spent fuel racks with Metamic have been installed at the operating plant but the time in service for these racks as of March 2008 has been only a few months, and no coupons have been withdrawn or tested yet. TR 65 and the DCD contain no mention of the coupon surveillance program implemented by the operating plant, nor do they recommend a similar program for the AP1000 plants.

Although the data from the operating plant surveillance program could be used to confirm the laboratory test results and could be extrapolated to the Metamic in the AP1000, a relatively small amount of data from the operating plant will be available when construction begins for the first AP1000 plants. Further, the service conditions for the Metamic material in the operating plant may not be identical to the expected service conditions for the Metamic material in the AP1000 design. Additionally, some qualification tests such as the radiation testing only encompassed a 40-year rather than a 60-year life. Therefore, the staff finds that a coupon sampling plan similar to that implemented in the operating plant should be implemented for the AP1000 plants.

The staff requests that the applicant provide the following information, and include the information in the next revision to the AP1000 DCD:

- 1) A description of the neutron absorbing material to be used in the spent fuel storage racks. The description should include the material type, chemical composition, mechanical properties, and a discussion of the suitability of the absorber material for long-term use in the spent fuel pool environment. Include a description of any testing performed to qualify the material for 60 years service in the spent fuel pool environment, specifically with respect to corrosion and radiation degradation. The description should also address whether the absorber material has an anodized finish, the anodizing process used, and the cleaning process to ensure removal of surface contaminants prior to installation.
- 2) A description of the recommended program to be implemented by the licensee to confirm that the behavior of the neutron absorbing material is consistent with the behavior of the material in the qualification tests. For example, the DCD may need to identify a COL item requiring the COL applicant to include a description in the COL application of the coupon sampling or monitoring program for the licensee to implement when the plant is placed into commercial operation.

Supplemental RAI (Revision 1) received 4/28/08:

By an e-mail dated March 12, 2008, the staff transmitted RAI-SRP 9.1.2-CIB-01 related to the AP1000 Design Certification Amendment Application (Docket No. 52-006) to Westinghouse Electric Co.: The staff requested that the applicant provide the following information, and include the information in the next revision to the AP1000 DCD:

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1. A description of the neutron absorbing material to be used in the spent fuel storage racks. The description should include the material type, chemical composition, and mechanical properties, and a discussion of the suitability of the absorber material for long-term use in the spent fuel pool environment.
2. Include a description of any testing performed to qualify the material for 60 years service in the spent fuel pool environment, specifically with respect to corrosion and radiation degradation. The description should also address whether the absorber material has an anodized finish, the anodizing process used, and the cleaning process to ensure removal of surface contaminants prior to installation.

A description of the recommended program to be implemented by the licensee to confirm that the behavior of the neutron absorbing material is consistent with the behavior of the material in the qualification tests. For example, the DCD may need to identify a COL item requiring the COL applicant to include a description in the COL application of the coupon sampling or monitoring program for the licensee to implement when the plant is placed into commercial operation.

The applicant responded by letter dated April 18, 2008 (Ref. 1). As requested in Question 1 of RAI-SRP 9.1.2-CIB1-01, the applicant's response adequately described the material type, chemical composition, and mechanical properties, and described the qualification testing that forms the basis for the applicant's conclusion that the Metamic material is suitable for service in the spent fuel pool environment for 60 years. The applicant's response indicated that surface contaminants would be cleaned from the surface using a glass beading process, and that the material would not be anodized. In response to Question 2 of RAI-SRP 9.1.2-CIB1-01, the applicant also proposed to include a COL Information Item requiring the COL applicant to include a description of the plant-specific Metamic Monitoring Program to be implemented. The applicant's response included recommended tests and acceptance criteria to be included in the plant-specific program, specifically neutron attenuation measurements (to verify the continued presence of boron), with acceptance criterion of a decrease of no more than 5% in Boron-10 content, as determined by neutron attenuation; and 2) Thickness measurement (as a monitor of potential swelling); with an acceptance criterion of an increase of thickness at any point not to exceed 10% of the initial thickness at that point. While the staff finds the proposed tests and acceptance criteria acceptable, additional tests may be necessary to ensure the neutron absorbing capability of the material is maintained for the life of the plant. In particular, the corrosion testing referenced as the basis for material qualification was conducted for a relatively short duration. Although these tests showed essentially no corrosion, the staff feels that the surveillance program should also monitor for corrosion to confirm the laboratory results. Also, the applicant proposed only thickness measurements to monitor for swelling. Thickness measurements alone would not measure swelling in the length or width direction.

Metamic has been previously approved by the staff for use in the spent fuel pool of an operating reactor. The staff's safety evaluation report related to a topical report supporting the use of Metamic in SFP applications (Reference 2) placed conditions upon the use of the material;

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specifically, that a coupon surveillance program be implemented. The coupon surveillance program was to include the following attributes:

- size and types of coupons to be used (i.e., similar in fabrication and layout as the proposed insert including welds and proximity to stainless steel);
- technique for measuring the initial B₄C content of the coupons;
- simulation of scratches on the coupons;
- frequency of coupon sampling and its justification; and tests to be performed on coupons (e.g., weight measurement, measurement of dimensions (length, width and thickness), and B₄C content); these tests should also address, as a minimum, any bubbling, blistering, cracking, flaking, or areal density changes of the coupons, any dose changes to the coupons, or the effects of any fluid movement and temperature fluctuations of the pool water.
- In the staff's safety evaluation report related to the License Amendment Request to use Metamic in the operating plant (Reference 3), the staff approved the licensee's coupon surveillance program which included visual examination and photography, measurement of weight and density, and measurement of the length and width dimensions in addition to thickness. The visual examination and photography and weight measurements provide the means to monitor for corrosion of the Metamic test coupons.

In the response to RAI-SRP 9.1.2 CIB1-01, the applicant described the mounting and location of the coupons in the spent fuel pool, but did not provide the size. The applicant indicated that the coupons would be precharacterized for weight, dimensions (especially thickness) and 10B loading, but did not provide the technique for measuring the initial B₄C content, a recommended schedule for withdrawal and testing of the coupons, whether coupons would include scratches, or recommended tests to address bubbling, blistering, cracking, flaking, or areal density changes of the coupons, any dose changes to the coupons, or the effects of any fluid movement and temperature fluctuations of the pool water.

Supplemental RAI (Revision 2) received 7/11/08:

Provide a recommendation to the COL applicant for the following aspects of the Metamic coupon surveillance program, and include the same information in the next revision to the DCD:

1. Recommended coupon withdrawal schedule
2. Size and types of coupons to be used (i.e., similar in fabrication and layout as the proposed insert including welds and proximity to stainless steel);
3. Technique for measuring the initial B₄C content of the coupons;
4. Whether the coupons should include simulated scratches, or explain why simulated scratches are unnecessary.
5. Tests to monitor bubbling, blistering, cracking, or flaking.
6. Test to monitor for corrosion, such as weight loss measurements and/or visual examination.

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If any of these items are not recommended, provide a justification for excluding the item from the recommended program.

Supplemental RAI (Revision 3) received 3/18/09:

In DCD Section 9.1.6.7, add the following sentence after the sentence beginning "This program will include tests to monitor bubbling, blistering...".

"The program will also include tests to monitor changes in physical properties of the absorber material, including neutron attenuation and thickness measurements."

References:

1. Letter from Robert Sisk, (Westinghouse) to USNRC dated April 18, 2008, Subject: AP1000 COL Response to Request of Additional Information (SRP 9.1.2)
2. Safety Evaluation By The Office Of Nuclear Reactor Regulation Related To Holtec International Report HI-2022871 Regarding Use Of Metamic® In Fuel Pool Applications Facility Operating License Nos. DPR-51 And NPF-6 Entergy Operations, Inc. Arkansas Nuclear One, Unit Nos. 1 And 2 Docket Nos. 50-313 And 50-368; Transmitted Via Letter From Thomas W. Alexion To Mr. Craig T. Anderson (ANO) Dated June 17, 2003, Subject: Arkansas Nuclear One, Units 1 And 2 - Review Of Holtec Report Re: Use Of Metamic® In Fuel Pool Applications (TAC Nos. MB5862 And MB5863)
3. Safety Evaluation By The Office Of Nuclear Reactor Regulation Related To Amendment No. 228 To Renewed Facility Operating License No. DPR-51 Entergy Operations, Inc., Arkansas Nuclear One, Unit No. 1, Docket No. 50-313; Transmitted Via Letter From Farideh E. Saba To Mr. Jeffrey S. Forbes (ANO) Dated January 26, 2007; Subject: Arkansas Nuclear One, Unit No. 1 - Issuance Of Amendment For Use Of Metamic® Poison Insert Assemblies In The Spent Fuel Pool (TAC No. MD2674)

Westinghouse Response:

1) The material that will be used in the AP1000 fuel storage racks is Metamic ®, a metal matrix composite material consisting of a Type 6061 aluminum alloy matrix reinforced with boron carbide (B₄C), as described in TR65. The Metamic will be in the form of sheets having a nominal thickness of 0.106 inches and a minimum ¹⁰B areal density of 0.0304 gm/cm² (minimum 30.5 wt% B₄C). The panels are not intended to be anodized, but will be cleaned via glass bead blasting and washing with demineralized water to ensure removal of surface contamination prior to installation.

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No credit is taken for Metamic in any structural analysis and the Metamic panels are completely encased in (and supported by) stainless steel panels, so the mechanical properties of the Metamic do not affect the performance of the panels. Nevertheless, mechanical properties (obtained from Reference 1) are summarized herein as follows:

| Property | Value |
|-------------------|--------------------------|
| Density | 2.646 gm/cm ³ |
| Yield Strength | 33000 psi |
| Ultimate Strength | 40000 psi |
| Elongation | 1.8% |

With the exception of density, which is given at 30 wt% B₄C, the properties in this table are all specified for 31 wt% B₄C. Metamic has been evaluated by the NRC for use in spent fuel pool applications (Reference 2).

The Metamic panels in the spent fuel storage racks are potentially affected by the pool's temperature, aqueous environment and radiation field. The effects of each of these parameters are discussed separately in the following paragraphs.

The pool's temperature will exceed the ambient temperature as a result of the stored fuel heat, but will typically be maintained at or below 120°F. Elevated temperature testing of 31 wt% B₄C Metamic was performed at 750°F in air for nearly a year (Reference 1), with no reduction in thickness, no change in weight, no reduction on ¹⁰B content and no change in density. The complete lack of any dimensional or chemical changes in these elevated rate tests is sufficient to show that temperatures up to 120°F, even for 60 years or more, will not detrimentally affect the condition of the Metamic panels.

The aqueous environment of the spent fuel pool with a nominal dissolved Boron concentration of 2,700 ppm (Reference 3, AP1000 DCD, Rev. 16, Subsection 9.1.2.2) will be slightly acidic. Elevated temperature (200°F) corrosion rate testing of 32 wt% B₄C Metamic (Reference 1) for 90 days indicated that "no corrosion was observed" and there was "no significant change in ¹⁰B areal density." While these tests were carried out at a temperature only 80°F higher than the typical upper bound, this is sufficient to yield results representative of longer periods. These observations are supported DOE Fundamentals Handbook DOE-HDBK-1015/1-93, Module 2 – Corrosion) Reference 4, which states:

"A temperature rise in the range of 20°F to 50°F doubles the corrosion rate until the formation of the protective oxide film is complete."

The aluminum oxide layer that forms on the Metamic is largely inert, so once the protective oxide film forms the corrosion rate becomes approximately zero. In addition, the DOE Handbook addresses the effects of pH on corrosion rate. In particular, Figure 9 of this document shows that the penetration of corrosion into the aluminum is zero for a pH around 5.5 and nearly zero

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throughout the pH range from 4 to 8. The normal pH of the AP1000 spent fuel pool is within this range. The complete lack of any chemical changes in the tests, combined with the knowledge of the effects of temperature and pH on corrosion rate, is sufficient to show that the aqueous pool environment, even for 60 years or more, will not detrimentally affect the condition of the Metamic panels.

The effects, if any, of the radiation field on the Metamic is of interest because of the history of prior art absorber materials (i.e., Boraflex) that are severely damaged by radiation. Samples of 31 wt% B₄C Metamic were subjected to a radiation field with both gamma (1.5×10^{11} rads) and fast neutron (1.7×10^{18} nvt to 5.8×10^{19} nvt) components (Reference 1). Conclusions of post-irradiation testing were as follows:

“Metamic exhibits excellent dimensional stability after irradiation.”

“There was no change in Boron-10 areal density.”

The complete lack of any dimensional or chemical changes as a result of these high radiation exposures is sufficient to show that the expected radiation field in the pool, even for 60 years or more, will not detrimentally affect the condition of the Metamic panels.

The above material has been summarized and placed in the DCD revision section below.

An in-situ surveillance program to monitor the condition of the Metamic in the racks will be implemented for the AP1000 spent fuel storage racks. This program uses representative material coupons, and is patterned after similar programs used for years at operating plants. The specific Metamic monitoring program will be developed by the COL Applicant.

The coupon measurement program includes coupons suspended on a mounting (called a "tree"), placed in a designated cell, and surrounded by spent fuel. Coupons are removed from the array on a prescribed schedule and certain physical and chemical properties measured from which the stability and integrity of the Metamic in the storage cells may be inferred over the 60 year design life of the spent fuel racks.

The coupons are taken from the same lots of material as that used for construction of the racks. Each coupon is carefully precharacterized prior to insertion in the pool to provide reference initial values for comparison with measurements made after irradiation. As a minimum, the surveillance coupons are precharacterized for weight, dimensions (especially thickness) and ¹⁰B loading.

Evaluation of the coupons removed will provide information of the effects of the radiation, thermal and chemical environment of the pool and by inference, comparable information on the Metamic panels in the racks. Over the duration of the coupon testing program, the coupons will have accumulated more radiation dose than the expected lifetime dose for normal storage cells.

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The coupon measurement program is intended to monitor changes in physical properties of the Metamic absorber material. Of the measurements to be performed on the Metamic surveillance coupons, the most important are (1) the neutron attenuation¹ measurements (to verify the continued presence of the boron) and (2) the thickness measurement (as a monitor of potential swelling). Acceptance criteria for these measurements are as follows:

- A decrease of no more than 5% in Boron-10 content, as determined by neutron attenuation, is acceptable. (This is tantamount to a requirement for no loss in boron within the accuracy of the measurement.)
- An increase in thickness at any point should not exceed 10% of the initial thickness at that point.

Changes in excess of either of these two criteria requires investigation and engineering evaluation which may include early retrieval and measurement of one or more of the remaining coupons to provide corroborative evidence that the indicated change(s) is real. If the deviation is determined to be real, an engineering evaluation shall be performed to identify further testing or any corrective action that may be necessary.

A future revision of the DCD will require the COL holder to implement a spent fuel rack Metamic coupon sampling or monitoring program when the plant is placed into commercial operation. Refer to DCD Revision below.

Response to Supplemental RAI (Revision 1):

Westinghouse and the COL Applicants together are providing a Metamic coupon surveillance program. Westinghouse is responsible for the design aspects of the Metamic coupon surveillance program and the COL Applicants are responsible for the programmatic aspects.

The following items should be included in the site surveillance program:

- Recommended coupon withdrawal schedule-Westinghouse
- Size and types of coupons to be used (i.e., similar in fabrication and layout as the proposed insert including welds and proximity to stainless steel)- Westinghouse
- Technique for measuring the initial B₄C content of the coupons-Westinghouse
- Whether the coupons should include simulated scratches, or explain why simulated scratches are unnecessary-Westinghouse
- Tests to monitor bubbling, blistering, cracking, or flaking-COL Applicants
- Test to monitor for corrosion, such as weight loss measurements and/or visual examination-COL Applicants

¹ Neutron attenuation measurements are a precise instrumental method of chemical analysis for Boron-10 content using a nondestructive technique in which the percentage of thermal neutrons transmitted through the panel is measured and compared with predetermined calibration data. Boron-10 is the nuclide of principal interest since it is the isotope responsible for neutron absorption in the Metamic panel.

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This information will be described in the COL Holder's Metamic coupon surveillance program. We have worked with Holtec to design the Metamic Coupon Tree. It requires eight coupons for 60 years of surveillance. Based on this, Westinghouse has specified a coupon tree with 14 coupons (six additional coupons).

Reference(s):

1. "Source Book for Metamic Performance Assessment," Holtec Report HI-2043215, Revision 2, Holtec International, September 2006.
2. Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Holtec International Report HI-2022871 Regarding the Use of Metamic ® in Fuel Pool Applications Facility Operating License NOS DPR-51 and NPF-6 Entergy Operations, Inc Arkansas Nuclear One, Unit NOS 1 and 2 Docket Nos. 50-313 and 50-368, United States Nuclear Regulatory Commission, June 17, 2003.
3. APP-GW-GL-700, Revision 16" AP1000 Design Control Document", Westinghouse Electric Company LLC, May 2007.
4. "DOE Fundamentals Handbook – Chemistry," DOE-HDBK-1015/1-93, U.S. Department of Energy, January 1993.

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Design Control Document (DCD) Revision (Cumulative changes for all RAI responses):

Change Table 1.8-2, "Summary of AP1000 Standard Plant Combined License Information Items," Sheet 7 of 13 to include Item No. 9.1-7 as shown below.

| Table 1.8-2 (Sheet 7 of 13) | | | | | |
|--|--|------------|------------------------------------|----------------------------------|-------------------------------|
| SUMMARY OF AP1000 STANDARD PLANT COMBINED LICENSE INFORMATION ITEMS | | | | | |
| Item No. | Subject | Subsection | Addressed by Westinghouse Document | Action Required by COL Applicant | Action Required by COL Holder |
| 9.1-2 | Criticality Analysis for New Fuel Rack | 9.1.6.2 | APP-GW-GLR-030 | No | No |
| 9.1-3 | Spent Fuel Racks | 9.1.6.3 | APP-GW-GLR-033 APP-GW-GLR-045 | No | No |
| 9.1-4 | Criticality Analysis for Spent Fuel Racks | 9.1.6.4 | APP-GW-GLR-029 | No | No |
| 9.1-5 | Inservice Inspection Program of Cranes | 9.1.6.5 | N/A | Yes | - |
| 9.1-6 | Radiation Monitor | 9.1.6.6 | N/A | Yes | - |
| 9.1.7 | Metamic Monitoring Program | 9.1.6.7 | N/A | Yes | Yes |
| 9.2-1 | Potable Water | 9.2.11.1 | N/A | Yes | - |
| 9.2-2 | Waste Water Retention Basins | 9.2.11.2 | N/A | Yes | - |
| 9.3-1 | Air Systems (NUREG-0933 Issue 43) | 9.3.7 | N/A | Yes | - |
| 9.4-1 | Ventilation Systems Operations | 9.4.12 | N/A | Yes | - |
| 9.5-1 | Qualification Requirements for Fire Protection Program | 9.5.1.8.1 | N/A | Yes | - |
| 9.5-2 | Fire Protection Analysis Information | 9.5.1.8.2 | N/A | Yes | - |

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| | | | | | |
|-------|--|-----------|----------------|-----|-----|
| 9.5-3 | Regulatory Conformance | 9.5.1.8.3 | N/A | Yes | – |
| 9.5-4 | NFPA Exceptions | 9.5.1.8.4 | N/A | Yes | – |
| 9.5-5 | Operator Actions Minimizing Spurious ADS Actuation | 9.5.1.8.5 | APP-GW-GLR-027 | No | No |
| 9.5-6 | Verification of Field Installed Fire Barriers | 9.5.1.8.6 | N/A | No | Yes |

Add the following paragraphs to subsection 9.1.2.2.1 Spent Fuel Rack Design (after first paragraph of A. Design and Analysis of Spent Fuel Racks)

The material used in the AP1000 fuel storage racks is Metamic ®, a metal matrix composite material consisting of a Type 6061 aluminum alloy matrix reinforced with boron carbide (B₄C). The Metamic is in the form of sheets having a nominal thickness of 0.106 inches and a minimum 10B areal density of 0.0304 gm/cm² (minimum 30.5 wt% B₄C). The panels are not anodized, but will be cleaned via glass bead blasting and washing with demineralized water to ensure removal of surface contamination prior to installation.

No credit is taken for Metamic in the rack structural analysis and the Metamic panels are completely encased in (and supported by) stainless steel panels, so the mechanical properties of the Metamic do not affect the performance of the panels. Nevertheless, mechanical properties (obtained from Reference 23) are summarized below:

| Property | Value |
|-------------------|--------------------------|
| Density | 2.646 gm/cm ³ |
| Yield Strength | 33,000 psi |
| Ultimate Strength | 40,000 psi |
| Elongation | 1.8% |

With the exception of density, which is given at 30 wt% B₄C, the properties in this table are all specified for 31 wt% B₄C. Metamic has been evaluated by the NRC for use in spent fuel pool applications (Reference 24).

The Metamic panels are suitable for long-term use in the spent fuel pool environment. The Metamic panels are potentially affected by the pool's temperature, aqueous environment and radiation field. The effects of each of these parameters are discussed separately in the following paragraphs.

The pool's temperature will exceed the ambient temperature as a result of the stored fuel heat, but will be maintained at or below 120°F. Elevated temperature testing of 31 wt% B₄C Metamic was performed at

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750°F in air for nearly a year (Reference 23), with no reduction in thickness, no change in weight, no reduction on 10B content and no change in density. The complete lack of dimensional or chemical changes in these elevated rate tests is sufficient to show that temperatures up to 120°F, even for 60 years or more, will not detrimentally affect the condition of the Metamic panels.

The aqueous environment of the pool with a nominal dissolved Boron concentration of 2,700 ppm will be slightly acidic. Elevated temperature (200°F) corrosion rate testing of 32 wt% B₄C Metamic (Reference 23) for 90 days indicated that “no corrosion was observed” and there was “no significant change in 10B areal density.” The complete lack of any chemical changes in the tests, combined with the knowledge of the effects of temperature and pH on corrosion rate, is sufficient to show that the aqueous spent fuel pool environment, even for 60 years, will not detrimentally affect the condition of the Metamic panels.

Samples of 31 wt% B₄C Metamic were subjected to a radiation field with both gamma (1.5x10¹¹ rads) and fast neutron (1.7x10¹⁸ nvt to 5.8x10¹⁹ nvt) components. Conclusions of post-irradiation testing were: Metamic exhibits excellent dimensional stability after irradiation and there was no change in Boron-10 areal density. (Reference 23) The complete lack of dimensional or chemical changes as a result of these high radiation exposures is sufficient to show that the expected radiation field in the pool, even for 60 years, will not detrimentally affect the condition of the Metamic panels.

A coupon tree with 14 coupons is provided with the spent fuel racks. Coupons are nominally 6 inches wide x 8 inches long x 0.106 inches thick. Each coupon is representative of the panel from which it is cut, including the presence of any scratches or other surface irregularities. The initial B₄C content of Metamic is determined from the amounts of B₄C and aluminum powder mixed together in the manufacturing process. If, for example, 1000 lbs of aluminum and 250 lbs of B₄C are used to manufacture one lot of material, it would be 20% B₄C. This approach has been validated by Metamic LLC, the supplier of the Metamic poison material and Holtec International, the rack designer.

The recommended Metamic monitoring schedule is:

- End of Cycle 1 - Remove First Coupon
- End of Cycle 2 - Remove Second Coupon
- End of Cycle 3 - Remove Third Coupon
- End of Cycle 5 - Remove Fourth Coupon
- End of Cycle 10 - Remove Fifth Coupon
- End of Cycle 20 - Remove Sixth Coupon
- End of Cycle 30 - Remove Seventh Coupon
- End of Cycle 40 - Remove Eighth Coupon

If the plant is operated on an 18-month cycle, eight coupons provide 60 years of Metamic surveillance. There are six additional coupons provided.

This coupon tree will be used to monitor the condition of the Metamic over the 60-year life of the spent fuel racks.

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Add a new subsection to 9.1.6 Combined License Information for Fuel Handling and Storage

9.1.6.7 Coupon Monitoring Program

The COL holder shall implement a spent fuel rack Metamic coupon monitoring program when the plant is placed into commercial operation. This program will include tests to monitor bubbling, blistering, cracking, or flaking and a test to monitor for corrosion such as weight loss measurements and or visual examination. The program will also include tests to monitor changes in physical properties of the absorber material, including neutron attenuation and thickness measurements.

Revise subsection 9.1.7 References, by adding references 23 and 24 as follows:

23. "Source Book for Metamic Performance Assessment," Holtec Report HI-2043215 Revision 2, Holtec International, September 2006.
24. Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Holtec International Report HI-2022871 Regarding the Use of Metamic ® in Fuel Pool Applications Facility Operating License NOS DPR-51 and NPF-6 Entergy Operations, Inc Arkansas Nuclear One, Unit Nos. 1 and 2 Docket Nos. 50-313

PRA Revision:

None

Technical Report (TR) Revision:

None