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U.S. Nuclear Regulatory Commission
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Your ref: Docket No. 52-006
Our ref: DCP/NRC2122

April 18, 2008

Subject: AP1000 COL Response to Request for Additional Information (SRP9.1.2)

Westinghouse is submitting a response to the NRC request for additional information (RAI) on Standard Review Plan (SRP) Section 9.1.2. This RAI response is submitted in support of the AP1000 Design Certification Amendment Application (Docket No. 52-006). The information included in the response is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification and the AP1000 Design Certification Amendment Application.

A response is provided for RAI-SRP9.1.2-CIB1-01 as sent in an email from Perry Buckberg to Sam Adams dated March 12, 2008. This response completes all requests received to date for SRP Section 9.1.2.

Pursuant to 10 CFR 50.30(b), the response to the request for additional information on SRP Section 9.1.2, is submitted as Enclosure 1 under the attached Oath of Affirmation.

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,

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

D063
NRO

/Attachment

1. "Oath of Affirmation," dated April 18, 2008

/Enclosure

1. Response to Request for Additional Information on SRP Section 9.1.2

cc:	P. Buckberg	-	U.S. NRC	1E	1A
	E. McKenna	-	U.S. NRC	1E	1A
	P. Ray	-	TVA	1E	1A
	P. Hastings	-	Duke Power	1E	1A
	R. Kitchen	-	Progress Energy	1E	1A
	A. Monroe	-	SCANA	1E	1A
	J. Wilkinson	-	Florida Power & Light	1E	1A
	C. Pierce	-	Southern Company	1E	1A
	G. Zinke	-	NuStart/Entergy	1E	1A
	R. Grumbir	-	NuStart	1E	1A
	E. Schmiech	-	Westinghouse	1E	1A
	B. Moore	-	Westinghouse	1E	1A

ATTACHMENT 1

"Oath of Affirmation"

ATTACHMENT 1

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of:)

AP1000 Design Certification Amendment Application)

NRC Docket Number 52-006)

APPLICATION FOR REVIEW OF
"AP1000 GENERAL INFORMATION"
FOR DESIGN CERTIFICATION AMENDMENT APPLICATION REVIEW

W. E. Cummins, being duly sworn, states that he is Vice President, Regulatory Affairs & Standardization, for Westinghouse Electric Company; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission this document; that all statements made and matters set forth therein are true and correct to the best of his knowledge, information and belief.

W E Cummins

W. E. Cummins
Vice President
Regulatory Affairs & Standardization

Subscribed and sworn to
before me this 18th day
of April 2008.

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Patricia S. Aston, Notary Public
Murrysville Boro, Westmoreland County
My Commission Expires July 11, 2011
Member, Pennsylvania Association of Notaries

Patricia S. Aston
Notary Public

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ENCLOSURE 1

Response to Request for Additional Information on SRP Section 9.1.2

AP1000 TECHNICAL REPORT REVIEW

Response to Request For Additional Information (RAI)

RAI Response Number: RAI-SRP9.1.2-CIB1-01
Revision: 0

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 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.

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 (B_4C), as described in TR65. The Metamic will be in the form of sheets having a nominal thickness of 0.106 inches and a minimum ^{10}B areal density of 0.0304 gm/cm^2 (minimum 30.5 wt% B_4C). 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.

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% B_4C, the properties in this table are all specified for 31 wt% B_4C. 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% B_4C 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 ^{10}B 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 ^{10}B 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 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% B_4C Metamic were subjected to a radiation field with both gamma ($1.5x10^{11}$ rads) and fast neutron ($1.7x10^{18}$ nvt to $5.8x10^{19}$ 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 ^{10}B 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. 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 attenuation[1] 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.

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.

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.

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.

Design Control Document (DCD) Revision:

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	–

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% B_4C, the properties in this table are all specified for 31 wt% B_4C. 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% B_4C Metamic was performed at 750°F in air for nearly a year (Reference 23), with no reduction in thickness, no change in weight, no reduction on ^{10}B 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 ^{10}B 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% B_4C 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. 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 will be provided with the spent fuel racks. This coupon tree will be used to monitor the condition of the Metamic over the 60-year life of the spent fuel racks.

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

9.1.6.7 Coupon Sampling or Monitoring Program
The COL holder shall implement a spent fuel rack Metamic coupon sampling or monitoring program when the plant is placed into commercial operation.

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