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Project No.: 700
Our ref: LTR-NRC-03-56
November 3, 2003

Subject: **Response to NRC Round #2 Request for Additional Information Regarding WCAP-16072-P & WCAP-16072-NP, "Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs" (Proprietary / Non-proprietary)**

References:
1. Fax, B. J. Benney (NRC) to R. Sisk (Westinghouse), "WCAP-16072 Formal RAIs," October 17, 2003.
2. WCAP-16072-P & -NP, "Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs," April 2003.
3. Letter, C. M. Molnar, Westinghouse to USNRC Document Control Desk, "Submittal of WCAP-16072-P, Revision 0, "Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs," (Proprietary/Non-proprietary), LTR-NRC-03-14, April 25, 2003.

Enclosed are copies of Westinghouse Electric Company LLC (Westinghouse) responses to the Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI), Reference 1, regarding WCAP-16072-P & -NP, "Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs," Reference 2. This topical report was submitted for NRC review and approval on April 25, 2003, Reference 3.

Also enclosed are:

1. One (1) copy of the Application for Withholding, AW-03-1730 with Proprietary Information Notice and Copyright Notice.
2. One (1) copy of Affidavit, AW-03-1730.

This submittal contains Westinghouse proprietary information of trade secrets, commercial or financial information which we consider privileged or confidential pursuant to 10 CFR 9.17(a)(4). Therefore, it is requested that the Westinghouse proprietary information attached hereto be handled on a confidential basis and be withheld from public disclosure.

This material is for your internal use only and may be used solely for the purpose for which it is submitted. It should not be otherwise used, disclosed, duplicated, or disseminated, in whole or in part, to any other person or organization outside the Office of Nuclear Reactor Regulation without the expressed prior written approval of Westinghouse.

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Correspondence with respect to any Application for Withholding should reference AW-03-1730 and should be addressed to B. F. Maurer, Acting Manager of Regulatory Compliance and Plant Licensing, Westinghouse Electric Company, P.O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

B. F. Maurer, Acting Manager
Regulatory Compliance and Plant Licensing

Copy to: F. M. Akstulewicz, NRC (w/o enclosures)
B. J. Benney, NRC (w/ 3 proprietary & 1 non-proprietary copies)
P. Clifford, NRC (w/o enclosures)

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APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: **Response to NRC Round #2 Request for Additional Information Regarding WCAP-16072-P & WCAP-16072-NP, "Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs," (Proprietary)**

Reference: Letter from B. F. Maurer, Westinghouse to USNRC Document Control Desk, "Response to NRC Round #2 Request for Additional Information Regarding WCAP-16072-P & WCAP-16072-NP, "Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs," (Proprietary / Non-proprietary), LTR-NRC-03-56, dated November 3, 2003

The Application for Withholding is submitted by Westinghouse Electric Company LLC (Westinghouse), a Delaware limited liability company, pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the Enclosure to the Reference letter. In conformance with 10 CFR Section 2.790, Affidavit AW-03-1730 accompanies this Application for Withholding, setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-03-1730 and should be addressed to the undersigned.

Very truly yours,

B. F. Maurer, Acting Manager
Regulatory Compliance and Plant Licensing

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared J. W. Winters, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC ("Westinghouse"), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

J. W. Winters, Manager
Passive Plant Projects and Development
AP600 and AP1000 Projects

Sworn to and subscribed before me
this 4th day of November 2003

Sharon L. Fiori
Notary Public

SHARON L. FIORI
COMMONWEALTH OF PENNSYLVANIA
NOTARY PUBLIC

Notarial Seal
Sharon L. Fiori, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires January 29, 2007
Member, Pennsylvania Association Of Notaries

(1) I am Manager, Passive Plant Projects and Development, in Nuclear Services, Westinghouse Electric Company LLC ("Westinghouse"), a Delaware limited liability company and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of Westinghouse.

(2) I am making this Affidavit in conformance with the provisions of 10 CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use 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 a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of

proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in the Enclosure for "Response to Round #2 NRC Request for Additional Information, WCAP-16072-P & -NP, Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs" (Proprietary / Non-proprietary)" (Proprietary)," October 31, 2003, for submittal to the Commission, being transmitted by Westinghouse letter (LTR-NRC-03-56) and Application for Withholding Proprietary Information from Public Disclosure, to the NRC Document Control Desk. The proprietary information as submitted for use by Westinghouse is expected to be applicable in other licensee submittals in response to certain NRC requirements for justification of the application of the Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs.

This information is part of that which will enable Westinghouse to:

(a) Conduct analyses of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs and ensure appropriate safety limits are met.

(b) Support licensees in implementing Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) Westinghouse can sell support and defense of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs.

(c) The information requested to be withheld reveals the distinguishing aspects of a methodology which was developed by Westinghouse.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar technical evaluation justifications and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs

would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing the enclosed improved core thermal performance methodology.

Further the deponent sayeth not.

Proprietary Information Notice

Transmitted herewith are proprietary and non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

Copyright Notice

Response to NRC Round #2 Request for Additional Information Regarding WCAP-16072-P & WCAP-16072-NP "Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs"

Round #2 RAI #1:

Where in CEN-372-P-A does it justify fuel clad burst as an acceptable mechanism to prevent DNB Propagation (i.e. excessive clad ballooning)?

Response:

The fuel clad high temperature creep and ballooning model is presented in the Request for Additional Information (RAI) on CEN-372-P. The RAI responses are included as Appendix A and the ballooning and rupture models are discussed in response to RAI #3 of CEN-372-P-A. Clad burst was not stated explicitly in RAI #3 as a mechanism to terminate strain and, therefore, prevent DNB propagation. This phenomenon was, however, explicitly identified in a follow-on report for ZIRLO™, CENPD-404-P-A. The burst stress for Zircaloy-4 is an explicit correlation in CEN-372-P-A, as is the high temperature creep equation. [

]^{a,c} Thus, creep was interpreted to be terminated, further strain would not occur, and DNB would not propagate. However, cladding burst as a mechanism to terminate ballooning and propagation has not been applied for Zircaloy-4. [

]^{a,c}

Page 10 of the SER for CEN-372-P-A provides a good discussion and perspective concerning the expected ballooning and rupture behavior of fuel rods in DNB and the impact on adjacent fuel rods. The likelihood of DNB propagation is recognized to be at most confined to a single adjacent fuel rod and no further because of the non-uniform circumferential temperature and non-uniform deformation. Only the surface of the adjacent rod which locally might now experience DNB will in turn deform back into the direction of the original DNB rod. Furthermore, the models for DNB propagation are also agreed to be conservative in the SER. Westinghouse concurs with this SER assessment and further concludes that DNB propagation, while it can be postulated as a phenomenon, is not a likely mechanism for additional fuel rod failure.

Round #2 RAI #2:

The DNB Propagation methodology assumes a constant rod internal pressure (i.e. no credit for an increase in rod internal volume accompanying clad ballooning). While this practice is conservative for calculating the amount of clad strain, would it be non-conservative for estimating clad burst (based on an overly conservative calculation of hoop stress) which is being credited to preclude DNB Propagation?

Response:

The clad burst stress is a function of temperature and can be compared to the high temperature creep rate versus clad stress and temperature. [

]^{a,c} Thus, while it appears that the methodology may be non-conservative, accounting for a pressure reduction due to internal volume increases would result in lower pressure and stress and insufficient strain to cause DNB propagation.

As discussed in Response 1, the [

]^{a,c} However, it is noted that bursting remains a justifiable mechanism for ballooning termination in Zircaloy-4 cladding.

Round #2 RAI #3:

Rod internal pressure increases at a faster rate in the ZrB2 IFBA fuel design than in standard UO2 rods (due to rapid buildup of Helium). As a result, fuel rod internal pressure may reach RCS pressure at a lower burnup in a greater number of rods. These higher power fuel rods (with internal pressures exceeding RCS pressure) are more likely to experience DNB during a Non-LOCA event (e.g. SS/SR or IOSGADV+LOP). W-CE methodology credits rod balloon/burst as part of the DNB Propagation Analysis.

c) During a postulated transient for reload cores containing ZrB2 IFBA fuel, would a larger number of fuel rods experience balloon/burst for the same number of calculated DNBR failures?

d) Would it be possible to demonstrate that no fuel pins with rod internal pressure exceeding system pressure will experience DNB during Condition III and Condition IV events.

Response #3a:

The fuel rods predicted to experience DNB would all experience some degree of ballooning if the internal gas pressure is in excess of the external pressure. Experiencing significant ballooning and/or burst is unlikely because of the conservatism of the maximum pressure calculation and conservatism of the ballooning and burst models. A number of fuel rods experiencing DNB are expected to be in the same region of the core, within an assembly, for example. All these rods are presumed to be failed (i.e., ruptured). Based on the calculated DNB propagation behavior, no additional rods are likely to fail. Thus, the number of failed rods would be the same as the number of initial DNBR failures.

Response #3b:

Westinghouse does not expect it to be possible to demonstrate that no fuel rods would experience DNBR during all Condition III and IV events. For example, Control Rod Ejection may result in DNB. Portions of the fuel rods inherently experience DNB conditions during a LOCA. Criteria more appropriate to predict failed fuel are applied under these accident conditions.

Round #2 RAI #4:

During normal operation, fuel pellets experience cracking and relocation and develop a "rim" consisting of fission products. In addition, dimensional changes in the fuel pellet and clad will lead to pellet-to-clad contact. During postulated transient events which experience DNB, the elevated clad temperature may promote outward creep in fuel rods with internal pressure in excess of system pressure. These same fuel rods may also burst as a result of these elevated temperatures (in the presence of high rod internal pressure).

d) As the clad creeps away from the fuel pellet and widens the gap, fuel pellet temperature will increase. Has the potential for an increase in fission gas release been evaluated?

e) The outward creep of the clad will disturb the rim region of the pellet which has partially bonded with the inside surface of the cladding. Has the potential for an increase in radiological source term been evaluated?

f) Has the potential for fuel fragment relocation in the balloon/burst region been evaluated for both a core coolable geometry and radiological source term perspective?

Response #4a:

The potential for increase in fission gas release has been evaluated in support of CEN-372-P-A. [

]^{a,c} Thus, potential for DNB propagation is concluded to be unlikely.

Response #4b:

The topical report WCAP-16072-P pertains to ZrB_2 coated pellets. It is unlikely that these pellets will bond with the cladding to any greater degree than uncoated pellets. The formation of a pellet rim region only begins at relatively high burnup, i.e., at pellet average burnups of 45-55 MWd/kgU. Furthermore, high burnup fuel rods are depleted and exhibit low power levels consistent with significant reductions in reactivity. It is unlikely that such rods will experience DNB and thus contribute to the calculated doses. Furthermore, the fission gas source term in the low power/high burnup rod is significantly smaller than that assumed for the limiting high power rods in the safety analysis. Thus the potential for a significant increase in radiological source term is negligible.

Response #4c:

Westinghouse has not evaluated the potential for fuel fragmentation and impact on coolable geometry based on postulated rim effects. Neither has the potential for increases in the radiological source terms been evaluated. Tests for which Westinghouse is aware do not indicate significant fuel fragmentation and relocation. Thus, until such data indicate a need, treatment of this phenomenon will not be considered necessary. Existing criteria are considered sufficient.

Round #2 RAI #5:

The depletion of B^{10} in the ZrB2 coating leads to the production of helium and lithium. This topical discusses the impact of helium production, but is silent on any potential impacts of lithium production.

c) Please describe the evolution of the lithium and any changes in its chemical state with burnup and temperature. In other words, does the lithium react or bond with any of the fission products and/or cladding?

d) During power maneuvers or anticipated operational occurrences, will the chemical state of the lithium change and/or is it possible for the lithium to reach a gaseous state (and contribute to the rod internal pressure)?

Response #5a:

[

]^{a,c}

[

]a,c

Response #5b:

[

]a,c