Westinghouse Electric Corporation
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Box 355
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February 2, 1999
CAW-99-1320

Document Control Desk
US Nuclear Regulatory Commission
Washington, DC 20555

Attention: T. E. Collins, Chief
Reactor Systems Branch
Division of Systems Safety and Analysis

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: "Response to Request for Additional Information on New Fuel Design," (Proprietary), February 1999.

Dear Mr. Collins:

The proprietary information for which withholding is being requested in the above-referenced letter is further identified in Affidavit CAW-99-1320 signed by the owner of the proprietary information, Westinghouse Electric Company, a division of CBS Corporation ("Westinghouse"). The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.790 of the Commission's regulations.

Accordingly, this letter authorized the utilization of the accompanying Affidavit by South Texas Project Nuclear Operating Company.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-99-1320, and should be addressed to the undersigned.

Very truly yours,

Henry A. Sepp, Manager
Regulatory and Licensing Engineering

Enclosures
cc: T. Carter / NRC (5E7)

Proprietary Information Notice

Transmitted herewith are proprietary and non-proprietary versions of documents furnished to the NRC. 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

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Henry A. Sepp, 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, a division of CBS Corporation ("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:

Henry A. Sepp

Henry A. Sepp, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 2nd day
of February, 1999.

Janet A. Schwab

Notary Public

Notarial Seal
Janet A. Schwab, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires May 22, 2000
Member, Pennsylvania Association of Notaries

JANET A. SCHWAB
COMMONWEALTH OF PENNSYLVANIA
NOTARY PUBLIC

(1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services Division, of the Westinghouse Electric Company, a division of CBS Corporation ("Westinghouse") 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 the Westinghouse Energy Systems Business Units.

(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 Energy Systems Business Units 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 provided in the document, "Response to Request for Additional Information on New Fuel Design," report for submittal to the Commission, being transmitted by South Texas Projects Nuclear Operating Company letter (NOC-AE-000-392) for Docket No. STN 50-498 and STN 50-499 and Application for Withholding Proprietary Information from Public Disclosure, Henry A. Sepp, W, Manager Regulatory and Licensing Engineering to the attention of T. E. Collins, Chief, Reactor Systems Branch, Division of Systems Safety and Analysis. The proprietary information was provided by Westinghouse Electric Corporation to address questions asked by the NRC on New Fuel Design Rod Bow.

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

(a) Analyze plant conditions as they relate to operational issues

(b) Assist customers to obtain license changes for improved operational flexibility

Further this information has substantial commercial value as follows:

(a) Westinghouse can use this information to further enhance their licensing position with their competitors.

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 licensing programs for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC licensing requirements 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 improved fuel design.

Further the deponent sayeth not.

ATTACHMENT 4

Westinghouse Response to Request for Additional Information on New Fuel Design (Non-Proprietary)

1.0 Background and Introduction

Protective grids (P-grid) were introduced in the 17x17 XL fuel design to provide both additional protection from possible debris induced fuel failures as well as to provide improved resistance to thimble tube distortion in the lower spans of the fuel assembly. The fuel rod bottom end-plug is lengthened and extends through the protective grid and the bottom Inconel grid. In addition, the fuel rod is positioned very close to the bottom nozzle (less than [ ]^{a,c}. The previous design had a gap between the bottom of the fuel rod and the bottom nozzle of about [ ]^{a,c}. The benefit in reduced thimble distortion with the protective grid is due to the transfer of the weight of the fuel rods from the guide thimble tubes (through the spacer grid supports) directly to the bottom nozzle at the time the fuel rod contacts with the bottom nozzle. Initial fuel rod growth occurs in both the upward and downward directions and then shifts to completely upward growth when the fuel rod contacts the bottom nozzle. For the P-grid design, [ ]^{a,c}. For the previous design, [ ]^{a,c}.

The effect of upward fuel rod growth associated with P-grid introduction on fuel rod bow has been studied by Westinghouse and the results are summarized in this report. The limiting fuel rod spans for rod bow are in the bottom portion of the fuel assembly. This is because the spans in the bottom section experience higher resistance forces when the fuel rod tends toward upward movement. [ ]^{a,c}. Fuel rod outer diameter size and distance between spacer grids also influences the degree of fuel assembly bow, with smaller fuel rod diameter and larger spacer grid spans resulting in worse fuel rod bow. Hence, the most limiting 17x17 fuel design for fuel rod bow is the [ ]^{a,c}. The use of ZIRLO™ instead of Zircaloy-4 results in a substantial reduction in fuel rod growth and consequently, a substantial reduction in fuel rod bow magnitude.

2.0 Summary and Conclusions

A design comparison of key parameters between the designs for which PIE examinations have been performed and the 17x17 XL VANTAGE + (V+) design with debris mitigating features (i.e., protective bottom grid with longer bottom end-plugs, commercially referred to as PERFORMANCE + (P+) fuel features) is provided below.

Parameter	17x17 V5	17x17 V+/P+	17x17 V+/P+	17x17 XL V+/P+
Fuel Rod Material	Zr-4	ZIRLO™	ZIRLO™	**ZIRLO™**
Fuel Rod Diameter (in.)	0.360	0.360	0.374	**0.374**
IFMs	Yes	Yes	No	**No**
Protective Grids	No	Yes	Yes	**Yes**
Bottom Span Lengths (in.)	~20	~20	~20	**~18**

V5 = VANTAGE 5 V+ = VANTAGE + P+ = PERFORMANCE +

Detailed fuel rod bow data reduction from videos, including South Texas "XLR" fuel, have been used to compute channel closure data and indicate, as expected, that the [

]^{a,c}. Additional 12 foot fuel designs which use ZIRLO™ as the fuel clad material, both with and without IFMs which utilize P-grids, have been operated to high burnups and visual inspections have shown much less fuel rod bow than previous Zircaloy-4 experience. The new XL fuel design (XL V+/P+) fabricated from ZIRLO™ and including the P-grid is expected to have reduced fuel rod bow relative to these designs since it is bounded by experience with more limiting fuel conditions relative to fuel rod bow.

3.0 Analysis

The rod bow mechanisms for both [ ]^{a,c} are equivalent. Both designs have the following common design features:

- [ ]^{a,c}
- [ ]^{a,c}
- [ ]^{a,c}
- [ ]^{a,c}

The design features of the XL V+/P+ design, including ZIRLO™ fuel rod, ZIRLO™ guide thimbles, ZIRLO™ instrumentation tube and a protective bottom grid, should result in similar rod bow performance as those of present products.

Data regression analysis is based on the maximum bow value of each [

]^{a,c}. Thus, the XL V+/P+ fuel rods will not contact each other at end-of-life.

3.1 Evaluation

Potential factors affecting the fuel rod bowing or channel closure performance include, but are not limited to, the following parameters:

- [ ]^{a,c}
- [ ]^{a,c}
- [ ]^{a,c}
- [ ]^{a,c}
- [ ]^{a,c}
- [ ]^{a,c}
- [ ]^{a,c}
- [ ]^{a,c}

Fuel rod bow performance evaluation is based on actual performance data, which provides more reliable and realistic predictions.

The channel closure predictions for the XL V+/P+ fuel rod are based on PIE data gathered from [ ]^{a,c}. Data regression analysis is conservatively based on the maximum bow value of each assembly. Those data are [ ]^{a,c}. The upper bound rod bow prediction is also conservatively established.

Westinghouse has identified possible root causes of fuel rod bowing. To mitigate fuel rod bow, the following design modifications have been incorporated into the fuel assembly design: [ ]^{a,c}. Fuel rod bow mitigation has been adapted in all Westinghouse fuel assembly designs, including the XL fuel assembly design. The PIE data has confirmed a decrease in fuel rod bow, since these features have been implemented.

The support configuration for the grids and fuel rods in the [ ]^{a,c}. All grids, [ ]^{a,c}, are welded or brazed to sleeves at each guide thimble and instrumentation tube position. The sleeves are [ ]^{a,c}. Although the XL fuel assembly is [ ]^{a,c}. An additional design improvement feature for the XL V+/P+ is the protective grid, which provides added supporting force for the fuel rods at the bottom grid.

The limiting fuel rod spans for rod bow for a 12 foot fuel assembly are in the bottom portion of the fuel assembly. This is because the spans in the bottom section experience higher resistance forces when the fuel rod experiences upward growth movement. PIE data derived from the [ ]^{a,c}.

To predict the XL rod bow performance [ ]^{a,c}. The basic beam equations from the theory of strength of materials are used to establish the fuel rod bow performance for the design. The XL fuel rod bow calculations are based on the following parameters for the two designs:

- Geometrical dimensions - span length, cross-section area, moment of inertia (I),
- Nominal rod-to-rod gap (G),
- Basic material properties - modulus of elasticity (E),
- Boundary conditions - six-point support in a grid cell, and
- Initial bow data - lower initial bow data for the XL design.

The primary [

] a, c and the basic theory of strength of materials, the rod bow criteria can be conservatively evaluated.

The [

] a, b, c assemblies was conservative.

A typical fuel rod bow distribution is given in Figure 1. Figure 1 shows the fuel rod channel closure data from [

] a, c. Figure 2 presents the fuel rod channel closure and span standard deviation data for Face 1 of "J65" fuel assembly. There are a number of fuel rod bow measurements [

] a, c.

In addition, several ZIRLO™ fuel assemblies were examined at [

] a, b, c. The fuel rod bow performance of the design, however, was excellent. Compared to the [

] a, b, c. The tapes showed that the rod bow performance was excellent. All of those assemblies have rod bow performance equivalent to or better than fuel assembly "J65".

Figure 3 shows the worst fuel rod channel closure [

]$^{a, b, c}$.

Additional fuel rod channel closure data were also reduced from several [

]$^{a, b, c}$.

Those data are used to verify and confirm the fuel rod channel closure performance for the XL V+/P+ fuel assembly design. Figures 4 through 7 present the measured channel closure data from four assemblies.

The fuel rod channel closure for the XL V+/P+ fuel assembly design is [

]$^{a, c}$. Rod bowing has been found to be dependent on the distance between grids (span length) and fuel rod moment of inertia. For a beam subjected to end moments, the middle span deflection is proportional to L^2/I, where L is the span length and I is the cross-sectional moment of inertia. The fuel rod channel closure is defined as $L^2/(IG)$, where G is the nominal rod-to-rod gap. Thus, the fuel rod bow is proportional to a combined geometrical and cross-sectional property factor of $L^2/(IG)$. The rod bow [

]$^{a, c}$ is calculated below:

$$d_{XL}\ (Deflection) \propto \frac{L_{XL}}{EI_{XL}}$$

$$[Channel\ Closure]_{XL} = \frac{d_{XL}}{G_{XL}}$$

where, G_{XL} = Nominal Rod-to-Rod Gap for XL Design

a, c

[

] ^{a,c}

Figure 8 presents the interpolated fuel rod channel closure data for the 17x17 XL fuel assembly. The best estimate [

] ^{a,b,c}. Therefore, the XL V+/P+ fuel rods will not contact each other at the end-of-life (EOL).

3.2 Discussion on Upgraded Design Features on Rod Bow Evaluation

The effects of fuel assembly design features, such as IFM grids, protective grid, and ZIRLO™ are discussed in this section.

[

] ^{a,c}.

The P-grid is positioned closely below the bottom Inconel grid. It adds additional supporting force for the fuel rod at the bottom grid. Because of its proximity to the bottom grid, structurally, [

] ^{a,c}. This was confirmed by the PIE of the Plant E "5C4" fuel assembly.

The rod bow data shown are all from Zircaloy-4 based fuel assemblies. ZIRLO™ and Zircaloy-4 are structurally similar materials. Figures 9 and 10 show the typical ZIRLO™ fuel assembly and rod growth data compared with those of Zircaloy-4 designs, respectively. The growth for the ZIRLO™ fuel assembly and fuel rod are much less than the Zircaloy-4 fuel assembly. The induced rod bow due to ZIRLO™ material will be less.

4.0 Conclusions

The rod bow mechanisms for both V5 and the XL V+/P+ fuel designs are equivalent. Both designs have the following common design features:

- [ ]a, c
- [ ]a, c
- [ ]a, c
- [ ]a, c

The design features of the XL V+/P+ design, including ZIRLO™ fuel rod, ZIRLO™ guide thimbles, ZIRLO™ instrumentation tube and P-grid, should result in similar rod bow performance as those of present product.

Data regression analysis is based on the maximum bow value of each [

]a, b, c. Thus, the XL V+/P+ fuel rods will not contact each other at end-of-life.

Figure 1
Typical Fuel Rod Channel Closure Data
[17x17 V5 "J65" Fuel Assembly]a, c

a, b, c

Figure 2
Typical Fuel Rod Channel Closure and Standard Deviation
[Plant A "J65" Fuel Assembly Face 1]^{a,c}

[ ]$^{a, b, c}$

Figure 3
Fuel Rod Channel Closure Standard Deviation
[Plant A Demonstration and J65 Fuel Assemblies] a, c

[ ] a, b, c

Figure 4
Fuel Rod Channel Closure
[Plant B "H50" 17x17 V5H Fuel Assembly][a, c]

[ ] a, b, c

Figure 5
Fuel Rod Channel Closure
[Plant D "L13" 17x17 V5H Fuel Assembly][a, c]

[ ]a, b, c

Figure 6
Fuel Rod Channel Closure
[Plant C "M48" 17x17 V5H Fuel Assembly]a, c

[ ]a, b, c

Figure 7
Fuel Rod Channel Closure
South Texas "F41" 17x17 XL V5H Fuel Assembly

[ ] a, b, c

Figure 8
Worst Channel Closure Prediction for 17x17 XL V5H

a, b, c

Figure 9
Fuel Rod Growth - Zircaloy-4 versus ZIRLO™ Rods

[ ] a, b, c

Figure 10
Fuel Assembly Growth - Zircaloy-4 versus ZIRLO™ Thimble Tubes

a, b, c