Westinghouse Electric Corporation
Energy Systems

Nuclear Services Division

Box 355
Pittsburgh Pennsylvania 15230-0355

January 20, 1997

AW-97-1064

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Attention: Mr. David B. Matthews

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: "Westinghouse Response to NRC Questions," (Proprietary)

Dear Mr. Matthews:

The application for withholding is submitted by Westinghouse Electric Corporation ("Westinghouse") 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 subject report. In conformance with 10 CFR Section 2.790, Affidavit AW-97-1064 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 10CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-97-1064 and should be addressed to the undersigned.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering.

Enclosure

cc: Kevin Bohrer/NRC (12H5)

Proprietary Information Notice

Transmitted herewith are proprietary and/or 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) contained within parentheses 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).

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 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 2th day
of January, 1997

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

(1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services Division, of the Westinghouse Electric Corporation 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 Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR 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 Unit 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 10CFR 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 material entitled "Westinghouse Response to NRC Questions," (Proprietary), being transmitted by Westinghouse Electric Corporation with Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk, Attention Mr. David B. Matthews. The proprietary information has been requested by the Nuclear Regulatory Commission and is being voluntarily provided by Westinghouse for review relative to the incomplete RCCA insertion phenomenon.

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

(a) Provide documentation of the methods for evaluating the implementation of fuel assembly and RCCA tests and inspections.

(b) Establish applicable analytical technologies relative to inspections.

(c) Establish the procedures and guidelines for the examination of fuel assemblies and RCCAs.

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 this information to its customers in the licensing process.

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 evaluation services 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 procedures, guidelines and analytical methods.

Further the deponent sayeth not.

Westinghouse Response to NRC Questions:

Susceptibility of Fuel Assemblies with IFMs (5 Questions)

Preliminary Report (10 Questions)

1) **While the proposed root cause for the Wolf Creek incomplete RCCA insertions is a plausible explanation, it is not conclusive. The model for growth due to oxide accumulation is based on a very small number of data points and Westinghouse has stated that it is extremely sensitive to temperature. The model provides a possible explanation, but it has not been verified. Verification of the model would not be possible because data are not sufficient to establish confidence levels or sensitivity studies involving the key parameters.**

We believe that the data and analysis resulting from the root cause investigation of Wolf Creek as reported in PPE-96-249 is consistent and substantiates the root cause as being thimble tube distortion caused by excessive compressive loads on the fuel assembly thimble tubes. Unusual fuel assembly growth contributed to the excessive compressive loads.

Fortunately, the Wolf Creek IRI experience is unique to 12 ft. cores, but this also means that Wolf Creek at this point in time is the only source of definitive information on the growth of thimble tubes due to oxide accumulation. Recognizing this, we are developing an [

.]a,b,c Current plans are for this system to be operational by the end of March, 1997. It is our intent to obtain oxide measurements in various fuel assemblies under a variety of plant operating temperatures and burnup conditions. The analysis of this data will give us added confidence in our model.

2) **The Westinghouse explanation of the root cause for the Wolf Creek event has not been extended to the South Texas event and it is the staff's understanding that it can not be, since the accelerated growth observed at Wolf Creek was not observed at South Texas. The phenomenon appears to be dependent on a number of factors, the interaction of which is not clearly understood. Nothing in the Westinghouse explanation would preclude other fuel designs, such as the 14x14 and 15x15 fuel, from exhibiting similar behavior at different combinations of burnup, power history, core exit temperature, and other factors that might be important.**

The root cause for the insertion anomaly experienced at Wolf Creek is thimble tube distortion. This is also the root cause for the insertion anomaly at South Texas. In both cases the cause of the thimble tube distortion is excessive compressive loads on the fuel assembly. Because of significant mechanical differences in the two fuel assembly designs, the application and results of the compressive loads differ greatly.

At Wolf Creek the compressive loads were caused by several factors including accelerated growth. The result in the Wolf Creek design (single dashpot - 12 foot active length) was distortion in the dashpot as well as the upper spans of the guide thimbles.

At South Texas the conditions for accelerated growth were present, but the growth was not manifested in fuel assembly length measurements. The compressive loads were caused by a combination of [

.]^{a,b,c} The hold down springs on the South Texas design have a higher spring constant which yields more compressive load for each increment of deflection as well as a higher initial hold down force. This puts more axial constraints on the XL fuel assembly preventing some of the growth. The 14 foot active length fuel assembly uses a double dashpot . This has a short section of guide tube diameter between two sections of reduced diameter as shown in Figure 1.
[.]^{a,b,c}
The design in which the insertion anomaly occurred uses a guide thimble of larger diameter above the dashpot (larger than 12 foot assemblies with zircaloy mid-grids). This further pushes the weak link to the dashpot transition. The result in this assembly design is large distortions in the dashpot and minimal distortions in the upper guide thimbles.

[

.]^{a,b,c} Therefore it is more probable that the RCCAs for XL fuel could stick due to high drag in the dashpot only.

The XL fuel design is distinctive from the 12 foot fuel design in the mode in which the thimble tubes distort. There is also a major difference in the location and magnitude of the resulting drag. Although the root cause of the "sticking RCCAs" is the same for both designs, the mechanical design differences cause the assemblies to behave differently. They must be analyzed separately, and different criteria for factors such as burnup and measured drag are expected.

For 14x14 and 15x15 fuel designs, no indications of an insertion anomaly have appeared. It is judged this is because these plants run at a relatively low temperature, and therefore [

.]^{a,b,c} Therefore, the degree of thimble tube distortion required for an anomaly does not occur.

In summary, the root cause of the insertion anomalies at Wolf Creek and South Texas is thimble tube distortion caused by compressive loads on the fuel assemblies. At Wolf Creek accelerated growth was a major contributor to the compressive load. The result in the Wolf Creek design was large distortions in the dashpot and also in the upper spans of the guide thimbles.

At South Texas high fuel assembly growth was not manifested in fuel assembly length measurements, although the conditions for high growth were present. The behavior of the assembly was different than Wolf Creek because of major differences in mechanical design. The result was thimble tube distortions and large drag in the dashpot only.

3) **While fuel with intermediate flow mixing grids (IFMs) would appear to be stiffer and thus less susceptible to distortion, it has not been shown that this fuel is not susceptible to thimble tube bowing from compressive loads. Furthermore, since the mid spans would be strengthened, the top and bottom spans might be left as the most susceptible portions of the fuel assembly and distortion of the top span could lead to control rod sticking very high in the core. Thus, the staff does not agree that plants with fuel assemblies containing IFMs are not susceptible.**

In Figures 3 through 8, the drag data that was presented in the Incomplete RCCA Insertion report are differentiated by:

- assembly type (IFM, Zr-4 thimble tubes, ZIRLO thimble tubes)
- temperature

The data in Figures 5 and 8 shows that IFM assemblies usually have lower upper guide thimble drag than non-IFM assemblies. As shown in those figures, the total upper guide thimble drag is usually [

.]^{a,b,c} Because of the lower upper guide thimble drag values, the RCCAs in IFM assemblies have greater momentum going into the dashpot which means a greater likely-hood that the RCCA will fully insert.

In the Westing ouse assembly design, IFMs are not located above grid seven (7) and below grid four (4). Since the upper guide thimble drag in IFM assemblies is usually less than [,]^{a,b,c} the IFMs have helped to minimize thimble tube distortion above the dashpot. Also as shown in Table 1, the top span drag values in IFM assemblies are much lower than the top span drag values of non-IFM assemblies. Insertion drag data is provided in the table. The insertion drag is "identical" to the withdrawal drag for the top span and upper guide thimble. Therefore, it is highly unlikely that RCCAs would stick high in the core in an IFM assembly.

The data in Figures 4 and 7 shows that the dashpot drag values are comparable for IFM and non-IFM assemblies. As noted previously for 12 foot fuel, both high dashpot and upper guide thimble drag is necessary for incomplete insertion. IFM assemblies have low upper guide thimble drag making them more resistant to incomplete insertion.

In conclusion, Westinghouse considers that there is sufficient data available from actual plant testing and analyses performed to permit the operation of Westinghouse fuel assemblies with IFMs to burnups within the current licensed range. The data which supports this conclusion is summarized below.

1. There have been no reports of incomplete RCCA insertion in fuel assemblies which have IFMs and have experienced a burnup up to approximately [.]a,b,c

2. Drag tests of fuel assemblies with IFMs have indicated that in no case has any IFM fuel assembly exceeded both the Westinghouse F Specification criteria.

3. Successful RCCA insertion has been reported in IFM fuel assemblies at VC Summer which have experienced operation with temperatures and burnups as well as power histories in the range of those fuel assemblies at Wolf Creek which had incomplete RCCA insertion.

4. The Westinghouse mechanical model predicts lower fuel assembly thimble tube bow for IFM fuel assemblies than the bow predicted for the Wolf Creek fuel assemblies that experienced incomplete RCCA insertions.

4) While most of the high drag data reported as a result of Bulletin 96-01 has been in high temperature plants, there have been a number of cases of high drag in lower temperature plants thus, it is not clear that plants with T Core Hot < 615°F are not susceptible to thimble tube bowing.

In Figures 3 through 5, the drag data is differentiated to investigate the temperature effect. In the Figure 3, assemblies that have greater than 615 F exceed the dashpot drag and upper guide thimble drag criteria. The majority of the low temperature assemblies that were tested have dashpot drag and upper guide thimble drag values within the drag criteria. The data points that exceed the upper guide thimble drag criteria but are within the dashpot drag criteria are 14x14 and 15x15 data points. Based on the drag data it does appear that plants with T-hot less than 615 F are less susceptible to thimble tube distortion since only plants with $T_{HOT} > 615°F$ exceeded both F-Spec criteria.

Comparing average drag data, the following results were obtained: The high temperature plants typically had an increase of approximately [

.]a,b,c

For IFM assemblies there is not much difference between high and low temperature drag. Although as stated elsewhere, the IFM drags are generally less than the non-IFM drags on the average.

5) **As yet, no explanation has been given for the high drags measured in several types of fuel or the number of cases in which a dummy control rod could not be fully inserted into an assembly. It is our understanding that length measurements showed normal growth for these assemblies and thus, excessive growth could not be the explanation for the distortion causing the high drag forces or inability to fully insert a dummy control rod.**

When fuel assemblies are drag tested in the spent fuel pool, a light weight tool is used for the most accurate results. In some cases the drag in the fuel assembly may exceed the buoyant weight of the RCCA and handling tool. In these cases the RCCA will stop at the elevation were the drag reaches the tool and RCCA weight [.][a,b,c]

When an RCCA does not fully insert, the preferred action is to push the RCCA fully into the fuel assembly, estimating the force required to achieve full insertion. The RCCA can then be re-tested during withdrawal and the numbers compared to refine the estimated drag. This requires additional tooling, procedures and time. In cases where these resources are not available, it is simply recorded that the RCCA did not fully insert.

During drag testing in the spent fuel pool at Wolf Creek RCCA RS31 failed to fully insert in fuel assembly H53. In this case the drag on withdrawal was already available since the RCCA was fully inserted when the assembly was removed from the core. The breakaway drag measured on withdrawal in the dashpot was [.][a,b,c] and the midpoint of the dashpot was [.][a,b,c] Since this is significantly higher than the dead weight (RCCA and tool) it was not surprising full reinsertion was not achieved. It is noted a significant portion of the total drag is from the guide thimbles [.][a,b,c] This indicates a high degree of thimble tube distortion, and caused an insertion anomaly during a trip.

During drag testing at Sequoyah the dummy RCCA failed to fully insert in fuel assembly E22. The RCCA was pushed in to full insertion and the drag measured on withdrawal was [.][a,b,c] Since this exceeds the dead weight, it is expected the RCCA would stop before reaching full insertion under test conditions. This assembly had very low drag in the guide thimbles [ ][a,b,c] on both insertion and withdrawal. Based on experience at Vogtle and V.C. Summer regarding assemblies with high drag in the dashpot and low drag in the guide thimbles, it is concluded that an insertion anomaly would not have taken place in this assembly.

When drag testing fuel assemblies 5G68 and 5G84 at Vogtle, the dummy RCCA did not fully insert. Due to constraints on resources the RCCA was not pushed to full insertion. Therefore, the drag in the dashpot is not available, but it is known this drag

[.][a,b,c] Although the dashpot drag is considered high there is no reason to believe these assemblies are significantly different from other assemblies of similar design and burnup. Because of the low drag in the guide thimbles it is judged an insertion anomaly would not have occurred in these assemblies. Fuel assembly 5G80 at Vogtle showed high drag in the dashpot [ ][a,b,c] and achieved full insertion in a trip.

Questions on Susceptibility of Fuel Assemblies with IFMs

1) **What is the basis (in addition to lack of incomplete insertions) for the conclusion that fuel assemblies with IFMs are not susceptible? Please give full details and data to validate this claim.**

A separate document (NSD-NRC-97-4944) has been prepared to address the susceptibility of IFMs to IRI including supporting data.

2) **Please present side by side comparisons of assembly growth for assemblies with and without IFMs. Since temperature and power history are such important factors, the assemblies compared should have the same temperatures and power histories.**

The fuel assembly growth data available from measurements at the plant sites are presented in Figure 9. However, since these are from a variety of plant sites and operating cycles, the assemblies do not have the same power histories and temperatures. Figures 19 and 20 show the results of our mechanical model for assembly H50 (w/o IFMs) and J32 (w/IFMs). Since the mechanical model is normalized to the hot cell results of H50, the addition of IFM grids as part of the fuel assembly structure is straight forward. The comparison of the results from the two fuel assembly types is meaningful. The temperature and power used to analyze J32 are identical to those experienced by H50.

A review of the figures shows[

.]^{a,b,c}

However, two additional pieces of information are noteworthy:

1) the magnitude of bow is still below the degree of bow]^{a,b,c} at which we would expect to see any drag. [
]^{a,b,c} and

2) of the 12 IFM assemblies measured during the root cause testing, [
.]^{a,b,c} The average drag in this Span being [
]^{a,b,c} This is typically within the background noise of the data.

3) **Please explain why there would not be a temperature power history combination for which the top span and the bottom span would bow sufficiently to cause control rod sticking.**

[

.]a,b,c This in fact is very much like the power history of H50. Therefore, our analysis of H50/J32 discussed above should be close to a worse case power history. We are currently performing a parametric study of power histories and temperatures to identify possible areas of concern. The boundary conditions of equivalent length and burnup through 3 cycles dictates allowable combinations of power histories. Formulating a parametric matrix that meets these boundary conditions is complex. We will notify you when such studies are complete.

4) Plotting the Vogtle drag data and the North Anna data together indicates that there is a greater drag for the IFM assemblies. Please explain how this is consistent with the position that fuel assemblies with IFMs are not susceptible.

IFMs do improve the lateral stability of the guide thimbles at the axial location of the IFMs. As IFMs are located in the upper guide thimble area, reduction in drag forces will be experienced at these locations. Figure 10 shows the drag in the upper guide thimble area for both Vogtle and North Anna. [

]a,b,c Figure 11 shows the dashpot drag for both of these assembly types.

[

.]a,b,c

Therefore, the RCCAs in IFM assemblies have greater momentum upon entering the dashpot. Because of the extra momentum, the RCCAs in IFM assemblies are less susceptible to incomplete RCCA insertion if they have similar dashpot drags.

5) Please give details of the Wolf Creek temperature and power history. How is it different from other power histories and temperatures?

The power histories and temperatures for the assemblies examined in the root cause testing program were delineated in Appendix B of PPE-96-249. [

.]a,b,c Our growth models indicate that high temperatures and fluence lead to accelerated growth.

The core average outlet temperatures in cycle 2 and 3 were 619° and 620°F. Although there are some plants which have temperatures slightly higher (1-2°F), Wolf Creek outlet temperatures are definitely higher than the average plant population.

Questions on the Preliminary Report

1) **Please provide the technical justification for the susceptibility conclusions on Page 31 of the report. (Lack of incomplete RCCA insertion is not sufficient justification.)**

Paragraph 7.0 (page 31) of PPE-96-249 states:

"7.0 Based on plant trip information, site test results and observations of growth data, Westinghouse presented the following susceptibility conclusions to the NRC on June 27, 1996:

- Based on the data and analysis to date, fuel with IFMs are not susceptible to incomplete insertion.
- The manufacturing period does not affect the susceptibility to incomplete insertion.
- Twelve foot Westinghouse fuel is not susceptible below a burnup of 40,000 MWD/MTU.
- Based on the data to date, while it does not appear that 14x14 and 15x15 fuel are less susceptible, it is difficult at this time to make a definitive conclusion."

A comprehensive discussion of IFM susceptibility is found in NSD-NRC-97-4944.

Section 8.2 of PPE-96-249 discusses the manufacturing process and associated facts and information which lead to this conclusion.

Figure 12, 13, and 14 show the drag information used to demonstrate the field experience/data which leads to the conclusion that 12 ft. Westinghouse assemblies less than 40 GWD/MTU are not susceptible to IRI.

Figure 12 shows that only Wolf Creek with drags greater than [ ]^{a,b,c} in the upper guide tube and dashpot respectively experienced IRI.

This same data is plot versus fluence in Figures 13 and 14. Note that a fluence of 7.5×10^{21} NVT corresponds to 40 GWD/MTU. There are no assemblies to the left of 40 GWD/MTU which experienced IRI as previously shown in Figure 12. In fact, the lowest burnup on one of the Wolf Creek assemblies which experienced IRI is FA #H32 with a burnup of 48.233 GWD/MTU. Therefore, we believe 40 GWD/MTU is conservative for assemblies of the Wolf Creek (H) design.

Responses to general question 2 addresses the susceptibility of 14x14 and 15x15 designs to IRI.

2) **The root cause conclusions for Wolf Creek stated that unusual growth is observed only in high temperature plants with certain power histories. Please specify the characteristics of this power history. How this will be avoided? How are you certain that only this power history can cause the problem?**

The first part of this question was answered in the response to Questions on Susceptibility of Fuel Assemblies with IFMs, Question 5.

We are taking a conservative position by not allowing three cycle, non-IFM assemblies to exceed 40 GWD/MTU in rodded positions in high (> 615°F) temperature plants regardless of power histories.

As previously stated, a parametric study will be performed to better understand the relationship of growth/bow to power histories. We will discuss these results when the analysis is complete.

3) **The South Texas experience shows that high drag in the dashpot region alone is sufficient to cause incomplete RCCA insertion. This contradicts the conclusion that RCCAs will completely insert if one of the F spec criteria is met. Please explain.**

The South Texas (ST) fuel design is different than the standard Westinghouse 12 foot assembly in many ways. One of the major differences is the double dashpot in the ST design as compared to the single dashpot in the majority of the remaining 12 foot designs. Figure 1 shows the differences between the standard 12 foot single dashpot design and the ST double dashpot design. The single dashpot design has one transition. This means the diameter of the thimble changes one time, from large to small, in the dashpot area. The double dashpot has three transitions in this area, which means the diameter of the thimble goes from large to small to large and back to small again. At these transitions the tubing is more flexible and can be more easily deformed laterally. The lateral deformations can cause high drag if they are large enough. The ST design which has three transitions is much more susceptible to high drag than the standard 12 foot single transition designs.

An additional consideration that makes the double dashpot feature more susceptible to high drag is that because there are lateral supports, grids and bottom nozzle, both above and below both of the dashpots, the bow expected in the dashpots can be in any orientation independent of one another. This means that the bow in the upper dashpot for instance could be at a [ ][a,b,c] while the bow in the lower dashpot could be [ ][a,b,c] to that. Two bows in two different orientations over such a small axial length can cause excessive drag and accentuate the possibility of an IRI. A single dashpot on the other hand is supported only above and below the dashpot. This design will only take on a single orientation of bow which is much less severe from a dashpot drag standpoint. Figure 2 has been included to pictorially show this phenomena.

4) **There were several assemblies at various plants into which the dummy RCCA could not be inserted and thus no drag data was taken. The RCCA was fully inserted and drag data taken for all the Wolf Creek assemblies. Please explain why the thimble tube distortion on the assemblies into which the dummy RCCA could not be inserted is not as serious as that of the Wolf Creek assemblies. Since these assemblies did not exhibit unusual growth, what is the explanation for the excessive thimble tube distortion? Why would this not cause incomplete RCCA insertion?**

This question is essentially the same as question 5 in the main body of the letter. Please see response to that question.

5) **The most likely root cause for the South Texas incomplete RCCA insertions was stated as "inadequate resistance to buckling in the fuel assembly design." Many other fuel assemblies at various plants exhibited high drag forces and thimble tube distortion in the dashpot area. Is the root cause for the distortion in these assemblies the same as in South Texas? Please explain your conclusion.**

On page 66 of the report we state the following:

"The apparent cause of the incomplete Rod Cluster Control Assembly insertion at the South Texas Project is fuel assembly thimble tube distortion resulting from high, in-vessel, compressive loading imparted on the fuel assembly skeleton. The problematic distortion is limited to the assembly dashpot area of the thimble tubes which prevents complete control rod insertion."

Refer to the response that is given for general question #2.

6) **Please explain Westinghouse plans to mechanically strengthen the fuel assemblies in order to avoid thimble tube distortion.**

Our first priority in making design changes to eliminate thimble tube distortion is our 14 ft design used in South Texas Units 1 and 2. A list of the potential changes under consideration are as follows together with a brief explanation of how these changes will reduce distortion:

a,b,c

The first two changes are being evaluated for incorporation into the next region of Unit 1 scheduled for delivery ~ 8/97. The remaining changes will take longer to incorporate and are being considered for subsequent regions. In addition, a substantial portion of the 12 ft. designs scheduled for manufacture are incorporating ZIRLO, and others may incorporate some of the above mentioned modifications to provide additional margin at higher burnups.

7) **It has been stated that the accelerated growth model was reviewed with "Non-Westinghouse experts (including GE)". Have you considered extending such an independent "peer review" to the overall mechanical model to validate confidence in it? How is creep handled in the mechanical model?**

We agree that a "peer review" of the overall mechanical model is appropriate, and plans for conducting such a review is being formulated by Westinghouse. The timing of such a review is important since the model has been recently developed and benchmarking is still ongoing as additional data becomes available.

We will keep you informed as to our progress.

Creep in the mechanical model is handled in the following manner. [

]^{a,b,c} This sequence is repeated at each time step until the end of life.

8) **Please estimate the sensitivity of the influence of changing input parameters over a reasonable range to the model, if a full parametric study is not feasible, at least give an indication with reference to the irradiation growth model and the oxide growth model. What are the estimated confidence limits on input curves to the model such as growth vs. fluence and their sensitivity to the current number of data points and the optimum number expected to be used.**

The mechanical model needs some modifications to efficiently perform a parametric study. As previously stated, a parametric study will be performed to better understand the relationship of growth/bow to power histories. The additional oxide data we plan to take will strengthen the confidence in the oxide growth model.

In addition we will also study the sensitivity of the growth models. We will discuss these results when the analysis is complete.

9) Please provide growth data and strength data for ZIRLO to validate the claim that ZIRLO is not susceptible to thimble tube distortion.

The basic material properties between ZIRLO and Zirc-4 are significant with regard to thimble tube distortion as follows:

- Growth Rate: Figure 15 shows the measured fuel assembly growth (thimble tube) data for Zirc-4 and ZIRLO up to fluences corresponding [ ]^{a,b,c} GWD/MTU. The improvements in the growth of ZIRLO is clearly evident.

- Creep Rate: Typical fuel rod diametrical creep is shown in Figure 16. Again, ZIRLO clearly [ ]^{a,b,c} than Zirc-4.

- Oxide Data: Figure 17 shows typical fuel rod oxide data for ZIRLO and two Zirc-4 materials. Again there is a significant improvement in the oxide thickness for ZIRLO relative to Zirc-4.

10) Please explain why there would not be a power history and temperature combination for which accelerated growth would occur for ZIRLO.

As we discussed earlier, our parametric study to illustrate the relationship between temperature and cycle power history is incomplete, however, we have performed an analysis showing the improvement in growth and bow had Wolf Creek assembly had ZIRLO instead of Zirc-4. Comparing the ZIRLO H50 results from Figure 18 with the Zirc-4 H50 results in Figure 19, we concluded that [

.]^{a,b,c}

Table 1: Measured Top Span, Guide Thimble and Dashpot Drag Data

a,b,c

Figure 1: 14 ft Fuel Assembly vs. 12 Ft Fuel Assembly Lower Guide Tube Geometry

[ ]a,b,c

Figure 2: Typical Dashpot Distortion for 14 ft and 12 ft Fuel Assemblies

a,b,c

Figure 3: NRC 96-01 Dashpot & Upper Guide Thimble Drag Data

a,b,c

Figure 4: NRC 96-01 Dashpot Drag Data

a,b,c

Figure 5: NRC 96-01 Upper Guide Thimble Drag Data

a,b,c

Figure 6: Dashpot & Upper Guide Thimble Drag Data - Root Cause Testing

a,b,c

Figure 7: Dashpot Drag Data - Root Cause Testing

a,b,c

Figure 8: Upper Guide Thimble Drag Data - Root Cause Testing

a,b,c

Figure 9: Recent Fuel Assembly Growth Data - Zr-4 Grids

a,b,c

Figure 10: North Anna and Vogtle Upper Guide Thimble Drag Data @ Fluence

a,b,c

Figure 11: North Anna & Vogtle Dashpot Drag Data @ Fast Fluence

a,b,c

Figure 12: Dashpot and Upper Guide Thimble Drag Data
(Drag Measured after Reactor Trip)

a,b,c

Figure 13: Dashpot Drag and Fast Fluence Data
(Drag Measured after Reactor Trip)

a,b,c

Figure 14: Upper Guide Thimble Drag and Fast Fluence Data
(Drag Measured after Reactor Trip)

a,b,c

Figure 15: ASSEMBLY GROWTH DATA (ZIRLO VS ZR-4 THIMBLES)

a,b,c

Figure 16: North Anna Creep Measurements

a,b,c

Figure 17: North Anna Corrosion Measurements

a,b,c

Figure 18

WC H50 ROD & ASSEMBLY GROWTH
(ZIRLO)

[ ] a,b,c

WC H50 THIMBLE SPAN BOW
(ZIRLO)

[ ] a,b,c

Figure 19

WC H50 ROD & ASSEMBLY GROWTH

(REF CASE)

a,b,c

WC H50 THIMBLE SPAN BOW

(REF CASE)

a,b,c

Figure 20

WC J32 ROD & ASSEMBLY GROWTH
(H50 POWER HISTORY)

[ ] a,b,c

FLUENCE (xE21 NVT)

WC J32 THIMBLE SPAN BOW
(H50 POWER HISTORY)

[ ] a,b,c