Westinghouse Electric Company LLC

Box 355
Pittsburgh Pennsylvania 15230-0355

March 29, 2001
LTR-NRC-01-7

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

Attention: J. S. Wermiel, Chief
Reactor Systems Branch
Division of Systems Safety and Analysis

Subject: Addendum 2 to WCAP-12472-P-A / WCAP-12473-A, "BEACON Core Monitoring and Operation Support System"

Dear Mr. Wermiel:

Enclosed are five copies of the Proprietary and Non-Proprietary versions of Addendum 2 to WCAP-12472-P-A / WCAP-12473-A, "BEACON Core Monitoring and Operation Support System," being submitted for review and approval.

Also enclosed are:

1. One (1) copy of the Application for Withholding, AW-01-1445 with Proprietary Information Notice and Copyright Notice.

2. One (1) copy of Affidavit, AW-01-1445.

Addendum 2 extends the previously licensed BEACON power distribution monitoring methodology to plants containing self-powered fixed incore detector types other than rhodium. Calvert Cliffs Nuclear Power Plant intends to use this methodology shortly and a timely review and approval of Addendum 2 is requested.

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.

T008
1/1

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.

Correspondence with respect to any Application for Withholding should reference AW-01-1445 and should be addressed to H. A. Sepp, Manager of Regulatory and Licensing Engineering, Westinghouse Electric Company LLC, P. O. Box 355, Pittsburgh, Pennsylvania 15230-0355.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

cc: R. Wharton, NRR

Westinghouse Electric Company LLC

Box 355
Pittsburgh Pennsylvania 15230-0355

March 29, 2001
AW-01-1445

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

Attention: J. S. Wermiel, Chief, Reactor Systems Branch
Division of Systems Safety and Analysis

Reference: Letter from H. A. Sepp to J. S. Wermiel, LTR-NRC-01-7, dated March 29, 2001

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject: Addendum 2 to WCAP-12472-P-A, "BEACON Core Monitoring and Operation Support System" [Proprietary]

Dear Mr. Wermiel:

The application for withholding is submitted by Westinghouse Electric Company LLC, a Delaware limited liability company ("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-01-1445 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-01-1445 and should be addressed to the undersigned.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

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:

ss

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 LLC, a Delaware limited liability company ("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, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 2ND day
of April, 2001.

Notary Public

LORRAINE M. PIPLICA COMMONWEALTH OF PENNSYLVANIA NOTARY PUBLIC

Notarial Seal
Lorraine M. Piplica, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Dec. 14, 2003
Member, Pennsylvania Association of Notaries

(1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services Division, of the Westinghouse Electric Company LLC, a Delaware limited liability company ("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 Electric Company LLC.

(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 Electric Company LLC 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 Westinghouse Electric Company LLC letter (LTR-NRC-01-7) and Application for Withholding Proprietary Information from Public Disclosure, H. A. Sepp, Westinghouse, Manager Regulatory and Licensing Engineering to the attention of J. S. Wermiel, Chief, Reactor Systems Branch. The proprietary information as submitted by Westinghouse Electric Company LLC is Addendum 2 to WCAP-12472-P-A which provides information on additional fixed incore detector types.

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

(a) Improve core monitoring methodology

(b) Assist customers to obtain license changes resulting from the improvements

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of the information to its customers for purposes of improving core monitoring techniques

(b) 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 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 information.

Further the deponent sayeth not.

WCAP 12473-A
Addendum 2

BEACON
Core Monitoring and Operation Support System

Westinghouse Electric Company LLC

WCAP-12473-A
Addendum 2

BEACON

Core Monitoring and Operation Support System

March 2001

W. A. Boyd

Approved:

T. J. Collier, Manager
Core Engineering

R. W. Miller, Manager
Advanced Software Development

Westinghouse Electric Company
Nuclear Fuel
4350 Northern Pike
Monroeville, PA 15146

TABLE OF CONTENTS

1.0 BACKGROUND

2.0 NEW FEATURES ADDED TO BEACON

(a) Use of Platinum and the use of Vanadium Fixed Incore non-depleting Self-Powered Detectors for incore monitoring

3.0 WESTINGHOUSE MONITORING METHODOLOGY

3.1 Platinum Self-Powered Detector

3.2 Vanadium Self-Powered Detector

3.3 Inferred Power Distribution

4.0 QUALIFICATION OF SPD MODEL AND MEASUREMENT VARIABILITY

5.0 POWER PEAKING FACTOR MONITORING UNCERTAINTY

6.0 TECHNICAL SPECIFICATION MODIFICATIONS

7.0 DETECTOR GEOMETRY

8.0 CONCLUSION

REFERENCES

LIST OF TABLES

1 SPD Measurement data for BEACON Qualification

2 Statistics of Deviation between Predicted and Measured Detector Current

LIST OF FIGURES

1 SPD Qualification Analysis Procedure

2 Platinum Standard Deviation of Prediction to Measurement Errors

3 Vanadium Average Detector Current Ratio of Prediction to Measurement

4 Platinum Axial Detector Locations

5 Vanadium Axial Detector Locations

1.0 BACKGROUND

A topical report on "BEACON Core Monitoring and Operations Support System," was submitted to the USNRC in April, 1990 and was approved in February, 1994.(1) The key aspects of the report are 1) the methodology used to obtain the measured power distribution from the Westinghouse standard instrumentation system, i.e., the movable incore detectors, core exit thermocouples and excore detectors, and 2) the methodology for assessing uncertainties to be applied to the measured power distribution and Technical Specifications with BEACON as the source of the measured power distribution.

An addendum to the topical report was submitted to the USNRC in May, 1996 and was approved in September, 1999.(2) The key aspects of this addendum are 1) the new methodology in BEACON to predict the Rhodium self-powered neutron detector (SPD) responses and 2) the methodology to assess uncertainties to be applied to the measured power distribution and Technical Specifications for SPD plants using BEACON as the source of the measured power distribution.

2.0 NEW FEATURES ADDED TO BEACON

The purpose of this addendum is to summarize the following additional optional features implemented into the BEACON system.

> The use of Platinum and the use of Vanadium Fixed Incore non-depleting Self-Powered Detectors for incore monitoring.

The basic principle of power distribution inference of the BEACON system is unchanged, i.e., the measured power distribution can be obtained by adjusting the predicted power distribution by the amount of difference between measured and predicted detector responses.

The only new aspect of the SPD BEACON methodology is how to predict the detector response, i.e., the Platinum or Vanadium detector currents. The Westinghouse methodology chosen to predict the detector current or Vanadium reaction rate is the licensed PHOENIX-P methodology.(3) The Platinum reaction rate is predicted by the licensed PHOENIX-4 methodology.(4)

The benefits of this approach and detectors are:

(i) Proven and licensed PHOENIX methodology, which is supported by many critical experiments and plant data

(ii) The method is based on basic neutron physics and to as great an extent as possible avoids the use of empirical correlations and data

(iii) These non-depleting detectors will replace existing Rhodium detectors and will not require new cabling runs or hardware configurations for data measurements.

3.0 WESTINGHOUSE MONITORING METHODOLOGY

3.1 Platinum Self-Powered Detector

The platinum detectors are most sensitive to the gamma flux with 80% of the detector response due to the gamma's. The detectors are also weakly sensitive to the neutron flux which provides the other 20% of the response. The depletion rate of the platinum is relatively small and can be neglected because natural platinum contains 5 stable isotopes in which most of the depletion comes from Pt-195 which depletes into the stable isotope Pt-196. Both the gamma and neutron signals are proportional to the assembly power.

The gamma response must be combined with the neutron response to provide the full detector response signal. These responses are obtained from the PHOENIX-4 code. The neutron and gamma response functions are enrichment and burnup dependent due to their impact on the flux. The gamma and neutron response functions are generated as a function of assembly enrichment and burnup.

The platinum detectors are sensitive to gamma rays emitted by fuel rods in close proximity to the detector. Because of this selective response and the power gradients in the assemblies, the actual power distributions in the core environments must be accounted for in determining the detector response. This is done by using pin weighting factors which represent the contribution of the various fuel pins to the detector signal. The pin powers are determined by the pin power reconstruction methodology of the nodal neutronic solution. The ANC[3] nodal solutions method is used in BEACON.

The BEACON system will predict the Pt-SPD current given by the following function:

a,c

The W_i factors are obtained from Monte Carlo calculation performed by the MCNP code. They depend on the fuel pin and assembly geometries, but not on the pin type, enrichment, burnup or power.

3.2 Vanadium Self-Powered Detector

The Vanadium detectors are neutron sensitive with a similar reaction as the commonly used Rhodium incore detector. Neutrons interact with the emitter material to produce electrons through an N-β reaction. The flow of electrons to the outer sheath produces an electrical current that is proportional to the number of neutron interactions in the emitter.

Vanadium is one of several well known neutron detector materials and has been used in both Light Water Reactors (LWR) and the AECL CANDU type reactors for many years. The benefit of Vanadium is its low depletion, which is a factor of twenty times less than Rhodium. Due to a relatively small absorption cross section, and the lack of a neutron resonance structure, a simple SPF model can predict the output current very accurately.

The BEACON system has the capability of predicting Vanadium SPD current, which is given by:

a,c

The effective microscopic cross section is a function of the Vanadium density and is obtained from the PHOENIX code. Instrumentation thimble flux is determined by the pin power reconstruction methodology of the nodal neutronic solution.

3.3 Inferred Power Distribution

Once the predicted power distribution and detector currents are calculated, the power distribution inference can be performed by using the existing BEACON flux map power distribution methodology.[1] The monitored power distribution determined by BEACON is defined by:

a,c

The ratio of I_M/I_P indicates the difference between the measured and predicted flux distribution. The best estimate measured power distribution is obtained by adjusting the predicted power distribution by the I_M/I_P current ratio.

a,c

After each radial node power has been interpolated, the 3-D power distribution will be normalized to unity. The ratio of the measured to predicted power in each node is defined as the incore calibration constant for that node. This constant is then multiplied by the node fluxes and node peak powers to generate the measured values of these parameters.

4.0 QUALIFICATION OF SPD MODEL AND MEASUREMENT VARIABILITY

In order to qualify the Westinghouse methodology, the plant measurement data acquired from operating plants were analyzed and the measured and predicted detector currents were compared. Table 1 shows the qualification plants, detector design features and the history of the SPD measurement data used for the analysis.

The purpose of this analysis is two fold, i.e.,

(i) To verify that the proposed Platinum and Vanadium SPD models are capable of predicting the magnitude of the detector current

(ii) To evaluate the detector measurement variability in the operating detector systems

Figure 1 shows the flow of the SPD Qualification Analysis Procedures. The averaged Platinum predicted detector currents are normalized to the measured results. The standard deviation of the measured to predicted detector current errors are determined for each map measurement. The results are shown in Figure 2.

The ratio of the core average predicted currents to the core averaged measured currents were determined over all Vanadium SPD measured data at each map measurement. The averaging process eliminates detector to detector variation and provides an accurate evaluation of the overall SPD model. The results are shown in Figure 3. The detector currents are proportioned to the reactor thermal power, therefore the accuracy of the thermal power measurement directly affects these results. Considering this inherent uncertainty, it is seen that the proposed SPD models are capable of predicting the magnitude of the Platinum or Vanadium detector currents (item i) with acceptable accuracy.

For the detector measurement variability (item ii), comparisons were made between measurement and prediction for each of the individual detectors. The measured and predicted currents are normalized to eliminate the difference due to the thermal power measurement uncertainty. The standard deviation of the detector measurement variability, σ_m, is shown in Table 2.

The variability is consistent with the variability shown for the 40 cm length rhodium detectors evaluated in Addendum 1 to WCAP-12472-P-A.[2] considering the number of data points.

Thus, it is concluded that the BEACON SPD methodology is generally consistent with the detector behavior observed in the operating plants.

5.0 POWER PEAKING FACTOR MONITORING UNCERTAINTY

The uncertainty of the BEACON "measured" peaking factor is affected by

- Detector Measurement Variability
- Number and Layout of Detectors and their Availability
- Interpolation Technique
- Differences between Predicted and True Power Distribution

The simulation methodology is described in detail in the WCAP-12472-P-A.[1] The BEACON power distribution uncertainty methodology is designed to determine the power peaking factor

measurement uncertainty for a wide range of the SPD detector operating conditions. The measured peaking factor uncertainty is defined as a function of the fraction of inoperable detectors and the detector measurement variability as given by Equation 3 and Equation 4 of Addendum 1 to WCAP-12472-P-A.(2) The methodology of the power peaking factor uncertainty determination is described in Section 5 of Addendum 1 to WCAP-12472-P-A.(2) This methodology is unchanged and is applicable to any required peaking factor parameter.

The Platinum and Vanadium incore detectors can be mixed in the core with each other or with Rhodium incore detectors. A bounding measurement variability will be used by the BEACON system for the limiting detector design. For example, the Platinum detector measurement variability listed in Table 2 is less than the bounding measurement variability used by the BEACON System for the comparable Rhodium detector design. If the current rhodium detector assemblies are gradually replaced by the similarly configured Platinum detector assemblies, the BEACON System power distribution measurement uncertainty remains bounding. Therefore, the current power distribution measurement uncertainty equations used by the BEACON System will bound the uncertainty of the transition from the Rhodium detector assemblies to the Platinum detector assembly design.

6.0 TECHNICAL SPECIFICATION MODIFICATIONS

Each vendor has power distribution Technical Specifications that require surveillance of parameters related to hot rod power and local power density. BEACON can easily provide any required surveillance of these limits. There is no need to change the actual power distribution related Technical Specifications requirements if the BEACON System is used with SPD's at Westinghouse, Babcock and Wilcox or Combustion Engineering designed plants. It will be necessary, however, to include a BEACON Operability specification in the Technical Requirements Manual (TRM) associated with either the NUREG-1430 or NUREG-1432 format Technical Specifications. This TRM specification will address the minimum number and distribution, as applicable, of plant sensor inputs required for BEACON to properly monitor the core power distribution. The minimum number and distribution of incore detectors required to insure that the core peaking factor measurement uncertainties remain bounded by the values assumed in the reactor design limits will be ascertained for the plant specific detector configuration as described in Section 5.0 of Addendum 1 to WCAP-12472-P-A.(2)

The sample TRM associated with BEACON operability included in Addendum 1 of WCAP-12472-P-A(2) requires that measurements be obtained from at least 75% of the incore detectors for the initial power ascension at the beginning of each operating cycle. After this time period, BEACON is considered operable as long as 50% of the incore detectors are available.

There is no requirement for the minimum number of operable detectors in a string or a minimum number of measured symmetric locations. The minimum number of incore detectors for quadrant tilt and axial offset monitoring recommended in Addendum 1 of WCAP-12472-P-A(2) is defined below.

a,c

[ ]

7.0 DETECTOR GEOMETRY

The incore detector assembly contains the detector elements (Platinum or Vanadium wires) distributed in several axial locations. The detector assemblies are installed in the instrument thimbles of selected fuel assemblies in a reactor core.

The NSSS vendor defines the detector locations to obtain the maximum information for a given number of detector assemblies. The actual detector configuration and layout in operating reactors varies by reactor vendor and plant. Implementation of the BEACON System with Platinum or Vanadium incore detectors will not require a change to the reactor core detector geometry configuration or layout.

Examples of possible Platinum and Vanadium detector axial locations are shown in Figures 4 and 5 respectively.

8.0 CONCLUSION

Westinghouse has applied the licensed PHOENIX-P/ANC and PHOENIX-4 Code Systems for the prediction of the Platinum and Vanadium Self-Powered Detector (SPD) currents. The qualification analysis has been performed for the plant measurement data acquired from multiple operating plants. The results indicate the proposed methodology is consistent with the detector behavior observed in the operating plants.

The qualified SPD methodology integrated with the existing BEACON System will provide the power distribution monitoring capability for SPD plants.

REFERENCES

1. Beard, C. L., Morita, T., "BEACON -- Core Monitoring and Operations Support System," WCAP-12472-P-A, August 1994.

2. Morita, T., "BEACON -- Core Monitoring and Operations Support System," WCAP-12472-P-A Addendum 1-A, January 2000.

3. Nguyen, T. Q. et al, "Qualification of the PHOENIX-P/ANC Nuclear Design System for Pressurized Water Reactor Cores," WCAP-11596-P-A, June 1988.

4. "The Advanced PHOENIX and POLCA Codes for Nuclear Design of Boiling Water Reactors," CENPD-390-P, April 1999.

Table 1

SPD Measurement Data for BEACON Qualification

Plant ID	Maker of Reactor	Detector Material	Detector Configuration	Age of Detector at BOC	# of SPD MAPS Analyzed	Max BU GWD/MTU
Plant A	CE	Platinum	2 x 5 40 cm	Fresh	15	16.1
Plant B	CE	Platinum	1 x 4* 40 cm	Fresh	14	18.9
Plant C	CE	Vanadium	2 x 5 66 cm	Fresh	230	5.3

M x N and L denotes M Detector Strings: each made of N Detectors of L cm length
* 1 detector excluded because of systematic measurement errors

Table 2

Statistics of $\left(\frac{I_{\rho}^{N}(I,J,K)}{I_{m}^{N}(I,J,K)} - 1\right)$ Standard Deviation in Percent

a,b, c

Plant	Detector Material	Detector Length (cm)	Age of Detector at BOC	# of Data Points	Measurement Variability σ_m

Figure 1
SPD QUALIFICATION ANALYSIS PROCEDURE

a,c

Figure 2
Platinum
Standard Deviation of Prediction to Measurement Errors

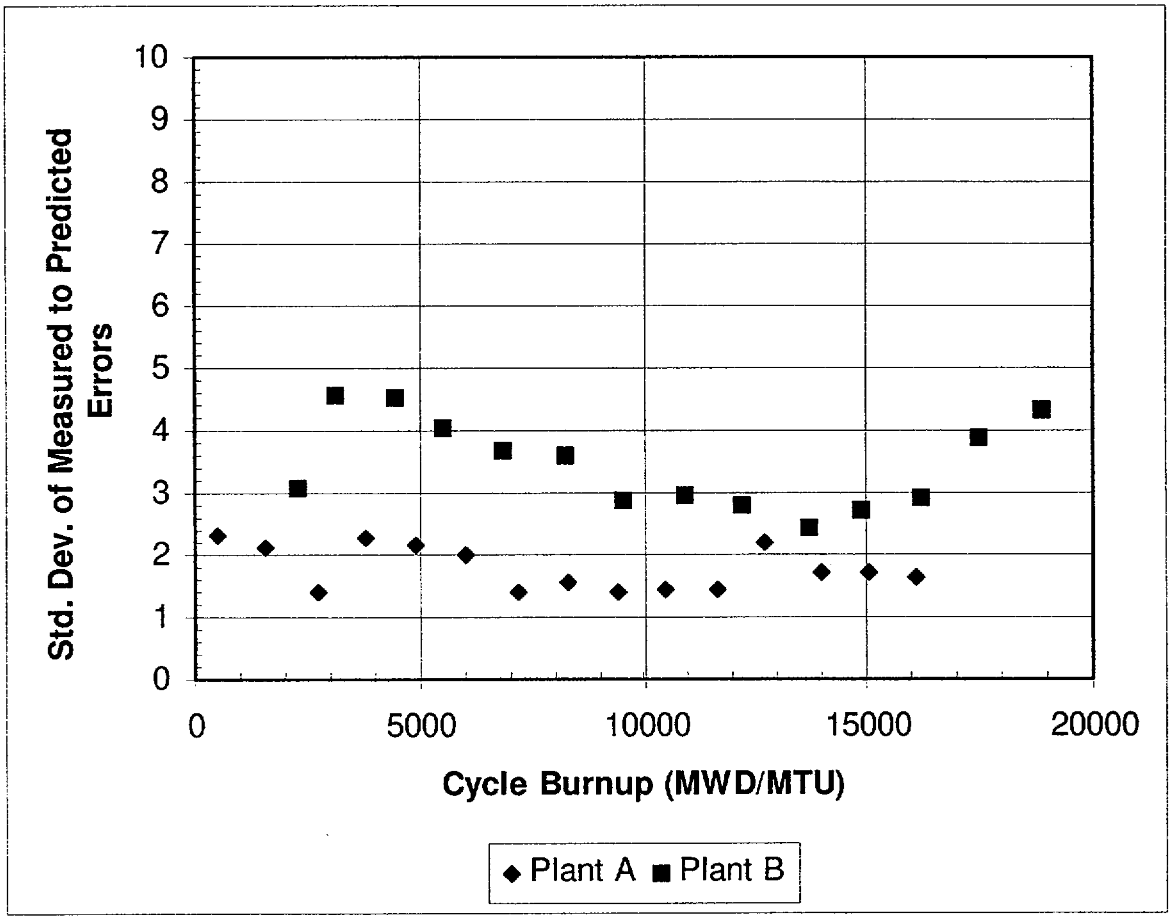


Figure 3
Vanadium
Average Ratio of Prediction to Measurement

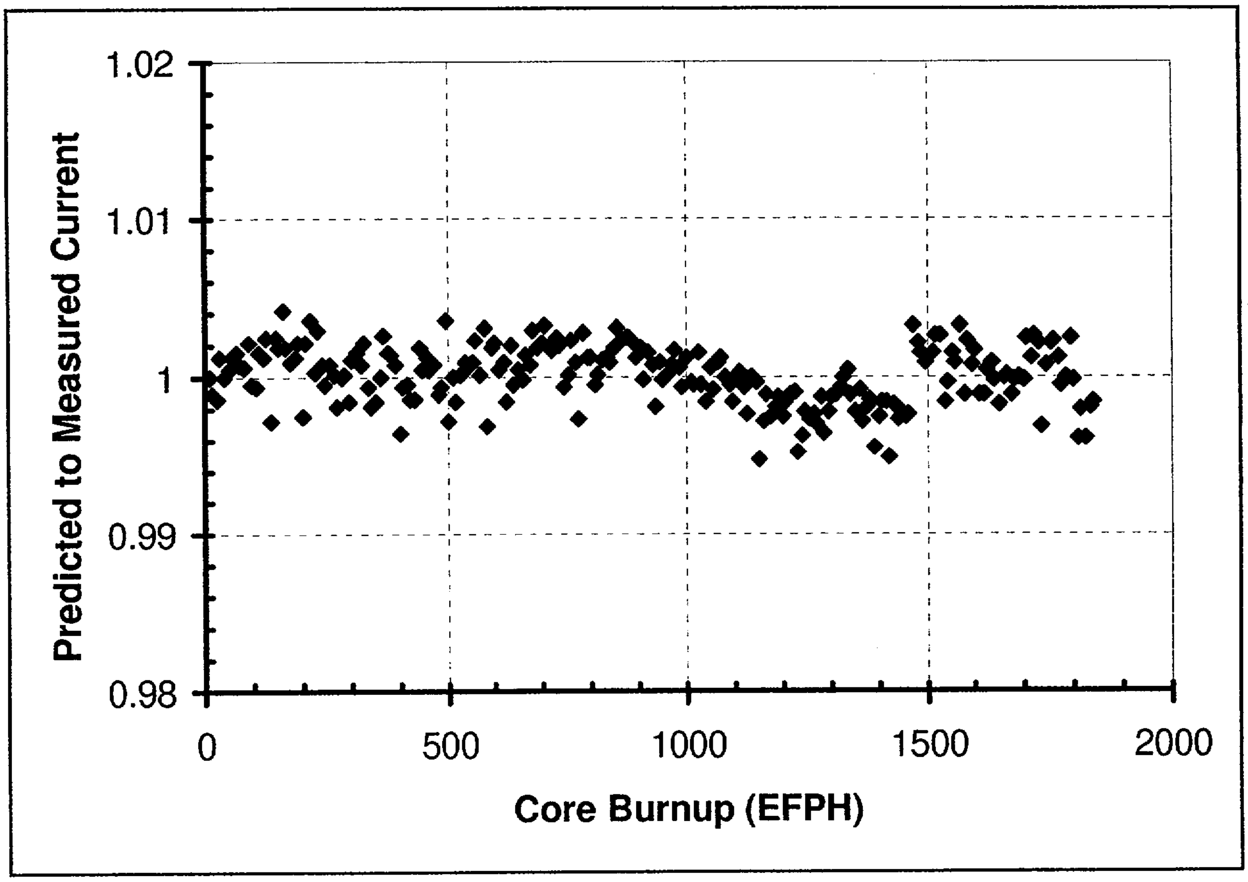
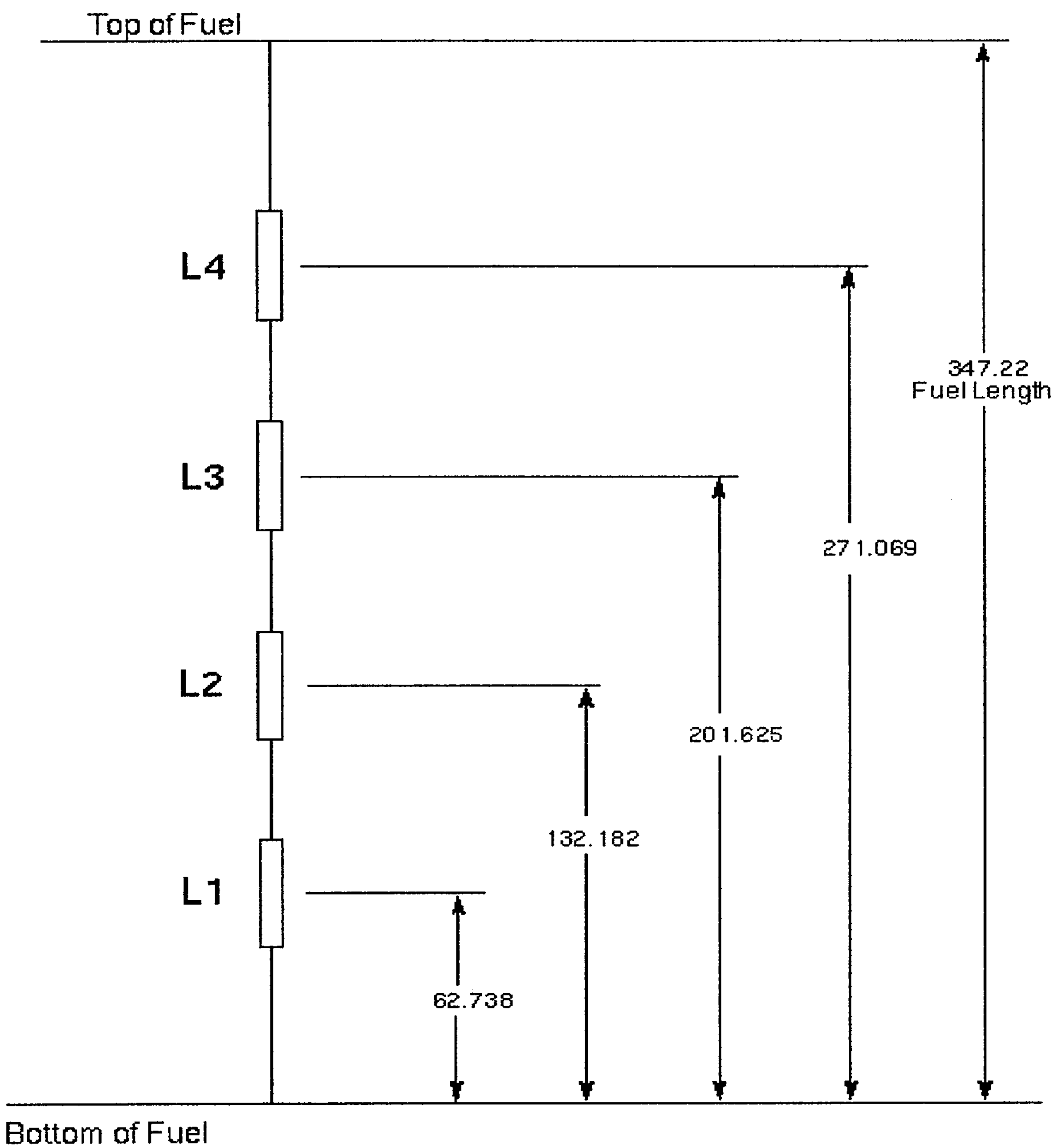
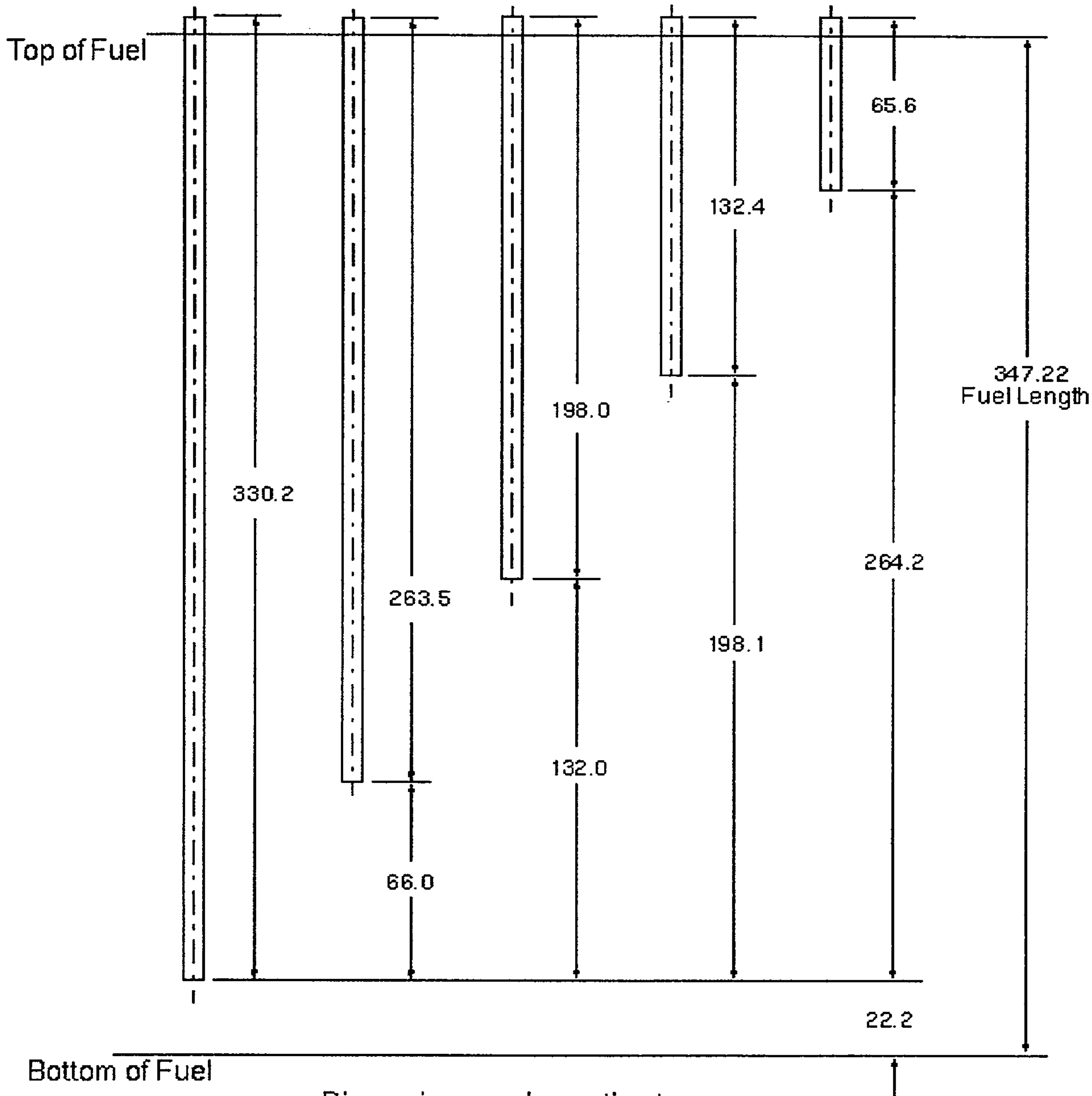


Figure 4
Platinum
Axial Detector Location



* Dimensions are in centimeters

Figure 5
Vanadium Detector Axial Layout



Dimensions are in centimeters