Westinghouse
Electric Corporation

Water Reactor
Divisions

Nuclear Technology Division

Box 355
Pittsburgh Pennsylvania 15230

April 6, 1982
CAW-82-15

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, Maryland 20014

SUBJECT: Westinghouse response to NRC questions on Improved Thermal Design Procedures for Byron/Braidwood

REF: Commonwealth Edison letter, Tramm to Denton, April 1982

Dear Mr. Denton:

The proprietary material for which withholding is being requested by Commonwealth Edison Company is proprietary to Westinghouse and withholding is requested pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. Withholding from public disclosure is requested with respect to the subject information which is further identified in the affidavit accompanying this application.

The proprietary material transmitted by the referenced letter supplements the proprietary material previously submitted. Further, the affidavit submitted to justify the previous material was approved by the Commission on April 17, 1978 and is equally applicable to the subject material.

Accordingly, withholding the subject information from public disclosure is requested in accordance with the previously submitted affidavit, AW-76-60, a copy of which is attached.

Accordingly, this letter authorizes the use of the proprietary information and affidavit CAW-82-15 by the Commonwealth Edison Company for the Byron/Braidwood Units.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference CAW-82-15 and be addressed to the undersigned.

Very truly yours,

Robert A. Wiesemann

Robert A. Wiesemann, Manager
Regulatory & Legislative Affairs

/bek
Enclosure

cc: E. C. Shomaker, Esq.
Office of the Executive Legal Director, NRC

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Robert A. Wiesemann, 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:

Robert A. Wiesemann

Robert A. Wiesemann, Manager
Licensing Programs

Sworn to and subscribed before me this 2 day of December 1976.

[signature]

Notary Public

(1) I am Manager, Licensing Programs, in the Pressurized Water Reactor Systems Division, of 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 or rule-making proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Water Reactor Divisions.

(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 Westinghouse Nuclear Energy Systems 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.

(g) It is not the property of Westinghouse, but must be treated as proprietary by Westinghouse according to agreements with the owner.

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 in 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 is not available in public sources to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in the attachment to Westinghouse letter number NS-CE-1298, Eicheldinger to Stolz, dated December 1, 1976, concerning information relating to NRC review of WCAP-8567-P and WCAP-8568 entitled, "Improved Thermal Design Procedure," defining the sensitivity of DNB ratio to various core parameters. The letter and attachment are being submitted in response to the NRC request at the October 29, 1976 NRC/Westinghouse meeting.

This information enables Westinghouse to:

(a) Justify the Westinghouse design.

(b) Assist its customers to obtain licenses.

(c) Meet warranties.

(d) Provide greater operational flexibility to customers assuring them of safe and reliable operation.

(e) Justify increased power capability or operating margin for plants while assuring safe and reliable operation.

(f.) Optimize reactor design and performance while maintaining a high level of fuel integrity.

Further, the information gained from the improved thermal design procedure is of significant commercial value as follows:

(a) Westinghouse uses the information to perform and justify analyses which are sold to customers.

(b) Westinghouse sells analysis services based upon the experience gained and the methods developed.

Public disclosure of this information concerning design procedures is likely to cause substantial harm to the competitive position of Westinghouse because competitors could utilize this information to assess and justify their own designs without commensurate expense.

The parametric analyses performed and their evaluation represent a considerable amount of highly qualified development effort. This work was contingent upon a design method development program which has been underway during the past two years. Altogether, a substantial amount of money and effort has been expended by Westinghouse which could only be duplicated by a competitor if he were to invest similar sums of money and provided he had the appropriate talent available.

Further the deponent sayeth not.

ATTACHMENT 1

Response 221.3

The following is the additional information requested on the Byron/Braidwood application of the Westinghouse Improved Thermal Design Procedure. Each of the items will be addressed individually. Items (3), (4), and (6) were addressed generically in some detail and submitted to the staff in NS-EPR-2577. As stated in that submittal, the plant specific responses to these items will supplement the generic response, serving only to note any non-conservative deviation from the generic set and the associated impact (if any) on the process parameters total uncertainties.

(1) Provide the sensitivity factors (S_i) and their range of applicability;

The sensitivity factors (S_i) and their range of applicability are given in Table 1 for Byron/Braidwood. Please note that these values are the same as those used in WCAP-9500 with the exception of the range for Vessel Flow. The range on flow for Byron/Braidwood has been extended down to 273270 GPM (70% flow) with no change in the corresponding sensitivity factor being required.

(2) If the S_i values used in the Byron/Braidwood analyses are different than those used in WCAP-9500, then the applicant must re-evaluate the use of an uncertainty allowance for application of equation 3-2 of WCAP-8567, "Improved Thermal Design Procedure" and the linearity assumption must be validated.

The S_i values used in the Byron/Braidwood analyses are the same as those used in WCAP-9500. Therefore, re-evaluating the use of an uncertainty allowance for application of equation 3-2 of WCAP-8567, "Improved Thermal Design Procedure" and the linearity assumption is not required.

(3) Provide and justify the variances and distributions for input parameters.

The distributions assumed for the input parameters such as pressurizer pressure, core average temperature, reactor power, and RCS flow are normal, two-sided, 95+% probability distributions.

The variances of these parameters for Byron/Braidwood are consistent with the variances calculated in the generic response. Specifically, the uncertainties for pressurizer pressure and core average temperature are identical to the generic response since the sensors, process racks, and computer and readout devices are standard Westinghouse supplied NSSS equipment.

Variances in reactor power and reactor coolant system flow are calculated based on equation 4 and equation 8 respectively in reference 1. As can be seen from the equations, both primary and secondary side parameters are measured for power and flow calorimetrics. The error allowances for the parameters measured by Westinghouse supplied equipment are identical to those used in the generic submittal (reference 1). Two input parameters are measured by

non-Westinghouse supplied instruments. These are feedwater temperature and feedwater pressure. As expected, the error allowances for these instruments vary slightly from those used in reference 1. The error allowances for feedwater temperature and pressure were statistically combined (as described in reference 1) to get the total channel allowance for each parameter.

The feedwater pressure error allowance was calculated to be less than the error allowance used in reference 1. Therefore, the error contribution to the reactor power and flow uncertainties from feedwater pressure is less than that used in the generic response.

Similiarly, the errors for feedwater temperature were combined to get the total channel allowance. The total allowance was found to be slightly higher than that used to calculate RCS flow uncertainty in reference 1. However, the error allowance from feedwater temperature is very small relative to the other contributing errors and in fact this small additional error is absorbed in the statistical combination. Therefore, the flow uncertainty calculated in reference 1 is applicable for Byron/Braidwood.

As stated in reference 1, the flow calorimetric can be performed one of several ways. Commonwealth Edison plans to do a precision flow calorimetric at the beginning of the cycle and normalize the loop elbow taps. For monthly surveillance to assure plant operation consistent with the ITDP assumptions, the loop flows will be read off of the plant process computer. The total flow uncertainty associated with this method was calculated in reference 1 and is applicable to the Byron/Braidwood units.

It is to be noted that the total channel allowance for feedwater temperature was calculated to be less than the error assumed for the reactor power uncertainty calculation in reference 1. Therefore, the power uncertainty for Byron/Braidwood is bounded by the uncertainty calculated in the generic response.

(4) Justify that the normal conditions used in the analyses bound all permitted modes of plant operation.

This item was addressed in reference 1 and is applicable to the Byron/Braidwood units.

(5) Provide a discussion of what uncertainties, including their values, are included in the DNBR analyses;

The uncertainties included in the ITDP DNBR analyses for Byron/Braidwood are given in Table 1. As a result of these values being different from those used in WCAP-9500, the Design DNBR Limits also differ. The calculation of the Design Limit DNBR's for the Typical and Thimble cells are given in Tables 2 and 3 respectively. Since the Design DNBR Limits given in Tables 2 and 3 are different from those originally given in the Byron/Braidwood FSAR, additional changes are required. These changes are addressed in Attachments 2 and 3.

(6) Provide a block diagram depicting sensor, processing equipment, computer and readout devices for each parameter channel used in the uncertainty analysis. Within each element of the block diagram identify the accuracy, drift, range, span, operating limits, and setpoints. Identify the overall accuracy of each channel transmitter to final output and specify the minimum acceptable accuracy for use with the new procedure. Also identify the overall accuracy of the final output value and maximum accuracy requirements for each input channel for this final output device.

Block diagrams will not be provided in this response. However, as in the generic response a table is provided giving the error breakdown from sensor to computer and readout devices. This table is abbreviated though, giving only the error breakdowns for instruments that differ from those in Table 4, "Typical Instrument Uncertainties", of reference 1. As noted earlier, these instruments are those that measure feedwater temperature and pressure.

(7) If there are any changes to the THINC-IV correlation, or parameter values outside of previously demonstrated acceptable ranges, the staff requires a re-evaluation of the sensitivity factors and of the use of equation 3-2 of WCAP-8567.

For Byron/Braidwood, the THINC-IV code and WRB-1 DNB Correlation are the same as that used in WCAP-9500. Therefore, re-evaluating the sensitivity factors and the use of equation 3-2 of WCAP-8567 is not required.

References

1. Westinghouse letter, NS-EPR-2577, E. P. Rahe to C. H. Berlinger (NRC), March 31, 1982.

ATTACHMENT 2

As a result of revised Design DNBR Limits (Typical and Thimble cells) for Byron/Braidwood, the FSAR originally prepared requires a change to these values.

The values of 1.33 for the Typical Cell Design DNBR Limit should be changed to a value of 1.34 throughout the FSAR (and Technical Specifications). Accordingly, the value of 1.31 for the Thimble Cell Design DNBR Limit should be changed to a value of 1.32. In the Byron/Braidwood FSAR Chapter 4.4, these DNBR limits are specified on pages 4.4-2 (each twice), 4.4-3, and in Figure 4.4-1 (thimble cell only). It should be noted that the changes to the Design DNBR Limit do not effect any previously related DNBR safety analyses. The Safety Analysis DNBR Limits of 1.49 and 1.47 (for typical and thimble cells respectively) remain unchanged. The change only affects the DNBR allowance between the Design DNBR Limits and the Safety Analysis DNBR Limits which is not required to meet the design basis. This DNBR allowance is available for the purpose of increasing operating flexibility in the design, operation, and analysis for the Byron/Braidwood plants.

Since a revision to the Byron/Braidwood FSAR is in order, it is suggested that the following errors in Chapter 4.4 also be corrected.

<u>Page 4.4-6</u>, the range for the Equivalent Heated Hydraulic Diameter should read:

$$0.46 \leq d_h \leq 0.68 \text{ inches}$$

<u>Page 4.4-8</u>, the units on Mass Velocity should be $lbm/hr\text{-}ft^2$ and the bulk outlet quality should read:

-52.1 to -13.5%

ATTACHMENT 3

For the purpose of determining the amount of DNBR margin available to offset rod bow penalties, the following relationship must be applied.

$$\text{SAFETY ANALYSIS DNBR LIMIT} = \frac{\text{Design DNBR Limit}}{\text{1-margin}}$$

For the Byron/Braidwood OFA application, the Design DNBR Limit is 1.32 for the thimble cell and 1.34 for the typical cell while the safety analysis DNBR limit is 1.47 and 1.49 for the thimble and typical cells respectively.

Applying the relationship above results in DNBR margin of 10.2% (thimble cells) and 10,1% (typical cells) for offsetting rod bow penalties.

The amount of fuel rod bowing to be accounted for in the OFA is described in Section 4.2.3.1 of the Byron/Braidwood FSAR and results in the same DNBR rod bow penalty as the standard 17x17 fuel assembly.

The current NRC approved licensing position for rod bow requires a 11.4% DNBR rod bow penalty for 85% gap closure at full flow conditions and a 14% DNBR rod bow penalty for 85% gap closure at low flow conditions (e.g. loss-of-flow transient). Gap closure is correlated as a function of region average burnup. At a region average burnup of 33000 MWD/MTU the resulting gap closure is 84%. This results in a required rod bow penalty of 11.1% for full flow conditions and 13.6% for low flow conditions.

The effect of rod bow on DNB is only considered for region average burnup $\leq$33000 MWD/MTU. Beyond this burnup, $F_{\Delta H}^{N}$ burndown effects preclude the fuel from achieving limiting peaking factor ($F_{\Delta H}^{N}$) due to the decrease in fissionable isotopes and the buildup of fission product inventory.

At full flow conditions, the amount of DNBR margin available to offset the required rod bow penalties is within 1.0% of that required (11.1% - 10.1%). Sufficient operating plant margin exists at low flow conditions to offset the additional 2.5% (13.6% - 11.1%) penalty between low flow and full flow conditio

Since the available DNBR margin is not sufficient by 1.0% to offset the current required rod bow penalty, a reduction in allowable $F_{\Delta H}^{N}$ as a function of burnup would be needed in the form of a Technical Specification limit for Byron/Braidwood.

However, a proposed revision to the calculation of the rod bow DNBR penalty for 17x17 fuel is contained in "Fuel Rod Bow Evaluation," WCAP-8691 (Rev. 1), Westinghouse Proprietary, and WCAP-8692 (Rev. 1), non-proprietary, July, 1979, and is currently undergoing NRC review. This revised calculation reduces the magnitude of the rod bow DNBR penalty to a value less than the 10.1% DNBR margin retained from above.

Since NRC approval of WCAP-8691 (Rev. 1) is anticipated in the near future, and since the final Byron/Braidwood Technical Specifications is not expected to be completed until later in 1982, no rod bow penalty on allowable $F_{\Delta H}^{N}$ is recommended.

TABLE 1

Byron/Braidwood ITDP

Parameter	Nominal Value	Range	Uncertainty Equivalent Standard Deviation	Sensitivity (% DNBR/% Parameter) Typical Cell	Sensitivity (% DNBR/% Parameter) Thimble Cell
Power	100% Power				
Inlet Temperature	558.5°F				
Pressure	2280 psia				
Vessel Flow	390390 GPM				
Effective Flow Fraction (Bypass)	0.957				
$F_{\Delta H}^{N}$	1.49				
$F_{\Delta H,1}^{E}$	1.0				
THINC IV	-				
Transient Code	-				

+(a,c)

TABLE 2

Calculation of Design DNBR Limit for Typical Cell

$$\left(\frac{\sigma y}{\mu y}\right)^2 = S_1^{\,2}\left(\frac{\sigma 1}{\mu 1}\right)^2 + S_2^{\,2}\left(\frac{\sigma 2}{\mu_2}\right)^2 + \ldots . S_n^{\,2}\left(\frac{\sigma n}{\mu_n}\right)^2$$

where: σ = Standard deviation

μ = mean

S = sensitivity

Parameter	Mean (μ)	σ	σ/μ	S	$S^2(\frac{\sigma}{\mu})^2$
Power	1.0				
T_{in}	558.5				
Pressure	2280				
Flow	1.0				
Bypass	.957				
$F_{\Delta H}^{N}$	1.49				
$F_{\Delta H,1}^{E}$	1.0				
THINC IV	1.0				
Transient Code	1.0				

+(a,c)

Σ=.0056785

$$\left(\frac{\sigma y}{\mu_y}\right) = \sqrt{\Sigma S_n^{\,2}\left(\frac{\sigma n}{\mu_n}\right)^2} = .075356$$

$$\therefore \text{Design DNBR Limit} = \frac{\text{Correlation Limit}}{1-(\text{Combined } \sigma)\ (1.645)}$$

$$= \frac{1.17}{1-(.075356)(1.645)}$$

Design DNBR Limit = 1.336

TABLE 3

Calculation of Design DNBR Limit for Thimble Cell

$$\left(\frac{\sigma y}{\mu y}\right)^2 = S_1^{\,2}\left(\frac{\sigma 1}{\mu 1}\right)^2 + S_2^{\,2}\left(\frac{\sigma 2}{\mu_2}\right)^2 + \ldots\ldots S_n^{\,2}\left(\frac{\sigma n}{\mu n}\right)^2$$

where: σ = Standard deviation

μ = mean

S = sensitivity

Parameter	Mean (μ)	σ	σ/μ	S	$S^2(\frac{\sigma}{\mu})^2$ +(a,c)
Power	1.0				
T_{in}	558.5				
Pressure	2280				
Flow	1.0				
Bypass	.957				
$F_{\Delta H}^{N}$	1.49				
$F_{\Delta H,1}^{E}$	1.0				
THINC IV	1.0				
Transient Code	1.0				
					Σ=.0045985

$$\left(\frac{\sigma y}{\mu_y}\right) = \sqrt{\Sigma S_n^{\,2}\left(\frac{\sigma n}{\mu_n}\right)^2} = .067812$$

$$\therefore \text{Design DNBR Limit} = \frac{\text{Correlation Limit}}{1-(\text{Combined } \sigma)\ (1.645)}$$

$$= \frac{1.17}{1-(.067812)(1.645)}$$

Design DNBR Limit = 1.317

TABLE 4

INSTRUMENT UNCERTAINTIES

	Feedwater[2] Temperature Indication (computer)	Feedwater[2] Temperature Indication (DVM)	Feedwater[2] Pressure Indication (computer)
Process Measurement Accuracy	---	---	---
Primary Element Accuracy	---	---	---
Sensor Calibration Accuracy	0.5	0.5	0.4
Sensor Drift	---	---	1.0
Sensor Temperature Effects	---	---	0.5
Sensor Pressure Effects	---	---	---
Rack Calibration[1]	---	---	---
Rack Drift	---	---	---
Rack Temperature Effects	---	---	---
Digital Volt Meter	---	0.2	---
Computer Isolator Drift	---	---	---
Analog to Digital Conversion	0.1	---	0.1
Controller Accuracy	---	---	---
Channel Statistical Allowance	[		] +a,c
Instrument Span	600°F	600°F	2000 psi

(1) Instrument output goes straight to plant process computer. Therefore rack inaccuracies are all zero.

(2) Uncertainties in percent instrument span.

(3) Determined by methodology described in generic response.