Westinghouse Electric Corporation Power Systems

PWR Systems Division

Box 355
Pittsburgh Pennsylvania 15230

September 9, 1980

NS-TMA-2303

Mr. James R. Miller, Chief
Special Projects Branch
Division of Project Management
U. S. Nuclear Regulatory Commission
Phillips Building
7920 Norfolk Avenue
Bethesda, Maryland 20014

SUBJECT: Responses to "Request for Additional Information on Addendum 1 to WCAP-8720", NRC letter from J. R. Miller to T. M. Anderson, July 23, 1980

Dear Mr. Miller:

Enclosed are:

1. Forty (40) copies of the proprietary responses to the NRC request for additional information on Addendum 1 to WCAP-8720.

2. Thirty-five (35) copies of the non-proprietary responses to the NRC request for additional information on Addendum 1 to WCAP-8720 (applicable to WCAP-8785).

Also enclosed are:

1. One (1) copy of Application for Withholding (Non-Proprietary).

2. One (1) copy of original Affidavit (Non-Proprietary).

This submittal contains proprietary information of Westinghouse Electric Corporation. In conformance with the requirements of 10CFR2.790, as amended, of the Commission's regulations, we are enclosing with this submittal an application for withholding from public disclosure and an affidavit. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission.

12 RIDS
LTR
T007 S 1/40
NP ENCL
T008 S 1/35

Correspondence with respect to the affidavit or application for withholding should reference AW-80-54 and should be addressed to R. A. Wiesemann, Manager of Regulatory and Legislative Affairs, Westinghouse Electric Corporation, P. O. Box 355, Pittsburgh, Pennsylvania 15230.

Very truly yours,

for T. M. Anderson, Manager
Nuclear Safety Department

CJR/kk
Enclosures

Westinghouse Electric Corporation

Water Reactor Divisions

Nuclear Technology Division

Box 355
Pittsburgh Pennsylvania 15230

September 9, 1980
AW-80-54

Mr. James R. Miller, Chief
Special Projects Branch
Division of Project Management
U. S. Nuclear Regulatory Commission
Phillips Building
7920 Norfolk Avenue
Bethesda, Maryland 20014

APPLICATION FOR WITHHOLDING PROPRIETARY

INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT: Proprietary Responses to "Request for Additional Information on Addendum 1 to WCAP-8720," NRC Letter from J. R. Miller to T. M. Anderson, July 23, 1980

REF: Westinghouse Letter No. NS-TMA-2303, Anderson to Miller, dated September 9, 1980

Dear Mr. Miller:

The proprietary material transmitted by the referenced letter is of the same technical type as material previously submitted concerning the Westinghouse PAD code models (Reference: NS-TMA-2140). Further, the affidavit submitted to justify the material previously submitted, AW-76-51 referenced via AW-79-36, was approved by the Commission on July 27, 1977, and is equally applicable to this material.

Accordingly, withholding the subject information from public disclosure is requested in accordance with the previously submitted affidavit and application for withholding, AW-76-51, dated November 2, 1976, a copy of which is attached.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-80-54, and should be addressed to the undersigned.

Very truly yours,

Robert A. Wiesemann

Robert A. Wiesemann, Manager
Regulatory & Legislative Affairs

/bek
Attachment

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

Westinghouse Electric Corporation

Power Systems Company

PWR Systems Division

Box 355
Pittsburgh Pennsylvania 15230

November 2, 1976

AW-76-51

Mr. John F. Stolz, Chief
Light Water Reactors Project
Division of Project Management
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
7920 Norfolk Avenue
Bethesda, Maryland 20014

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT: PAD Code Models

REF.: Westinghouse Letter No. NS-CE-1262, Eicheldinger to Stolz, dated November 2, 1976

Dear Mr. Stolz:

The proprietary material being transmitted by the referenced letter supplements proprietary material previously submitted concerning Westinghouse fuel rod designs and fuel rod performance.

Accordingly, withholding the subject information from public disclosure is requested in accordance with our previously submitted affidavit and application for withholding AW-76-43, dated October 18, 1976, a copy of which is attached.

Correspondence with respect to this application should reference AW-76-51 and should be addressed to the undersigned.

Very truly yours,

Robert A. Wiesemann

Robert A. Wiesemann, Manager
Licensing Programs

/smh

Attachment

cc: J. A. Cooke, Esq.
Office of the Executive Legal Director, NRC

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

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, Manager
Licensing Programs

Sworn to and subscribed
before me this 18 day
of October 1976.

Notary Public

[illegible]

[illegible]

(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 rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Water Reactor Divisions.

(2) I am making this Affidavit in connection with the provisions of 10 CFR Section 2.790 and Section 9.5(a)(4) of the Commission's regulations.

(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 being withheld from public disclosure should continue to be withheld.

(i) The information being 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 was transmitted to the Commission in confidence, was received in confidence by the Commission, and was not submitted in a rulemaking proceeding.

(iv) The information is not available in public sources to the best of our knowledge and belief.

(v) The proprietary information being withheld are the Westinghouse reports: (1) "Densification of Recycle Mixed Oxide Compared to the Densification of UO_2," previously transmitted to the Commission on February 19, 1974, and (2) WCAP-8218, October 1973, "Fuel Densification, Experimental Results and Model for Reactor Application," previously transmitted to the Commission on October 29, 1973. This Affidavit and Westinghouse Letter No. NS-CE-1246, Eicheldinger to Felton, dated October 18, 1976, are being furnished in response to the September 13, 1976 NRC request for information in connection with a Freedom of Information Act request and to enable the NRC to determine whether it will continue to withhold the subject reports from public disclosure pursuant to the provisions of 10 CFR Section 9.5(a)(4) of the Commission's regulations.

This information enables Westinghouse to:

(a) Justify the design basis for the fuel.

(b) Justify the Westinghouse design correlations.

(c) Reduce fuel needs of customers and reduce plant and fuel costs of customer.

Further, this information has substantial commercial value as follows:

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

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

(c) Westinghouse uses the information to sell nuclear fuel and related services to its customers.

Public disclosure of this information is likely to cause substantial harm to the competitive position of Westinghouse in selling nuclear fuel and related services.

Westinghouse retains a marketing advantage by virtue of the knowledge, experience, and competence it has gained through long involvement and considerable investment in all aspects of the nuclear power generation industry. In particular, Westinghouse has developed a unique understanding of the factors and parameters which are variable in the process of design of nuclear fuel and which do affect the in-service performance of the fuel and its suitability for the purpose for which it was provided.

In all cases, that purpose is to generate energy in a safe and efficient manner while enabling the operating nuclear generating station to meet all regulatory requirements affected by the core loading of nuclear fuel. Confidence in being able to accomplish this comes from the exercise of judgement based on experience, in the application of empirically derived models based on prior data and in the use of proven analytical models to simul e behavior of the fuel in normal operation and under hypothetical transients.

Thus, the essence of the competitive advantage in this field lies in an understanding of which analyses should be performed and in the methods and models used to perform these analyses. A substantial part of this competitive advantage will be lost if the competitors of Westinghouse are able to use the results of the analyses and by reverse engineering to normalize or verify their own methods or models or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar results. Its use by a competititor would reduce his expenditure of resources or improve his competitive position in the design and licensing of a similar product.

This information is a product of Westinghouse design technology. As such, it is broadly applicable to the sale and licensing of fuel in pressurized water reactors. The development of this information is the result of many years of Westinghouse effort and the expenditure of a considerable sum of money. In order for competitors of Westinghouse to duplicate this information and the computer programs and analytical techniques which we are seeking to protect by withholding this information, would require the investment of substantially the same amount of effort and expertise that Westinghouse possesses and which was acquired over a period of more than fifteen years and by the investment of millions of dollars. Over the years, this has included the development of heat transfer codes, nuclear analysis codes, transient analysis codes, core and system simulation methods, and an experimental data base to support them.

Further the deponent sayeth not.

1. Please provide a copy of missing page B-9 of WCAP-8720.

A copy of page B-9 of WCAP-8720[1] is attached.

2. The Addendum to WCAP-8720 states that the fission gas release model was based on data from rods that experienced variable power operation. Provide plots of the power history for a representative rod of each data set shown in Appendix B of WCAP-8720.

Representative power histories for Saxton load follow and mixed oxide rods are given in Figures 3.2 and 3.3 of WCAP-8720 Addendum 1.[2] Cycle average powers of Zorita rod 386 are shown as a typical high power rod in Figure 1 of Reference (3). The detailed power history for Zorita rod 386 is given in the answer to question 3. Power histories for representative Yankee and Saxton HPCT rods are shown in Figures 1 and 2.

3. Provide a representative example (Zorita Rod #386) of the data used to derive the Westinghouse fission gas release model. Include sufficient detail for an NRC audit calculation.

A list of input data required to make fission gas release predictions for Zorita rod #386 are given below:

Fuel Rod Parameters - Zorita Rod 386

Fuel Column Length = [ ]$^{+a,c}$
Plenum Length = [ ]$^{+a,c}$
Net Plenum Volume = [ ] in.^{3}]$^{+a,c}$
Net Rod Void Volume = [ ]$^{+a,c}$
Cladding O.D. = [ ]$^{+a,c}$
Cladding I.D. = [ ]$^{+a,c}$
Cladding I.D. Roughness ≤ [ ]$^{+a,c}$
Cladding Material = Zircaloy
Fuel Enrichment = [ ]$^{+a,c}$
Pellet O.D. = [ ]$^{+a,c}$
Pellet O.D. Roughness ≤ [ ]$^{+a,c}$
Initial gap size = [ ]$^{+a,c}$
Fuel Pellet Length = [ ]$^{+a,c}$
Fuel Pellet Dish Depth = [ ]$^{+a,c}$

POOR ORIGINAL

Fuel Pellet Dish Spherical Radius = [$]^{+a,c}$

% Dish Volume in Fuel Pellet Volume = [$]^{+a,c}$

Fill Gas Type = Helium

Fill Gas Pressure = 451 psia

Initial Fuel Density = [$]^{+a,c}$

Fuel Sintering Temperature = [$]^{+a,c}$

Coolant Pressure = [$]^{+a,c}$

Equivalent Hydraulic Diameter = [$]^{+a,c}$

Coolant Mass Flow Rate = [$]^{+a,c}$

Coolant Inlet Temperature = [$]^{+a,c}$

Fast Flux (> 1 Mev) = [$]^{+a,c}$

Fast Fluence (> 1 Mev) = [$]^{+a,c}$

Power History for Rod 386

Time Step	Time (hrs.)	ΔT (hrs)	Rod Average Power (kw/ft)	Axial Power Shape $^{+(a,c)}$
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				

Power History for Rod 386 (Cont'd)

Time Step	Time (hrs)	ΔT (hrs)	Rod Average Power (kw/ft)	Axial Power Shape
				+(a,c)
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				

Axial Power Shapes For Zorita Rod 386

Axial	Station (Inch)	Heat Flux Distribution (Bottom To Top) 1	2	3	4	5	6	7	8	9	10
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

+(a,c

4. Explain why you believe the Westinghouse fission gas release model is applicable to all conditions during normal operation. Are there normal operating conditions outside of the data base for the gas release model? Specifically, consider the case of extended operation at low power to high burnup followed by high power operation for a period of greater than 50 hours.

The power histories for the rods given in the Attachment to Appendix B of WCAP-8720[1] were reviewed. Peak local powers in each cycle and at end-of-life were recorded. All of the peak powers recorded existed for time periods of at least one hundred hours. Peak local powers in each cycle and at end-of-life for representative rods are plotted versus local burnup in Figure 3. The data bound the values of peak local powers as functions of burnup that occur during normal operation of Westinghouse commercial PWRs. Thus, there are no normal operating conditions outside the data base for the gas release model.

5. Describe the power histories used in calculating LOCA initial conditions. Explain why the power histories selected yield more appropriate LOCA initial conditions than continuous operation at maximum permitted power levels.

The power histories used in calculating LOCA initial conditions and the basis for selecting these power histories is given in Reference (4). The objective is to produce axial power distributions and rod average powers that are typically produced rather than arbitrary shapes and values.

Rods are depleted using a relatively flat axial power shape up to the time of interest. At the time of interest, the axial shape is changed to produce the desired local peak power. Calculations were performed to compare results of this method to results obtained by continuous operation at the maximum permitted local power. Fuel average temperatures for a local power of 15 kw/ft are plotted versus time in Figure 4. For both examples the peak fuel temperatures occurred near beginning of life. The peak values obtained by the two methods were nearly equal, being within 2°F of each other. However, for times beyond the peak values, the method employed by W gave higher fuel temperatures. This method gives more conservative values of fuel average temperature over most of the fuel lifetime.

In summary, the power histories used by W to evaluate LOCA initial conditions;

1) Are meant to simulate actual operation
2) Give essentially the same values of peak fuel temperatures as are obtained by operating at the maximum permitted power level.
3) Give more conservative values of fuel average temperature than operating at the maximum permitted power levels for burnups beyond the burnup where the peak fuel temperatures occur.

Thus, the power histories used by W are considered to be more appropriate than continuous operation at maximum permitted power levels.

6. Describe the power historues used in calculating end-of-life rod pressures. Explain why the power histories selected yield more appropriate end-of-life rod pressures than continuous operation at maximum permitted power levels.

Power histories used to calculate end-of-life rod pressures bound the rod average powers that occur during normal operation. A typical limiting rod average power history used in these analyses is plotted versus burnup in Figure 5.

A constant value of rod average power is used during the cycle. Rod average powers for this limiting power history vary from several percent above the average value at the beginning of the cycle to several percent below the average value at the end of the cycle. Use of a constant average value of rod power during each cycle gives slightly more conservative results than the use of a value of rod power that decreases during the cycle. This occurs because higher powers occur at higher burnups. This leads to a larger prediction of fission gas release.

The effects of the variation of axial power shape with time were also investigated. The axial power shape used to determine end-of-life rod pressures is relatively flat and matches the end-of-life axial burnup distribution that is obtained from time varying axial shapes. It has been determined from calculations that use of the time integrated axial power shape gives higher end-of-life pressures than the use of time varying axial power shapes.

The use of bounding rod average power histories and flat axial shapes in the analysis gives conservative values of end-of-life pressure.

7. In light of the model's limitations in following power increases, explain why the fission gas release model is applicable to the power histories used in establishing LOCA initial conditions and end-of-life conditions and end-of-life rod pressures.

Peak fuel average temperatures occur near beginning of life. In the answer to question 4 it was shown that the power histories used to determine LOCA initial conditions gave more conservative fuel average temperatures over most of the fuel lifetime than continuous operation at the maximum permitted power level. In the answer to question 6 it was explained that limiting power histories and axial power shapes are used to calculate end-of-life rod pressures. It was shown in the answer to question 2 that the fission gas release data base bounds the peak powers that occur during normal operation.

The use of conservative methods along with a fission gas release model based on data which bounds the normal operation powers of commercial fuel ensures that appropriately conservative values are calculated for LOCA initial conditions and end-of-life rod pressures.

8. Westinghouse predictions of fission gas release from rods operated at high power for extended time periods appear to be nonconservative (see average measured-to-predicted ratios for Saxton rods, page 5, and Riso rods, page 8). Is this a valid interpretation of your results?

The average value of the measured-to-predicted values of the data shown in Attachment B of WCAP-8720 is [ ]$^{+a,c}$ with a standard deviation of [ ].$^{+a,c}$ The Saxton data are included in this data set. The M/P values of the Saxton rods given on page 5 range from [ ]$^{+a,c}$ with an average value of [ ].$^{+a,c}$ The mean value of the Saxton data are quite close to the mean value of the complete data set and no data point is more than one standard deviation from the mean. It is concluded that the Saxton data are from the same population as the complete data set. Variations in the Saxton data are due to normal scatter.

The three RISO rods have M/P values that range from [ ].$^{+a,c}$ These values are within the normal scatter of the data presented in Attachment B.

9. Provide fission gas release predictions for two additional RISO rods, PA 29-4 and M2-2C, as described in Riso-M-2152.

Predictions were made with the PAD code for RISO rods PA 29-4 and M2-2C as described in RISO-M-2152. Comparisons of measured and predicted values are given below:

Rod	M	P	M/P
PA29-4	48.1%	[	] +a,c
M2-2C	35.6%		

References

1) Miller, J. V., ed., "Improved Analytical Models Used In Westinghouse Fuel Rod Design Computations," WCAP-8720, October, 1976.

2) Leech, W. J., "Improved Analytical Models Used In Westinghouse Fuel Rod Design Computations; Application for Transient Analyses," WCAP-8720 Addendum 1, September, 1979.

3) Leech, W. J. and Kaiser, R. S., "The Effects of Fission Gas Release on PWR Fuel Rod Design and Performance," IAEA Specialists Meeting on Water Reactor Fuel Element Performance Computer Modelling, Blackpool, U.K. March 16-21, 1980.

4. Letter, R. Salvatori, Westinghouse to D. Knuth, U.S.A.E.C., NS-S1-521, Attachment L, January 4, 1973.

ATTACHMENT B (cont)

PARAMETERS OF INTEREST FOR FUEL RODS WHICH ARE SIMILAR TO THE STANDARD PRODUCT

Rod I. D.	Burnup MWD/MT	kw/ft Avg	kw/ft Peak	ρ % T. D.	P_o Psia	Fission Gas % Measured	Fission Gas % Predicted	M/P
Saxton -831 L. F.	16,070	6.6/ 9.1	13.9	92.6	15			.57
-832	14,780	7.0/ 8.2	13.8	92.6	15			1.11
-869	16,990	8.1/ 8.9	14.3	92.4	272			.91
-910	14,780	7.5/ 7.6	13.7	92.7	273			1.26
-838	11,130	9.2	16.0	92.8	298			.51
-908	10,830	8.9	14.0	92.9	272			.69
-846	16,780	8.3/ 8.5	14.1	92.8	337			.91
-899	9,700	8.2	12.5	94.8	15			2.65
-122	6,930	9.2	16.6	94.4	15			1.05
-898	15,040	7.5/ 8.3	14.0	94.8	15			1.03
-887	14,910	7.1/ 8.0	14.1	94.8	15			.64
F5	13,570	7.1/ 8.1	13.3	92.5	370			1.38
-875	10,730	9.1	13.5	94.9	176			.81
-876	14,290	6.9/ 8.3	13.9	94.8	170			1.24

(b,c)

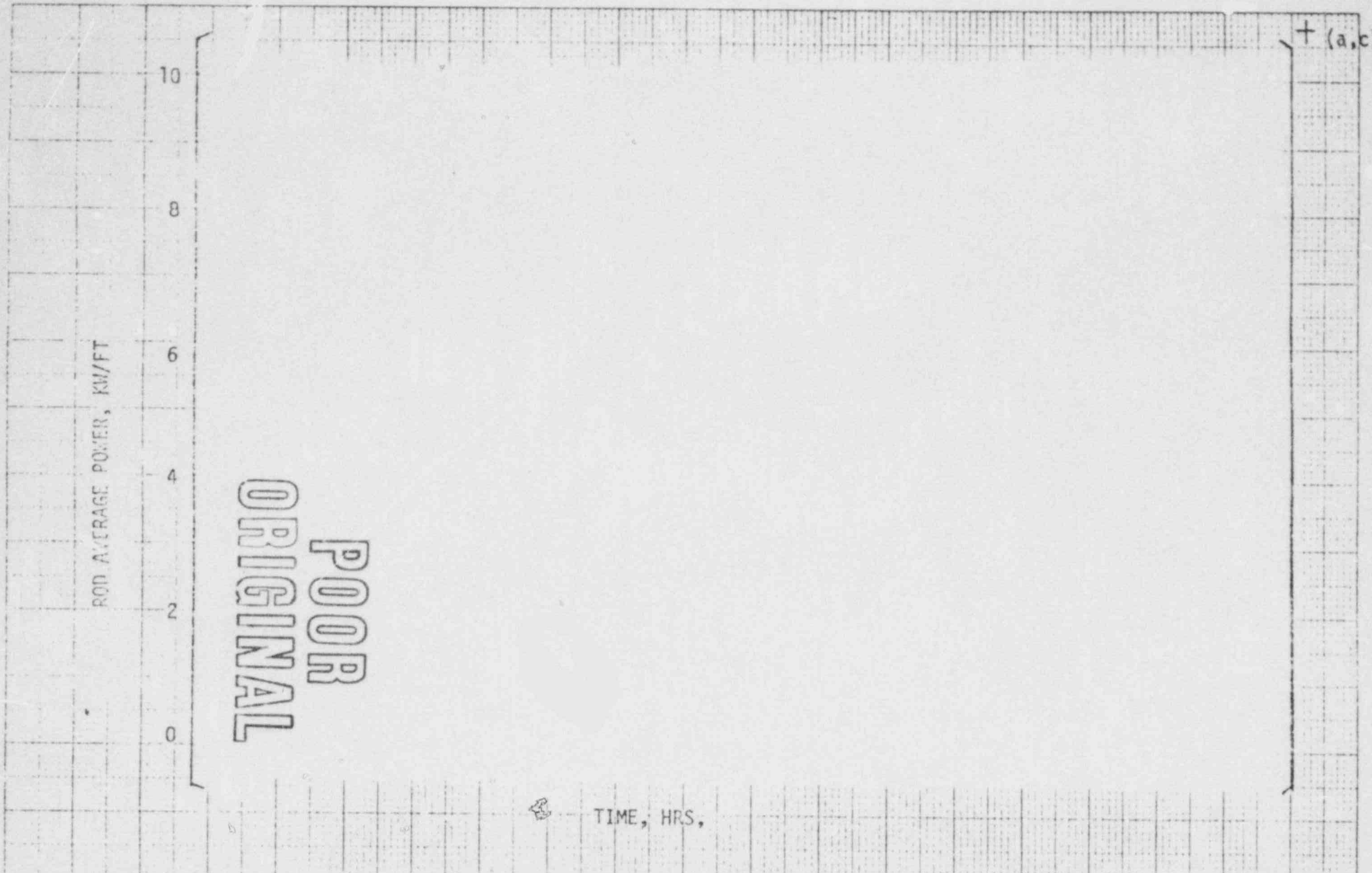

FIGURE 1. POWER HISTORY OF YANKEE ROD F-5

FIGURE 2. POWER HISTORY OF ROD HPCT-732

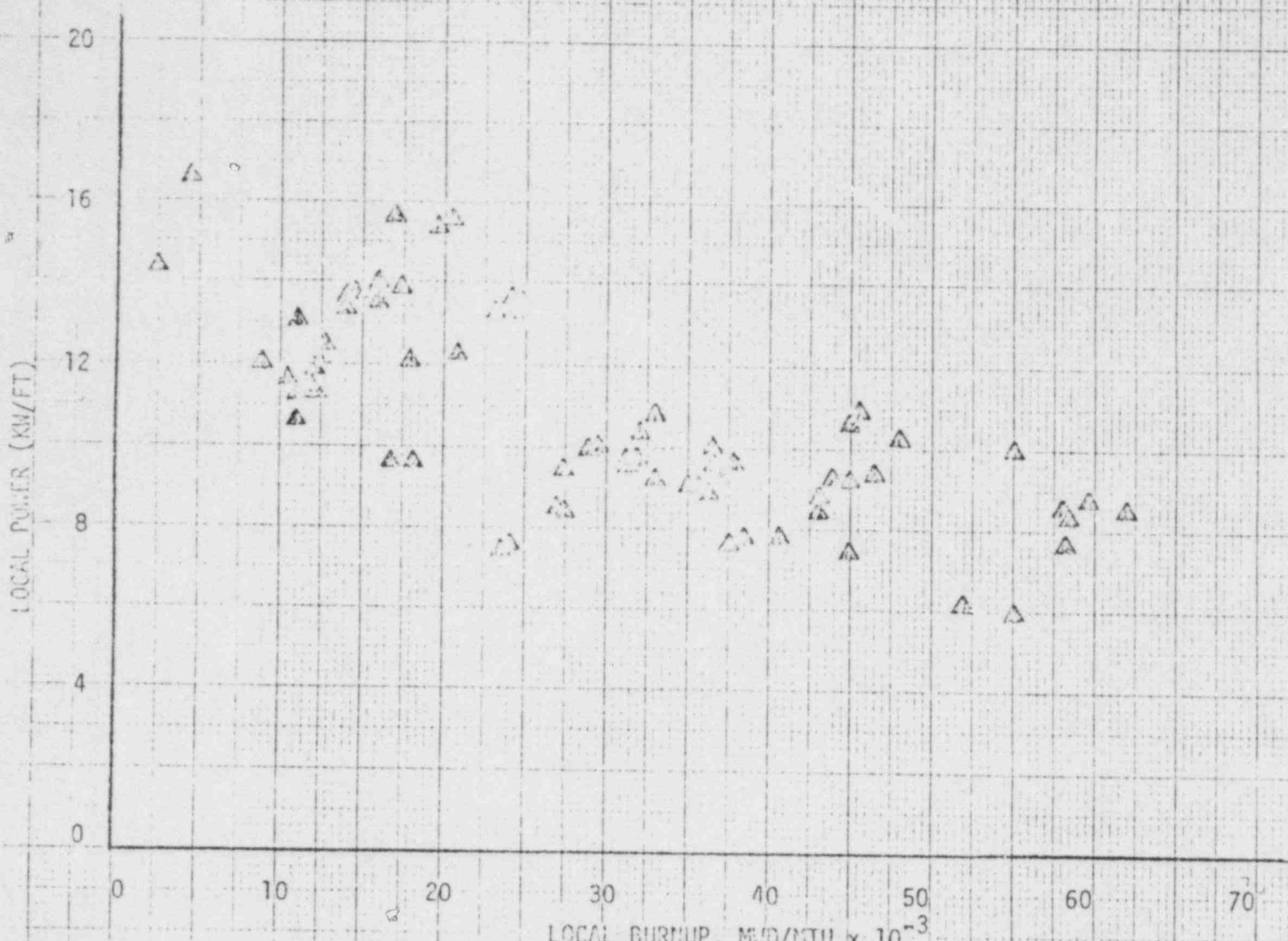

FIGURE 3. PEAK LOCAL POWER VERSUS PEAK LOCAL BURNUP FOR RODS WITH FISSION GAS RELEASE MEASUREMENTS

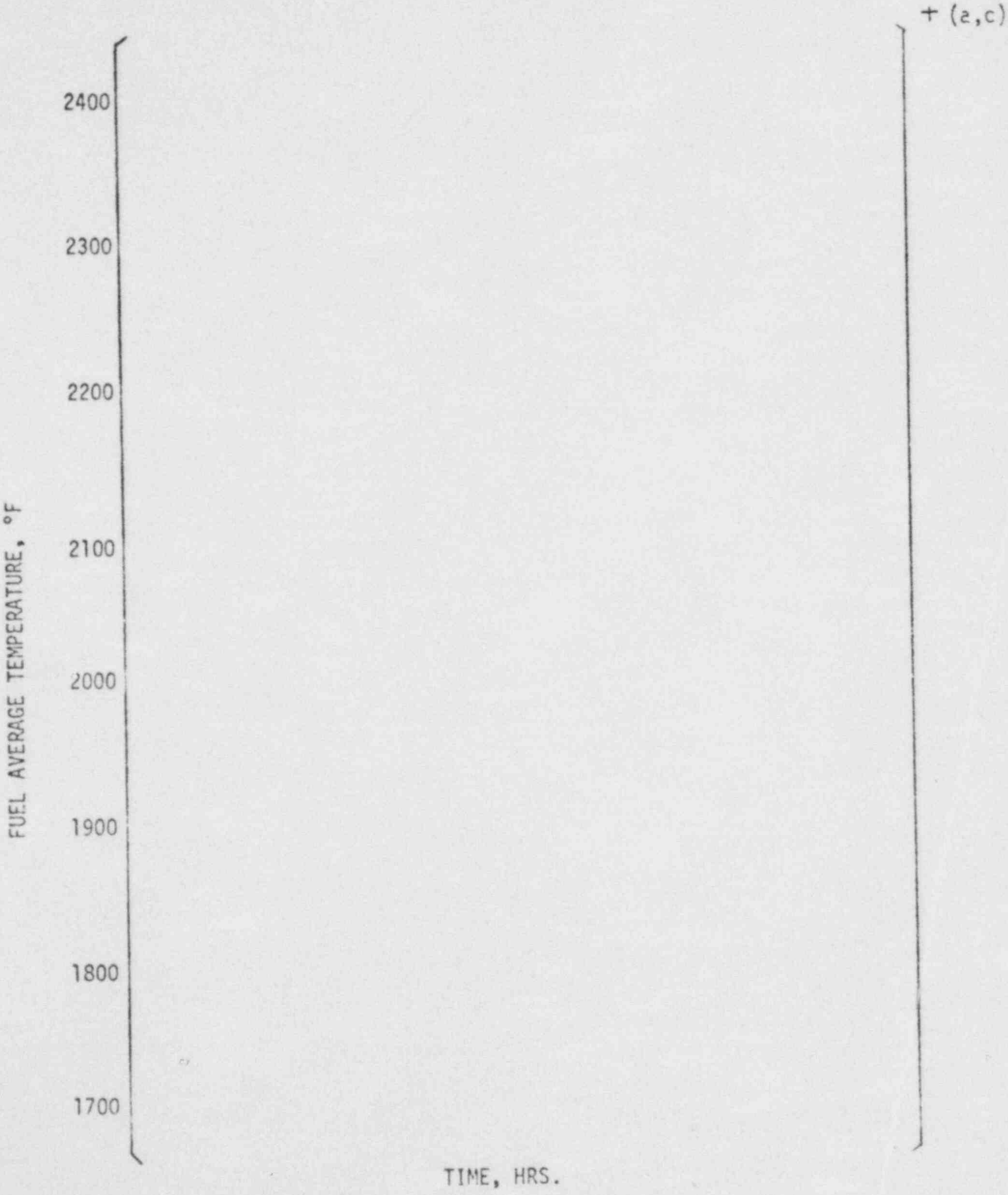

FIGURE 4. FUEL AVERAGE TEMPERATURE VERSUS TIME

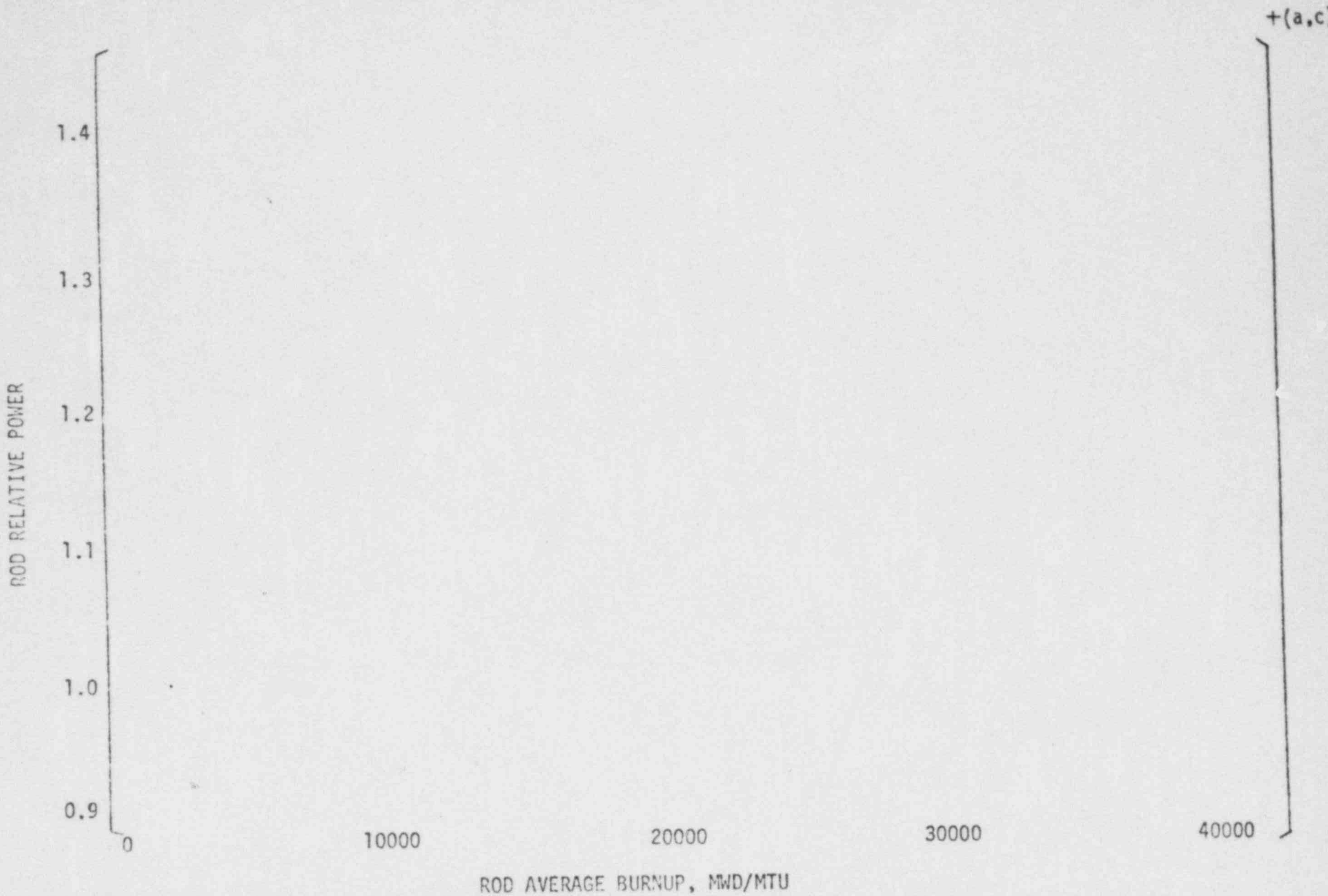

FIGURE 5. TYPICAL LIMITING POWER HISTORY FOR CALCULATING END OF LIFE PRESSURE

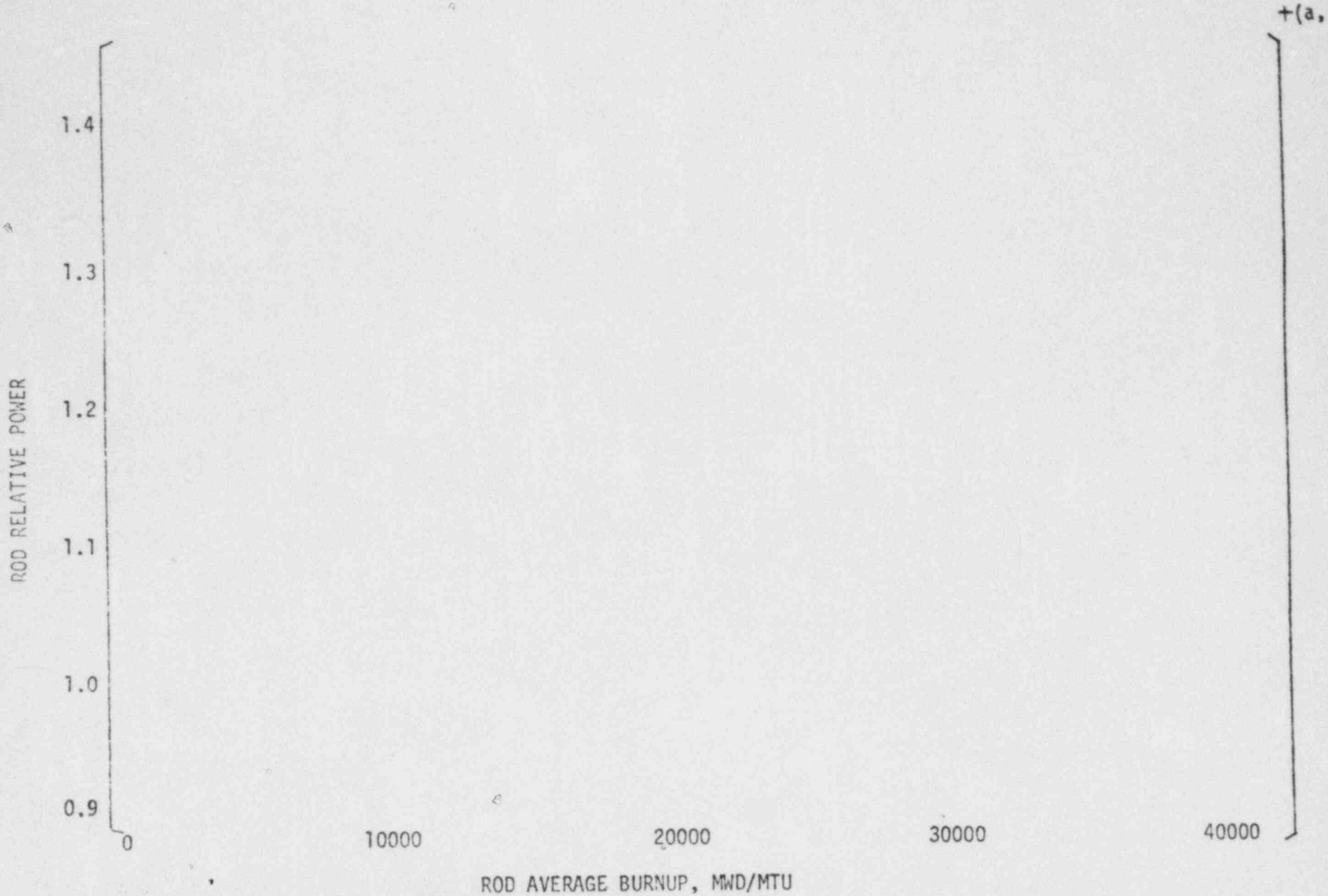

FIGURE 5. TYPICAL LIMITING POWER HISTORY FOR CALCULATING END OF LIFE PRESSURE