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November 25, 1980

Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTENTION: Mr. R. A. Clark, Chief
Operating Reactors Branch #3
Division of Licensing

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit No. 1, Docket No. 50-317
Amendment to Operating License DPR-53
Supplement 2 to Fifth Cycle License Application

REFERENCE 1: A. E. Lundvall to R. A. Clark letter dated 9/22/80, Fifth Cycle License Application

Gentlemen:

Reference 1 presented the results and conclusions of the ECCS analysis for Calvert Cliffs Unit 1, Cycle 5. Although the original conclusions reported in Section 8.0 have been verified, completion of the independent verification has determined that the specific results for peak clad temperature and clad oxidation require a minor revision. Although the clad temperature and clad oxidation values remain well below 10CFR50.46 limits, a verified calculation utilizing CE's NRC approved evaluation model indicated the reported peak clad temperature should increase from 1942°F to 1987°F. This increase exceeds the 20°F tolerance above which it is considered necessary to revise the ECCS portion of the reload report.

Except for the small increase in clad temperature and oxidation, the original conclusions pertaining to Unit 1, Cycle 5 remain unchanged. A revised Section 8.0 is attached to this letter.

Very truly yours,

BALTIMORE GAS AND ELECTRIC COMPANY

A. E. Lundvall, Jr.
Vice President - Supply

AEL/WJL/dw

Attachment: 40 copies

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Copies To: J. A. Biddison, Esquire (w/out Encl.)
G. F. Trowbridge, Esquire (w/out Encl.)
Mr. E. L. Conner, Jr., NRC
Mr. P. W. Kruse, CE

ATTACHMENT

8.0 Introduction and Summary

An ECCS performance analysis was performed for Calvert Cliffs Unit I Cycle 5 to demonstrate compliance with 10 CFR 50.46 which presents the NRC Acceptance Criteria for Emergency Core Cooling Systems for Light-Water-Cooled reactors(1). The analysis justifies an allowable peak linear heat generation rate (PLHGR) of 15.5 kw/ft. This PLHGR represents an increase over the Cycle 4 limit of 14.2 kw/ft and is equal to the existing limit for Unit II. The method of analysis and detailed results which support this value are presented herein.

8.1 Method of Analysis

The analysis for Unit II Cycle 2 operation(6), approved by the NRC, was used as the reference cycle analysis for the Unit I Cycle 5 evaluation. The Unit II analysis was selected as the reference since the core in Unit I Cycle 5 is comprised only of high density stable fuel as in Unit II Cycle 2 and the PLHGR for Unit II is 15.5 kw/ft. The one residual low density fuel assembly contained in Unit I Cycle 4(7) was removed.

The method of analysis used the NRC approved C-E evaluation model(2). The model was used to re-evaluate the limiting large break LOCA performance. The blowdown and refill-reflood hydraulic calculations employed in Unit II Cycle 2 were performed generically for both Units I & II and apply to the Unit I fifth fuel cycle. Therefore, only the STRIKIN-II(3) calculations were necessary to account for the different fuel pin conditions.

Burnup dependent calculations were performed using the FATES(4) and STRIKIN-II(3) codes to determine the limiting condition for the ECCS performance analysis.

The PARCH(9) code was not utilized in the Cycle 5 evaluation.
The late reflood heat transfer benefit from the use of the PARCH generated steam cooling heat transfer coefficients would have reduced the peak clad temperature reported herein.

8.2 Results

Table 1 presents the analysis results reported for the 1.0 DES/PD* break. The 1.0 DES/PD break is the limiting break for Unit I Cycle 5. The reference cycle analysis for Unit II Cycle 2 defines this as the limiting break size for high density fuel when clad rupture occurs during the refill period as predicted in this evaluation for Unit I. The results of the evaluation confirm that 15.5 kw/ft is an acceptable value for the PLHGR in Cycle 5. The peak clad temperature and maximum local and core wide clad oxidation values as shown in Table 1 are below 10 CFR 50.46 acceptance limits.

Table 2 Presents a list of the significant parameters displayed graphically for the limiting 1.0 DES/PD break.

8.3 Evaluation of Results

The reason for the lower peak clad temperature (PCT) for Unit I Cycle 5 (Table 1) as compared to the Reference Cycle, Unit II Cycle 2, despite a higher initial stored energy for Cycle 5 (Table 3) was due to the more favorable overall fuel performance, a lower heat sink temperature and improved heat transfer conditions, e.g., a lower fuel rod gas pressure and a lower hot bundle linear heat rate (Table 3), hence a lower hot bundle average power.

Since Unit I Cycle 5 had a lower hot bundle average power than in the Reference Cycle, the transient enthalpy during the later portions of the blowdown period was lower. Therefore, the residual fuel stored energy and clad temperature at the start of the refill period were also lower.

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*DES/PD = Double-Ended Slot at Pump Discharge

The fuel and clad heat up during the refill period therefore proceeded at a slower rate resulting both in lower clad temperatures and lower clad oxidation than in the Reference Cycle. The hot rod gas pressure (Table 3) which was initially lower than in the Reference Cycle, together with the lower refill period fuel and clad temperatures resulted in clad rupture occuring 3.4 seconds later than in the Reference Cycle. As a consequence of this delay in clad rupture, the more favorable refill period heat removal from the fuel and clad was prolonged. During the reflood period, after reflood rates have fallen below 1.0 inches per second, the lower average hot bundle power enhanced the rod-to-rod radiation cooling of the hot rod by providing a lower heat sink temperature. The net result was a slightly lower PCT (by 4°F) and a lower peak local clad oxidation (by 0.5%) as shown in Table 1.

8.4 Conclusion

As discussed above, conformance to the ECCS criteria is summarized by the analysis results presented in Table 1. The results of the analysis identified the peak clad temperature as 1987°F as opposed to the acceptance limit of 2200°F. The peak local clad oxidation was 9.7% versus the acceptance limit of 17% and the peak core wide clad oxidation was less than .51 % versus the acceptance limit of 1.0%. Hence, Unit I Cycle 5 operation at a peak linear heat generation rate of 15.5 kw/ft and at a power level of 2754 Mw_t (102% of 2700 Mw_t) will result in acceptable ECCS performance.

8.5 Computer Code Version Identification

The following version of Combustion Engineering ECCS Evaluation Model computer code was used in this analysis:

STRIKIN-II: Version No. 77036

8.6 References

1. Acceptance Criteria for Emergency Core Cooling Systems for Light Water Cooled Nuclear Power Reactors, Federal Register, Vol. 39, No. 3 - Friday, January 4, 1974.

2. CENPD-132, "Calculative Methods for the CE Large Break LOCA Evaluation Model", August 1974 (Proprietary).

   CENPD-132, Supplement 1, "Updated Calculative Methods for the CE Large Break LOCA Evaluation Model", December 1974 (Proprietary).

   CENPD-132, Supplement 2, "Calculational Methods for the CE Large Break LOCA Evaluation Model", July 1975 (Proprietary).

3. CENPD-135, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program", April 1974 (Proprietary).

   CENPD-135, Supplement 2, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program (Modification)", February 1975 (Proprietary).

   CENPD-135, Supplement 4, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program", August 1976 (Proprietary).

   CENPD-135, Supplement 5, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program", April 1977 (Proprietary).

4. CENPD-139, "CE Fuel Evaluation Model", July 1974 (Proprietary).

5. CENPD-137, "Calculative Methods for the CE Small Break LOCA Evaluation Model", Combustion Engineering Proprietary Report, August 1974 (Proprietary).

   CENPD-137, Supplement 1, "Calculative Methods for the CE Small Break Evaluation Model", January 1977 (Proprietary).

6. To be supplied by BG&E (Calvert Cliffs II Cycle II ECCS Analysis).

7. To be supplied by BG&E (Calvert Cliffs I Cycle IV ECCS Analysis).

8. To be supplied by BG&E (Calvert Cliffs II Cycle I ECCS Analysis).

9. CENPD-138, "PARCH - A FORTRAN-IV Digital Program to Evaluate Pool Boiling, Axial Rod and Coolant Heatup", August 1974 (Proprietary).

   CENPD-138, Supplement 2-P January 1977 (Proprietary).

Table 1

Calvert Cliffs Unit I Cycle5

Limiting Break Size (1.0 DES/PD)

Analysis	Blowdown Peak Clad Temperature	Peak Clad Temperature	Time of Peak Clad Temperature	Time of Clad Rupture	Peak Local Clad Oxidation	Total Core-Wide Clad Oxidation
Unit I, Cycle 5	1725°F	1987°F	250. sec	32.8 sec	9.7%	≪ .51%
Reference Cycle (Unit II, Cycle 2)	1725°F	1991°F	248. sec	29.4 sec	10.24%	< .51%

Table 2

Calvert Cliffs I Cycle 5

Analysis Plots

Variables	Figure Designation
Peak Clad Temperature	1 A
Hot Spot Gap Conductance	1 B
Peak Local Clad Oxidation	1 C
Clad Temperature, Centerline Fuel Temperature, Average Fuel Temperature and Coolant Temperature for Hottest Node	1 D
Hot Spot Heat Transfer Coefficient	1 E
Hot Rod Internal Gas Pressure	1 F

Table 3

Significant Parameters

Quantity	Unit I Values Cycle 5	Unit II Values Cycle 2	
Reactor Power Level (102% of Nominal)	2754	2754	Mw_t
Average Linear Heat Rate (102% of Nominal)	6.45	6.52	kw/ft
Peak Linear Heat Generation Rate (PLHGR) Hot Assembly, Hot Channel	15.5	15.5	kw/ft
Peak Linear Heat Generation Rate (PLHGR) Hot Assembly, Average Channel	13.43	13.57	kw/ft
Gap Conductance at PLHGR	1704*	1731*	BTU/hr-ft-°F
Fuel Centerline Temperature at PLHGR	3626*	3604*	°F
Fuel Average Temperature at PLHGR	2242*	2219*	°F
Hot Rod Gas Pressure	1144*	1198*	psia
Hot Rod Burnup	758*	1522*	MWD/MTU

*For high density fuel, when gap conductance is minimum

FIGURE 1A

CALVERT CLIFFS UNIT I CYCLE V
1.0 x DOUBLE ENDED SLOT BREAK IN PUMP DISCHARGE LEG
PEAK CLAD TEMPERATURE

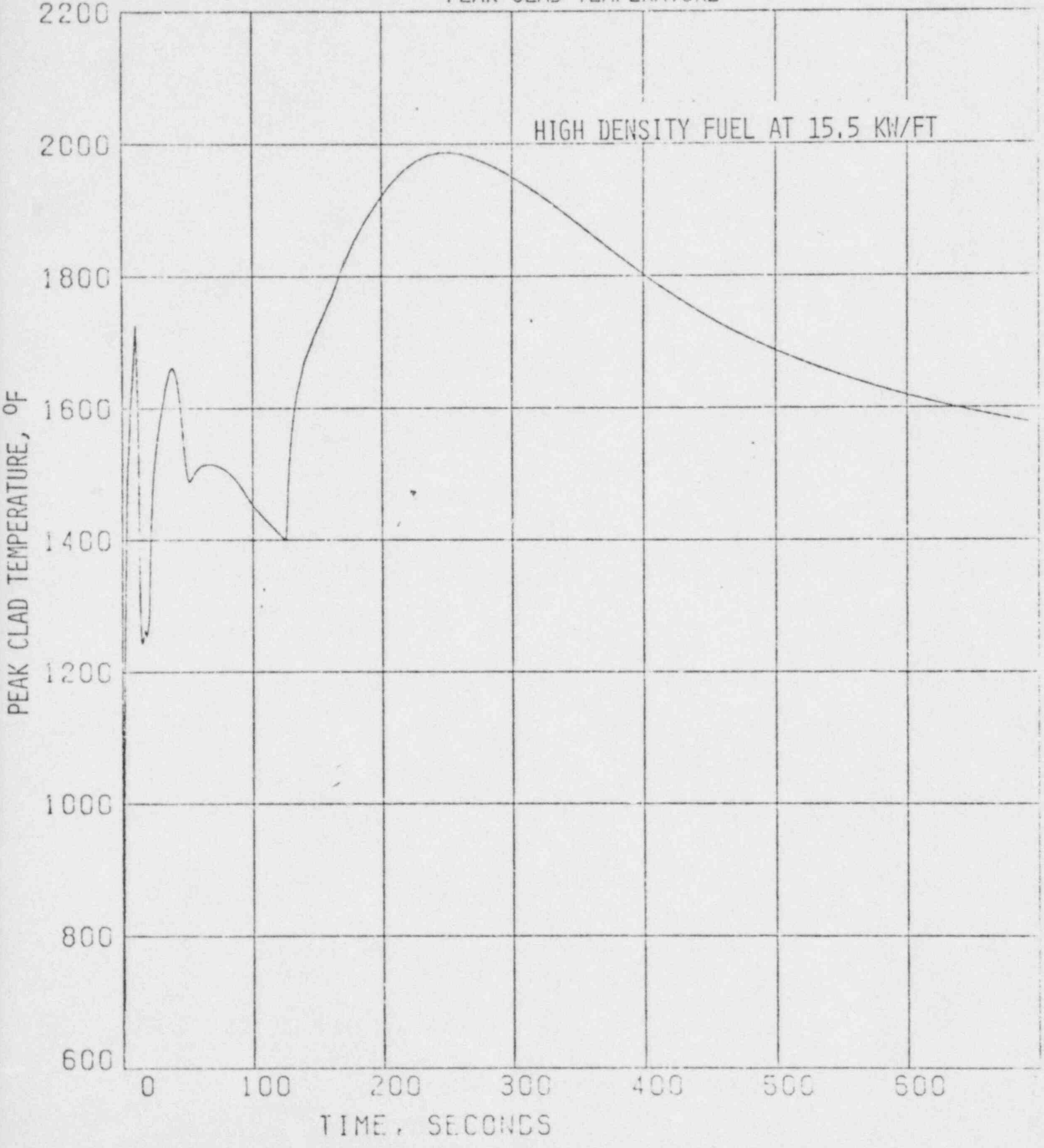

FIGURE 1B

CALVERT CLIFFS UNIT I CYCLE V
1.0 x DOUBLE ENDED SLOT BREAK IN PUMP DISCHARGE LEG
HOT SPOT GAP CONDUCTANCE

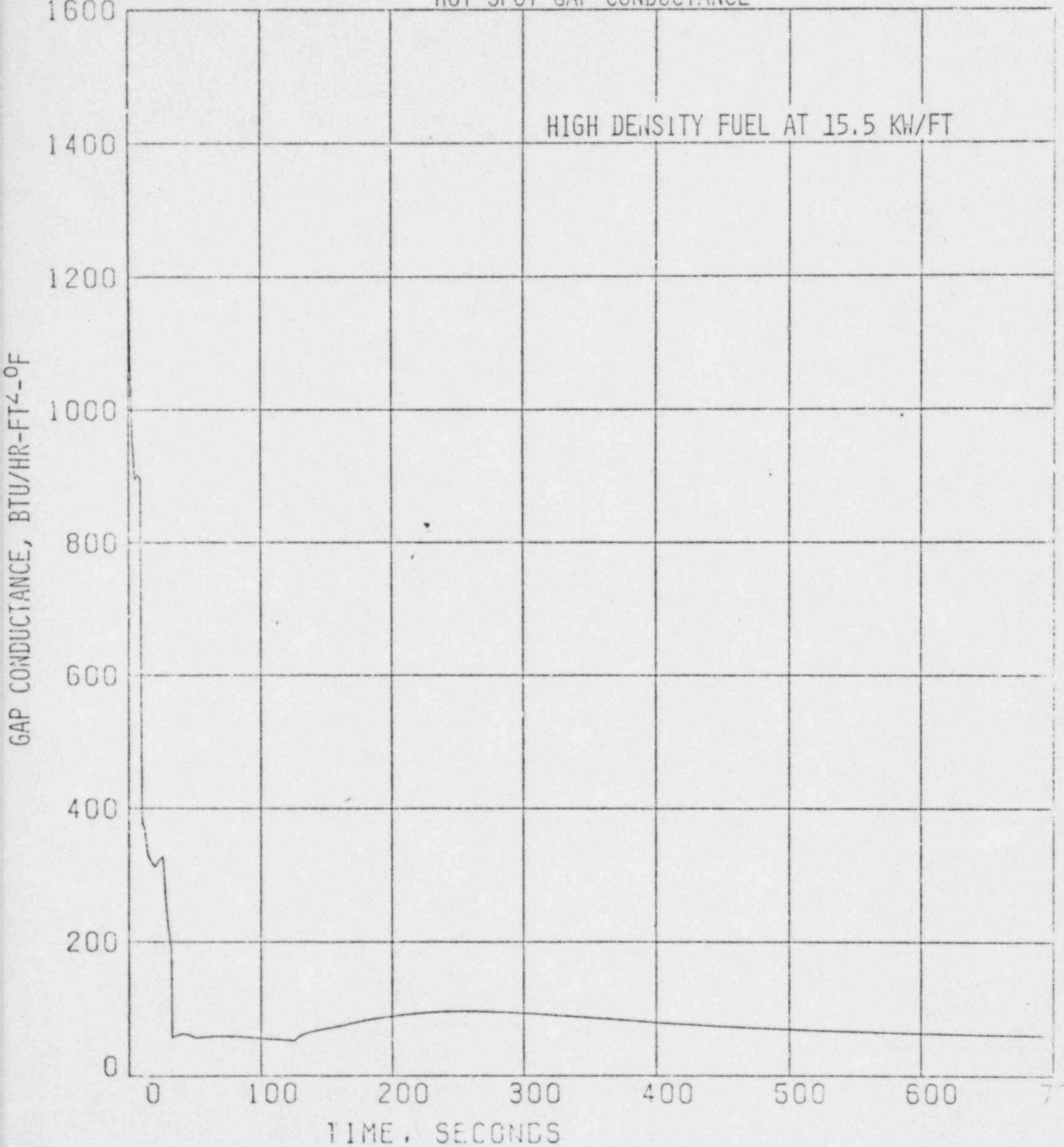

FIGURE 1C

CALVERT CLIFFS UNIT I CYCLE V
1.0 x DOUBLE ENDED SLOT BREAK IN PUMP DISCHARGE LEG
PEAK LOCAL CLAD OXIDATION

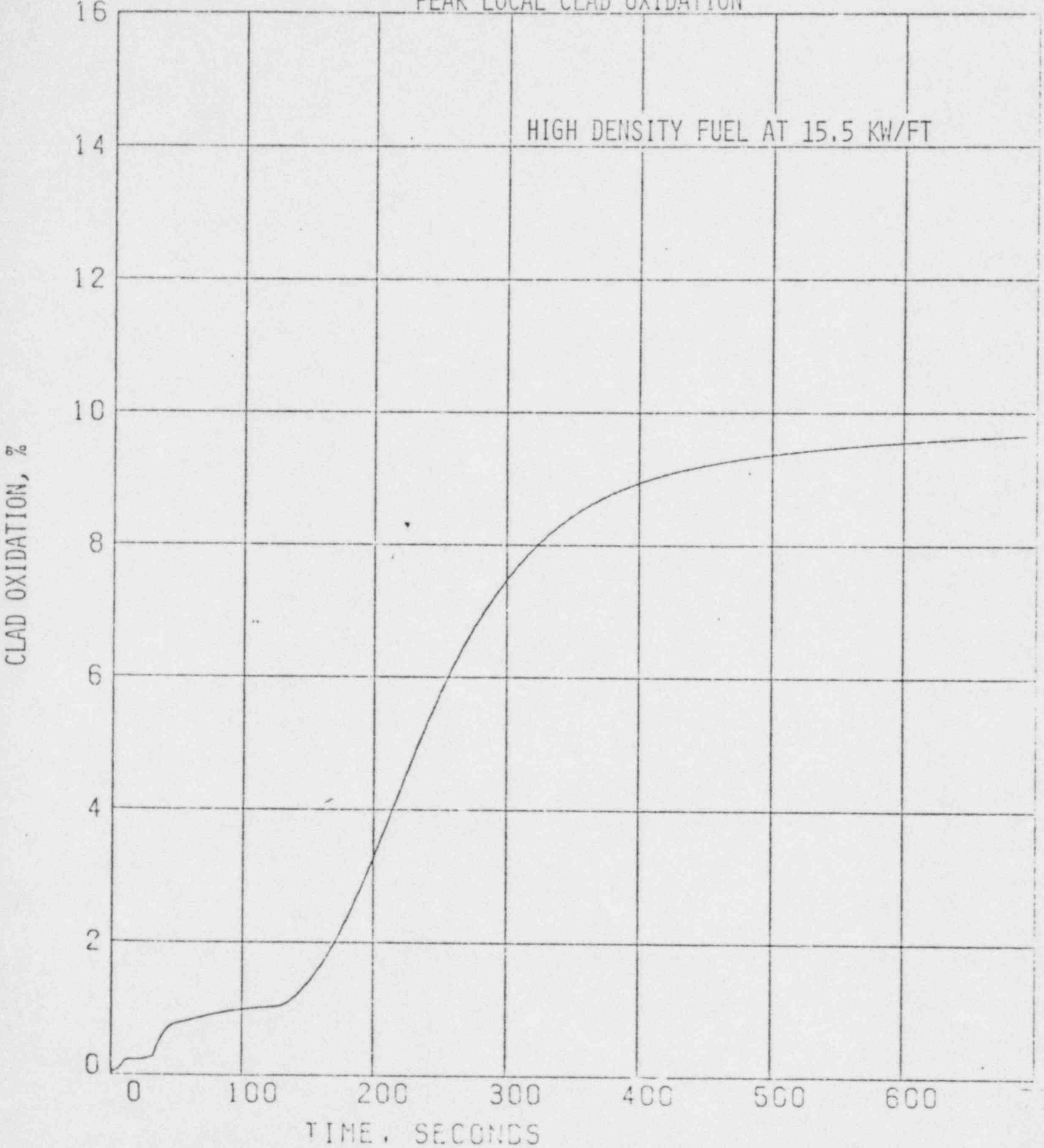

FIGURE 1D

CALVERT CLIFFS UNIT I CYCLE V
1.0 x DOUBLE ENDED SLOT BREAK IN PUMP DISCHARGE LEG
CLAD TEMPERATURE, CENTERLINE FUEL TEMPERATURE, AVERAGE FUEL TEMPERATURE AND COOLANT TEMPERATURE FOR HOTTEST NODE

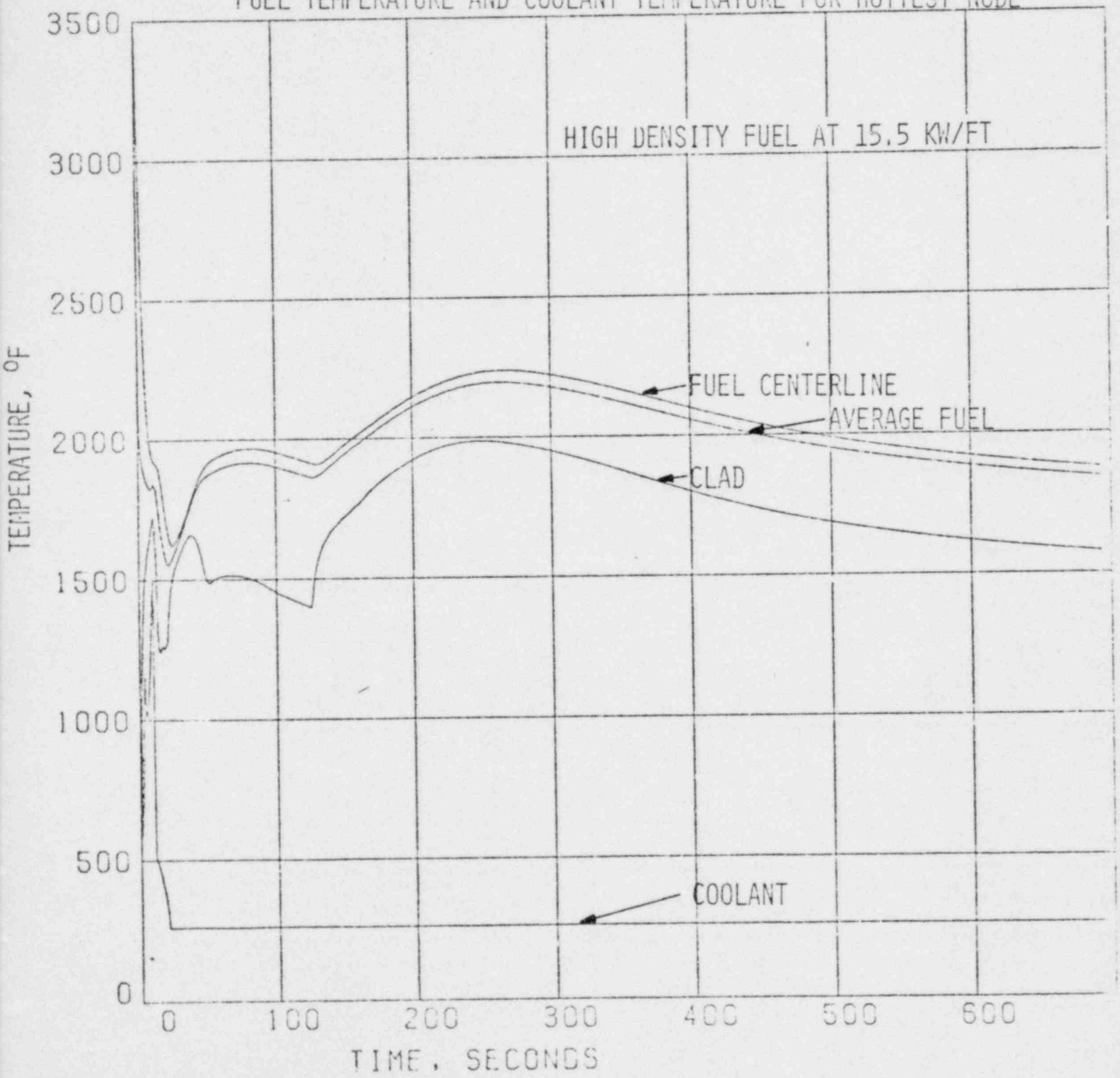

FIGURE 1E

CALVERT CLIFFS UNIT I CYCLE V

1.0 x DOUBLE ENDED SLOT BREAK IN PUMP DISCHARGE LEG

HOT SPOT HEAT TRANSFER COEFFICIENT

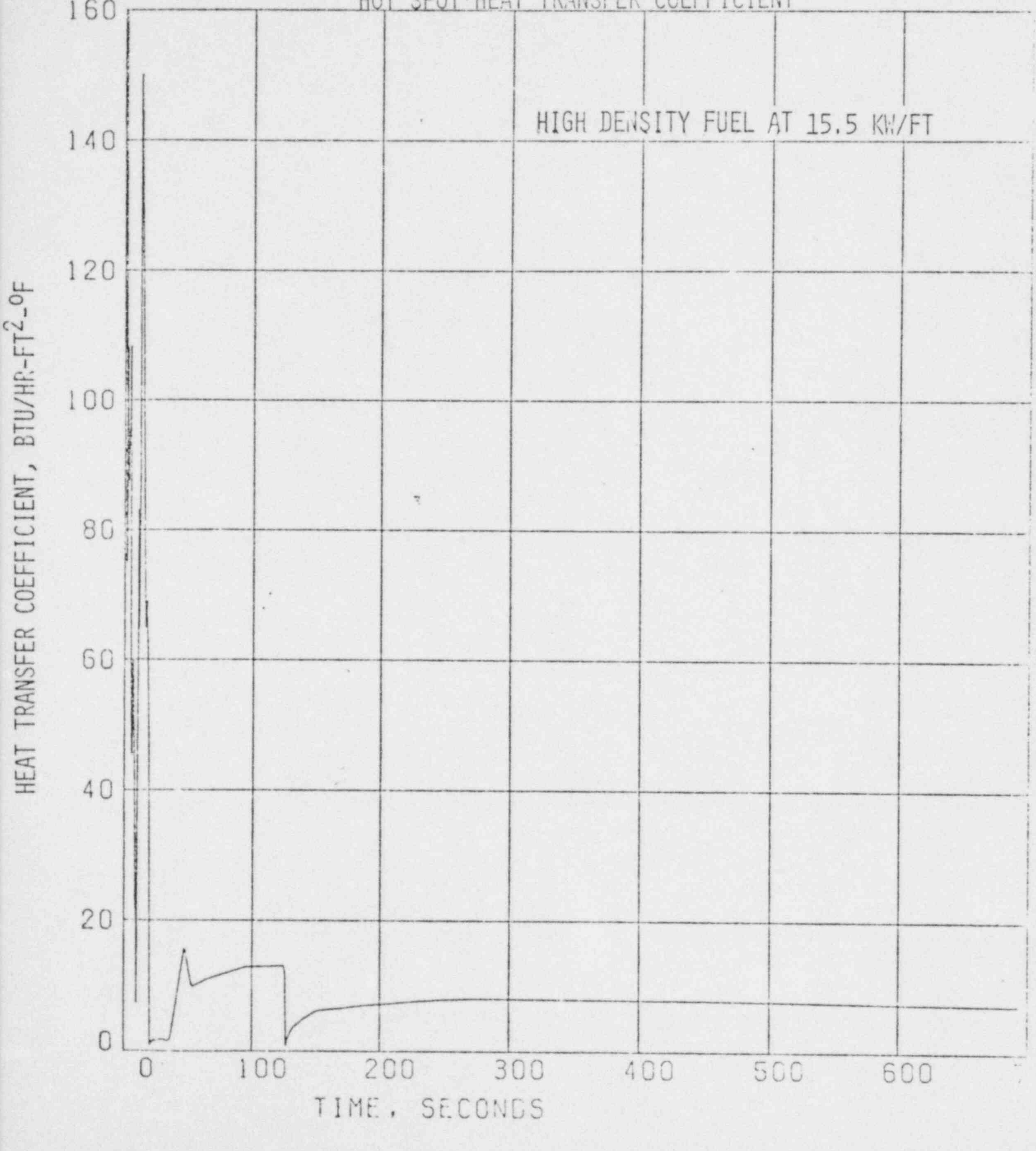

FIGURE 1F

CALVERT CLIFFS UNIT I CYCLE V
1.0 x DOUBLE ENDED SLOT BREAK IN PUMP DISCHARGE LEG
HOT ROD INTERNAL GAS PRESSURE