MONTICELLO
NUCLEAR POWER STATION
LOSS-OF-COOLANT ACCIDENT ANALYSES
CONFORMANCE WITH 10 CFR 50
APPENDIX K
(JET PUMP PLANT)

JUNE
1975

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DISCUSSION

Presented in the following document are the results of the loss-of-coolant accident analysis of the Monticello Nuclear Power Station. The analysis was performed using General Electric calculational models which are consistent with the requirements of Appendix K of 10 CFR part 50. A complete discussion of each code employed in the analysis is presented in Reference 1.

Between August and December, 1974, General Electric and the USAEC worked together to resolve differences in interpretation of Appendix K and to consider additional phenomena in the evaluation models. As a result, the models used in the present analysis differ from those used in previous submittals in the following respects:

(1) The new analysis assumes a fuel assembly planar power consistent with 102% of the MAPLHGR shown in the Figures;

(2) Fission product decay is computed assuming an energy release rate of 200 MeV/Fission;

(3) Pool film boiling is assumed after nucleate boiling is lost during the flow stagnation period;

(4) The effects of core spray entrainment and counter-current flow limiting are included in the reflooding calculation.

In addition, there have been a few other minor improvements to the computer codes which individually and jointly have a small effect on the calculated results. The figures in this submittal reflect these changes, as well as the four major changes enumerated above.

INPUT TO THE ANALYSIS

A list of the significant plant input parameters to the loss-of-coolant accident analysis is presented in Table 1.

TABLE 1

SIGNIFICANT INPUTS PARAMETERS TO THE LOSS-OF-COOLANT ACCIDENT ANALYSIS

FOR MONTICELLO

PLANT PARAMETERS:

Core Thermal Power.......................... 1703 MWt which corresponds to 102% of licensed core power*

Vessel Steam Output............. 6.913×10^6 Lbm/h which corresponds to 102 % of rated steam flow

Vessel Steam Dome Pressure............ 1040 psia

Design Basis Recirculation Line Break Area for Large Breaks 3.9 ft^2 1.0 ft^2

Recirculation Line Break Area for Small Breaks 1.0 ft^2 0.07 ft^2

FUEL PARAMETERS:

FUEL TYPE	FUEL BUNDLE GEOMETRY	PEAK TECHNICAL SPECIFICATION LINEAR HEAT GENERATION RATE (kw/ft)	DESIGN AXIAL PEAKING FACTOR	INITIAL MINIMUM CRITICAL POWER RATIO
Initial Core 7D225	7 x 7	17.5	1.57	1.18
Reload 1 7D230	7 x 7	17.5	1.57	1.18
Reload 2 8D262	8 x 8	13.4	1.57	1.18
Reload 3 8D250	8 x 8	13.4	1.57	1.18
Reload 4 8D219	8 x 8	13.4	1.57	1.18

A more detailed list of input to each model and its source is presented in Section II of Reference 1.

*This power level equals the Appendix K requirement of 102%. The core heatup calculation assumes a bundle power consistent with operation of the highest powered rod at 102% of its maximum (technical specification) linear heat generation rate.

RESULTS OF THE ANALYSIS

The results of the analysis are presented in the order in which they are calculated. The presentation of the results is divided into four major portions according to the model from which the output is obtained. These portions are:

A. Calculated by the Short-Term Thermal Hydraulics Model (LAMB)

B. Calculated by the Transient Critical Power Model (SCAT)

C. Calculated by the Long-Term Thermal Hydraulics Model (SAFE)

D. Calculated by the Core Heatup Model (CHASTE)

A summary of the results is presented in Table 2. At the MAPLHGR* employed in the analysis, the most severe pipe break yields a calculated peak cladding temperature less than or equal to 2200°F, a calculated maximum local metal-water reaction less than or equal to 17% and a calculated core-wide metal-water reaction less than or equal to 1%. Compliance with the 10CFR50.46 criteria for coolable geometry and long-term cooling has been shown in Reference 1. The reactor is, therefore, fully in conformance with 10CFR50.46 and Appendix K with operation at the MAPLHGR used in the analysis. These values, if more limiting than other design parameters, represent limits for operation to ensure conformance with 10CFR50.46 and Appendix K.

The peak cladding temperatures as a function of time are shown in Figure D-1a and D-1b. Other parameters relevant to the analysis are shown in the attached figures and are described in subsequent paragraphs.

Results for guillotine severances of a main steam line, a feedwater line, and a core spray line are presented in Reference 2.

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*Maximum (Bundle) Average Planar Linear Heat Generation Rate

TABLE 2

APPENDIX K RESULTS FOR MONTICELLO

Break Size Location Single Failure		PCT(°F)	Peak Local Oxidation %	Core-Wide Metal-Water Reaction %
DBA ANALYSIS(1)				
3.9 ft^2 (DBA) Recirc Suction LPCI Injection Valve		2200(1)	8.7%	0.5
BREAK SPECTRUM ANALYSIS(3)				
3.9 ft^2 (DBA) Recirc Suction LPCI Injection Valve		2200(1)	8.7%	0.5
1.0 ft^2 Recirc Suction LPCI Injection Valve	Large Break Methods	1670(1)	< 1	-
	Small Break Methods	1690(2)	< 1	-
0.07 ft^2 Recirc Suction HPCI		1430(2)	< 1	-

Notes:

(1) CHASTE - large break methods
(2) Non-DBA reflood
(3) For other breaks in spectrum see lead plant analysis, Reference 2. For justification of selection of lead plant, see Reference 3.

A. Appendix K Short-Term Thermal Hydraulics Analysis

General Description of the LAMB Code

The LAMB code is a model which is used to analyze the short-term thermodynamics and thermal hydraulics behavior of the coolant in the vessel during a postulated loss-of-coolant accident. In particular, LAMB predicts the core flow, core inlet enthalpy and core pressure during the blowdown prior to the end of lower plenum flashing (~20 seconds). For a detailed description of the model and a discussion regarding sources of input to the model refer to the "LAMB Code Documentation" portion of Reference 1.

Results of the LAMB Analysis

Presented in the section are results of the loss-of-coolant accident analysis which are calculated by LAMB. Table 3 lists the figures provided for all the analyses. These results include the following:

Parameter	Figure
Core Average Inlet Flow Rate (Normalized to unity at the beginning of the accident)	
-- Following a Design Basis Accident	A-1a
-- Following a 1.0 Sq. Ft. Break	A-1d
Core Inlet Enthalpy	
-- Following a Design Basis Accident	A-2a
-- Following a 1.0 Sq. Ft. Break	A-2d
Core Average Pressure	
-- Following a Design Basis Accident	A-3a
-- Following a 1.0 Sq. Ft. Break	A-3d

These results are input to the SCAT code discussed in Section B.

B. Appendix K Transient Critical Power Analysis

General Description of the SCAT Code

The SCAT code is used to evaluate the short-term thermal hydraulics response of the coolant in the core during a postulated loss-of-coolant accident. In particular, the convective heat transfer process in the thermally limiting fuel bundle is analyzed during the transient. For a detailed description of the model and a discussion regarding sources of input to the model refer to the "SCAT Code Documentation" portion of Reference 1.

Results of the SCAT Analysis

Presented in this section are results of the loss-of-coolant accident analysis which are calculated by SCAT. Table 3 lists the figures provided for all the analyses. These results include the following:

Parameter	Figure
Minimum Critical Power Ratio	
-- Following a Design Basis Accident, 8x8	B-1a-1
-- Following a Design Basis Accident, 7x7	B-1a-2
-- Following a 1.0 Sq. Ft. Break, 8x8	B-1d
Convective Heat Transfer Coefficient	
-- Following a Design Basis Accident	B-2a
-- Following a 1.0 Sq. Ft. Break	B-2d

These results are used as input to the CHASTE code discussed in Section D.

C. Appendix K Long-Term Thermal Hydraulics Analysis

General Description of SAFE Code

The SAFE code is a model which is used to analyze the long-term thermodynamic behavior of the coolant in the vessel during both small and large breaks. Since the calculational procedure of the loss-of-coolant accident analysis differs depending on whether or not a break is classified as "small" or "large," it is appropriate to distinguish between two classifications of breaks. A small break is defined as that size break for which nucleate boiling heat transfer exists in the core until the heat fluxes are below the pool boiling critical power condition. This occurs approximately 20 to 25 seconds after the break. For small breaks, core heatup is, therefore, based solely on the uncovery and recovery of the fuel and the duration of spray cooling all of which are predicted by the SAFE code. For the "large" break analysis, the LAMB and SAFE codes are employed to determine the time of boiling transition and the post-boiling transition convective heat transfer coefficient during the blowdown. The SAFE code calculates the uncovery and reflooding of the fuel and the duration of spray cooling.

The SAFE analytical model has been expanded and refined to consider explicitly the following phenomena:

(1) Counter-current flow limiting (CCFL) in the fuel bundles and in the core bypass region, of ECCS water injected over the core;

(2) Entrainment and loss of ECCS water injected over the core; and

(3) Filling of discrete volumes (control rod guide tubes, core bypass and lower plenum) which were previously taken together.

Calculation of these effects is presently external to the SAFE code: the calculationa logic will eventually be incorporated in the SAFE code.

For a detailed description of the model and a discussion regarding sources of input to the model refer to the "SAFE Code Documentation" portion of Section II of Reference 1.

Results of the SAFE Analysis

Presented in this section are results of the loss-of-coolant accident analys which are calculated by SAFE. Table 3 lists the figures provided for all the analyses. These results include the following:

Parameter	Figure
Water Level Inside Shroud	
-- Following a Design Basis Accident (LPCI Inj. Valve Failure)	C-1a-1
-- Following a 1.0 Sq. Ft. Large Break (LPCI Inj. Valve Failure)	C-1d-1
-- Following a 1.0 Sq. Ft. Small Break (LPCI Inj. Valve Failure)	C-2a-1
-- Following a 0.07 Sq. Ft. Small Break (HPCI Failure)	C-2b-1
Reactor Vessel Pressure	
-- Following a Design Basis Accident (LPCI Inj. Valve Failure)	C-1a-2
-- Following a 1.0 Sq. Ft. Large Break (LPCI Inj. Valve Failure)	C-1d-2
-- Following a 1.0 Sq. Ft. Small Break (LPCI Inj. Valve Failure)	C-2a-2
-- Following a 0.07 Sq. Ft. Small Break (HPCI Failure)	C-2b-2

D. Appendix K Core Heatup Analysis

General Description of CHASTE Code

The Transient thermal response of the core to a loss-of-coolant accident calculated by CHASTE can generally be broken down into four stages; (1) fuel pin temperature redistribution; (2) fuel rod bundle temperature redistribution; (3) metal-water reaction heatup; and (4) core standby cooling system effects. Phenomena occurring during these stages that are considered in the analysis are described below.

Fuel Pin Temperature Redistribution

Following a reactor shutdown, a large heat source is still available within the core in the form of sensible heat in the fuel. This is represented by the temperature profile in the fuel rod. Initially, the temperature profile is steep because of the high power generation rates during normal operation. Following the shutdown, the sensible heat in the fuel will be redistributed by thermal conduction within the fuel and cladding and by convection and radiation in the gap between fuel and cladding, with the amount of heat removed being dependent on surface conditions. At the end of three or more fuel time constants (fuel thermal time constant is about 8 to 10 seconds), the radial temperature profile in the fuel pin is almost flat, consistent with the low fission product decay power generation.

Fuel Rod Bundle Temperature Redistribution

As the cladding temperature increases and the core coolant void fraction approaches unity, radiant heat transmission between rods and the channel will tends to equalize the temperature of all rods at a given axial position. The total energy in the core continues to increase during this period due to continuing fission product decay.

Metal-Water Reaction Heatup

The fuel pin cladding is made of Zircaloy, which reacts with steam at high temperatures. The zircaloy-steam chemical reaction rate is exothermic and stongly dependent upon the reaction temperature. The temperature dependence is exponential and the rate of reaction becomes significant at cladding temperatures in the range of 2200°F or higher.

Emergency Core Cooling System (ECCS) Effects

Redundant emergency core cooling systems performance for a given LOCA is dependent upon the conditions of the accident. The core cooling systems will provide sufficient cooling to prevent excessive cladding heatup. The primary purpose of the core heatup analysis is to determine the effectiveness of the emergency core cooling systems.

For a detailed description of the CHASTE model and a discussion regarding sources of input to the model refer to the "CHASTE Code Documentation" portion of Section II of Reference 1.

A break spectrum analysis has been performed using the CHASTE code showing that the most limiting (highest calculated) peak clad temperature is associated with the design basis accident. The conclusion of this analysis is applicable to this plant. The analysis has been documented in the Quad Cities Station Special Report 15, Supplement C (Docket No. 50-254).

For each submittal of a construction permit, operating license, or reload license, the DBA peak cladding temperature, peak local oxidation, and a MAPLHGR is determined for each fuel type of interest. For calculational convenience in some cases, the rod-to-rod power distribution is assumed to be flat and the least favorable exposure is assumed in determining gap conductance. Calculation of the results under these conditions conservatively represents the results at all exposures. The code application is described, briefly, as follows:

A. For jet-pump plants a LAMB calculation is performed. In mixed cores, full-core LAMB calculations are performed for 7x7 and 8x8 fuel and the more restrictive of the two is used in the SCAT input.

B. For jet-pump plants, SCAT calculations are performed for 7x7 fuel and 8x8 fuel, as appropriate.

C. A SAFE and a DBA-REFLOOD calculation is performed, assuming the fuel to be the most predominant type of bundle in the core (7x7 or 8x8).

D. CHASTE calculations are performed for each fule type (which in a given reactor may include several 7x7 fuel types and several 8x8 fuel types) at several exposure points.

The MAPLHGR, peak cladding temperature and maximum local oxidation variations with exposure for each fuel type are the results of these calculations.

Results of the CHASTE Analysis

Presented in this section are results of the loss-of-coolant accident analysis which are calculated by CHASTE. These results include the following:

Parameter	Figure
Peak Cladding Temperature	
-- Following a Design Basis Accident	D-1a
-- Following a 1.0 Sq. Ft. Large Break	D-1d
-- Following a 1.0 Sq. Ft. Small Break	D-2a
-- Following a 0.07 Sq. Ft. Small Break	D-2b
Peak Cladding Temperature and Local Peak Oxidation versus Break Area	D-3
Peak Cladding Temperature and Local Peak Oxidation versus Planar Exposure	
-- Initial Core Fuel (7D225)	D-4a
-- Reload 1 Fuel (7D230)	D-4b
-- Reload 2 Fuel (8D262)	D-4c
-- Reload 3 Fuel (8D250)	D-4d
-- Reload 4 Fuel (8D219)	D-4e

TABLE 3

KEY TO FIGURES

	LARGE BREAK METHOD			INTERMEDIATE BREAK		SMALL BREAK				
	DBA	2 DBA	.60 DBA	1.0 FT^2 LARGE BREAK METHODS	1.0 FT^2 SMALL BREAK METHODS	WORST SMALL BRK. 0.07 FT^2 HPCI FAIL	ADDITIONAL SMALL BRK.	CORE SPRAY LINE	FEED WATER LINE	MAIN STEAM LINE
Core Average Inlet Flow	A-1a	A-1b*	A-1c*	A-1d	----	----	-----	----	-----	-----
Core Inlet Enthalpy	A-2a	A-2b*	A-2c*	A-2d	----	----	-----	----	-----	-----
Core Average Pressure	A-3a	A-3b*	A-3c*	A-3d	----	----	-----	----	-----	-----
Minimum Critical Power Ratio	B-1a	B-1b*	B-1c*	B-1d	----	----	-----	----	-----	-----
Convective Heat Transfer Coefficient	B-2a	B-2b*	B-2c*	B-2d	D-2a	D-2b	D-2c*	D-2d*	D-2e*	-----
Water level Inside Shroud AND Reactor Vessel Pressure	C-1a	C-1b*	C-1c*	C-1d	C-2a	C-2b	C-2c*	C-d*	C-2e*	C-2f*
Peak Cladding Temperature	D-1a	D-1b*	D-1c*	D-1d	D-2a	D-2b	D-2c**	D-2d**	D-2e*	-----
Break Spectrum	D-3									
Peak Cladding Temperature and Maximum Oxidation vs. Expose	D-4									
MPALHGR	D-5									

* FOR: THESE PLOTS SEE LEAD PLANT ANALYSIS FOR BWR/3 Quad Cities 2

SINGLE FAILURE STUDY ON ECC SYSTEM MANUALLY CONTROLLED ELECTRICALLY OPERATED VALVES

The effects of a single failure or operator error that causes any manually controlled, electrically operated valve in the ECC System to move to a position that could adversely affect the ECCS has been studied. The purpose of this evaluation is to determine that any such malfunction does not affect the ECCS more than the results of the worst single failure which is reported in the LOCA calculations performed in accordance with 10CFR50 Appendix K.

The results of the break spectrum analysis show the single failure which results in the maximum calculated peak clad temperature (PCT). For any other single failure to be more significant, its effect on the ECCS must be greater than this single failure. Therefore, a study was made to determine if the malfunction of a manually controlled, electrically operated valve by some unknown cause or by an operator improperly positioning a control switch could affect the ECCS more severely than this failure.

In accordance with appropriate IEEE standards, the ECC System valves are electrically assigned to different divisions of power supply. The effect of an operator improperly actuating a single switch on the control panel is to cause only a single valve to move to an incorrect position. For the operator error of actuating a single switch of the ADS System, the system valves are not actuated. However, the consequences of a malfunction which causes one ADS valve to inadvertently open has been noted.

The summary of the ECCS Valve Single Failure Analysis is provided in the attached Table 4. Comparing the effects of the single valve failure noted in Table I with the results of the Appendix K LOCA analysis, it can be seen that these failures are not more severe than those reported. The single failures considered for the ECCS analysis are presented in Table 5 .

TABLE 4

MONTICELLO

ECCS SINGLE VALVE FAILURE ANALYSIS

SYSTEM	VALVE(S)	POSITION FOR NORMAL PLANT OPERATION CLOSED	OPENED	CONSEQUENCES OF VALVE FAILURE ASSUMED TOGETHER WITH DESIGN BASIS LOCA
Core Spray	Suction		X	Negate use of one core spray loop
	Injection(s)	X	X	Negate use of one core spray loop
	Test Return	X		Negate use of one core spray loop
High Pressure Coolant Injection	Condensate Suction		X	Utilize Suppression Pool Water
	Suppression Pool Suction Valve	X		Utilize Condensate Storage Tank water
	Suppression Pool Test Return	X		Partial loss of flow due to flow to suppression pool
	Injection(s)	X	X	Negate HPCI
	Turbine Inlet(s)	X	X	Negate HPCI
Low Pressure Coolant Injection	Injection(s)	X	X	Negate use of LPCI
	Minimum Flow	X		Partial flow loss in one loop due to flow to suppression pool
	Cross Tie		X	No LPCI fix: Negate on LPCI Loop (two pumps per loop)
	Test Return	X		No consequence
	HX Bypass	X	X	Reduce Flow due to HX Pressure Drop
	Pump Suction		X	Negate one loop
Automatic Depressurization System	One Relief Valve	X		Vessel depressurizes faster, increases rate of HPCI injection (assuming the failure of a single ADS valve to open does not affect the results because the effects on small breaks is insignificant with HPCI in operation)

TABLE 5

SINGLE FAILURES CONSIDERED FOR ECCS ANALYSIS

PLANT	SINGLE FAILURE	REMAINING ECCS
BWR/3	LPCI Injection Valve	2 CS + HPCI + ADS
MONTICELLO	HPCI	2 CS + CPCI + ADS

(Suction Break)

Reference Plant Analysis

The lead plant for this product line BWR is Quad Cities 2. (2)

The 60% DBA, 80% DBA analyses, additional Small Break analyses, Core Spray line break, Feedwater line break, and Main Steam line break analyses for the lead plant are applicable to this plant and are hereby incorporated by reference (3).

REFERENCES

1. General Electric Company Analytical Model for Loss-of-Coolant Analysis in Accordance with 10CFR50 Appendix K, NED-20566 (draft), submitted August 1974, and General Electric Refill/Reflood Calculation (supplement to SAFE Code Description) transmitted to the USAEC by letter, G. L. Gyorey to Victor Stello, Jr., dated, December 20, 1974.

2. Quad Cities Station Special Report No. 15, Supplement C, Unit 2 and Attachment A (Proprietary information).

3. Letter, G. L. Gyorey to V. Stello, "Compliance with Acceptance Criteria of 10CFR50.46," May 12, 1975.

FIGURE A-1 a

NORMALIZED CORE AVERAGE INLET FLOW
FOLLOWING A DESIGN BASIS ACCIDENT

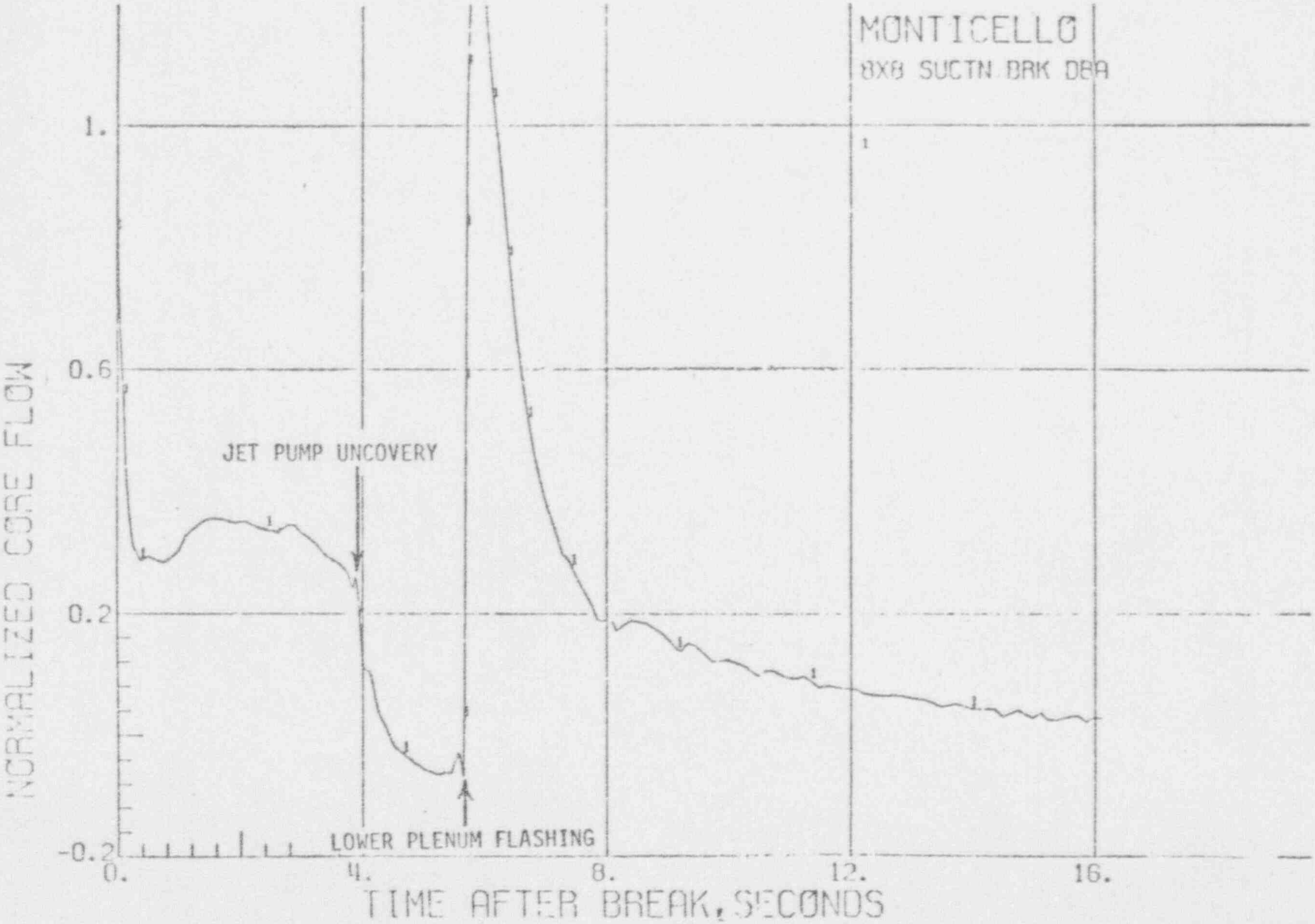


FIGURE A-1d

NORMALIZED CORE AVERAGE INLET FLOW
FOLLOWING A 1sq. ft. BRK

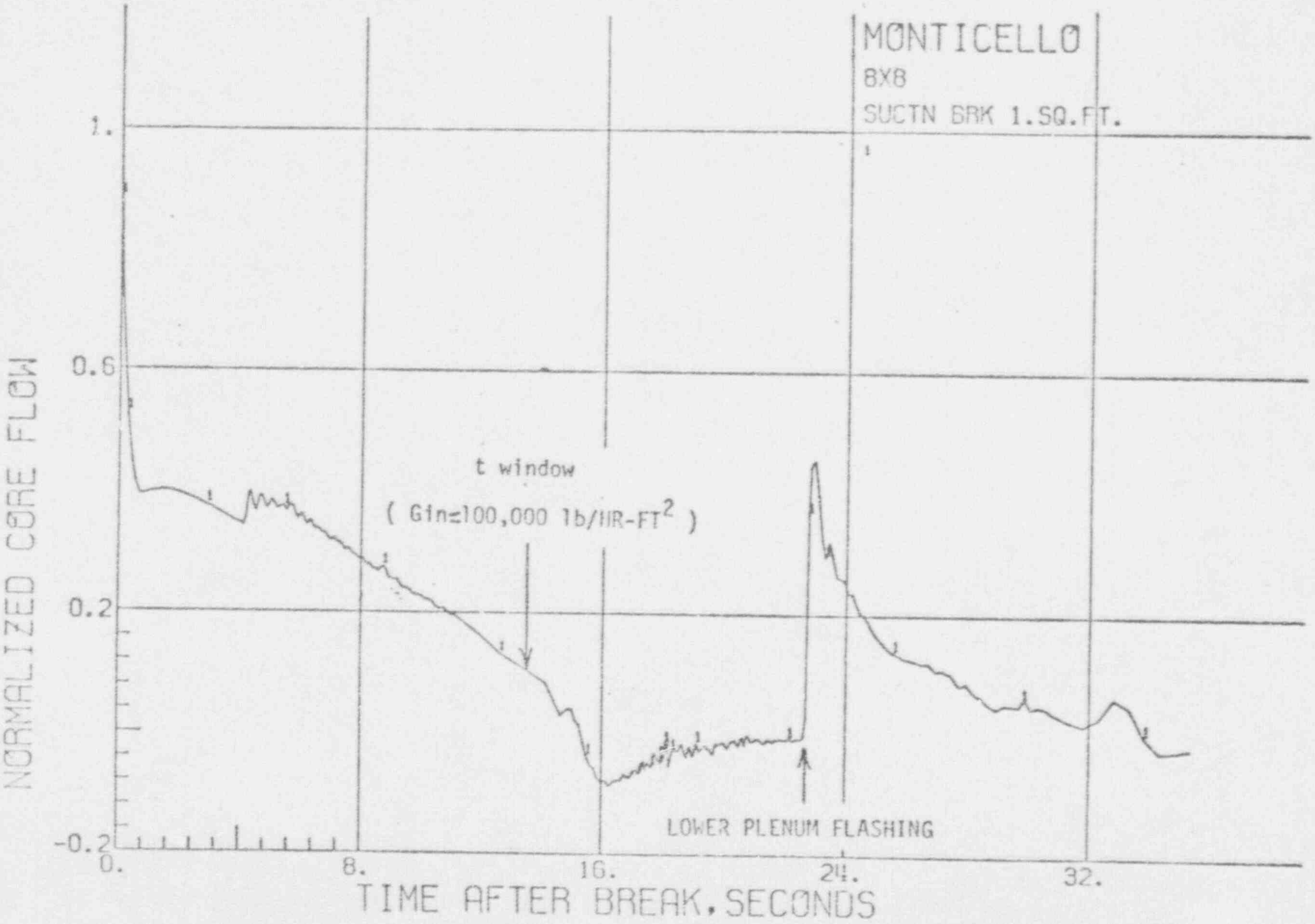


FIGURE A-2a

CORE INLET ENTHALPY FOLLOWING
A DESIGN BASIS ACCIDENT

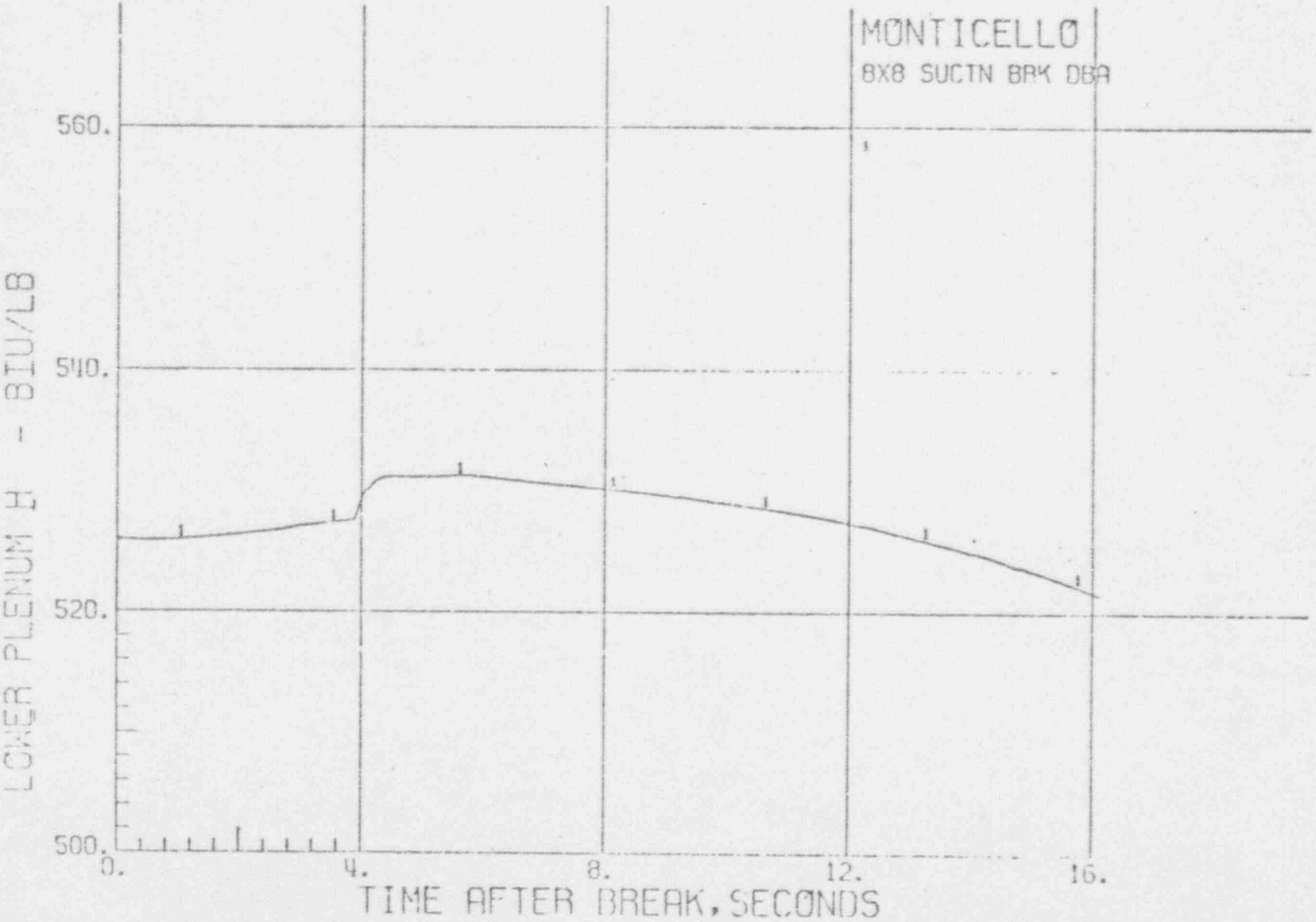


FIGURE A-2d

CORE INLET ENTHALPY
FOLLOWING A 1.0 SQ. FT. BREAK

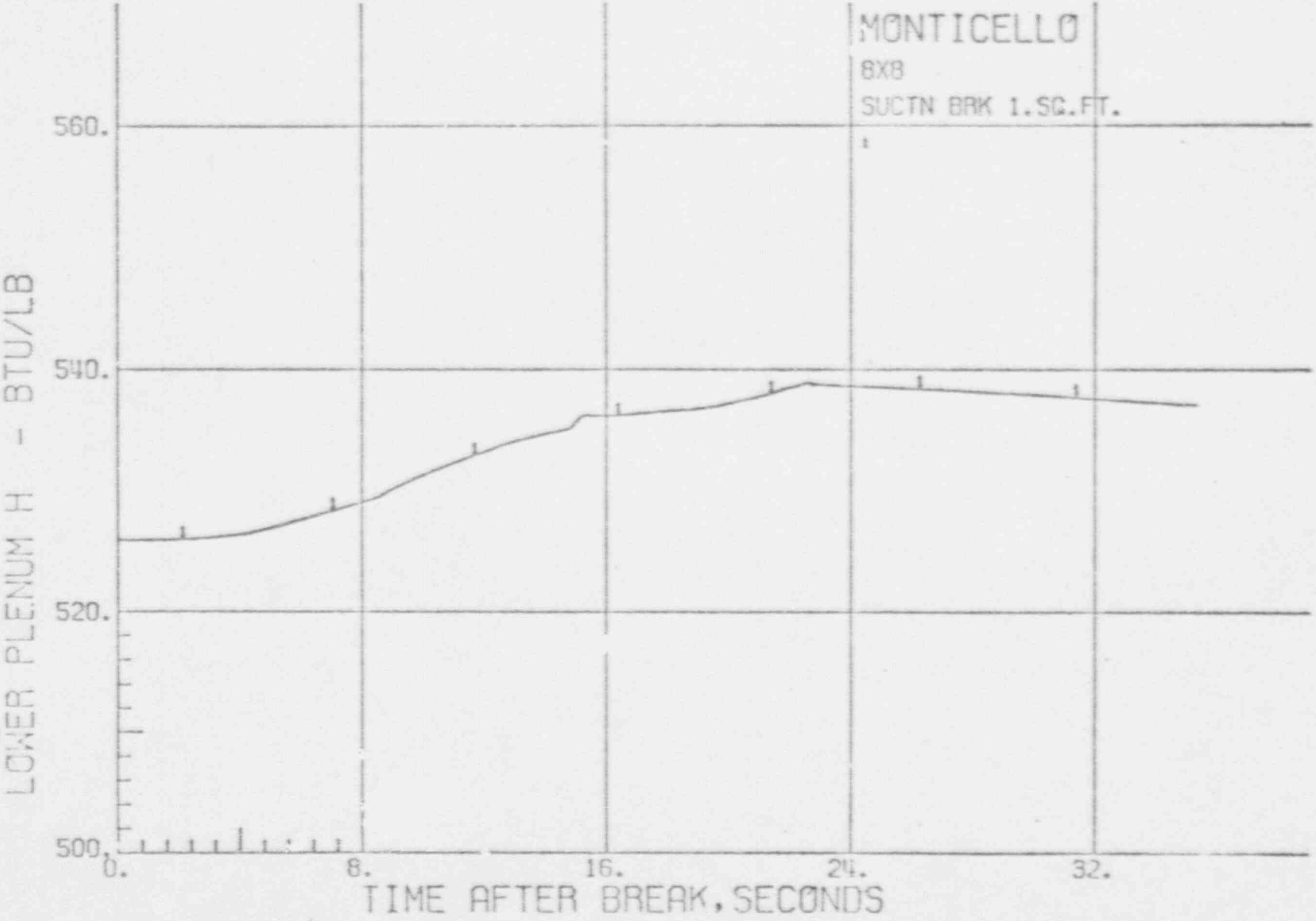


FIGURE A-3a

CORE AVERAGE PRESSURE
FOLLOWING A DESIGN BASIS ACCIDENT

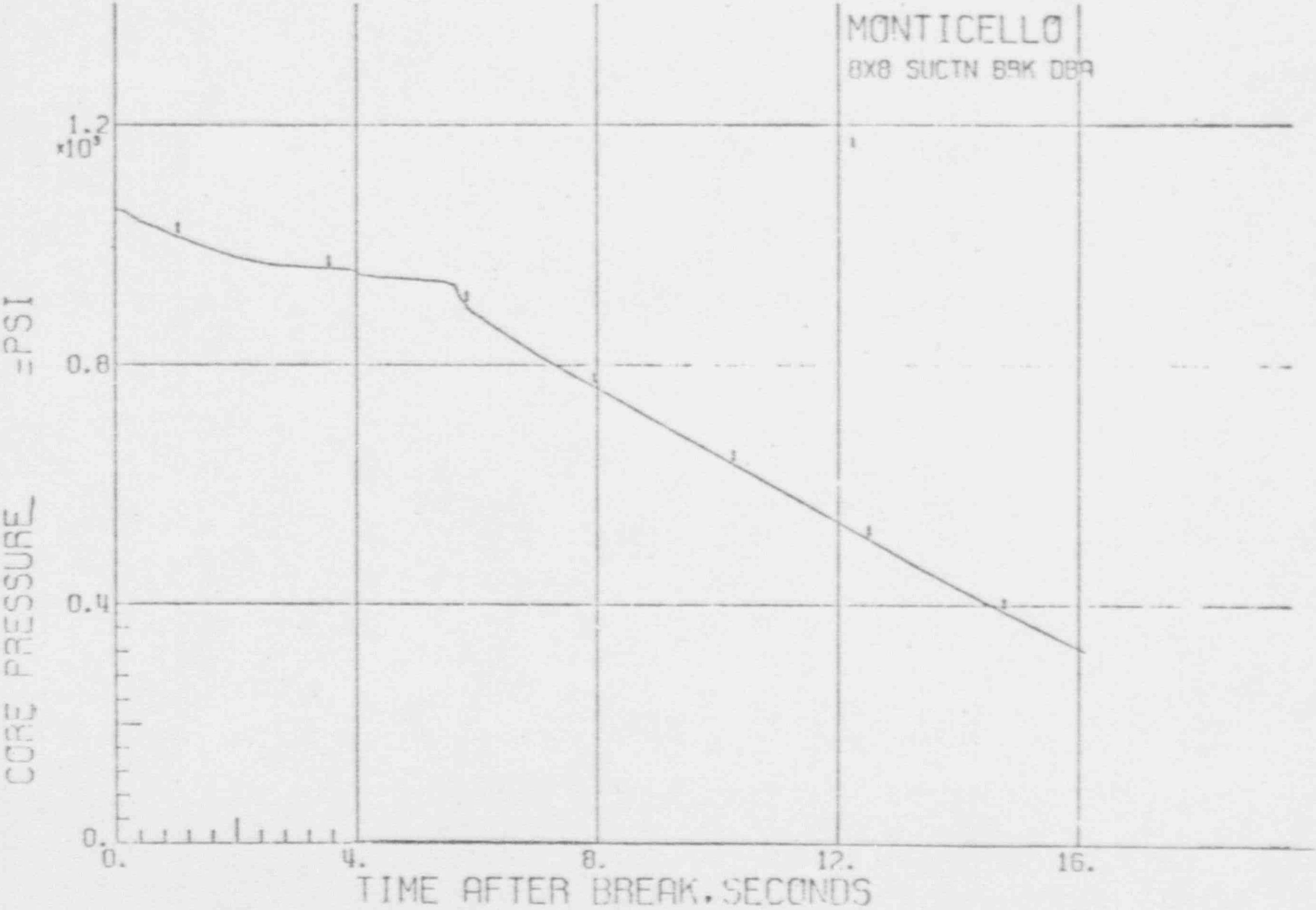


FIGURE A-3d

CORE AVERAGE PRESSURE
FOLLOWING A 1sq. ft. BRK

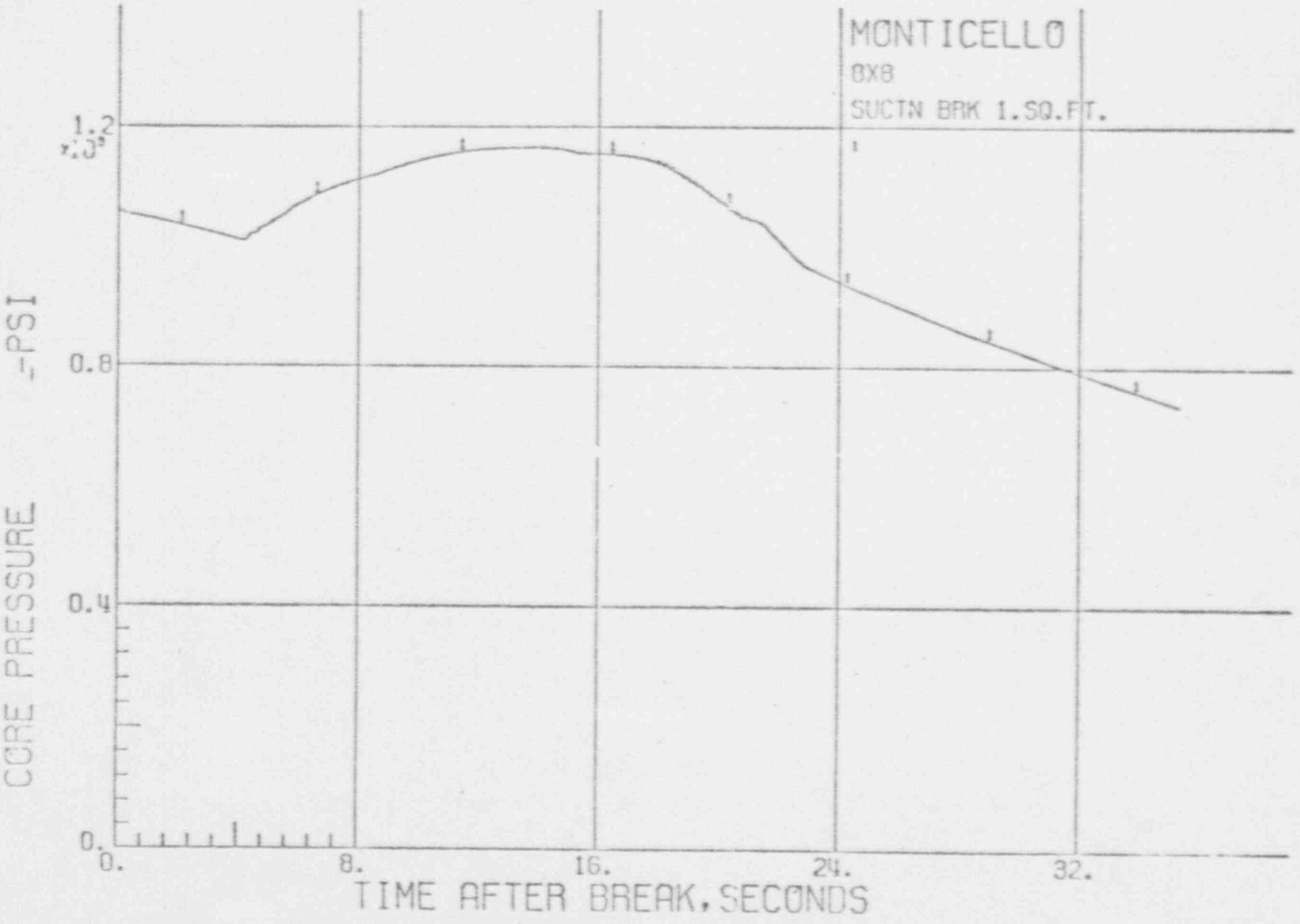


FIGURE B-1a-1
MINIMUM CRITICAL POWER
RATIO FOLLOWING A DBA
8 X 8 FUEL

Note 1: CPR = 1 @ Spacer 2
9.53 Kw/ft Average
Planar Linear Heat
Generation Rate (APLHGR);
85% of Maximum Average
Planar Linear Heat Generation
Rate (MAPLHGR)

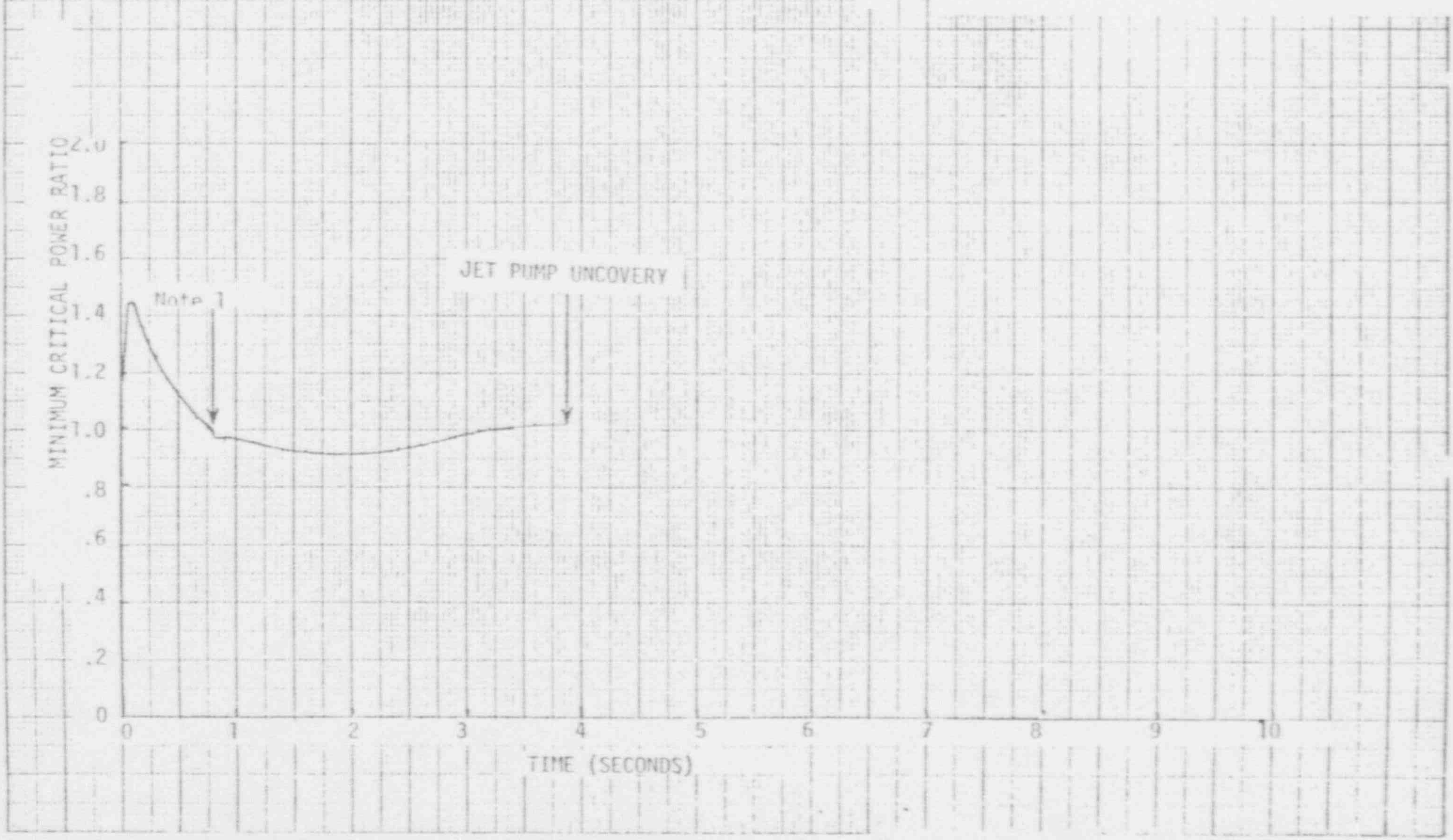
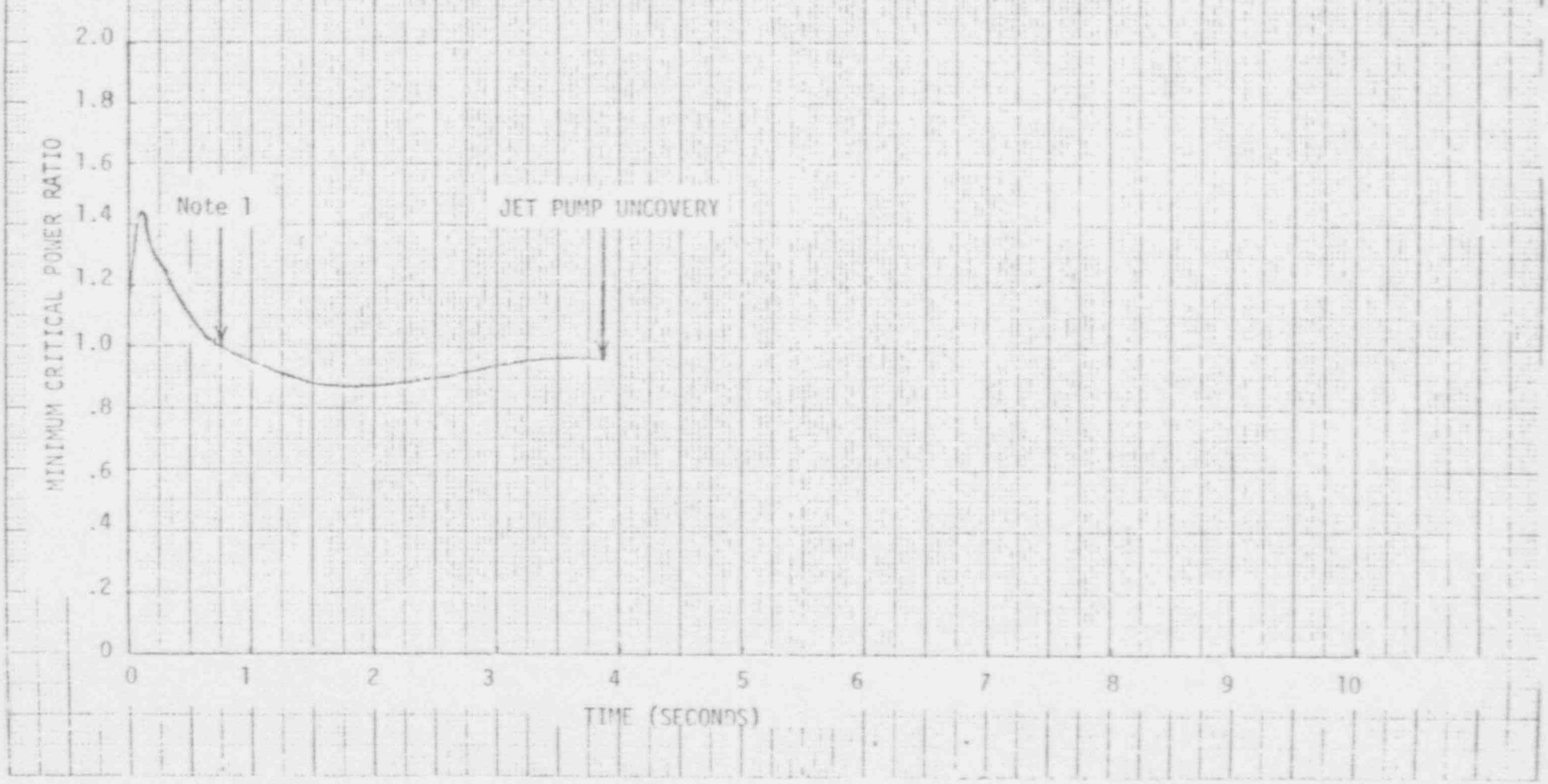


FIGURE B-1a-2

MINIMUM CRITICAL POWER
RATIO FOLLOWING A DBA
(7 X 7 FUEL)



Note 1: CPR - 1 @ Spacer 2
12.24 Kw/ft Average
Planar Linear Heat
Generation Rate (APLHGR);
85% of Maximum Average
Planar Linear Heat Generation
Rate (MAPLHGR)

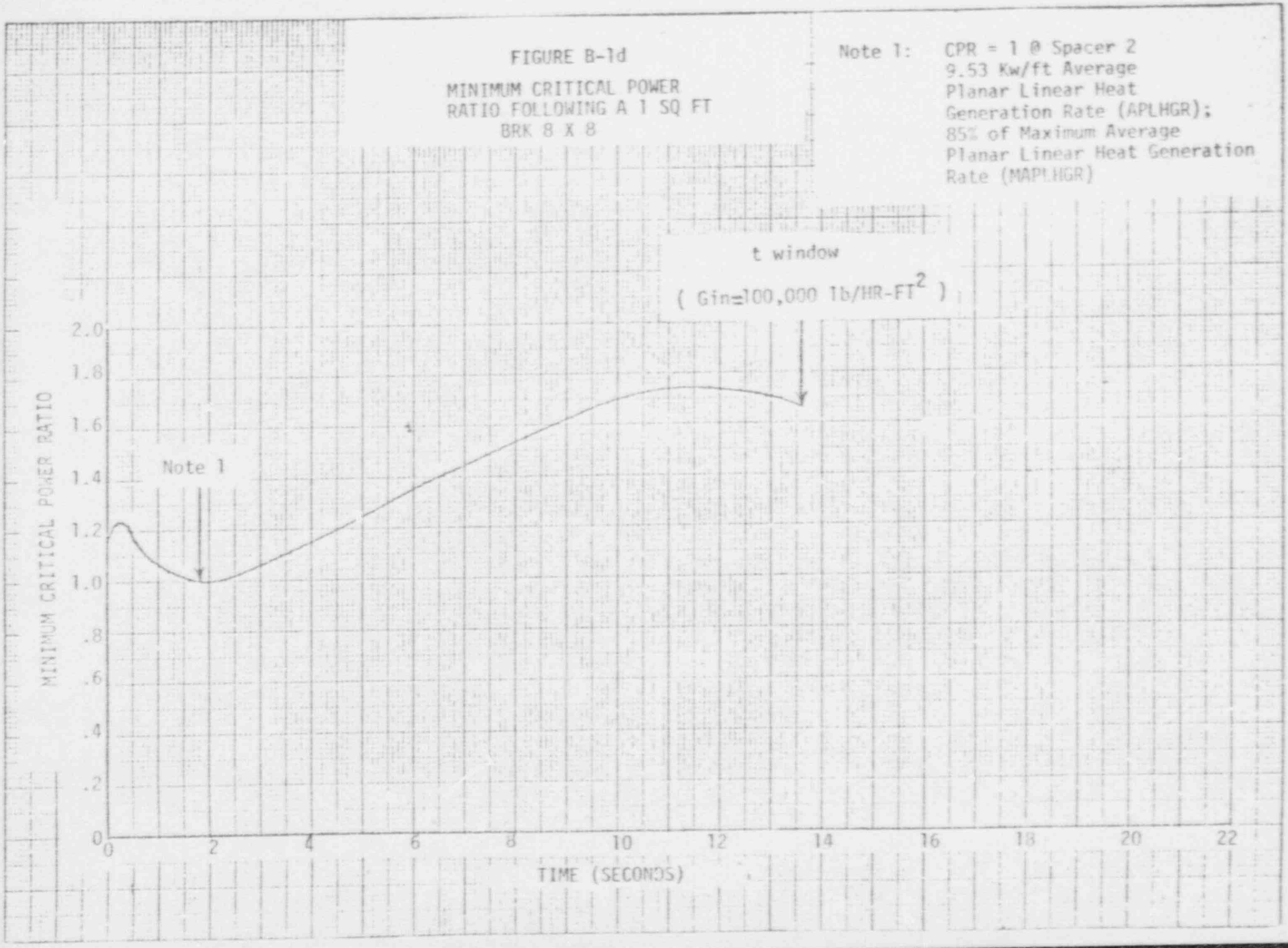


FIGURE B-1d

MINIMUM CRITICAL POWER RATIO FOLLOWING A 1 SQ FT BRK 8 X 8

Note 1: CPR = 1 @ Spacer 2
9.53 Kw/ft Average
Planar Linear Heat
Generation Rate (APLHGR);
85% of Maximum Average
Planar Linear Heat Generation
Rate (MAPLHGR)

FIGURE 6-28

FUEL ROD CONVECTIVE HEAT TRANSFER COEFFICIENT
DURING BLOWDOWN AT THE HIGH POWER AXIAL NODE (DBA)

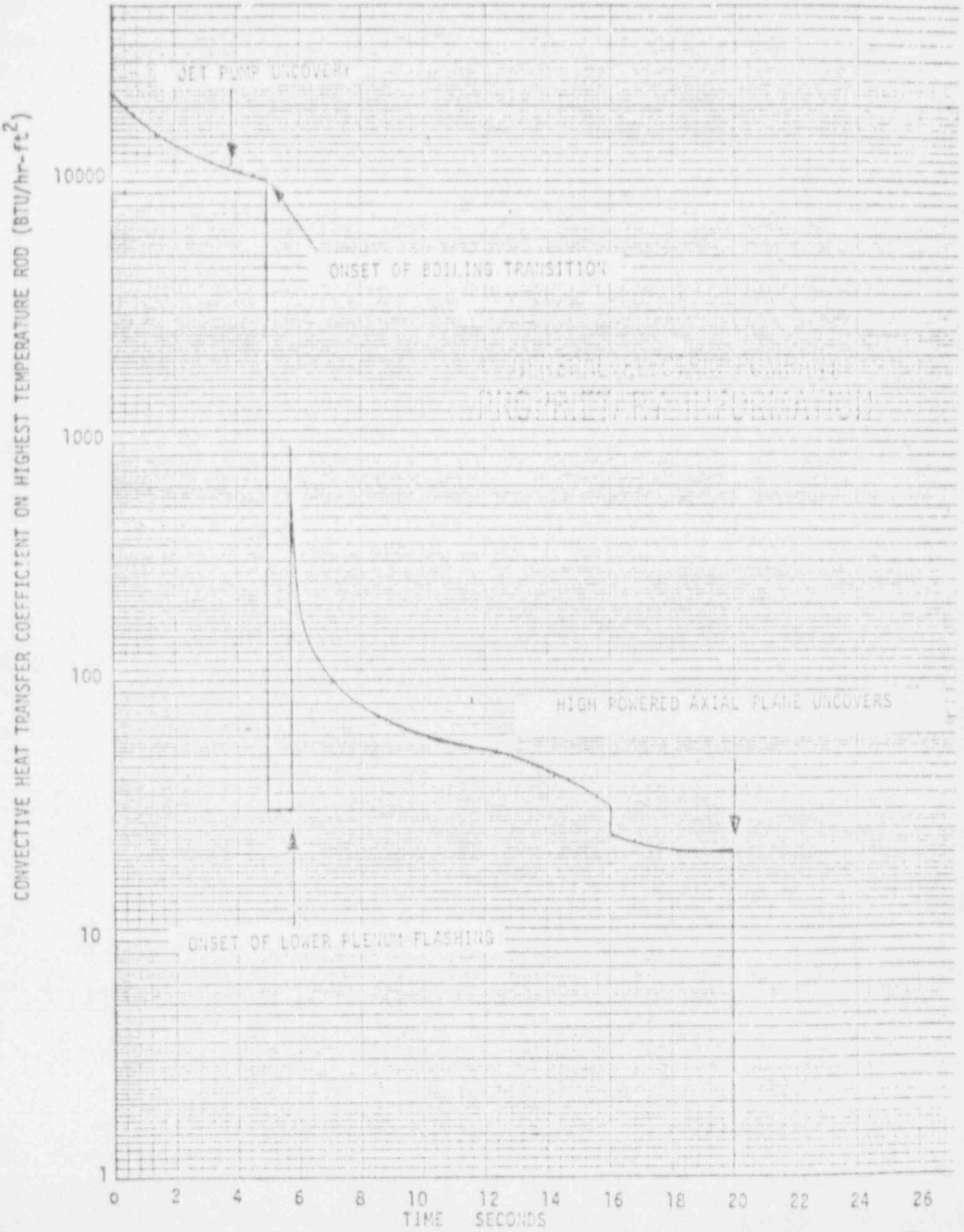


FIGURE B-2d

FUEL ROD CONVECTIVE HEAT TRANSFER COEFFICIENT FOLLOWING A 1.0 FT² BREAK

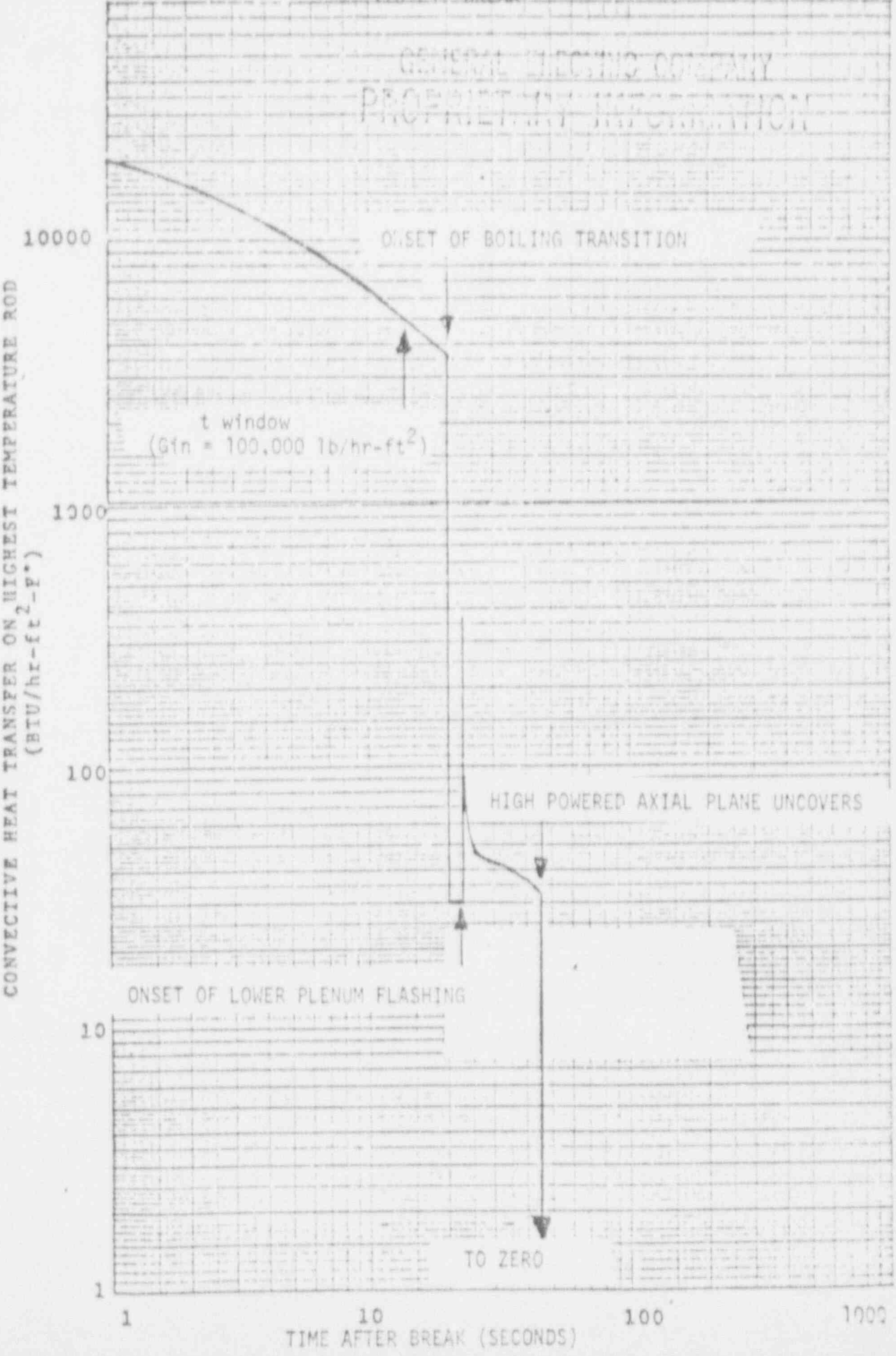
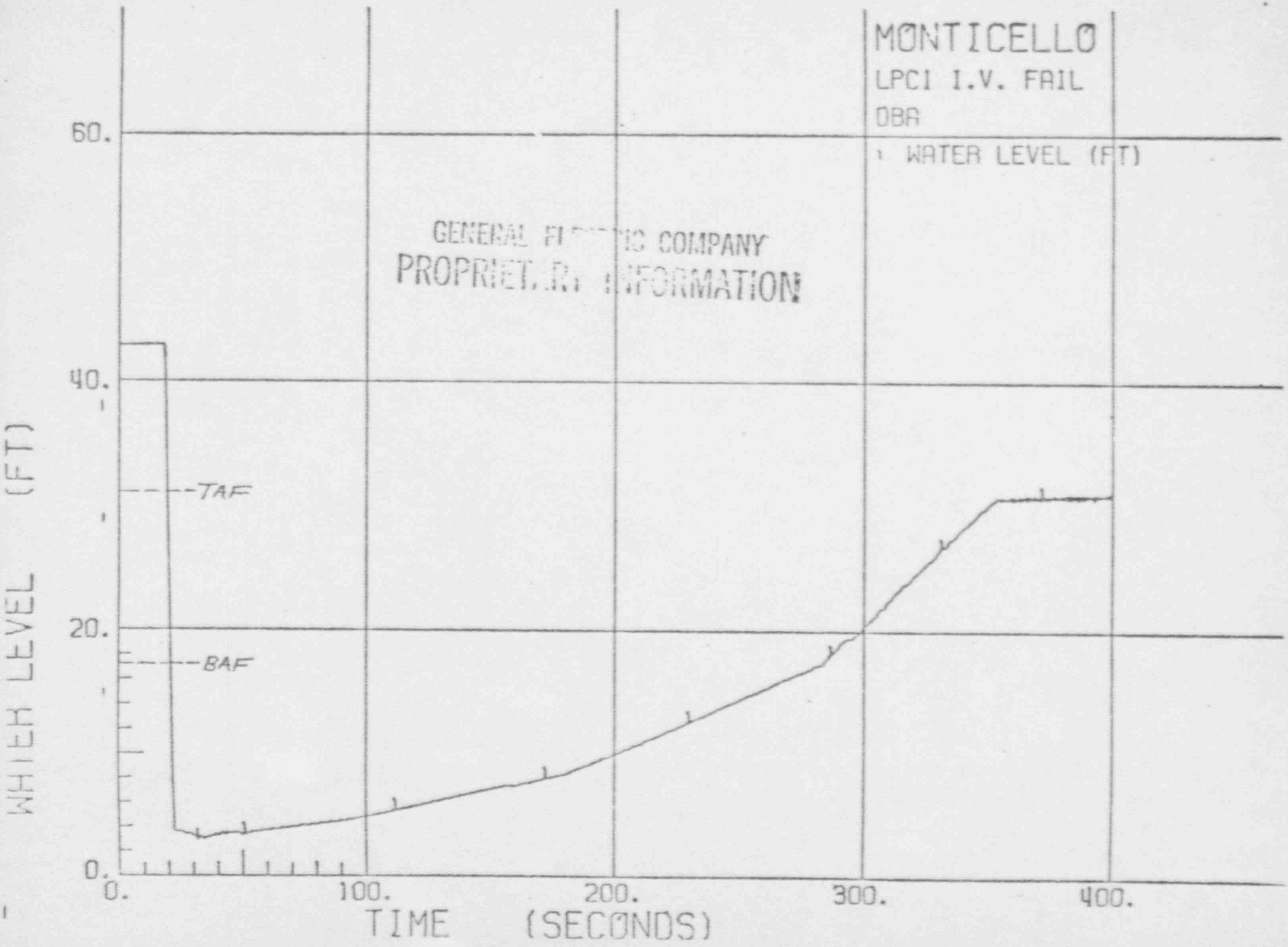


FIGURE C-1a-1



GENERAL ELECTRIC COMPANY
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FIGURE C-1d-1

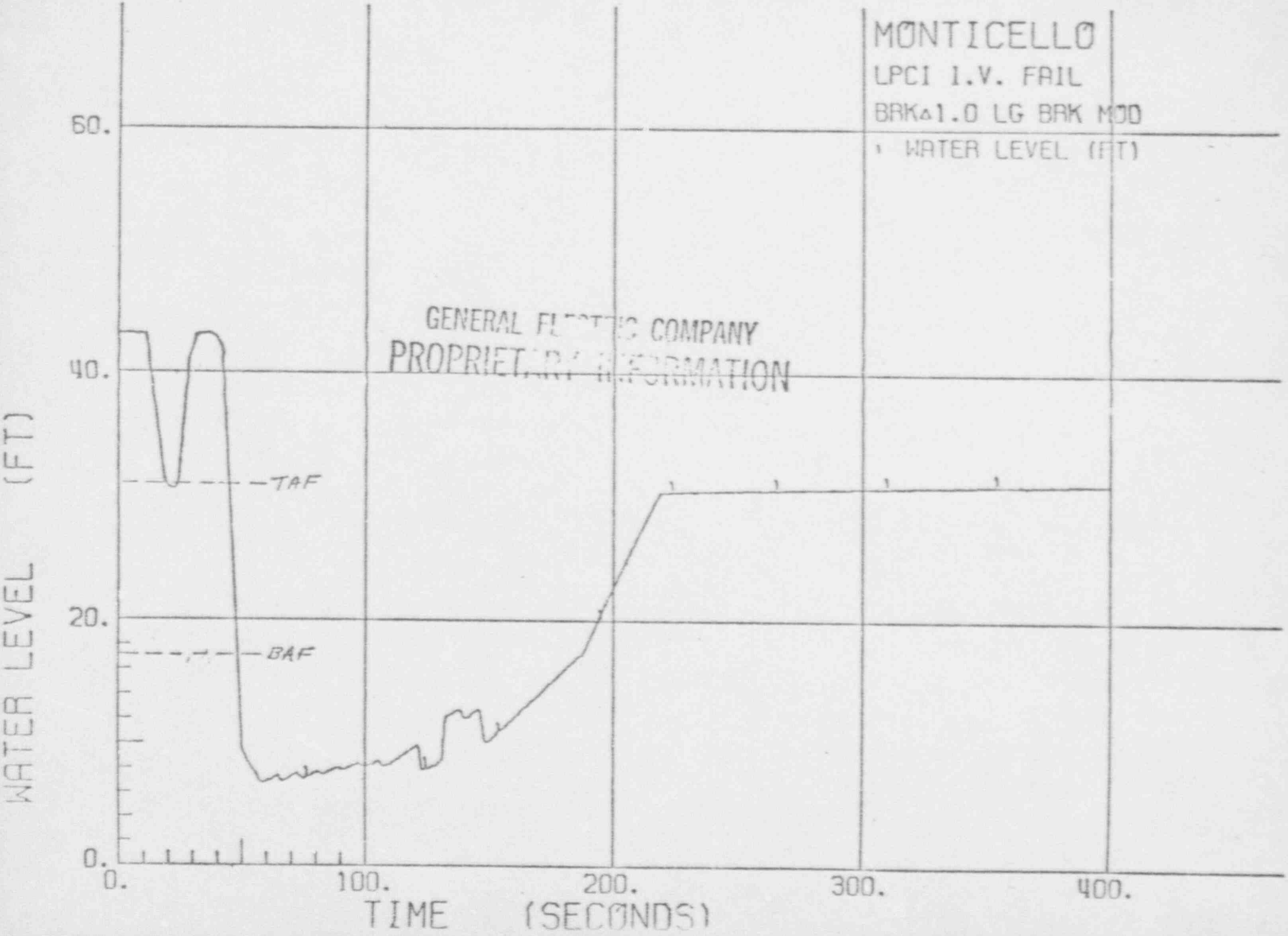

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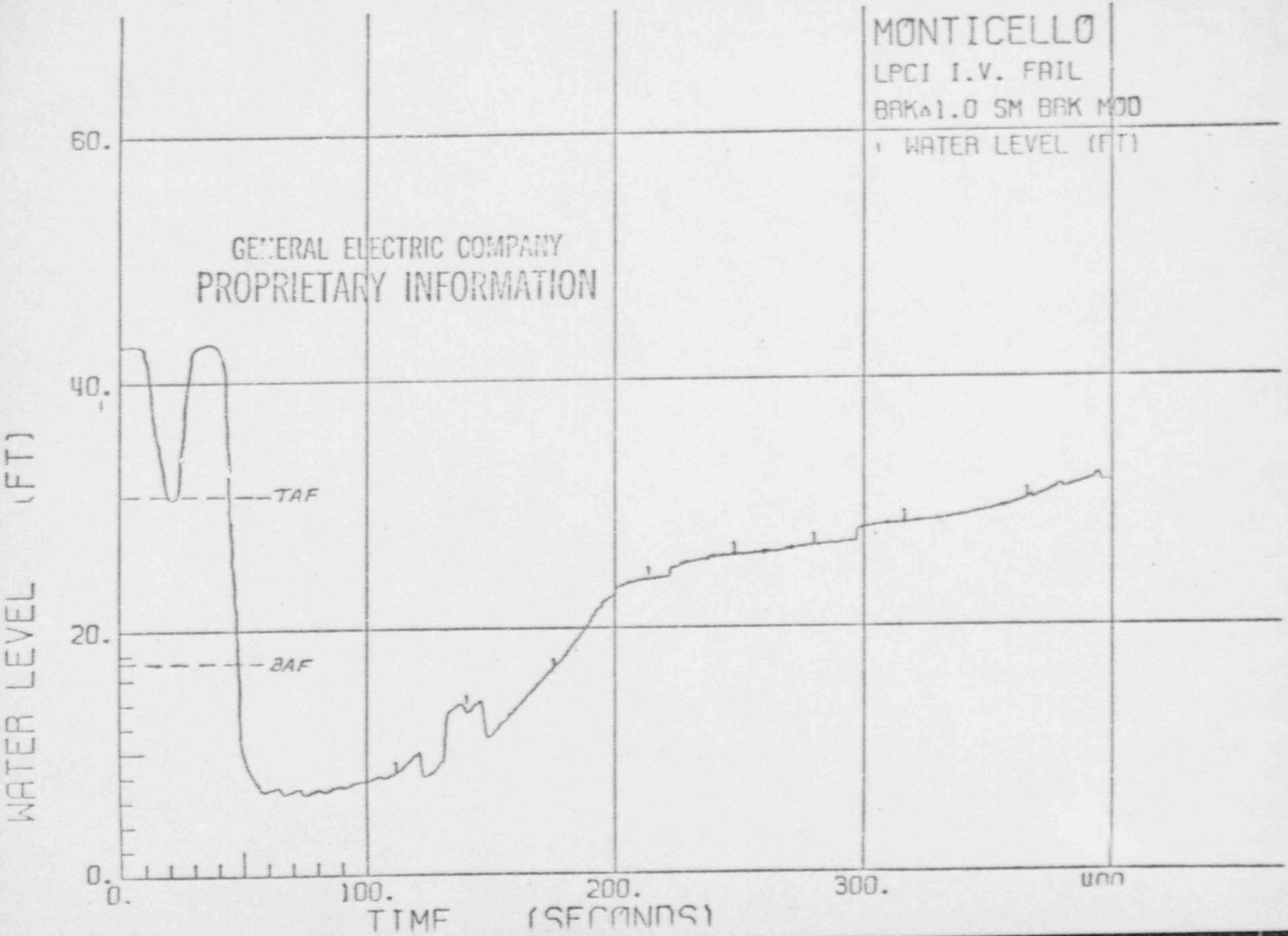
FIGURE C 2a-1



GENERAL ELECTRIC COMPANY
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FIGURE C 2b-1

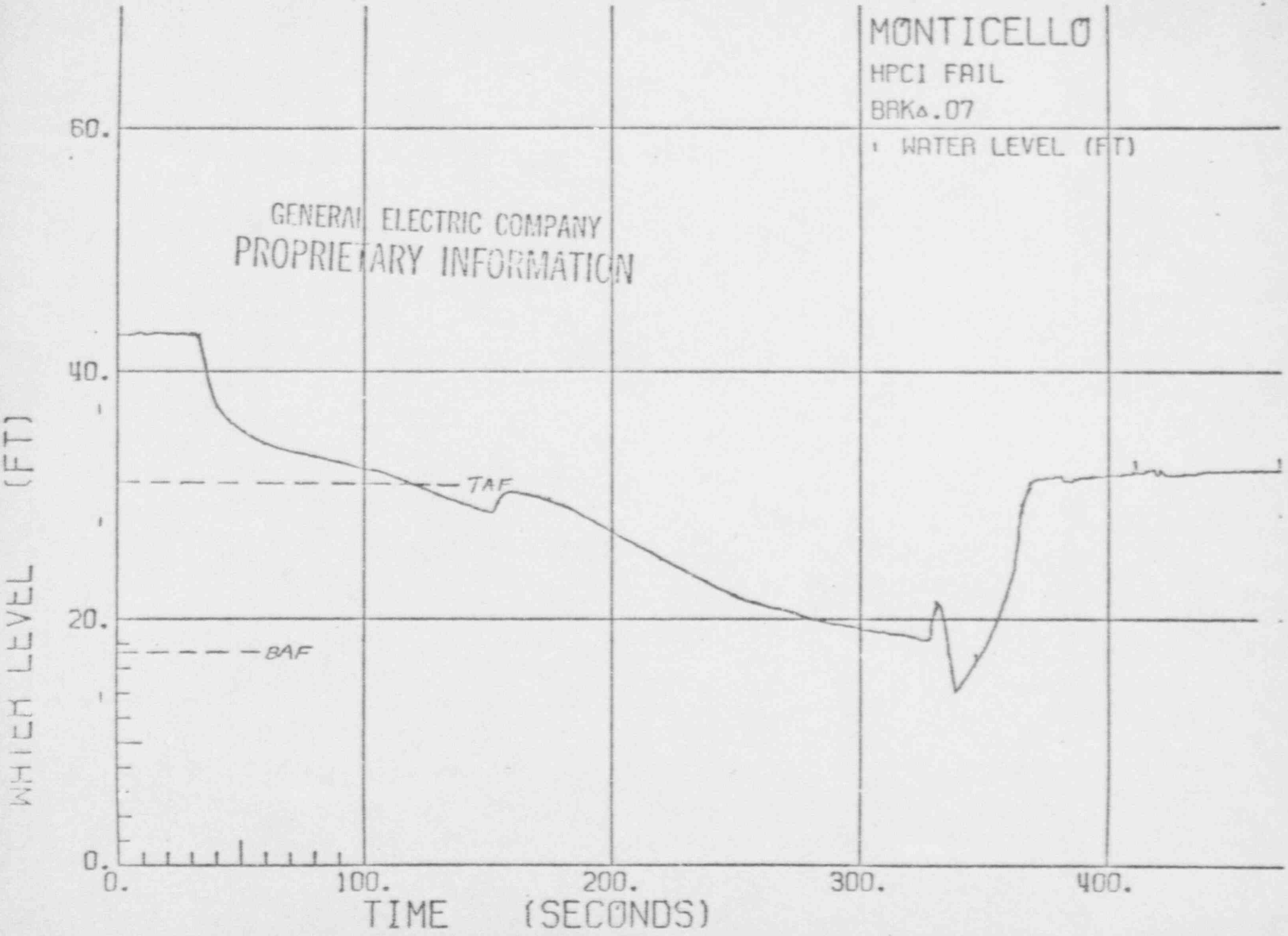

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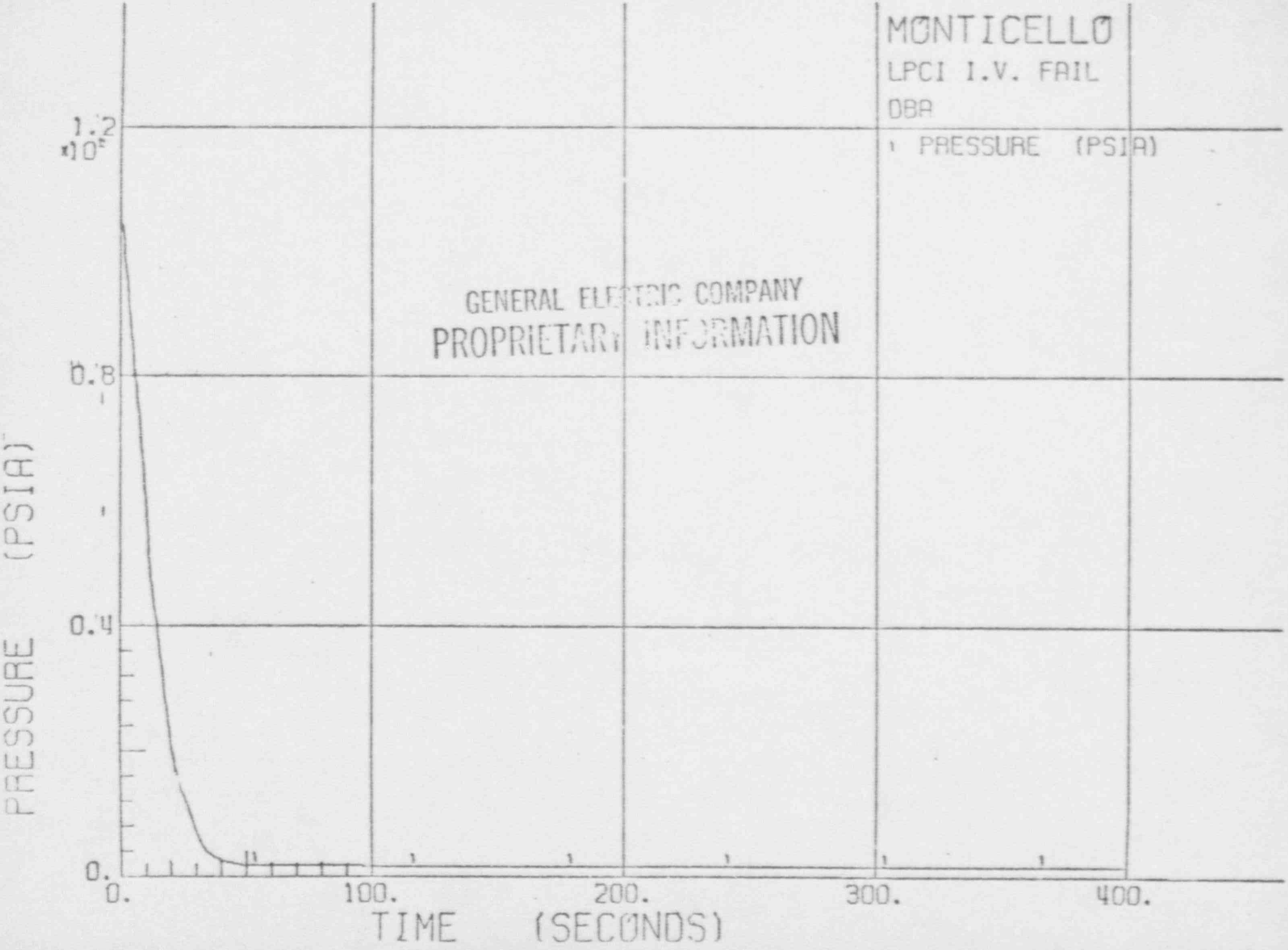
FIGURE C-1a-2



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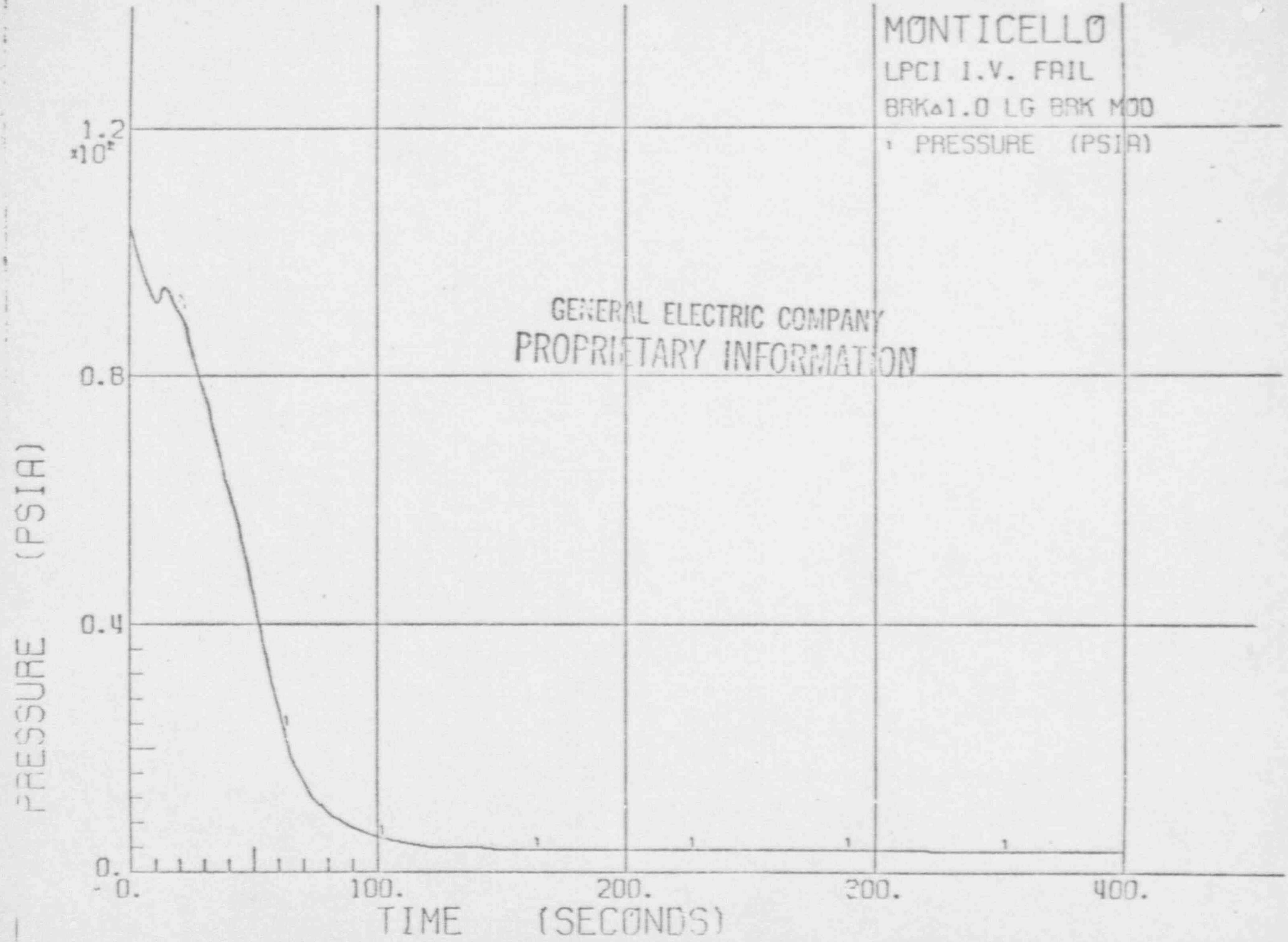
PROPRIETARY INFORMATION

FIGURE C-1d 2



GENERAL ELECTRIC COMPANY
PROPRIETARY INFORMATION

FIGURE C 2a-2

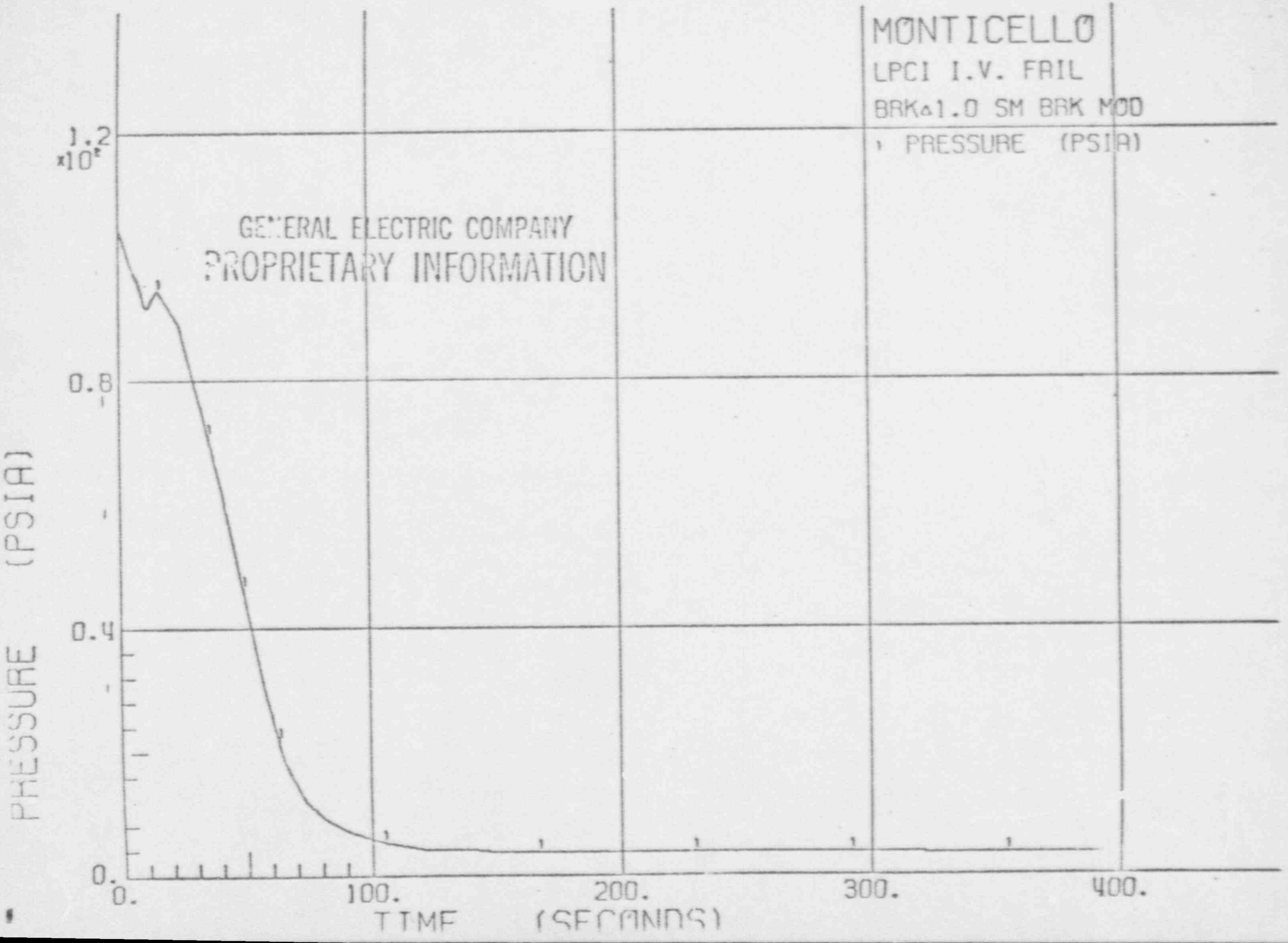
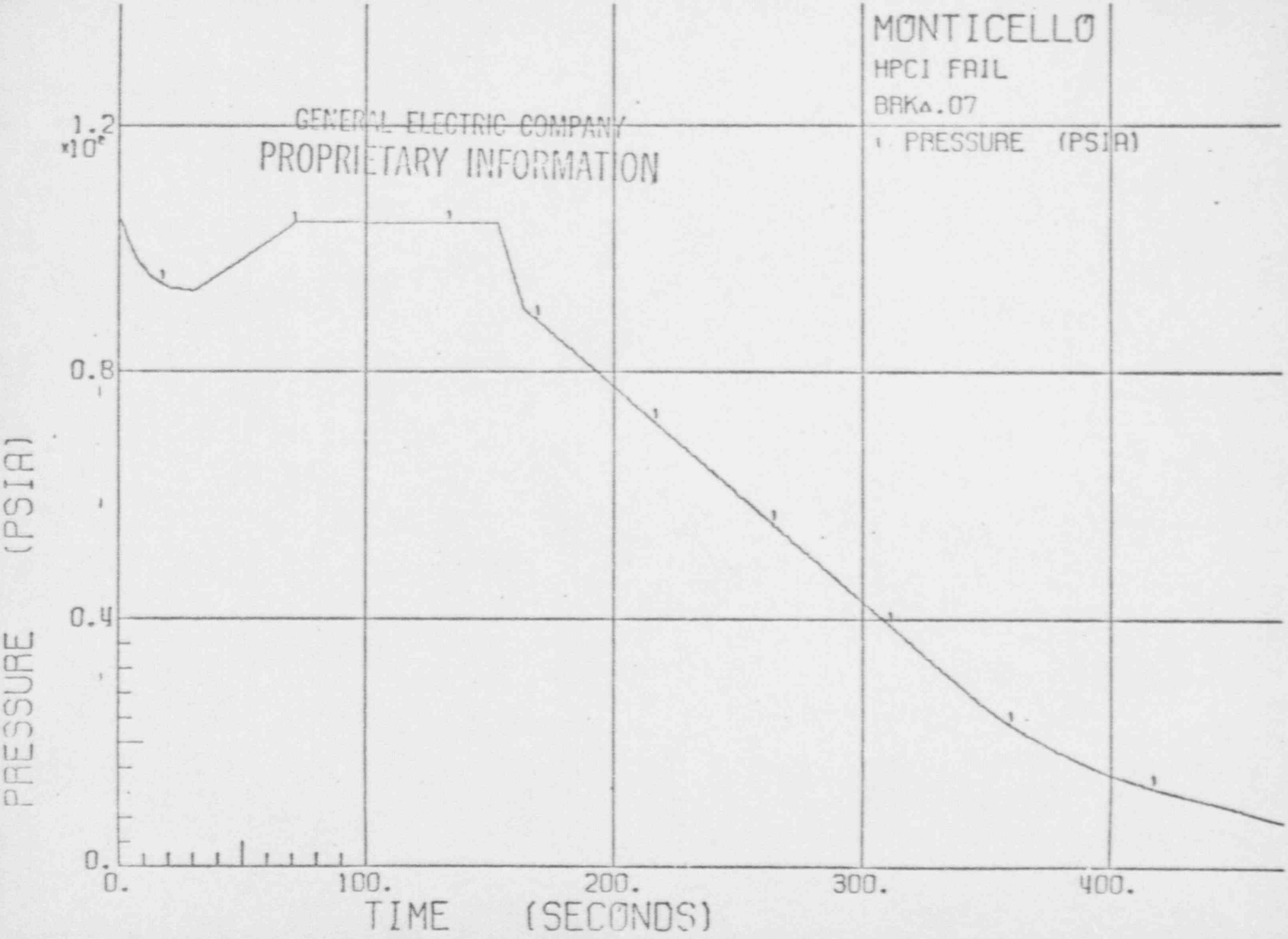

MONTICELLO
LPCI I.V. FAIL
BRK∆1.0 SM BRK MOD
1 PRESSURE (PSIA)
1.2
x10³
0.8
0.4
0.
PRESSURE (PSIA)
0.
100.
200.
300.
400.
TIME (SECONDS)

FIGURE C-2b-2



GENERAL ELECTRIC COMPANY
PROPRIETARY INFORMATION

FIGURE D-1a

PEAK CLADDING TEMPERATURE FOLLOWING A DESIGN BASIS ACCIDENT

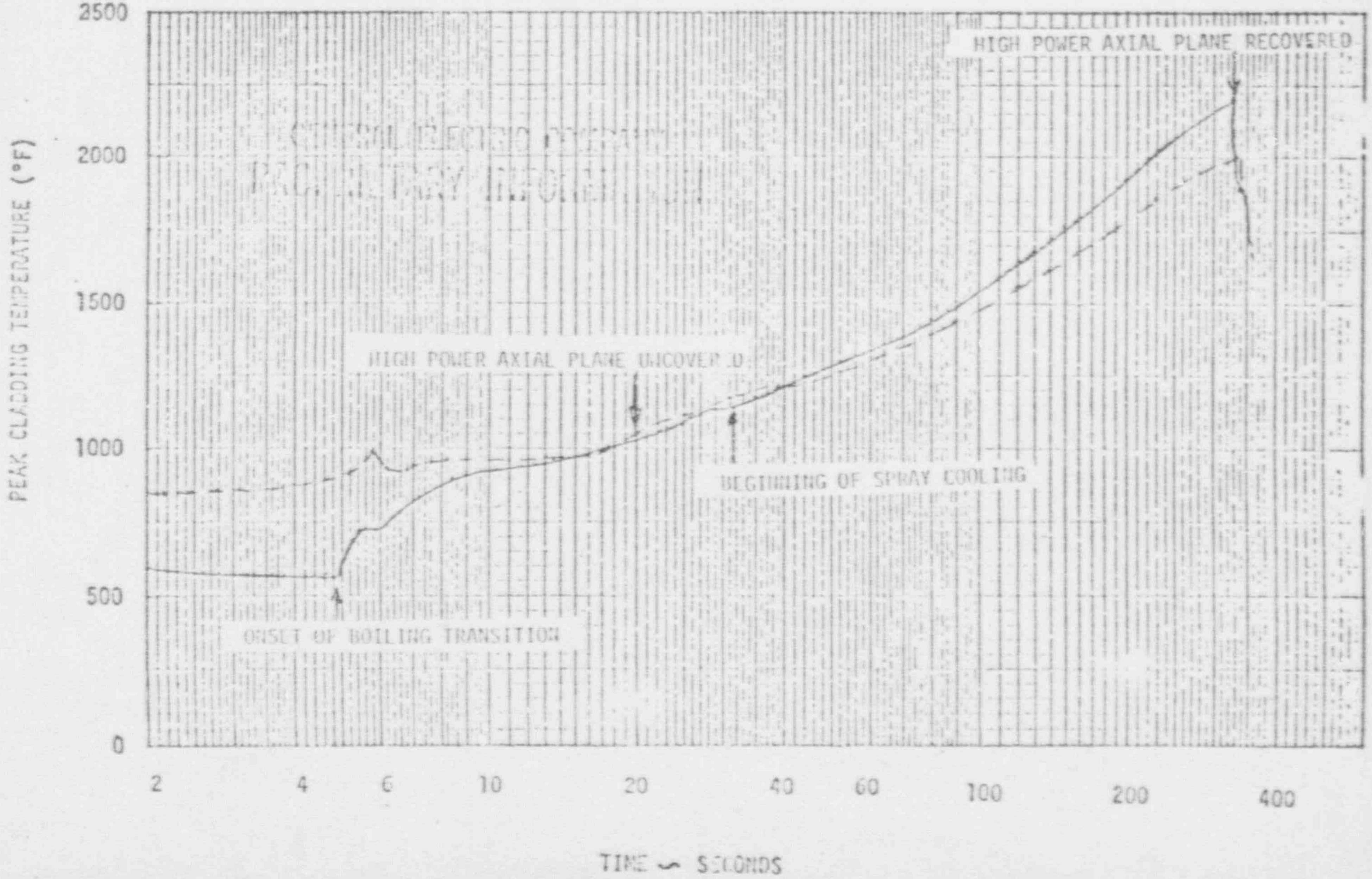


FIGURE D-1d

PEAK CLADDING TEMPERATURE FOLLOWING A DESIGN
BASIS ACCIDENT - 1.0 FT^2 INTERMEDIATE BREAK
(LARGE BREAK METHODS)

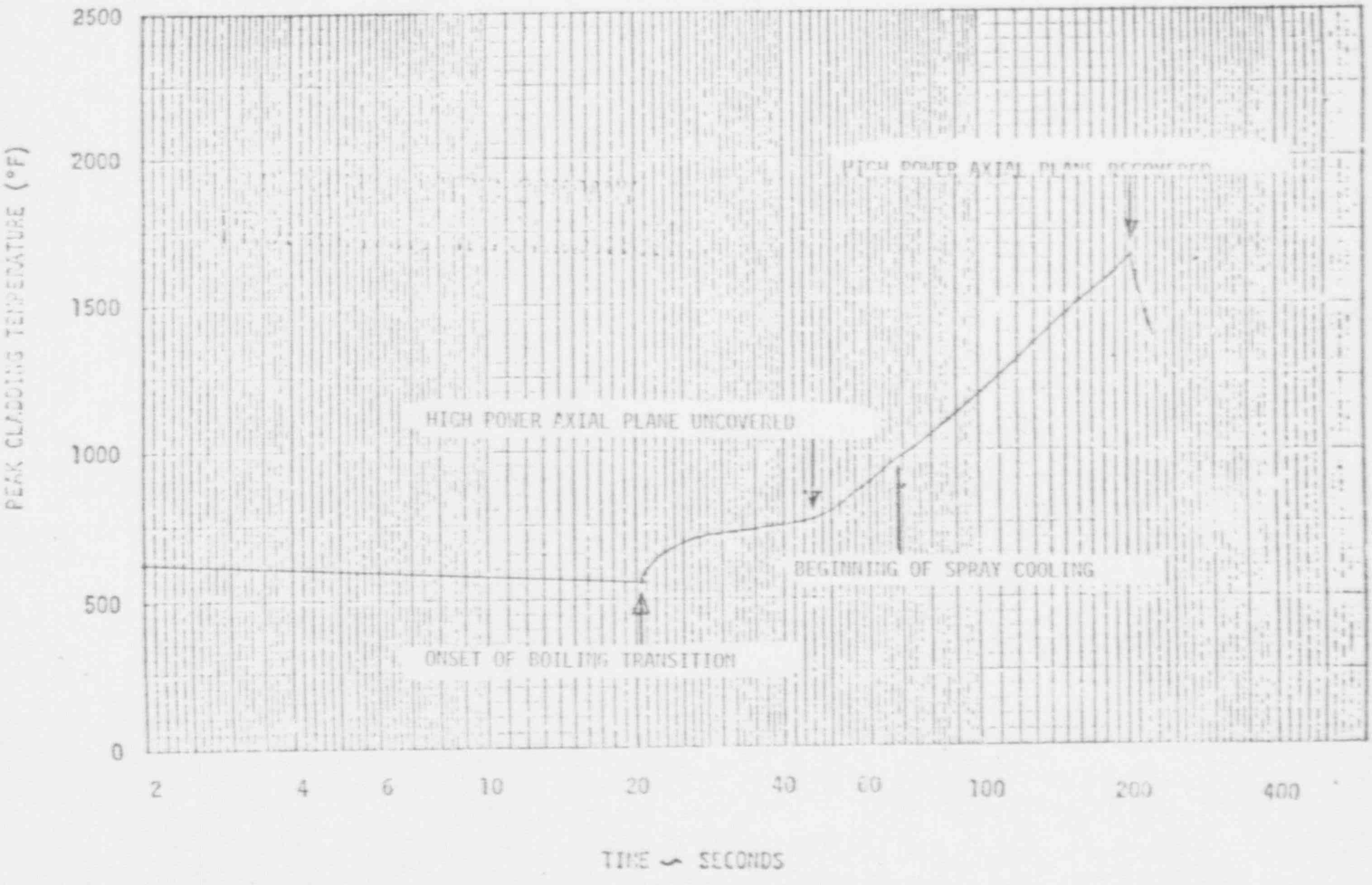
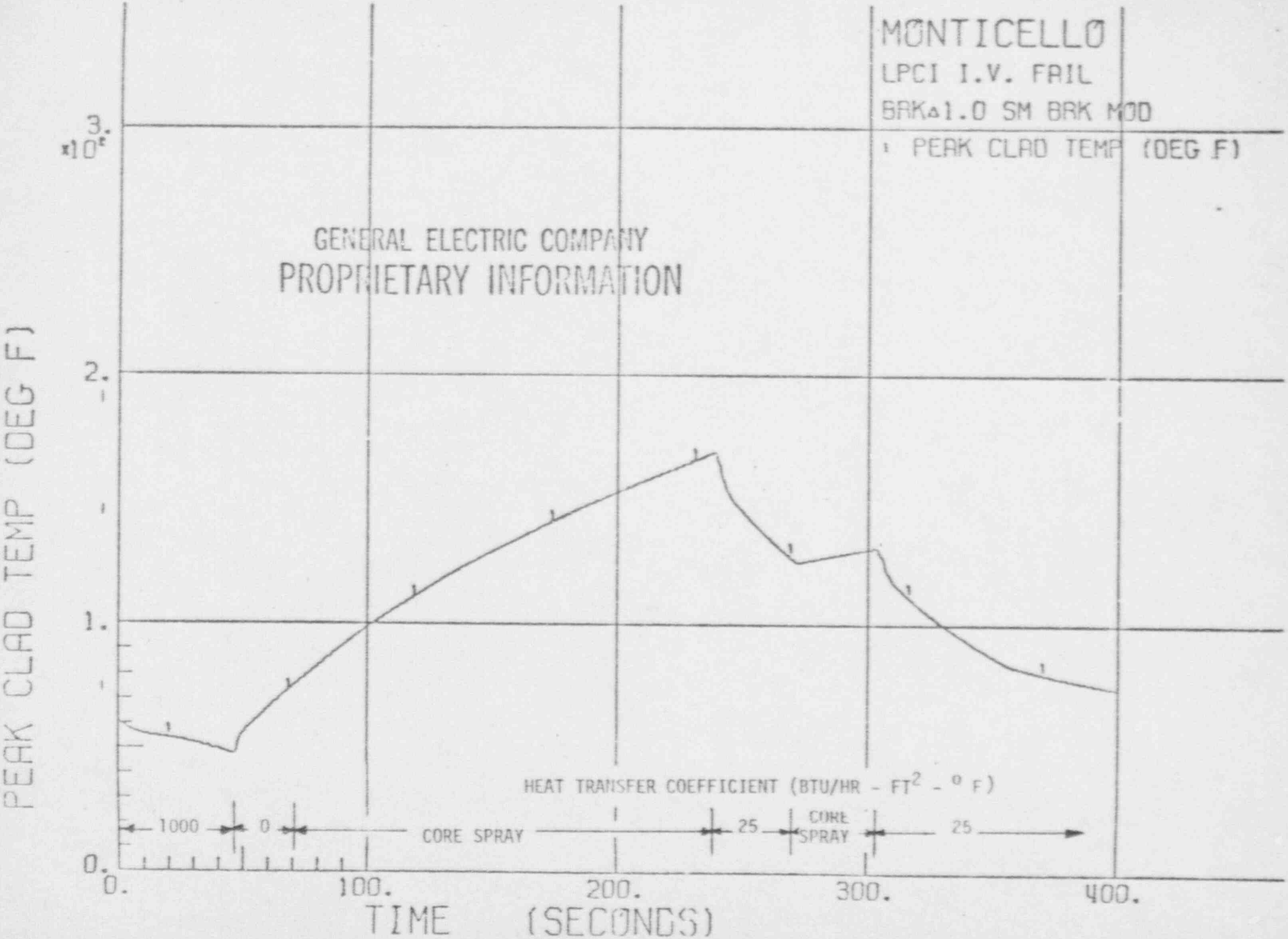


FIGURE D-2a



GENERAL ELECTRIC COMPANY
PROPRIETARY INFORMATION

FIGURE D-2b

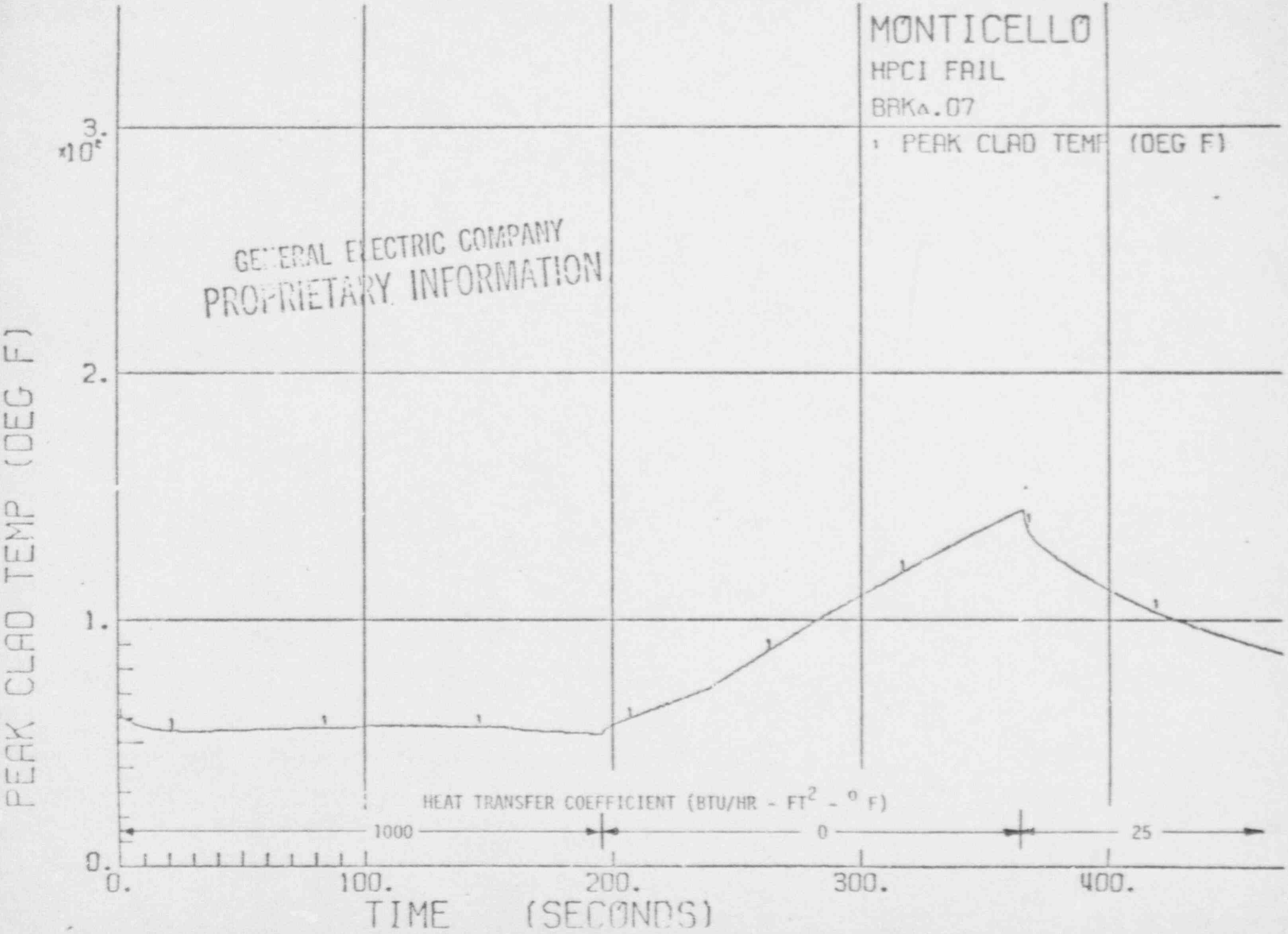

MONTICELLO
HPCI FAIL
BRKA.07
1 PEAK CLAD TEMP (DEG F)
3.
x10³
2.
1.
0.
PEAK CLAD TEMP (DEG F)
HEAT TRANSFER COEFFICIENT (BTU/HR - FT² - ° F)
1000
0
25
0.
100.
200.
300.
400.
TIME (SECONDS)

FIGURE D-3

PEAK CLADDING TEMPERATURE AND
LOCAL PEAK OXIDATION
VERSUS BREAK AREA

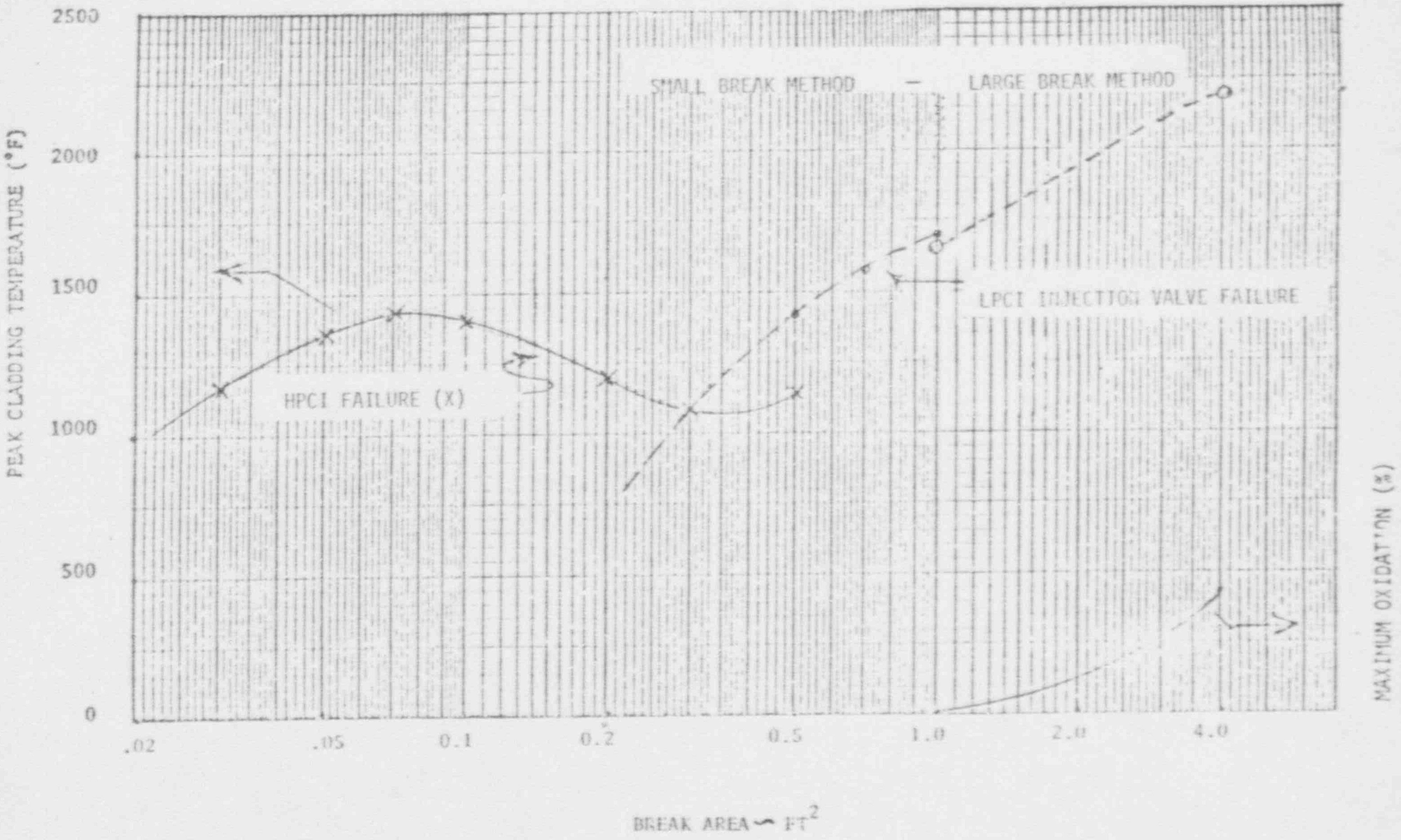
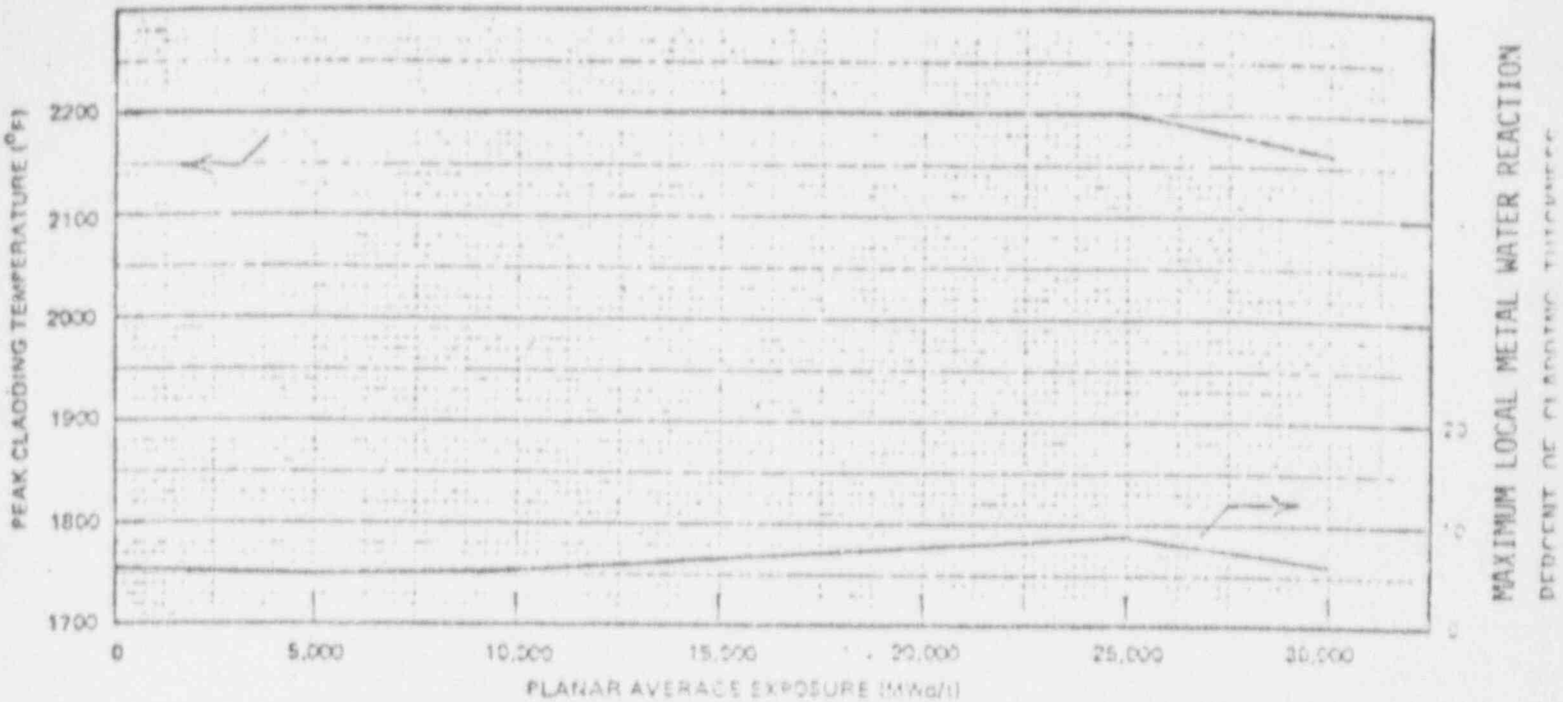
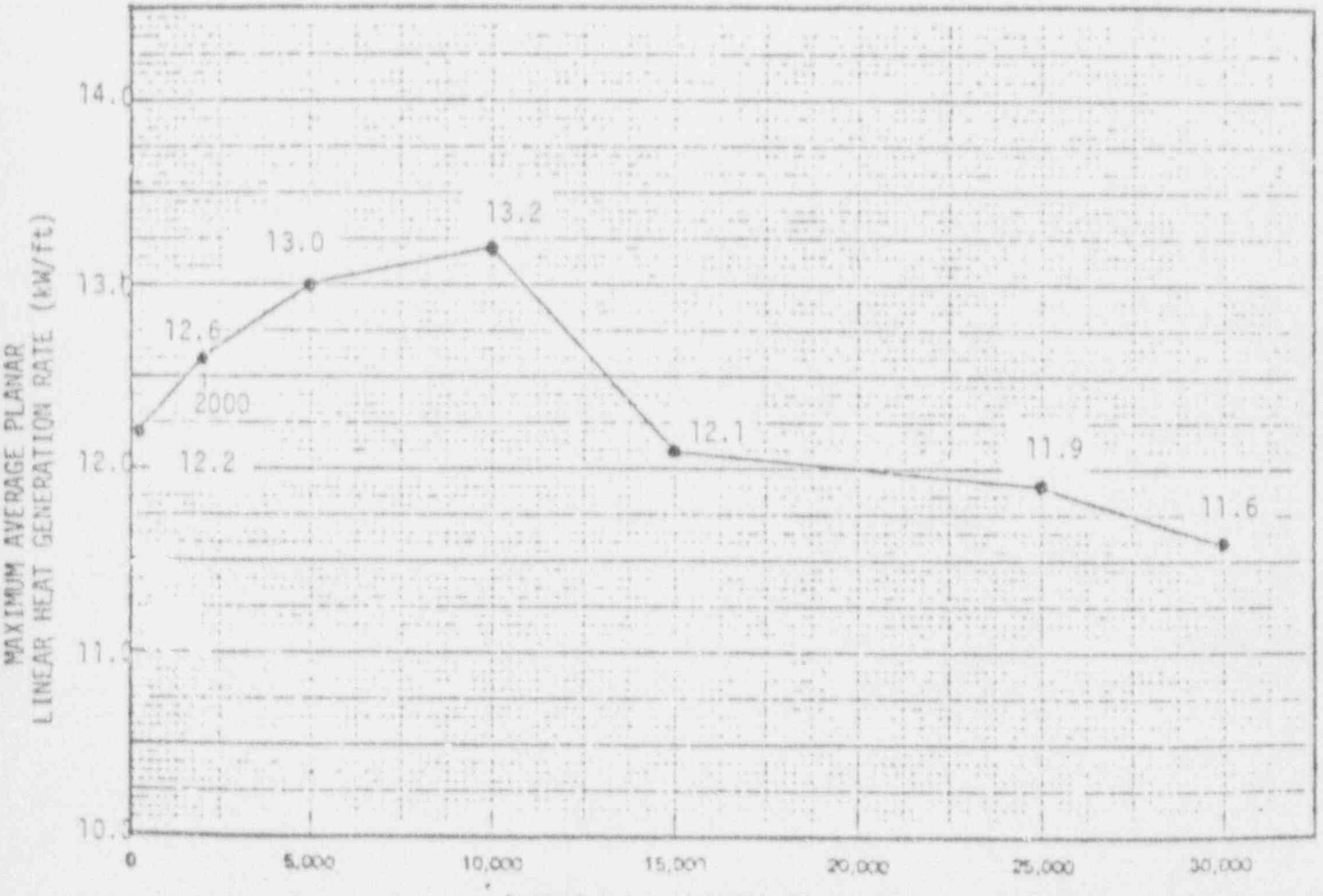


FIGURE D-4A & D-5A



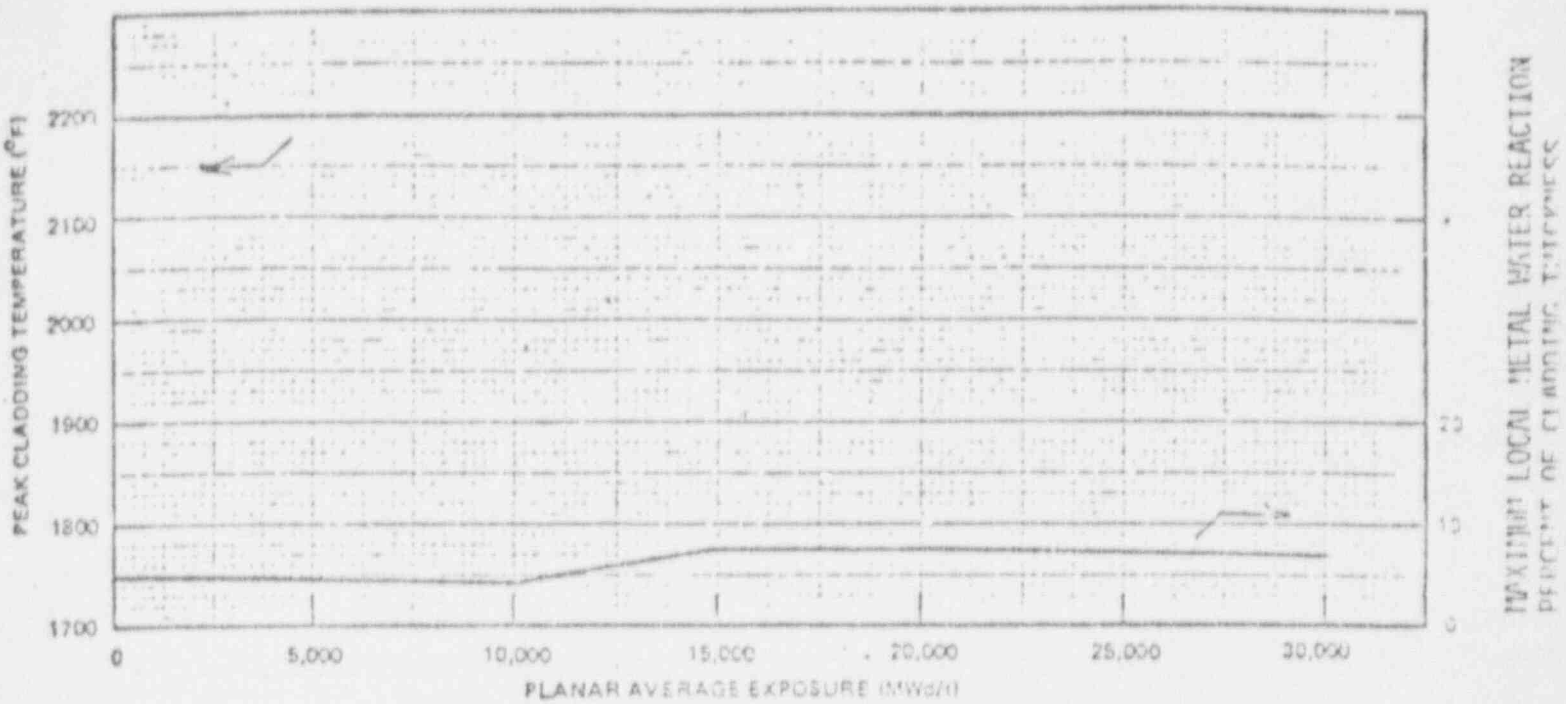
D-4A PEAK CLADDING TEMPERATURE VERSUS PLANAR AVERAGE EXPOSURE



D-5A MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS PLANAR AVERAGE EXPOSURE

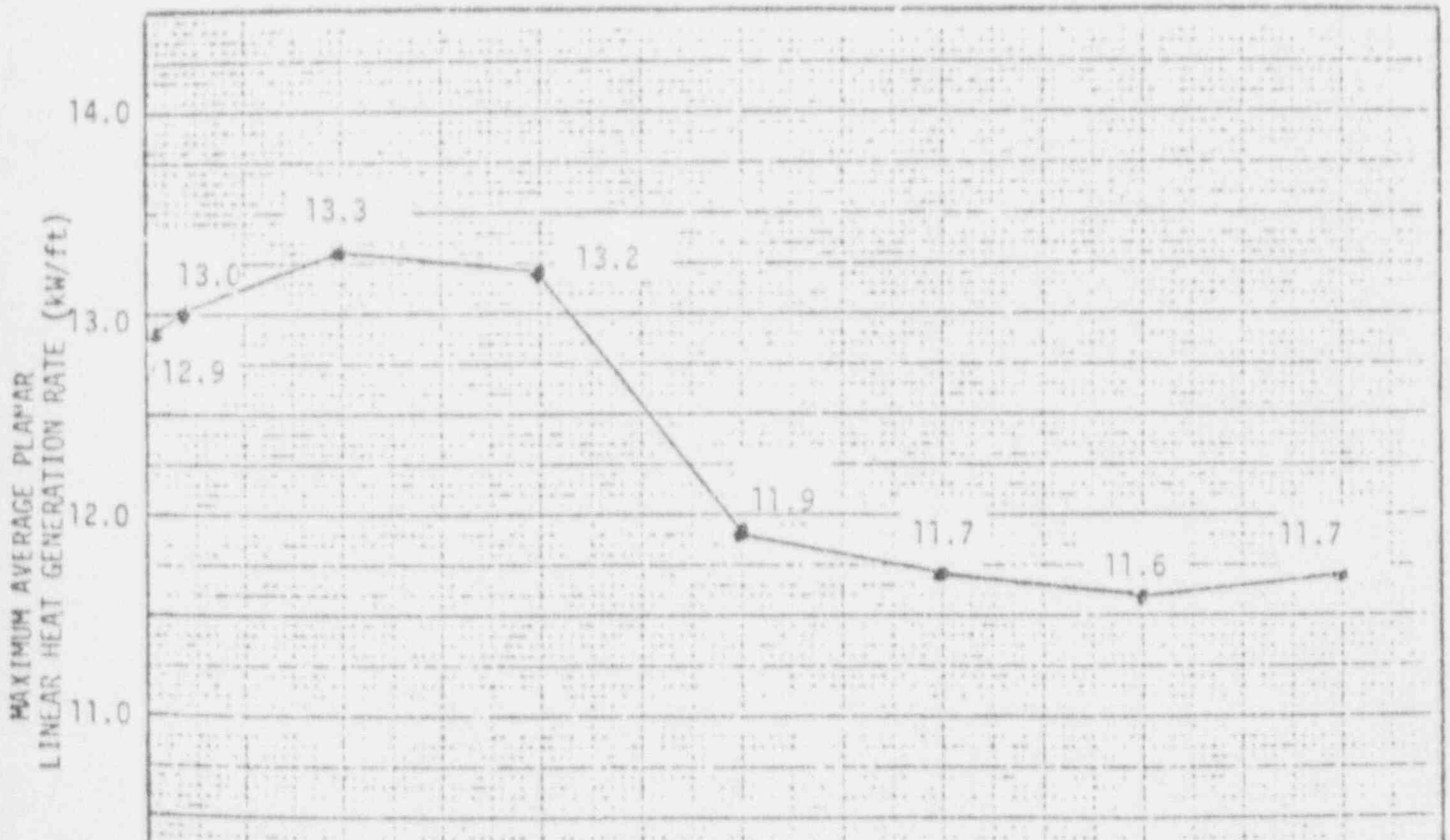
MONTICELLO
INITIAL CORE 7D225

FIGURE D-4B & D-5B



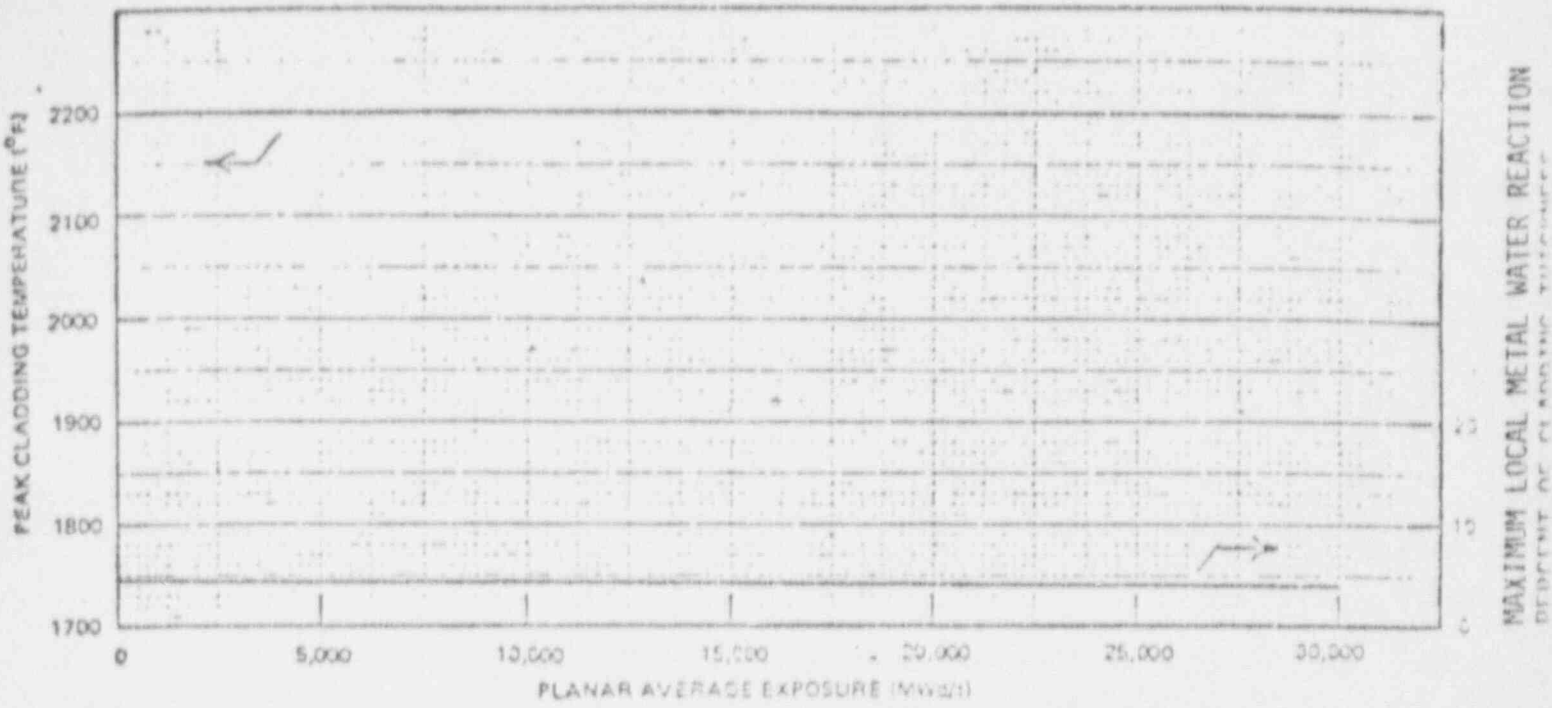
D-4B

PEAK CLADDING TEMPERATURE VERSUS PLANAR AVERAGE EXPOSURE

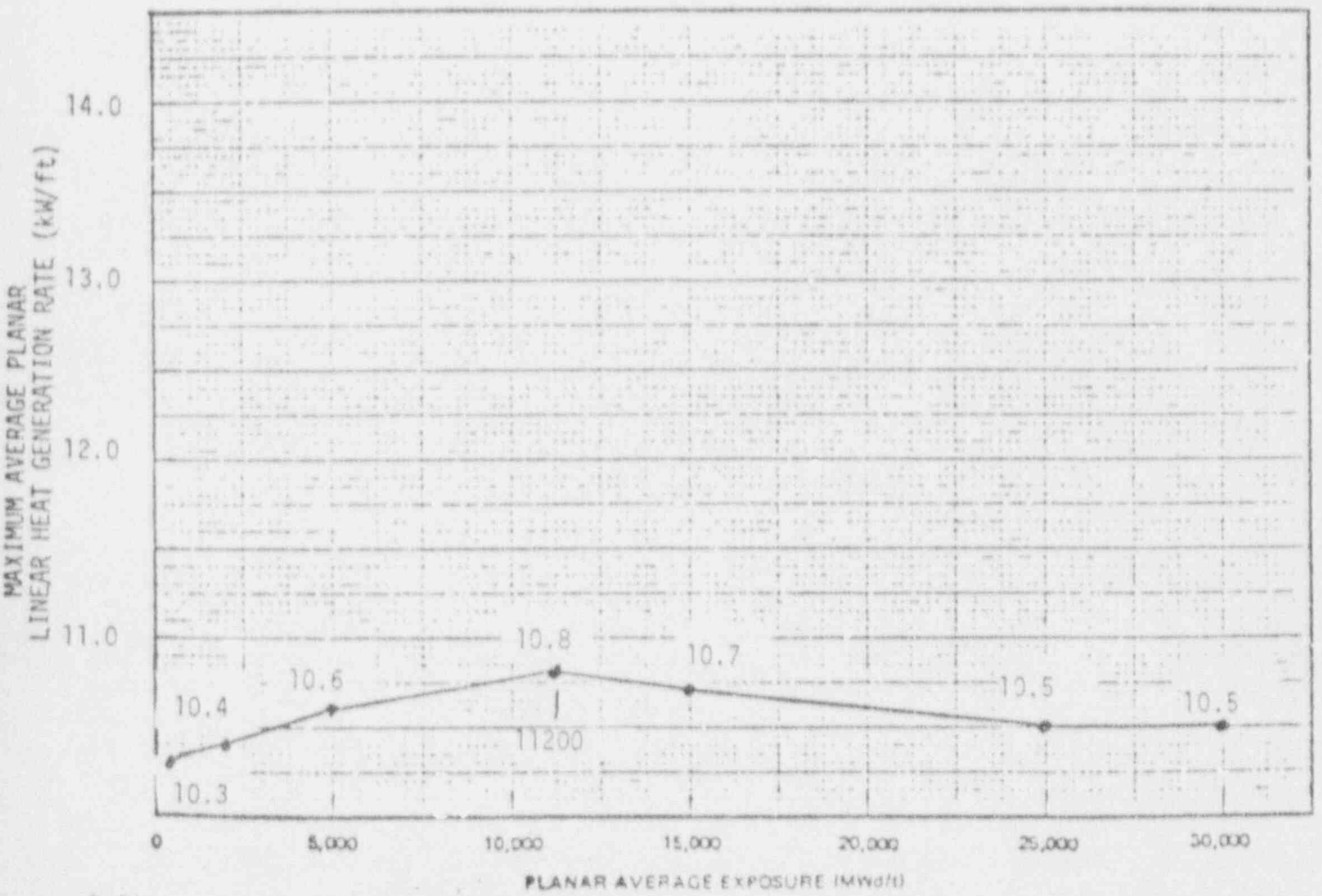


MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR)
VERSUS PLANAR AVERAGE EXPOSURE

FIGURE D-4C & 5C



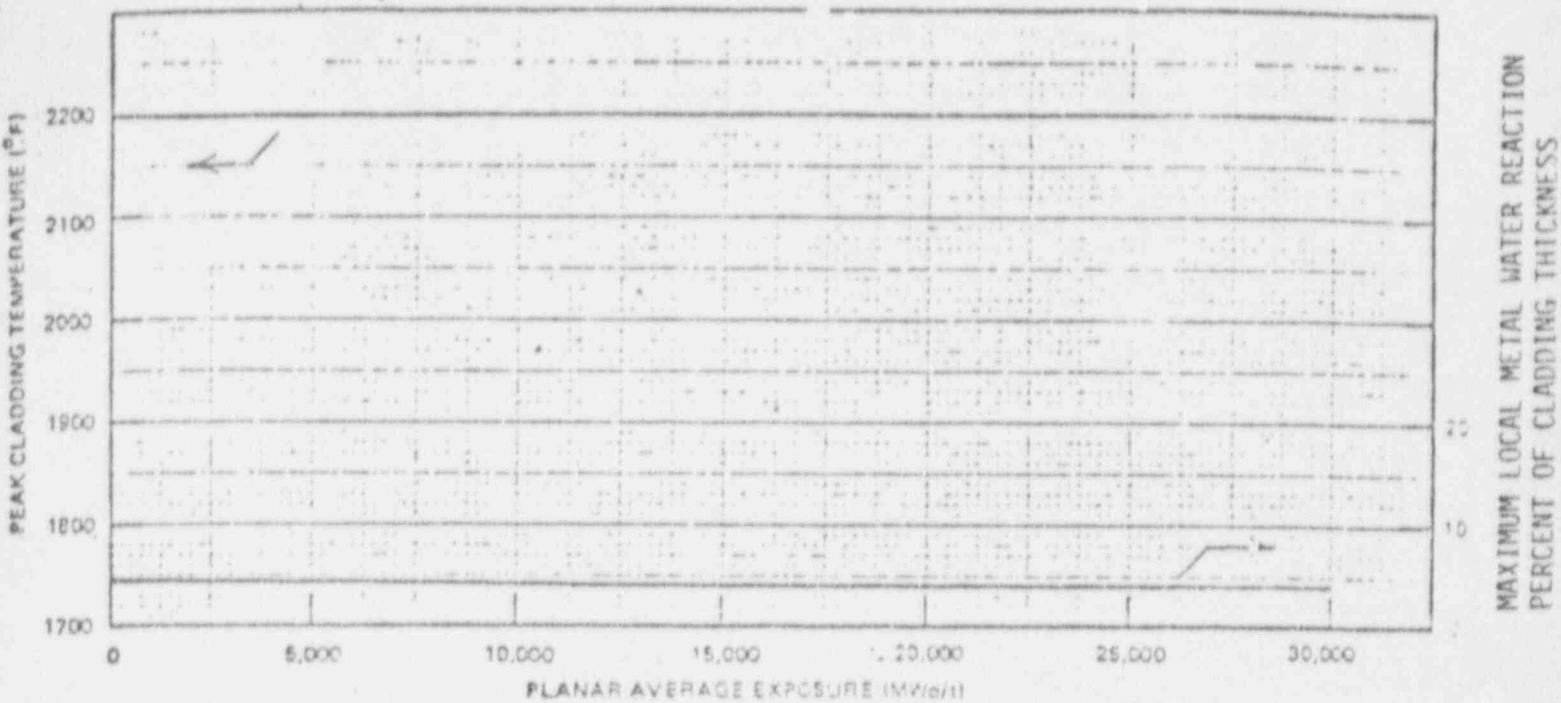
D-4C PEAK CLADDING TEMPERATURE VERSUS PLANAR AVERAGE EXPOSURE



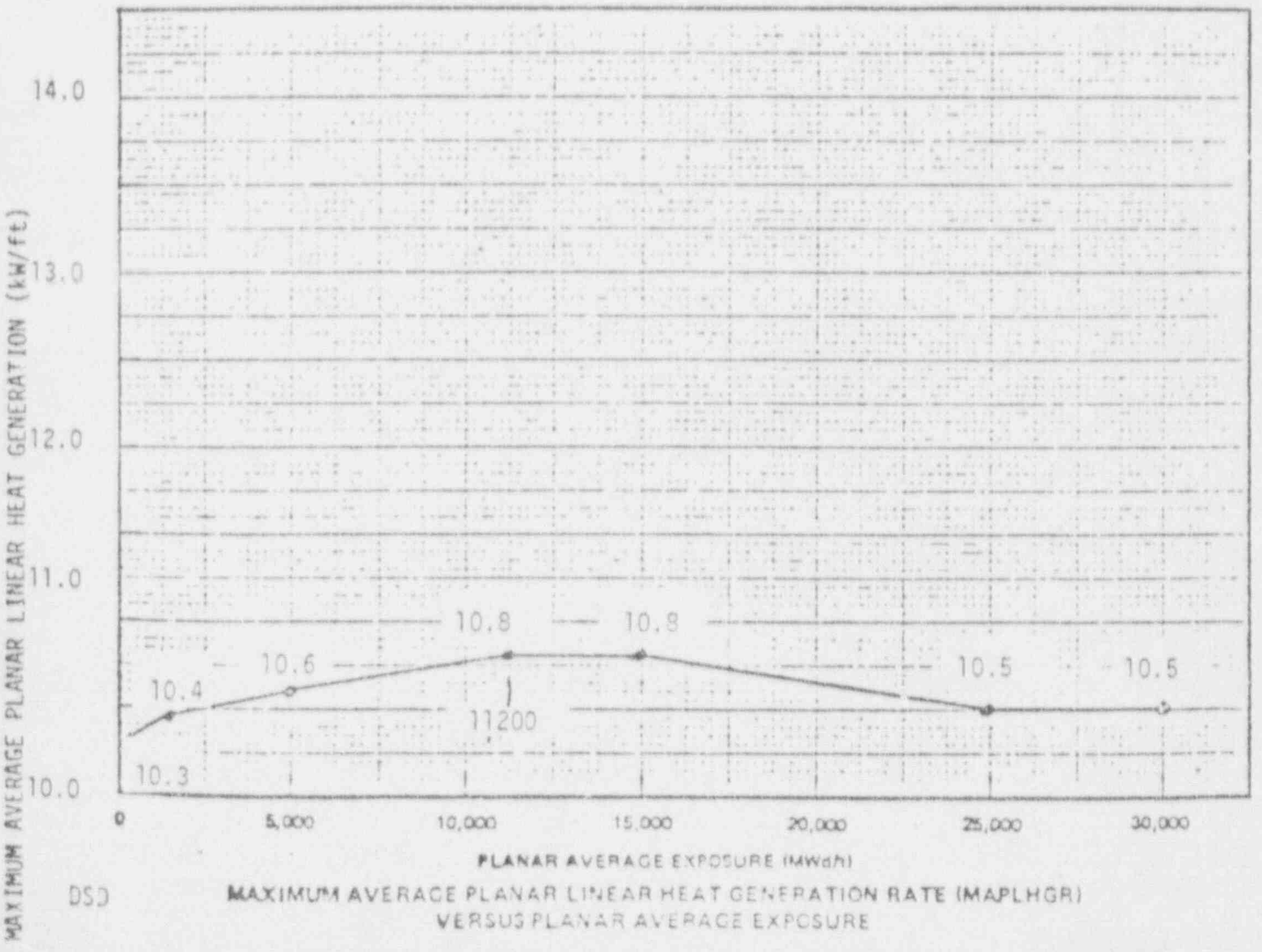
D-5C MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS PLANAR AVERAGE EXPOSURE

MONTICELLO
RELOAD 2 8D262

FIGURE D-4D & D-5D



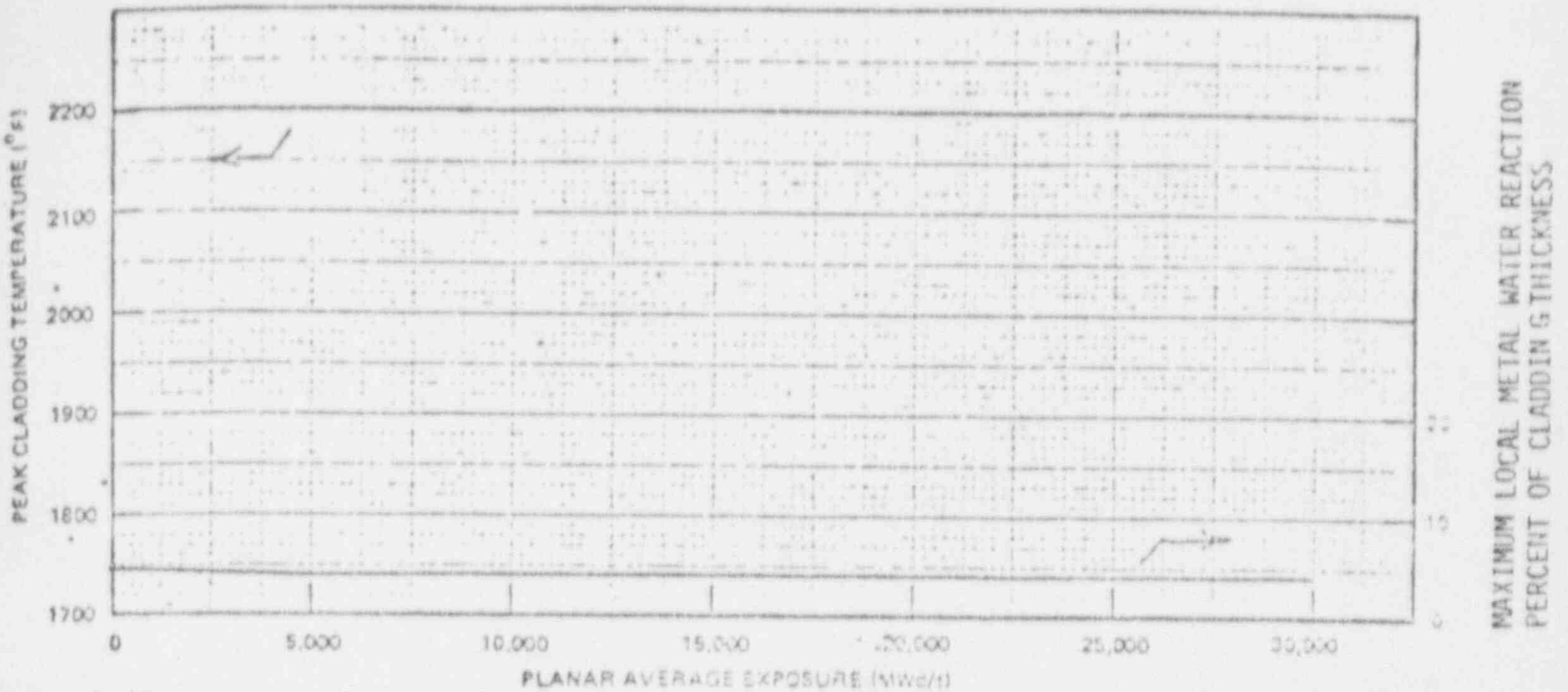
D-4D PEAK CLADDING TEMPERATURE VERSUS PLANAR AVERAGE EXPOSURE



D5D MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS PLANAR AVERAGE EXPOSURE

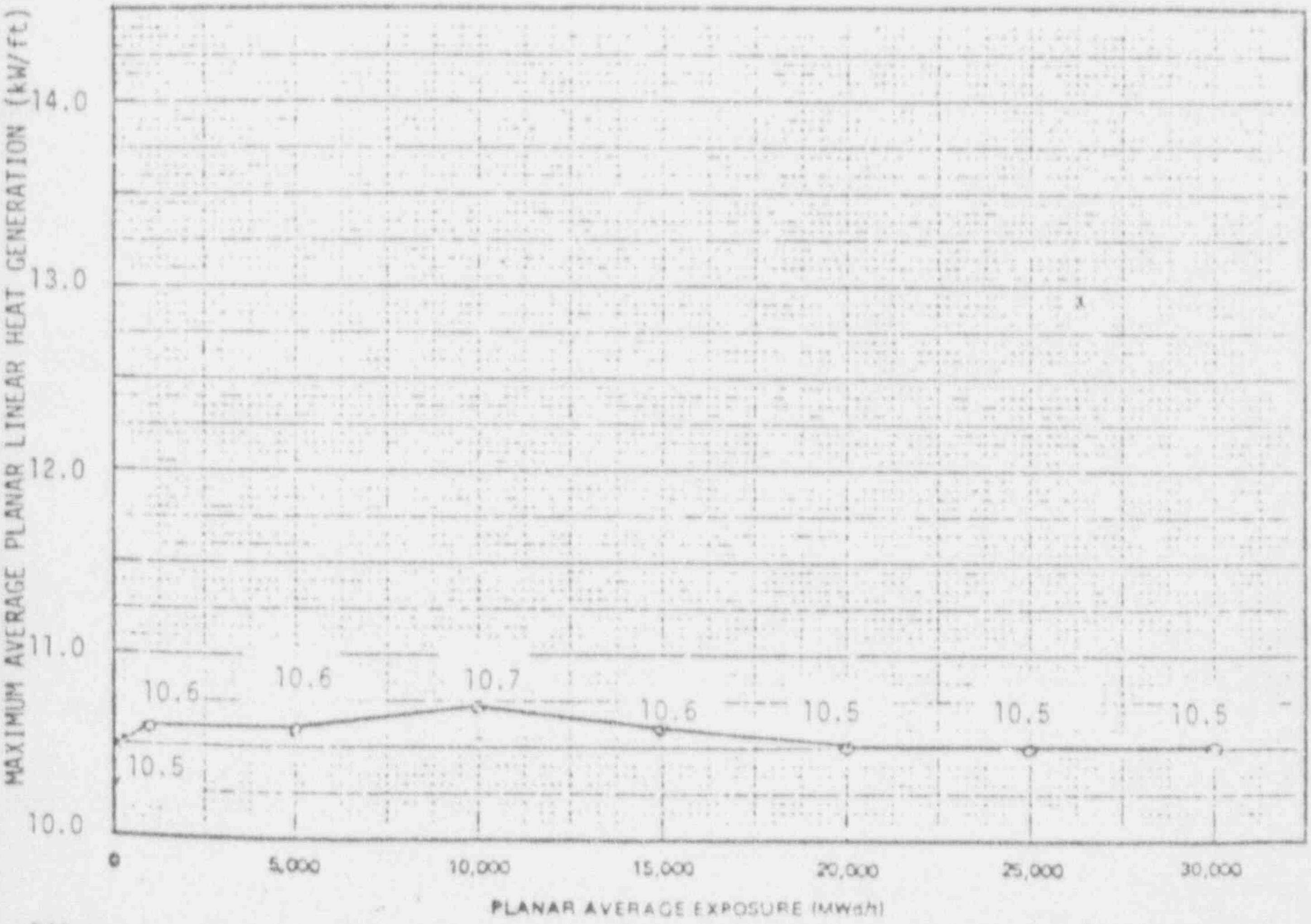
MONTICELLO
RELOAD 3 8D250

FIGURE D-4E & D-5E



D-4E

PEAK CLADDING TEMPERATURE VERSUS PLANAR AVERAGE EXPOSURE



D-5E

MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR)
VERSUS PLANAR AVERAGE EXPOSURE