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RECIP.NAME RECIPIENT AFFILIATION
DENTON,H.R. Office of Nuclear Reactor Regulation, Director

SUBJECT: Requests changes to analysis of record,supporting current Tech Specs.Proposed revised analysis for 3,250 MWt large break LOCA analysis encl.Fee paid.

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July 23, 1985
AEP:NRC:0941

Donald C. Cook Nuclear Plant Unit No. 1
Docket No. 50-315
License No. DPR-58
CHANGE TO ANALYSIS OF RECORD SUPPORTING F_Q LIMITS FOR WESTINGHOUSE FUEL

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Denton:

By this letter and its attachment, we request changes to the analysis of record, which supports the current Technical Specifications for the Donald C. Cook Nuclear Plant Unit No. 1. This revised analysis is submitted in accordance with a May 28, 1985 telephone call with members of your staff concerning the Westinghouse BART-WREFLOOD interface revision, the details of which have been reported to your staff by Westinghouse Electric Corporation. Our review indicates that no change is required to the Technical Specifications for the Donald C. Cook Nuclear Plant Unit No. 1 as a result of this analysis. The proposed revised analysis is contained in the attachment, and is of the same format as Attachment D to letter AEP:NRC:0745M, dated August 23, 1984.

Review of this analysis is needed prior to initial entry into Mode 1 for the Donald C. Cook Unit 1 Cycle 9 startup. This is currently scheduled to occur on August 18, 1985.

These proposed changes to the analysis and their interaction with the current Technical Specifications will be reviewed by the Plant Nuclear Safety Review Committee (PNSRC) and by the Nuclear Safety and Design Review Committee (NSDRC) prior to Unit 1 entry into Mode 1.

In compliance with the requirements of 10 CFR 50.91(b)(1), a copy of this letter and its attachments have been transmitted to Mr. R. C. Callen of the Michigan Public Service Commission.

Pursuant to 10 CFR 170.12(c), we have enclosed an application fee of $150.00 for the review of the attached analysis.

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This document has been prepared following Corporate procedures which incorporate a reasonable set of controls to insure its accuracy and completeness prior to signature by the undersigned.

Very truly yours,

M. P. Alexich
Vice President

Attachment: "D. C. Cook Unit 1 3250 MWt Large Break LOCA Analysis", Westinghouse Electric Corporation, July, 1985.

cc: John E. Dolan
W. G. Smith, Jr. - Bridgman
R. C. Callen
G. Bruchmann
G. Charnoff
NRC Resident Inspector - Bridgman

8507310028

ATTACHMENT TO
AEP:NRC:0941

"D. C. COOK UNIT 1 3250 MWt
LARGE BREAK LOCA ANALYSIS",
WESTINGHOUSE ELECTRIC CORPORATION, JULY, 1985.

14.D.1 Major LOCA Analyses Applicable to Westinghouse Fuel

Identification of Causes and Frequency Classification

A loss-of-coolant accident (LOCA) is the result of a pipe rupture of the RCS pressure boundary. For the analyses reported here, a major pipe break (large break) is defined as a rupture with a total cross-sectional area equal to or greater than 1.0 ft^2. This event is considered an ANS Condition IV event, a limiting fault, in that it is not expected to occur during the lifetime of D. C. Cook Unit 1, but is postulated as a conservative design basis.

The Acceptance Criteria for the LOCA are described in 10 CFR 50.46 (10 CFR 50.46 and Appendix K of 10 CFR 50 1974)[1] as follows:

1. The calculated peak fuel element clad temperature is below the requirement of 2,200°F.

2. The amount of fuel element cladding that reacts chemically with water or steam does not exceed 1 percent of the total amount of Zircaloy in the reactor.

3. The clad temperature transient is terminated at a time when the core geometry is still amenable to cooling. The localized cladding oxidation limit of 17 percent is not exceeded during or after quenching.

4. The core remains amenable to cooling during and after the break.

5. The core temperature is reduced and decay heat is removed for an extended period of time, as required by the long-lived radioactivity remaining in the core.

These criteria were established to provide significant margin in emergency core cooling system (ECCS) performance following a LOCA. WASH-1400 (USNRC 1975)[10] presents a recent study in regards to the probability of occurrence of RCS pipe ruptures

Sequence of Events and Systems Operations

Should a major break occur, depressurization of the RCS results in a pressure decrease in the pressurizer. The reactor trip signal subsequently occurs when the pressurizer low pressure trip setpoint is reached. A safety injection signal is generated when the appropriate setpoint is reached. These countermeasures will limit the consequences of the accident in two ways:

1. Reactor trip and borated water injection supplement void formation in causing rapid reduction of power to a residual level corresponding to fission product decay heat. However, no credit is taken in the LOCA analysis for the boron content of the injection water. In addition, the insertion of control rods to shut down the reactor is neglected in the large break analysis.

2. Injection of borated water provides for heat transfer from the core and prevents excessive clad temperatures.

The time sequence of events following a large break LOCA is presented in Table 14.D-6.

Before the break occurs, the unit is in an equilibrium condition; that is, the heat generated in the core is being removed via the secondary system. During blowdown, heat from fission product decay, hot internals and the vessel, continues to be transferred to the reactor coolant. At the beginning of the blowdown phase, the entire RCS contains subcooled liquid which transfers heat from the core by forced convection with some fully developed nucleate boiling. After the break develops, the time to departure from nucleate boiling is calculated, consistent with Appendix K of 10 CFR 50.[1] Thereafter, the core heat transfer is unstable, with both nucleate boiling and film boiling occurring. As the core becomes uncovered, both turbulent and laminar forced convection and radiation are considered as core heat transfer mechanisms.

The heat transfer between the RCS and the secondary system may be in either direction, depending on the relative temperatures. In the case of continued heat addition to the secondary system, the secondary system pressure increases

and the main steam safety valves may actuate to limit the pressure. Makeup water to the secondary side is automatically provided by the emergency feedwater system. The safety injection signal actuates a feedwater isolation signal which isolates normal feedwater flow by closing the main feedwater isolation valves, and also initiates emergency feedwater flow by starting the emergency feedwater pumps. The secondary flow aids in the reduction of RCS pressure.

When the RCS depressurizes to 600 psia, the accumulators begin to inject borated water into the reactor coolant loops. The conservative assumption is made that accumulator water injected bypasses the core and goes out through the break until the termination of bypass. This conservatism is again consistent with Appendix K of 10 CFR 50. Since loss of offsite power (LOOP) is assumed, the RCPs are assumed to trip at the inception of the accident. The effects of pump coastdown are included in the blowdown analysis.

The blowdown phase of the transient ends when the RCS pressure (initially assumed at 2280 psia) falls to a value approaching that of the containment atmosphere. Prior to or at the end of the blowdown, the mechanisms that are responsible for the emergency core cooling water injected into the RCS bypassing the core are calculated not to be effective. At this time (called end-of-bypass) refill of the reactor vessel lower plenum begins. Refill is completed when emergency core cooling water has filled the lower plenum of the reactor vessel, which is bounded by the bottom of the fuel rods (called bottom-of-core recovery time).

The reflood phase of the transient is defined as the time period lasting from the end-of-refill until the reactor vessel has been filled with water to the extent that the core temperature rise has been terminated. From the latter stage of blowdown and then the beginning-of-reflood, the safety injection accumulator tanks rapidly discharge borated cooling water into the RCS, contributing to the filling of the reactor vessel downcomer. The downcomer water elevation head provides the driving force required for the reflooding of the reactor core. The low head and high head safety injection pumps aid in the filling of the downcomer and, subsequently, supply water to maintain a full downcomer and complete the reflooding process.

Continued operation of the ECCS pumps supplies water during longterm cooling. Core temperatures have been reduced to longterm steady state levels associated with dissipation of residual heat generation. After the water level of the residual water storage tank (RWST) reaches a minimum allowable value, coolant for long-term cooling of the core is obtained by switching to the cold recirculation phase of operation in which spilled borated water is drawn from the engineered safety features (ESF) containment sumps by the low head safety injection (residual heat removal) pumps and returned to the RCS cold legs. The containment spray system continues to operate to further reduce containment pressure.

Approximately 24 hours after initiation of the LOCA, the ECCS is realigned to supply water to the RCS hot legs in order to control the boric acid concentration in the reactor vessel.

Core and System Performance

Mathematical Model:

The requirements of an acceptable ECCS evaluation model are presented in Appendix K of 10 CFR 50 (Federal Register 1974).[1]

Large Break LOCA Evaluation Model

The analysis of a large break LOCA transient is divided into three phases: (1) blowdown, (2) refill, and (3) reflood. There are three distinct transients analyzed in each phase, including the thermal-hydraulic transient in the RCS, the pressure and temperature transient within the containment, and the fuel and clad temperature transient of the hottest fuel rod in the core. Based on these considerations, a system of interrelated computer codes has been developed for the analysis of the LOCA.

A description of the various aspects of the LOCA analysis methodology is given by Bordelon, Massie, and Zordan (1974)[6]. This document describes the major phenomena modeled, the interfaces among the computer codes, and the features of the codes which ensure compliance with the Acceptance Criteria.

The SATAN-VI, WREFLOOD, BART and LOCTA-IV codes, which are used in the LOCA analysis, are described in detail by Bordelon, et al. (1974)[5]; Kelly, et al. (1974)[9]; Young, et al. (1980)[16]; Bordelon and Murphy (1974)[4]; and Bordelon, et al. (1974)[6]. Code modifications are specified in References 2, 7, 13, and 17. These codes assess the core heat transfer geometry and determine if the core remains amenable to cooling throughout and subsequent to the blowdown, refill, and reflood phases of the LOCA. The SATAN-VI computer code analyzes the thermal-hydraulic transient in the RCS during blowdown and the WREFLOOD computer code calculates this transient during the refill and reflood phases of the accident. The LOTIC computer code, described by Hsieh and Raymund in WCAP-8355 (1975) and WCAP-8345 (1974)[3], calculates the containment pressure transient. The containment pressure transient is input to WREFLOOD for the purpose of calculating the reflood transient. The LOCTA-IV computer code calculates the thermal transient of the hottest fuel rod during the three phases. The Revised Pad Fuel Thermal Safety Model, described in Reference 15, generates the initial fuel rod conditions input to LOCTA-IV.

SATAN-VI calculates the RCS pressure, enthalpy, density, and the mass and energy flow rates in the RCS, as well as steam generator energy transfer between the primary and secondary systems as a function of time during the blowdown phase of the LOCA. SATAN-VI also calculates the accumulator water mass and internal pressure and the pipe break mass and energy flow rates that are assumed to be vented to the containment during blowdown. At the end of the blowdown phase, these data are transferred to the WREFLOOD code. Also, at the end-of-blowdown, the mass and energy release rates during blowdown are input to the LOTIC code for use in the determination of the containment pressure response during this first phase of the LOCA. Additional SATAN-VI output data from the end-of-blowdown, including the core inlet flow rate and enthalpy, the core pressure, and the core power decay transient, are input to the LOCTA-IV code.

With input from the SATAN-VI code, WREFLOOD uses a system thermal-hydraulic model to determine the core flooding rate (that is, the rate at which coolant enters the bottom of the core), the coolant pressure and temperature, and the quench front height during the reflood phase of the LOCA. WREFLOOD also calculates the mass and energy flow addition to the containment through the

break. Reflood conditions are supplied to the BART[16][18] code which performs the heat transfer calculation for the average fuel channel in the hot assembly using a mechanistic core heat transfer model. This information is then used by LOCTA-IV to calculate the fuel clad temperature and metal-water reaction of the hottest rod in the core.

The large break analysis was performed with the December 1981 version of the Evaluation Model modified to incorporate the BART[16] computer code.

Input Parameters and Initial Conditions:

The analysis presented in this section was performed with a reactor vessel upper head temperature equal to the RCS hot leg temperature.

The bases used to select the numerical values that are input parameters to the analysis have been conservatively determined from extensive sensitivity studies (Westinghouse 1974[12]; Salvatori 1974[11]; Johnson, Massie, and Thompson 1975[8]). In addition, the requirements of Appendix K regarding specific model features were met by selecting models which provide a significant overall conservatism in the analysis. The assumptions which were made pertain to the conditions of the reactor and associated safety system equipment at the time that the LOCA occurs, and include such items as the core peaking factors, the containment pressure, and the performance of the ECCS. Decay heat generated throughout the transient is also conservatively calculated.

A meeting was held at the Westinghouse Licensing Office in Bethesda on December 17, 1981 between members of the U. S. Nuclear Regulatory Commission and members of the Westinghouse Nuclear Safety Department to discuss the impact of maximum safety injection on the large break ECCS analysis on a generic basis. Further discussion of this issue is provided in a letter from E. P. Rahe, Manager of Westinghouse Nuclear Safety Department, to Robert L. Tedesco of the U. S. Nuclear Regulatory Commission[14]. A brief description of this issue is given below.

Westinghouse ECCS analyses currently assume minimum safeguards for the safety injection flow, which minimizes the amount of flow to the RCS by assuming

maximum injection line resistances, degraded ECCS pump performance, and the loss of one residual heat removal (RHR) pump as the most limiting single failure. This is the limiting single failure assumption when offsite power is unavailable for most Westinghouse plants. However, for some Westinghouse plants, including D. C. Cook Unit 1, the current nature of the Appendix K ECCS evaluation models is such that it may be more limiting to assume the maximum possible ECCS flow delivery. In that case, maximum safeguards, which assume minimum injection line resistances, enhanced ECCS pump performance, and no single failure, result in the highest amount of flow delivered to the RCS.

Current LOCA analysis for D. C. Cook Unit 1 has demonstrated that maximum safeguards assumptions result in the highest peak clad temperature. Therefore, the worst break for D. C. Cook Unit 1 (CD = 0.6) was reanalyzed, assuming maximum safeguards.

Results:

Based on the results of the LOCA sensitivity studies (Westinghouse 1974[12]; Salvatori 1974[11]; Johnson, Massie, and Thompson 1975[8]) the limiting large break was found to be the double ended cold leg guillotine (DECLG). Therefore, only the DECLG break is considered in the large break ECCS performance analysis. Calculations were performed for a range of Moody break discharge coefficients. The results of these calculations are summarized in Tables 14.D-5 and 14.D-6.

The containment data used to generate the LOTIC backpressure transient are shown in Table 14.D-1. The mass and energy release data for the minimum and maximum safeguards cases are shown in Tables 14.D-2 and 14.D-3, respectively. Nitrogen release rates to the containment are given in Table 14.D-4.

Figures 14.D-1 through 14.D-64 present the transients for the principal parameters for the break sizes analyzed. The following items are noted:

<u>Figures 14.D-1 through 14.D-12</u> The following quantities are presented at the clad burst location and at the hot spot (location of maximum clad temperature), both on the hottest fuel rod (hot rod):

1. fluid quality,
2. mass velocity;
3. heat transfer coefficient.

The heat transfer coefficient shown is calculated by the LOCTA-IV code.

<u>Figures 14.D-13 through 14.D.24</u> The system pressure shown is the calculated pressure in the core. The flow rate from the break is plotted as the sum of both ends for the guillotine break cases. The core pressure drop shown is from the lower plenum, near the core, to the upper plenum at the core outlet.

<u>Figures 14.D-25 through 14.D-36</u> These figures show the hot spot clad temperature transient and the clad temperature transient at the burst location. The fluid temperature shown is also for the hot spot and burst location. The core flow (top and bottom) is also shown.

<u>Figures 14.D-37 through 14.D-44</u> These figures show the core reflood transient.

<u>Figures 14.D-45 through 14.D-52</u> These figures show the Emergency Core Cooling System flow for all of the cases analyzed. As described earlier, the accumulator delivery during blowdown is discarded until the end of bypass is calculated. Accumulator flow, however, is established in the refill and the reflood calculations. The accumulator flow assumed is the sum of that injected in the intact cold legs.

<u>Figures 14.D-53 through 14.D-54</u> The containment pressure transient used in the analysis is also provided for the minimum and maximum SI cases.

<u>Figures 14.D-55 and 14.D-60</u> These figures show the heat removal rates of the heat sinks found in the lower compartment and the heat removal by the lower containment drain, and the heat removal by the sump and LC sprays (minimum and maximum SI cases).

Figures 14.D-61 through 14.D-64 These figures show the temperature transients in both the upper and lower compartments of the containment and flow from the upper to lower compartments. Total heat removal in the lower compartment is the sum of all the heat removal rates shown (for minimum and maximum SI cases).

The maximum clad temperature calculated for a large break is 2154°F, which is less than the Acceptance Criteria limit of 2200°F. The maximum local metal-water reaction is 6.46 percent, which is well below the embrittlement limit of 17 percent as required by 10 CFR 50.46. The total core metal-water reaction is less than 0.3 percent for all breaks, as compared with the 1 percent criterion of 10 CFR 50.46. The clad temperature transient is terminated at a time when the core geometry is still amenable to cooling. As a result, the core temperature will continue to drop and the ability to remove decay heat generated in the fuel for an extended period of time will be provided.

References for Section 14.D-1

1. "Acceptance Criteria for Emergency Core Cooling System for Light Water Cooled Nuclear Power Reactors," 10 CFR 50.46 and Appendix K of 10 CFR 50, Federal Register 1974, Volume 39, Number 3.

2. Rahe, E. P. (Westinghouse), letter to J. R. Miller (USNRC), Letter No. NS-EPRS-2679, November 1982.

3. Hsieh, T., and Raymund, M., "Long Term Ice Condenser Containment LOTIC Code Supplement 1," WCAP-8355, Supplement 1, May 1975, WCAP-8345 (Proprietary), July 1974.

4. Bordelon, F. M. et al., "LOCTA-IV Program: Loss-of-Coolant Transient Analysis," WCAP-8301 (Proprietary) and WCAP-8305 (Non-proprietary), 1974.

5. Bordelon, F. M. et al., "SATAN-VI Program: Comprehensive Space, Time Dependent Analysis of Loss-of-Coolant," WCAP-8302 (Proprietary) and WCAP-8306 (Non-proprietary), 1974.

6. Bordelon, F. M.; Massie, H. W.; and Zordan, T. A., "Westinghouse ECCS Evaluation Model - Summary," WCAP-8339, 1974.

7. Rahe, E. P., "Westinghouse ECCS Evaluation Model, 1981 Version," WCAP-9220-P-A (Proprietary Version), WCAP-9221-P-A (Non-proprietary version), Revision 1, 1981.

8. Johnson, W. J.; Massie, H. W.; and Thompson, C. M., "Westinghouse ECCS - Four Loop Plant (17x17) Sensitivity Studies," WCAP-8565-P-A (Proprietary) and WCAP-8566-A (Non-proprietary), 1975.

9. Kelly, R. D. et al., "Calculational Model for Core Reflooding After a Loss-of-Coolant Accident (WREFLOOD Code)," WCAP-8170 (Proprietary) and WCAP-8171 (Non-proprietary), 1974.

10. U. S. Nuclear Regulatory Commission 1975, "Reactor Safety Study - An Assessment of Accident Risks in U. S. Commercial Nuclear Power Plants," WASH-1400, NUREG-75/014.

11. Salvatori, R., "Westinghouse ECCS - Plant Sensitivity Studies," WCAP-8340 (Proprietary) and WCAP-8356 (Non-proprietary), 1974.

12. "Westinghouse ECCS - Evaluation Model Sensitivity Studies," WCAP-8341 (Proprietary) and WCAP-8342 (Non-proprietary), 1974.

13. Bordelon, F. M., et al., "Westinghouse ECCS Evaluation Model - Supplementary Information," WCAP-8471 (Proprietary) and WCAP-8472 (Non-proprietary), 1975.

14. Rahe, E. P. (Westinghouse). Letter to Robert L. Tedesco (USNRC), Letter No. NS-EPR-2538, December 1981.

15. "Westinghouse Revised PAD Code Thermal Safety Model," WCAP-8720, Addendum 2 (Proprietary) and WCAP-8785 (Non-proprietary).

16. Young, M. Y. et al., "BART-A1: A Computer Code for the Best Estimate Analysis of Reflood Transients," WCAP-9561-P-A (Proprietary) and WCAP-9695-A (Non-proprietary) January 1980.

17. Thomas, C. O., (NRC) "Acceptance for Referencing of Licensing Topical Report WCAP-10484(P)/10485(NP), 'Spacer Grid Heat Transfer Effects During Reflood,'" Letter to E. P. Rahe (Westinghouse), June 21, 1984.

18. Special Report NS-NRC-85-3025 (NP),"BART-WREFLOOD Input Revision".

TABLE 14.D-1
LARGE BREAK
CONTAINMENT DATA
(ICE CONDENSER CONTAINMENT)

NET FREE VOLUME		
(Includes Distribution Between Upper, Lower. and Dead-Ended Compartments)	UC	746,829ft^3
	LC	249,446
	DE	116,168
	IC	122,400
Initial Conditions		
Pressure		14.7 psia
Temperature for the Upper, Lower and Dead-Ended Compartments	UC	100°F
	LC	120°F
	DE	120°F
RWST Temperature		70°F
Service Water Temperature		40°F
Temperature Outside Containment		-7°F
Initial Spray Temperature		70°F
Spray System		
Runout Flow for a Spray Pump		3600 gpm
Number of Spray Pumps Operating		2
Post-Accident Initiation of Spray System		40 secs
Distribution of the Spray Flow to the Upper and Lower Compartments	LC	2835 gpm
	UC	4365 gpm
Deck Fan		
Post-Accident Initiation of Deck Fans		600 secs
Flow Rate Per Fan		39,000 cfm per fan
Hydrogen Skimmer System Flow Rate		2,800 cfm per fan
Assumed Spray Efficiency of Water from Ice Condenser Drains		100%

TABLE 14.D-1
(continued)

STRUCTURAL HEAT SINKS

Compartment	Area (ft2)	Thickness (ft)	Material
1. LC	12,105	0.0469/2.0	steel/concrete
2. LC	11,700	2.0	concrete
3. LC	65,980	1.35	concrete
4. LC	5,481	0.0833	steel
5. LC	4,735	0.01147	steel
6. LC	289	0.25	lead
7. LC	14,690	0.0079	steel
8. LC	3,439	0.1561	steel
9. LC	5,775	0.009	steel
10. LC	4,966	0.0096	steel
11. LC	7,013	0.037	steel
12. LC	2,457	0.0334	steel
13. UC	378	.1667/.0365	steel/concrete
14. UC	29,772	.0092	steel
15. UC	8,033	.0209	steel
16. UC	420	.0052	steel
17. UC	29,330	1.47	concrete
18. UC	34,125	0.0469/2.0	steel/concrete
19. UC	210	.0052	steel

UC: Upper Compartment
LC: Lower Compartment
DE: Dead-Ended Compartment
IC: Ice Condenser Compartment

TABLE 14.D-2
MASS AND ENERGY RELEASE RATES
MINIMUM SI

TIME (sec)	MASS (lb/sec)	ENERGY (BTU/sec)
0.	.5529E+05	.2082E+08
.2000E+01	.4948E+05	.2488E+08
.4000E+01	.3508E+05	.1831E+08
.6000E+01	.2747E+05	.1488E+08
.8000E+01	.2231E+05	.1207E+08
.1000E+02	.2081E+05	.1138E+08
.1200E+02	.1818E+05	.1032E+08
.1240E+02	.1700E+05	.9828E+07
.1400E+02	.1604E+05	.9348E+07
.1500E+02	.1480E+05	.8782E+07
.1600E+02	.1371E+05	.8166E+07
.1700E+02	.1282E+05	.7580E+07
.1800E+02	.1107E+05	.6643E+07
.2000E+02	.1046E+05	.6277E+07
.2100E+02	.8743E+04	.5884E+07
.2200E+02	.8256E+04	.5534E+07
.2300E+02	.7786E+04	.4880E+07
.2400E+02	.7322E+04	.4503E+07
.2500E+02	.6939E+04	.3961E+07
.2600E+02	.6422E+04	.3398E+07
.2700E+02	.6228E+04	.3418E+07
.2800E+02	.6947E+04	.3298E+07
.2900E+02	.7588E+04	.3176E+07
.3000E+02	.7484E+04	.2906E+07
.3200E+02	.5516E+04	.2162E+07
.3400E+02	.5140E+04	.1420E+07
.3600E+02	.3825E+04	.9890E+06
.3800E+02	.2668E+04	.6749E+06
.3850E+02	.7905E+03	.1672E+06
.4500E+02	.4880E+03	.2909E+05
.5000E+02	.4880E+03	.2909E+05
.5513E+02	.4880E+03	.2909E+05
.5573E+02	.4817E+03	.3386E+05
.5593E+02	.4817E+03	.3384E+05
.5603E+02	.4817E+03	.3383E+05
.5623E+02	.4816E+03	.3374E+05
.5633E+02	.4816E+03	.3373E+05
.6223E+02	.5196E+03	.7003E+05
.7183E+02	.8881E+03	.2273E+06
.8643E+02	.8787E+03	.2333E+06
.1048E+03	.8824E+03	.2328E+06
.1248E+03	.9013E+03	.2282E+06
.1468E+03	.9086E+03	.2228E+06
.1863E+03	.9222E+03	.2103E+06
.2528E+03	.9338E+03	.1872E+06
.3236E+03	.9507E+03	.1837E+06
.3623E+03	.9882E+03	.1773E+06

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TABLE 14.D-3
MASS AND ENERGY RELEASE RATES
MAXIMUM SI

TIME (sec)	MASS (lbm/sec)	ENERGY (BTU/sec)
0.	.6935E+05	.2691E+08
.2000E+01	.5708E+05	.2986E+08
.4000E+01	.3971E+05	.2117E+08
.6000E+01	.3076E+05	.1702E+08
.8000E+01	.2791E+05	.1568E+08
.1000E+02	.2437E+05	.1405E+08
.1200E+02	.1956E+05	.1161E+08
.1240E+02	.1749E+05	.1051E+08
.1400E+02	.1546E+05	.9504E+07
.1500E+02	.1378E+05	.8649E+07
.1600E+02	.1225E+05	.7896E+07
.1700E+02	.1051E+05	.7056E+07
.1800E+02	.9591E+04	.6565E+07
.1900E+02	.8509E+04	.5891E+07
.2000E+02	.7006E+04	.5018E+07
.2100E+02	.4979E+04	.3701E+07
.2200E+02	.4677E+04	.2909E+07
.2300E+02	.6867E+04	.3176E+07
.2400E+02	.7351E+04	.2906E+07
.2500E+02	.6629E+04	.2235E+07
.2600E+02	.5302E+04	.1511E+07
.2700E+02	.4580E+04	.1166E+07
.2800E+02	.3860E+04	.9156E+06
.2893E+02	.3672E+04	.7425E+06
.3086E+02	.2539E+04	.3709E+06
.3500E+02	.2867E+03	.1091E+05
.4000E+02	.2867E+03	.1091E+05
.4344E+02	.2867E+03	.1091E+05
.4394E+02	.2909E+03	.1633E+05
.4464E+02	.2944E+03	.2092E+05
.4492E+02	.2908E+03	.1623E+05
.4553E+02	.2956E+03	.2244E+05
.4977E+02	.3186E+03	.5222E+05
.5188E+02	.3249E+03	.6043E+05
.5371E+02	.4579E+04	.4290E+06
.6333E+02	.1098E+04	.2085E+06
.7408E+02	.1105E+04	.2076E+06
.9313E+02	.1111E+04	.2055E+06
.1032E+03	.1035E+04	.1901E+06
.1243E+03	.1038E+04	.1898E+06
.1379E+03	.1199E+04	.2182E+06
.1463E+03	.1041E+04	.1895E+06
.1578E+03	.1050E+04	.1909E+06
.1706E+03	.1064E+04	.1831E+06
.1818E+03	.1072E+04	.1840E+06
.1949E+03	.1152E+04	.2079E+06
.2164E+03	.1157E+04	.2072E+06

TABLE 14.D-4
NITROGEN MASS AND ENERGY
RELEASE RATES

TIME (sec)	FLOWRATE (lb/sec)
37.5	71.9
39.5	60.7
45.5	37.2
47.5	31.6
53.5	18.8
55.5	15.6
57.5	12.8
60.2	266.6
66.2	159.9
68.2	135.9
74.2	83.3
76.2	70.3
78.2	59.0
80.2	49.1
82.2	40.6
84.2	33.3
90.2	18.5
92.2	15.7
106.2	6.9
108.2	6.3
122.2	3.0
124.2	2.7
138.2	1.3
140.2	1.2
154.2	0.52
156.2	0.47
166.2	0.28

TABLE 14.D-5

LARGE BREAK

Results	DECLG C_D=0.8 Min SI	DECLG C_D=0.6 Min SI	DECLG C_D=0.4 Min SI	DECLG C_D=0.6 Max SI
Peak Clad Temp., °F	1873	1937	1885	2154
Peak Clad Location, ft	6.25	6.0	7.50	6.25
Local Zr/H_2O Reaction (Max), %	2.81	5.11	2.83	6.46
Local Zr/H_2O Location, ft	6.00	6.25	5.75	6.25
Total Zr/H_2O Reaction, %	<0.3	<0.3	<0.3	<0.3
Hot Rod Burst Time, sec	51.0	43.2	54.60	43.20
Hot Rod Burst Location, ft	6.0	6.25	5.75	5.75

Calculation

Licensed Core Power (MWT) 102% of	3250
Peak Linear Power (kw/ft) 102% of	14.098
Peaking Factor (at License Rating)	2.10
Accumulator Water Volume (ft^3) per Accumulator	950
Cycle Analyzed	Cycle 8

TABLE 14.D-6
LARGE BREAK
TIME SEQUENCE OF EVENTS

	Min SI DECLG C_D=0.8 (sec)	Min SI DECLG C_D=0.6 (sec)	Min SI DECLG C_D=0.4 (sec)	Max SI DECLG C_D=0.6 (sec)
START	0.00	0.00	0.00	0.00
Reactor Trip Signal	0.62	0.63	0.64	0.63
Safety Injection Signal	3.82	3.94	4.20	3.93
Accumulator Injection	13.0	15.6	20.80	15.7
End of Blowdown	27.32	30.35	38.49	30.85
Bottom of Core Recovery	40.00	43.38	52.64	43.44
Accumulator Empty	56.27	59.29	65.65	60.29
Pump Injection	28.82	28.94	29.20	28.93

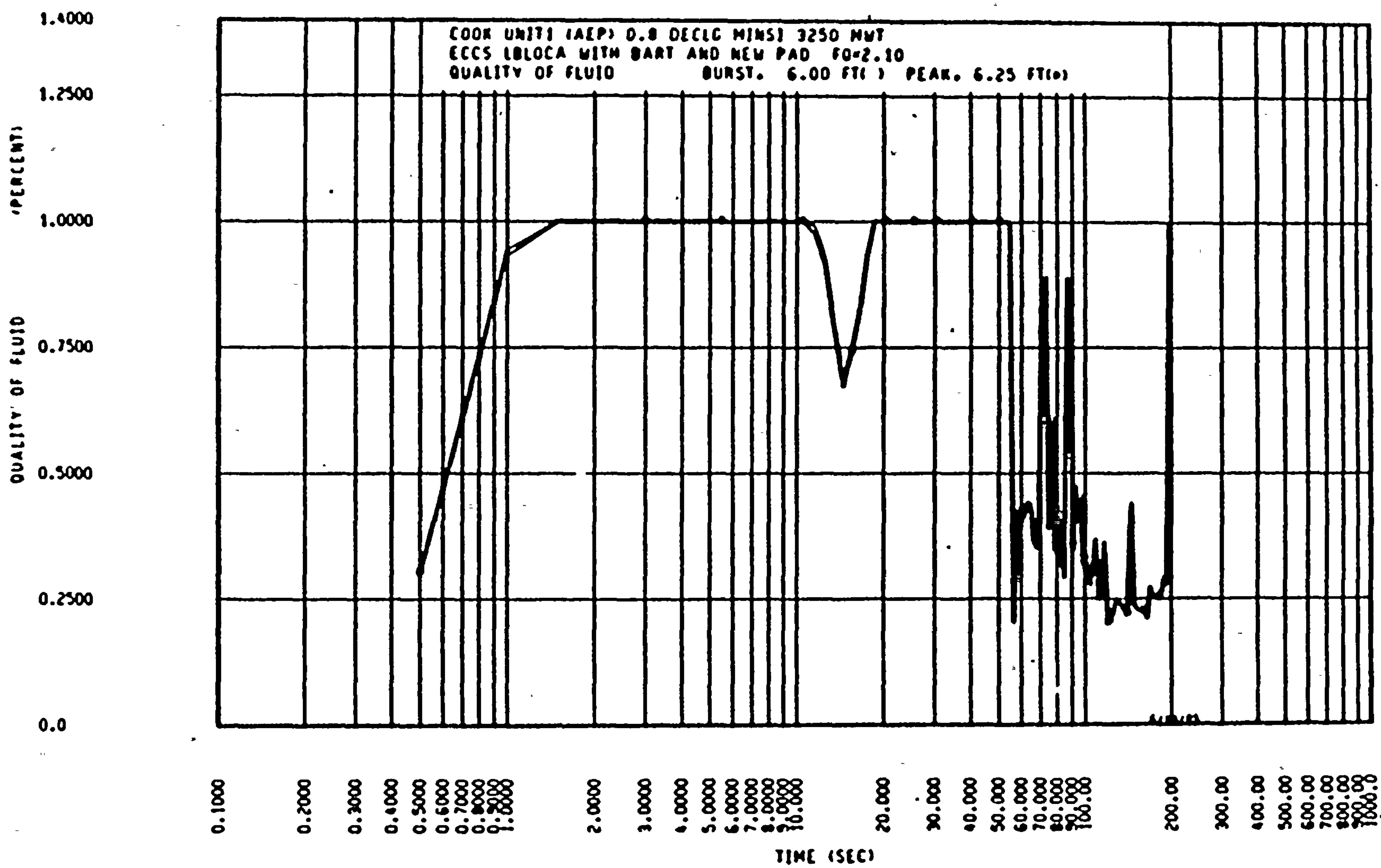

FIGURE 14.D -1 FLUID QUALITY,
DECLG (C_D=0.8) MIN SI

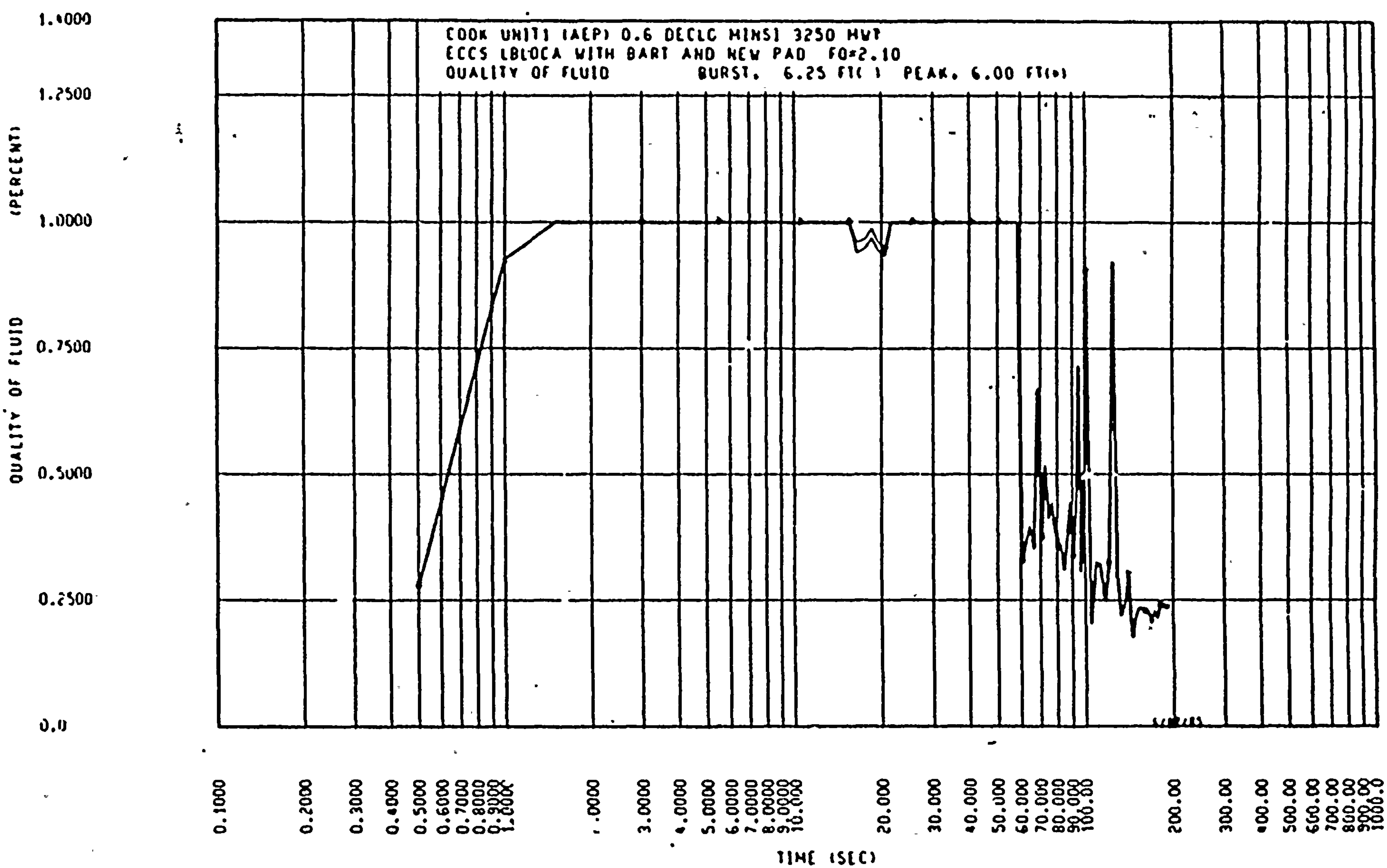

FIGURE 14.D. -2 FLUID QUALITY,
DECLG (C_D=0.6) MIN SI

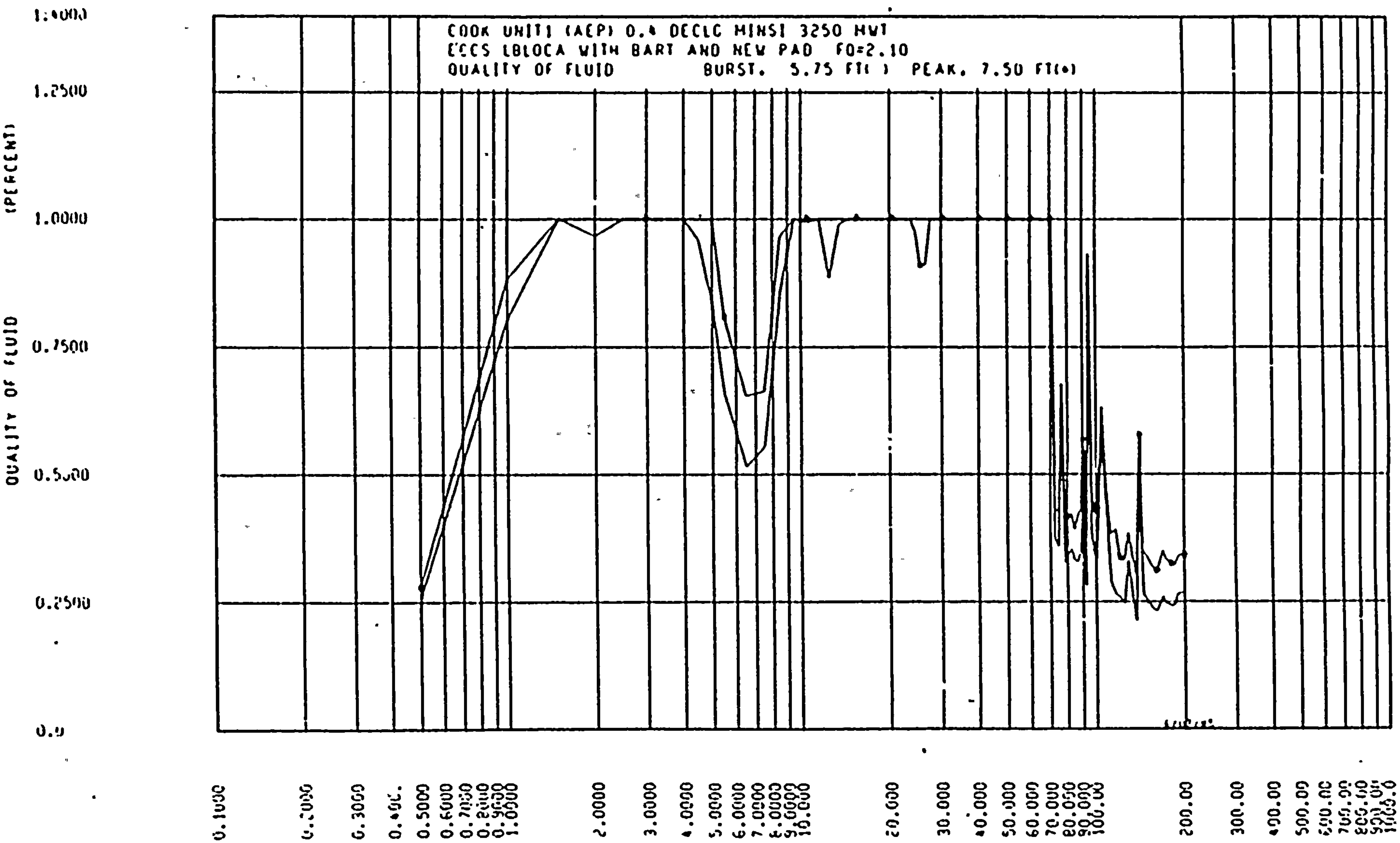

FIGURE 14.D -3 FLUID QUALITY
DECLG (C_D=0.4) MIN SI

COOK UNIT 1 (AEP) 0.6 DECLG MAXSI 3250 MWT UPRATING
ECCS LBLOCA WITH BART AND NEW PAD FQ=2.10
QUALITY OF FLUID BURST, 5.75 FT( ) PEAK, 6.25 FT(*)

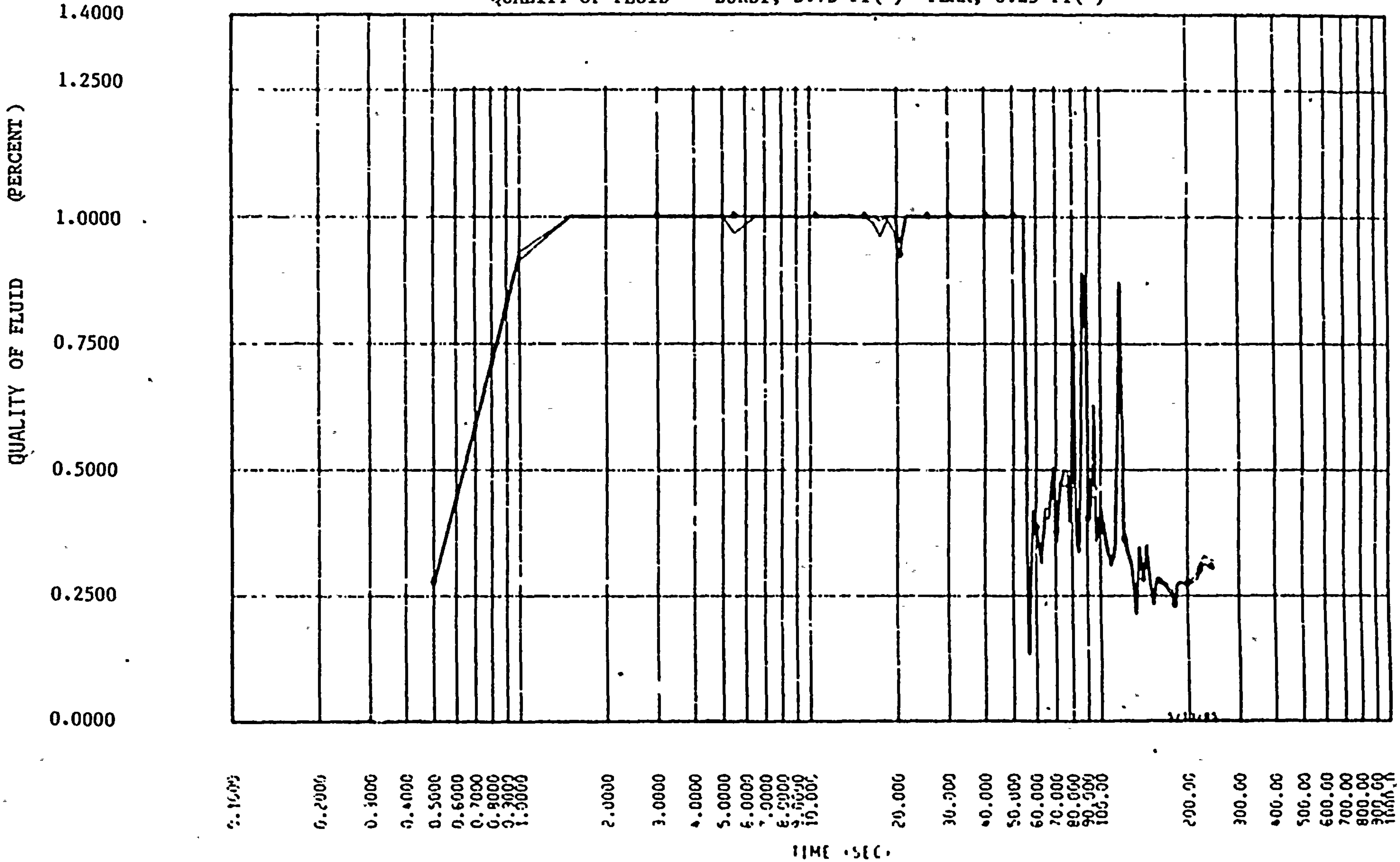

FIGURE 14.D -4 FLUID QUALITY,
DECLG (C_D=0.6) MAX SI

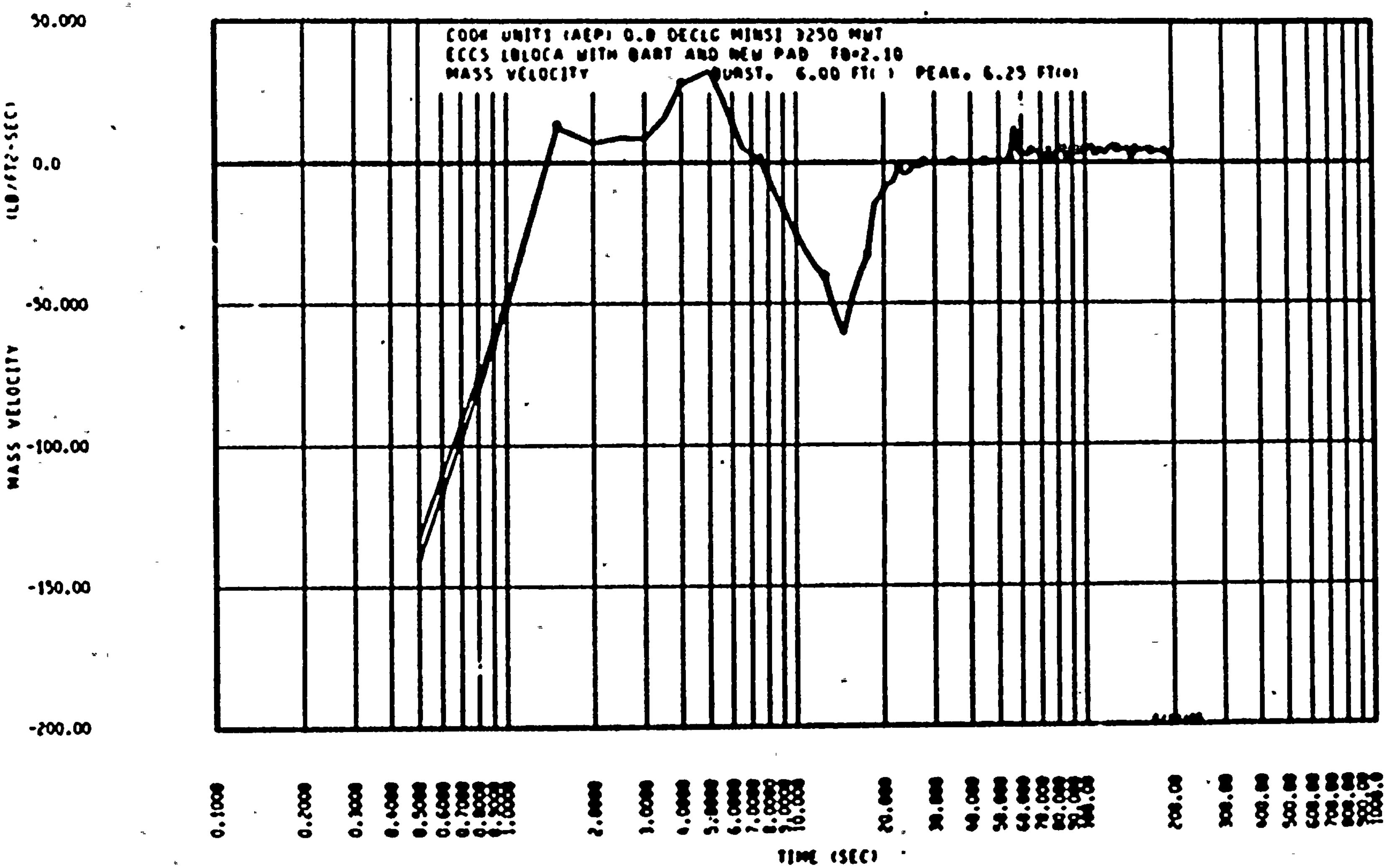

FIGURE 14.D -5 MASS VELOCITY, DECLG (C_D=0.8) MIN SI

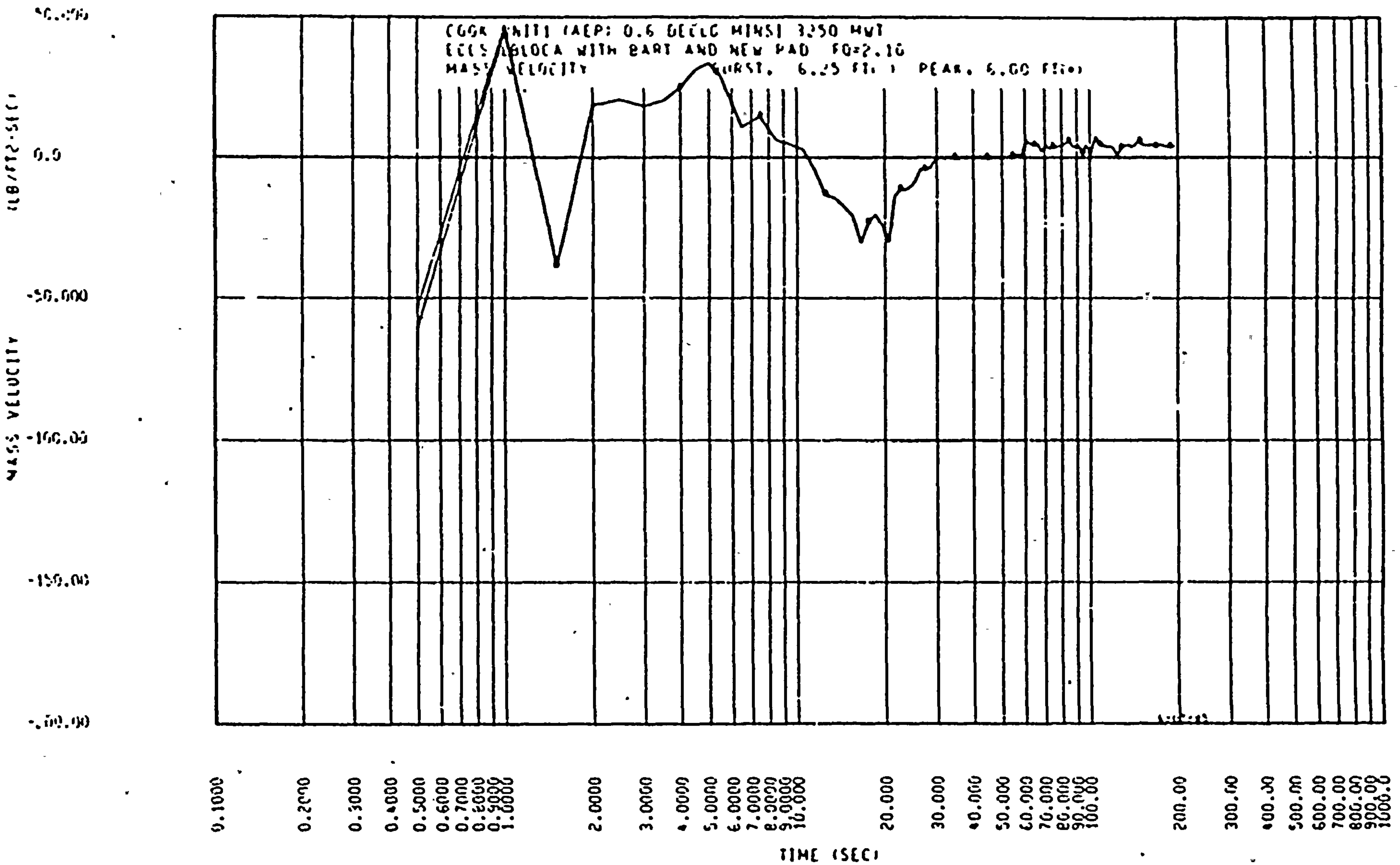

FIGURE 14.D -6 MASS VELOCITY,
DECLG (C_D=0.6) MIN SI

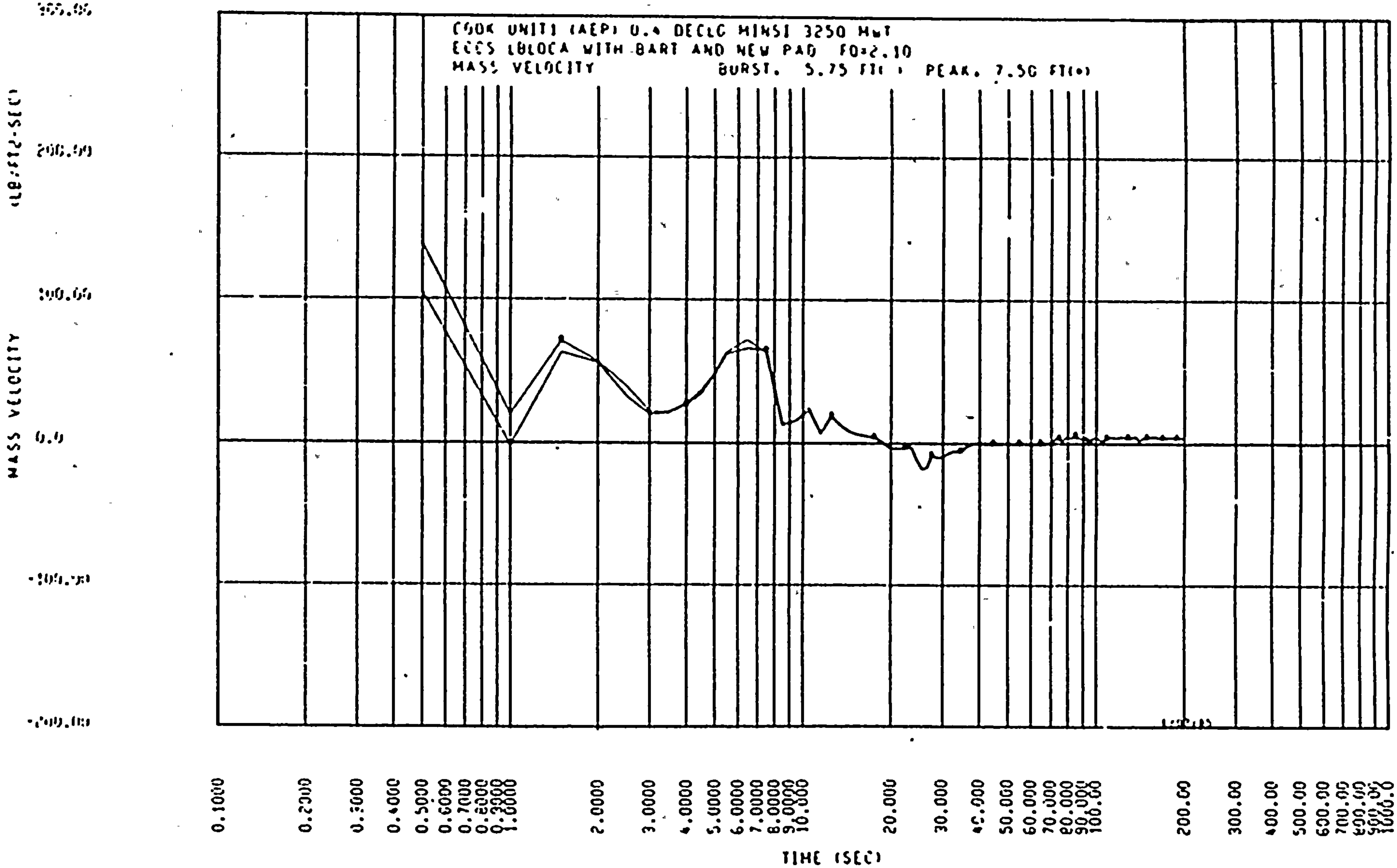

FIGURE 14.D -7 MASS VELOCITY,
DECLG (C_D=0.4) MIN SI

COOK UNIT 1 (AEP) 0.6 DECLG MAXSI
ECCS LBLOCA WITH BART FQ=2.10
MASS VELOCITY BURST, 5.75 FT( ) PEAK, 6.00 FT(*)

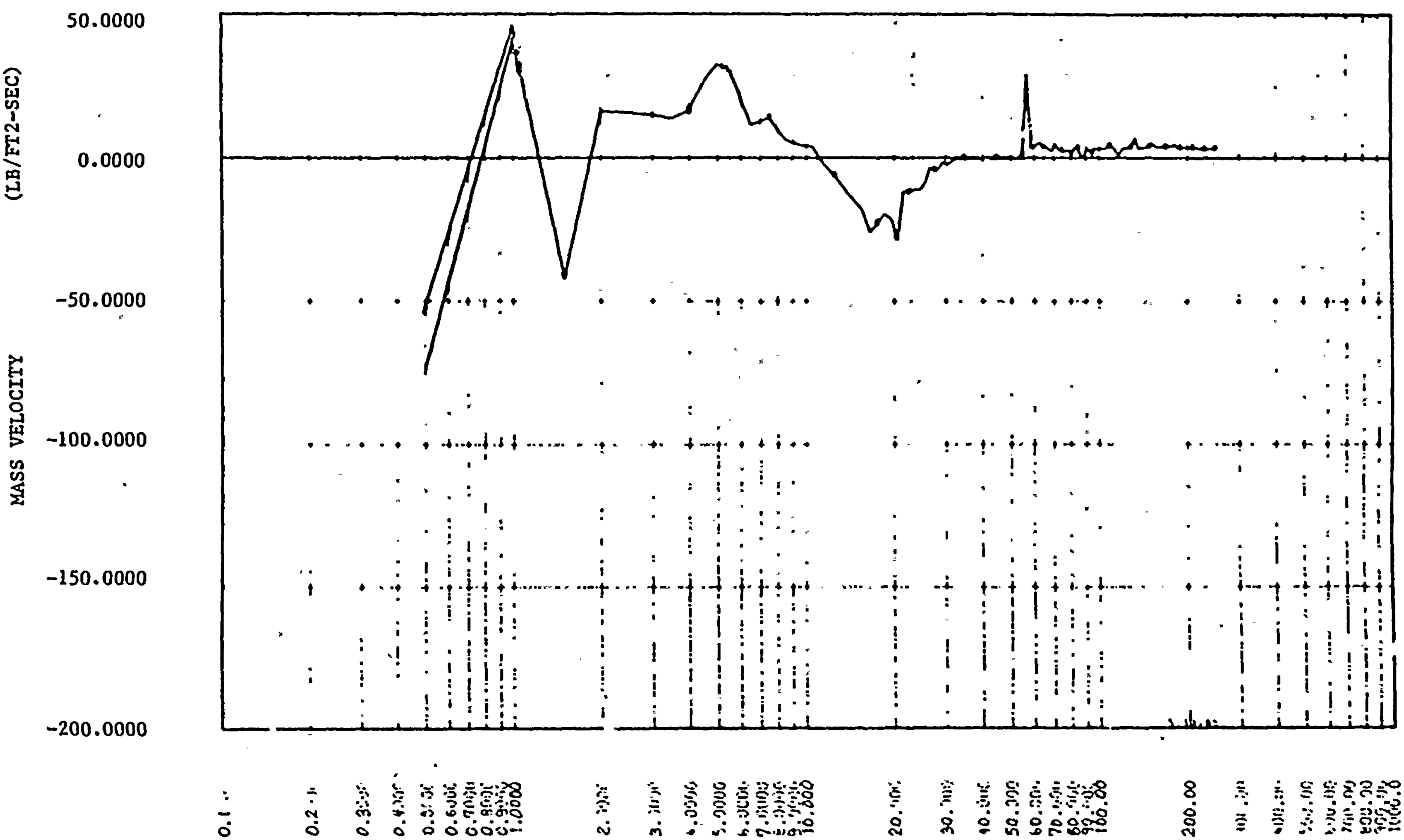

FIGURE 14.D -8 MASS VELOCITY, DECLG (C_D=0.6) MAX SI

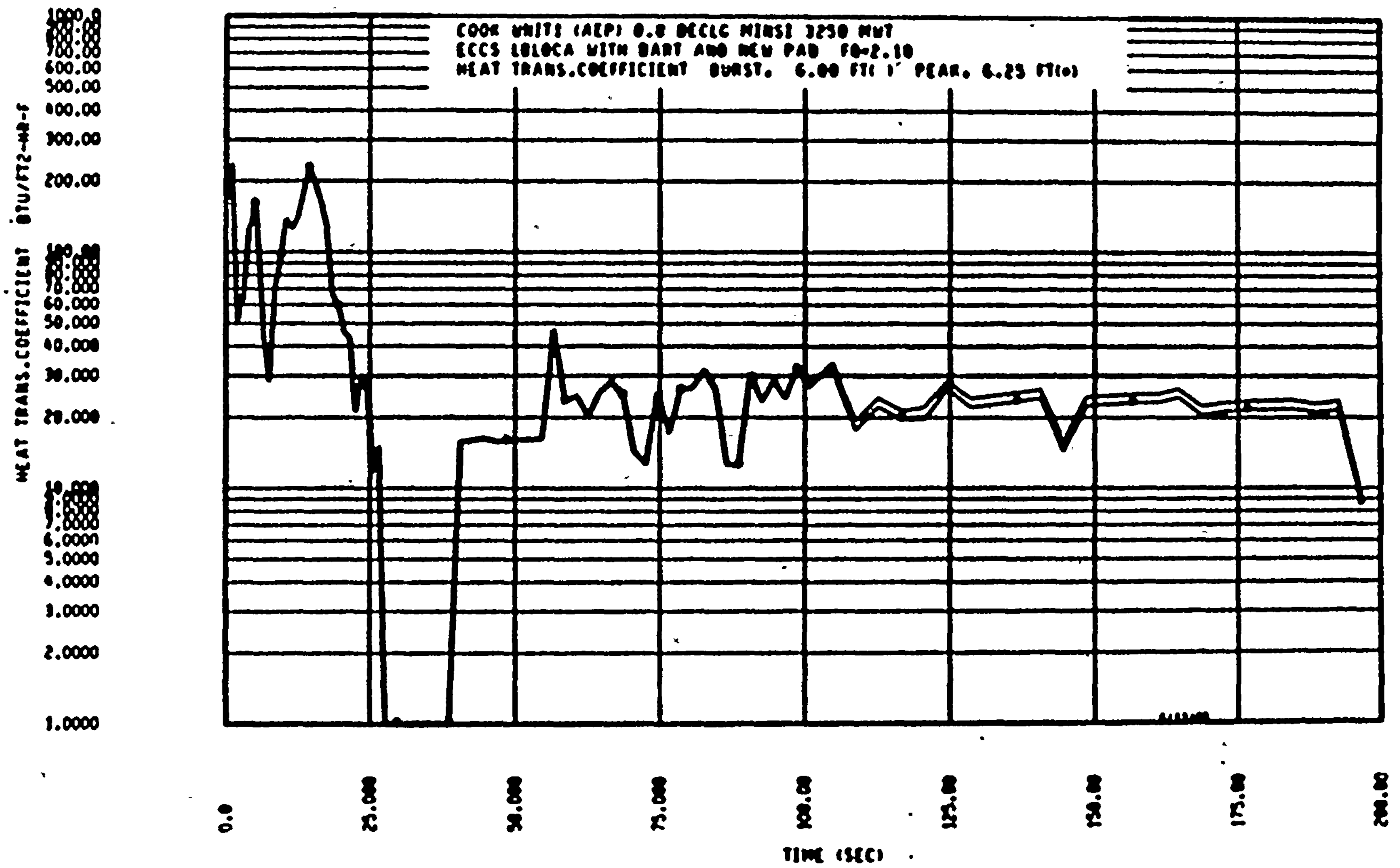

FIGURE 14.D -9 HEAT TRANSFER COEFFICIENT
DECLG (C_D=0.8) MIN SI

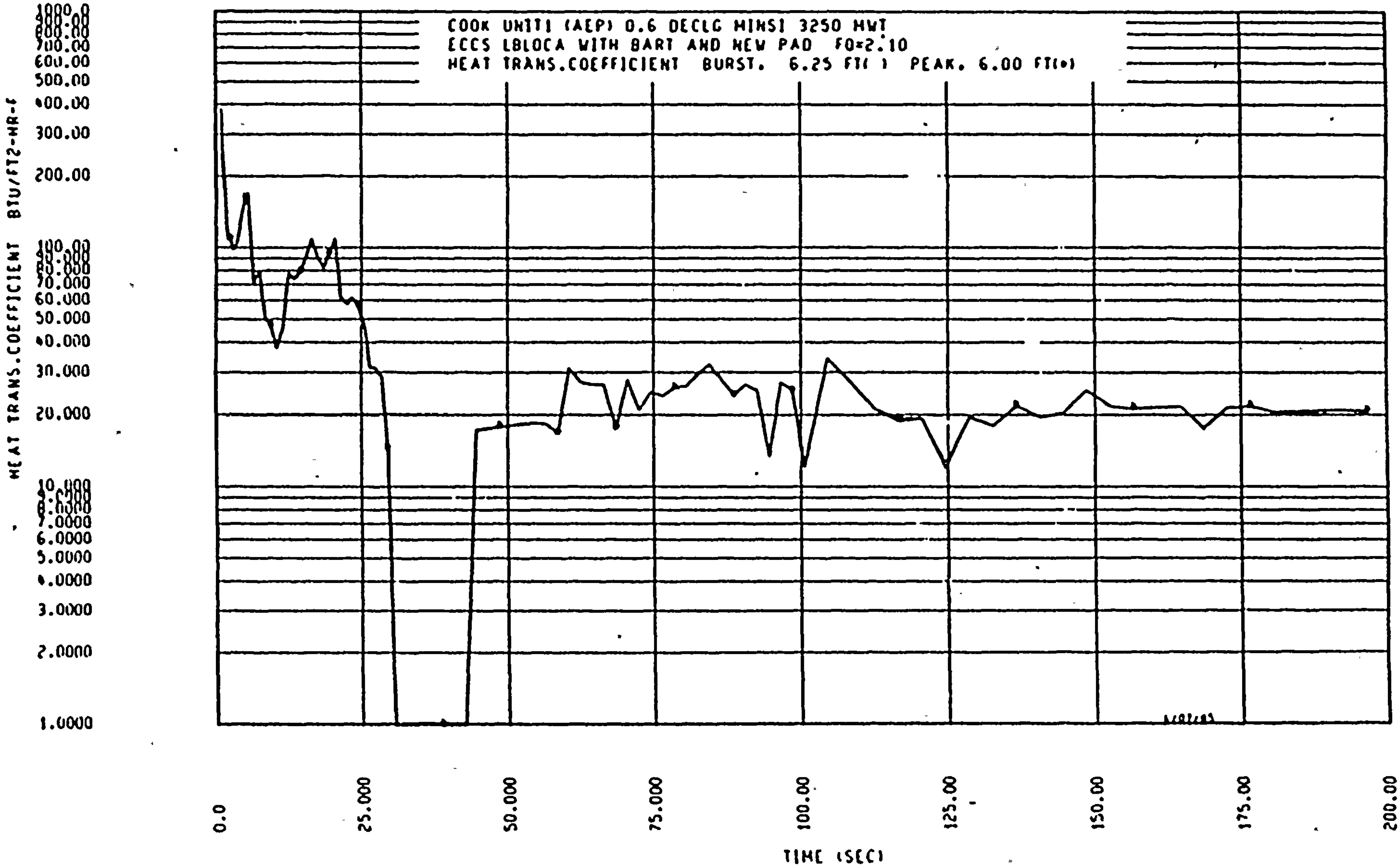

FIGURE 14.D -10 HEAT TRANSFER COEFFICIENT
DECLG (C_D=0.6) MIN SI

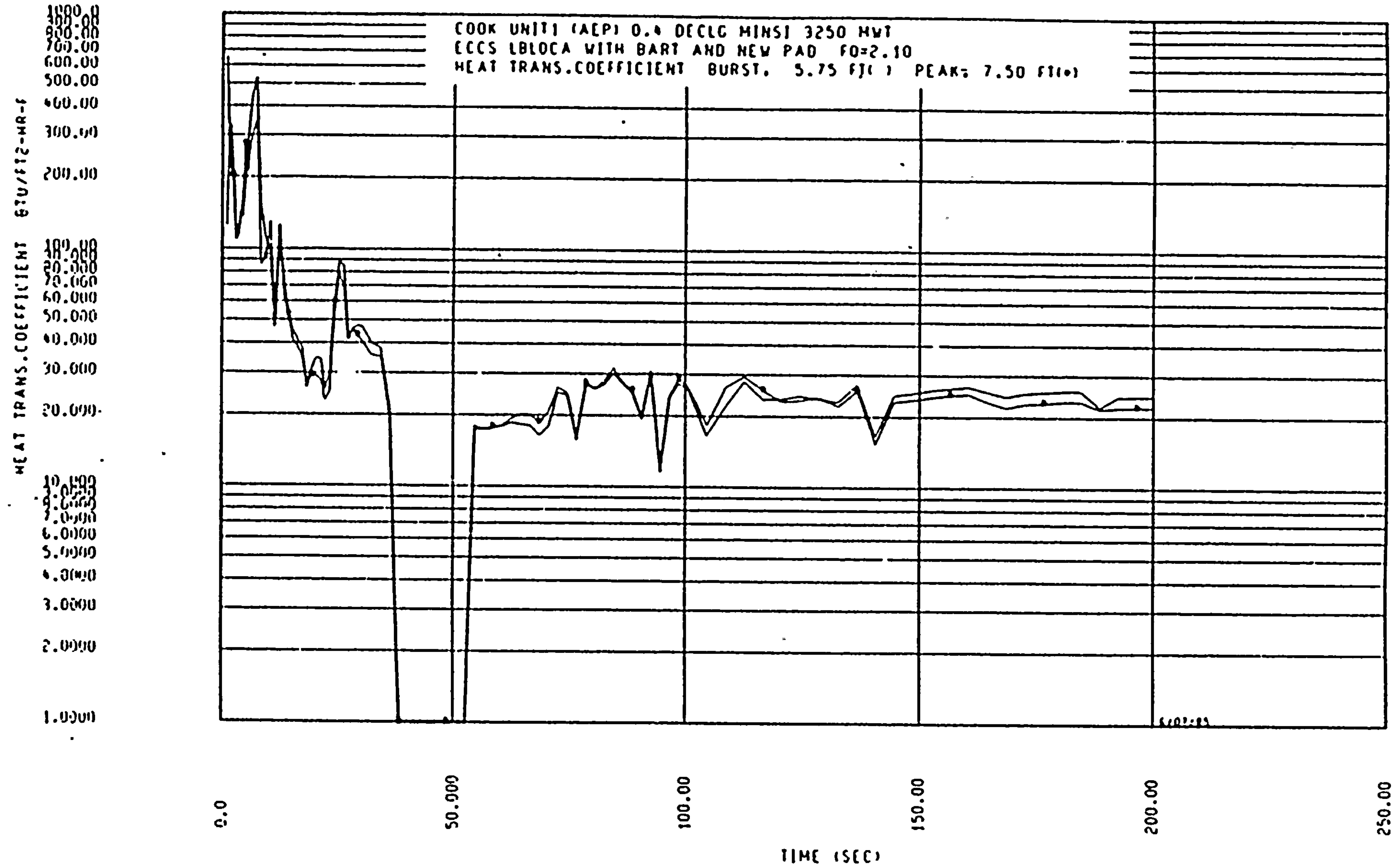

FIGURE 14.D -11 HEAT TRANSFER
COEFFICIENT
DECLG (C_D=0.4) MIN SI

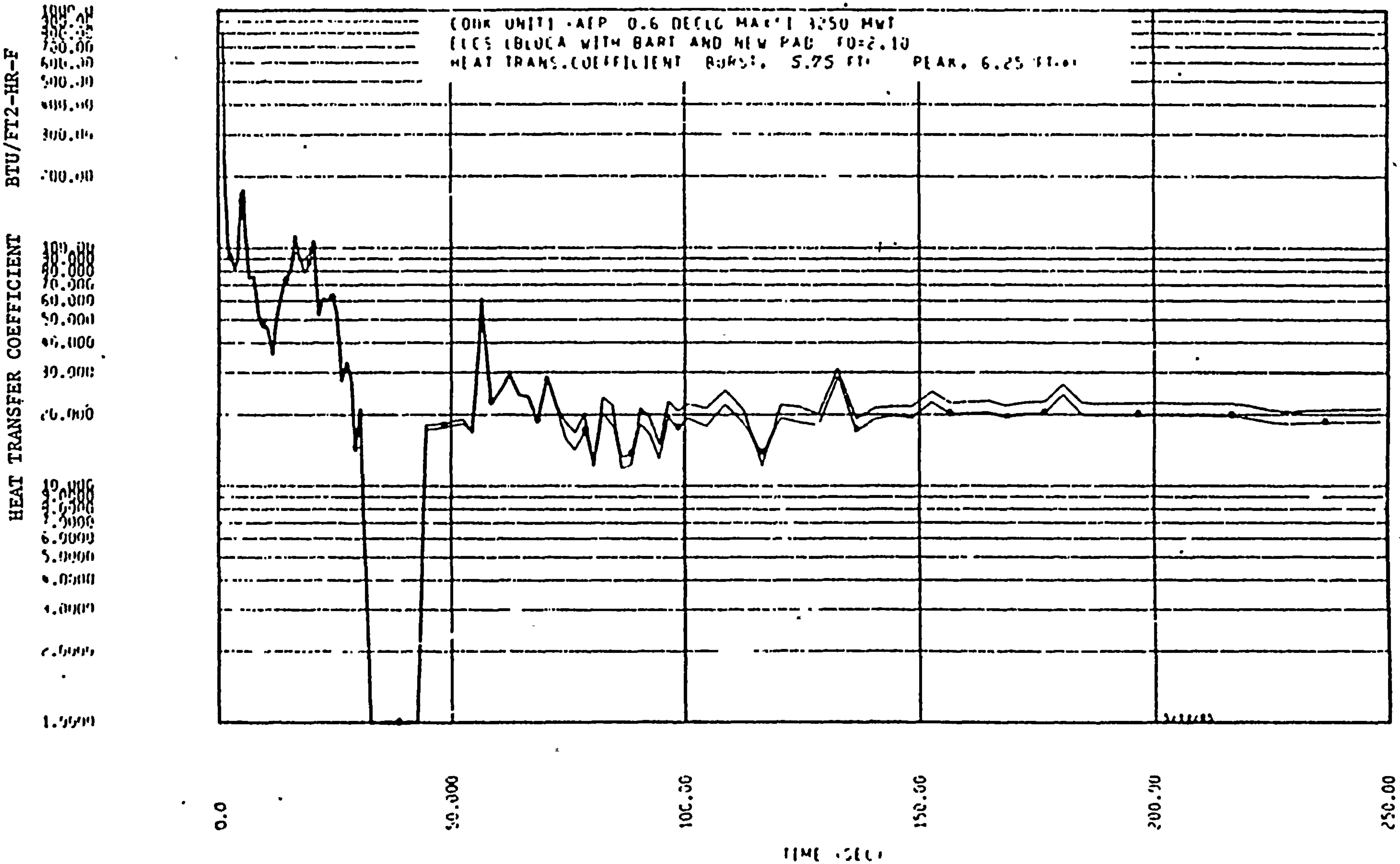

FIGURE 14.D -12 HEAT TRANSFER
COEFFICIENT
DECLG (C_D=0.6) MAX SI

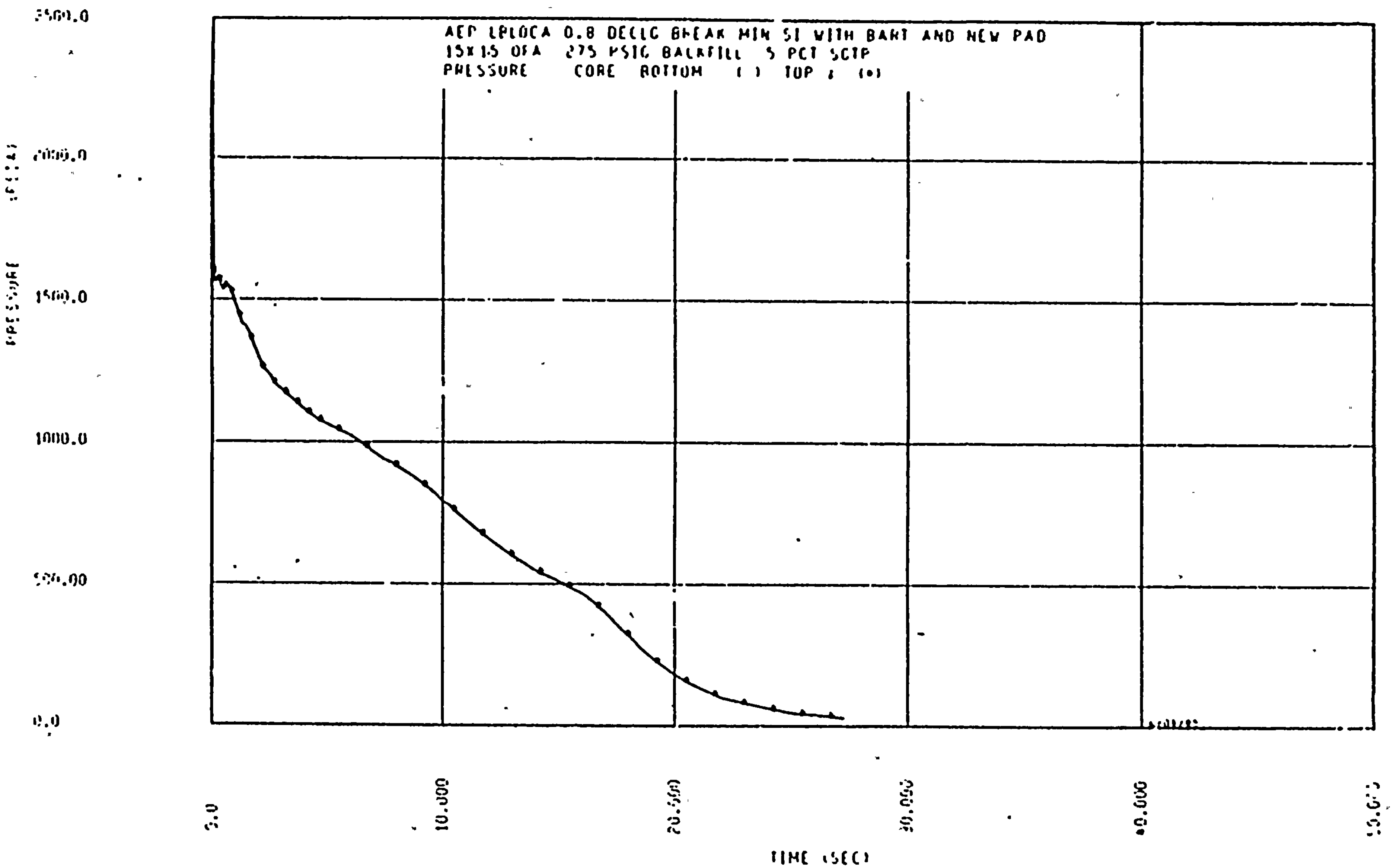

FIGURE 14.D -13 CORE PRESSURE, DECLG (C_D=0.8) MIN SI

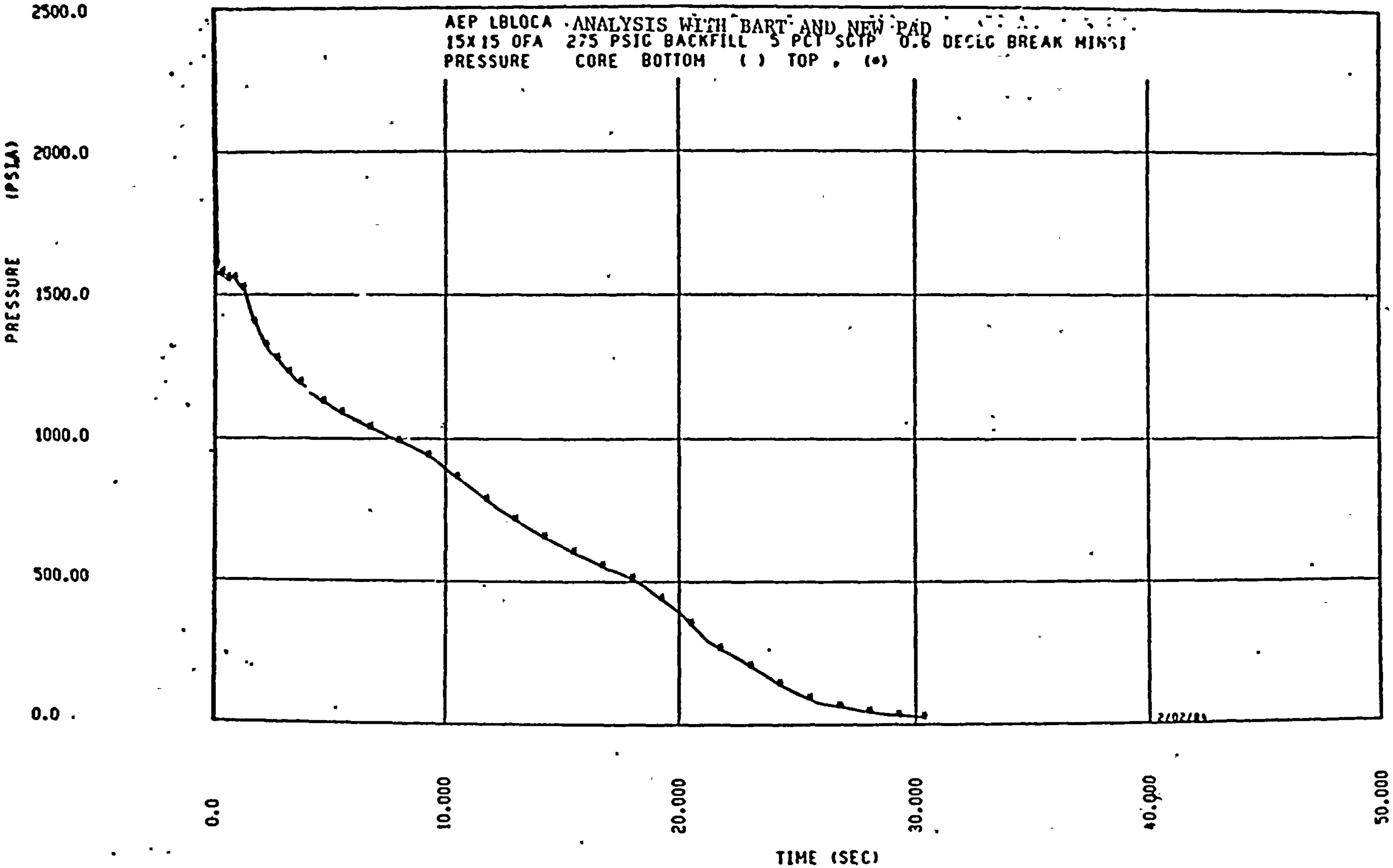

FIGURE 14.D -14 CORE PRESSURE
DECLG (C_D=0.6) MIN SI

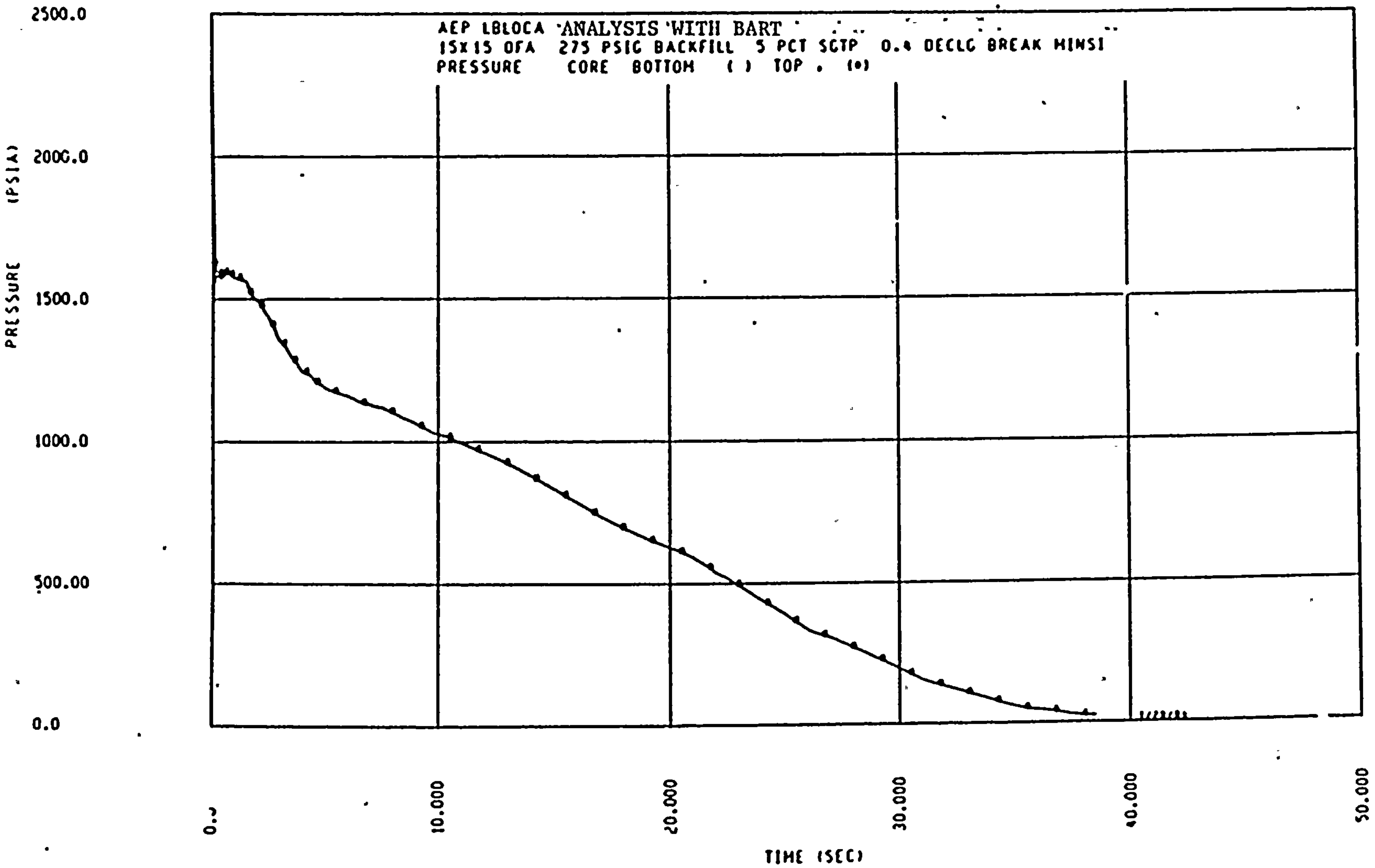

FIGURE 14.D .-15 CORE PRESSURE
DECLG (C_D=0.4) MIN SI

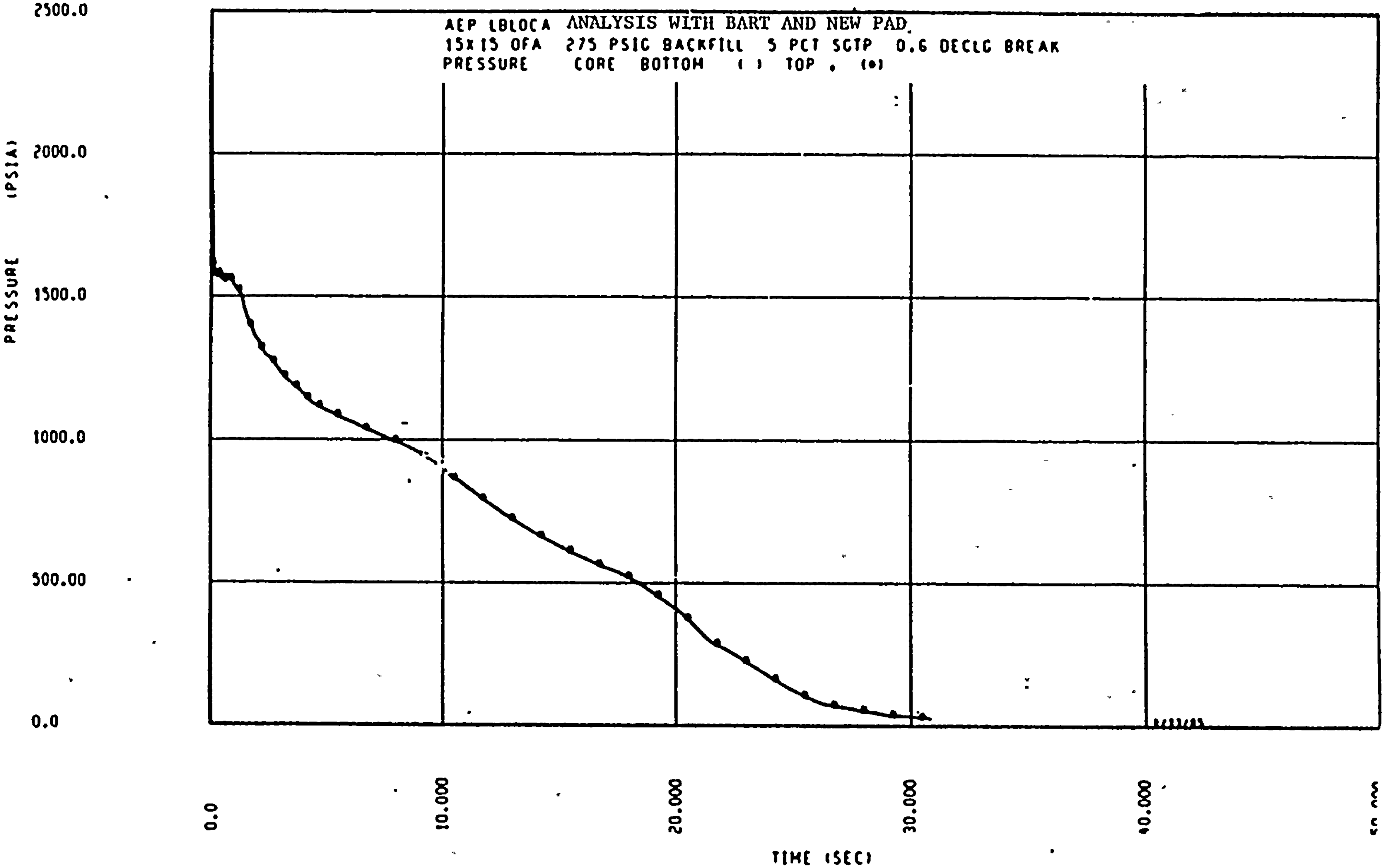

FIGURE 14.D -16 CORE PRESSURE DECLG (C_D=0.6) MAX SI

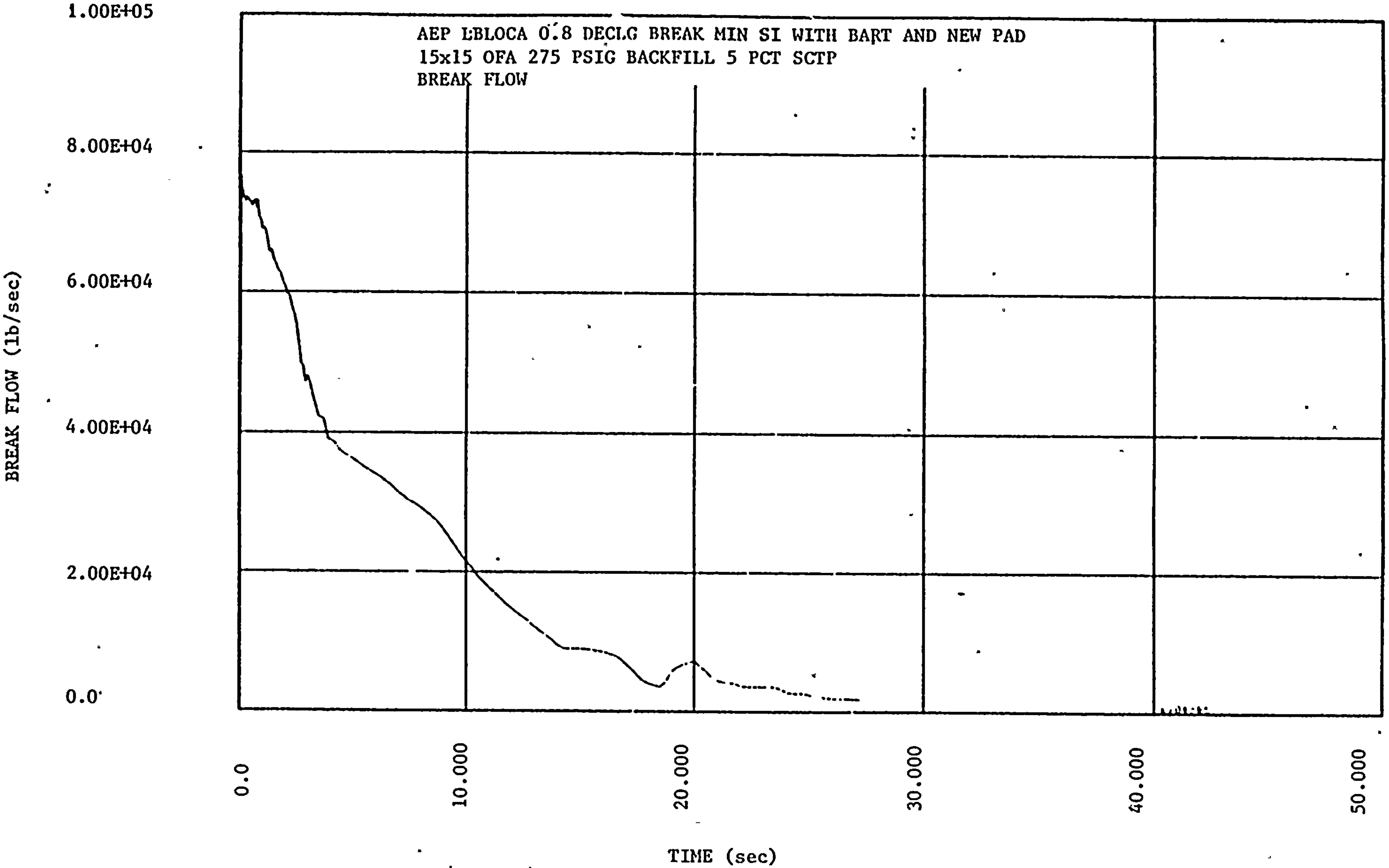

FIGURE 14.D -17 BREAK FLOW RATE, DECLG (C_D=0.8) MIN SI

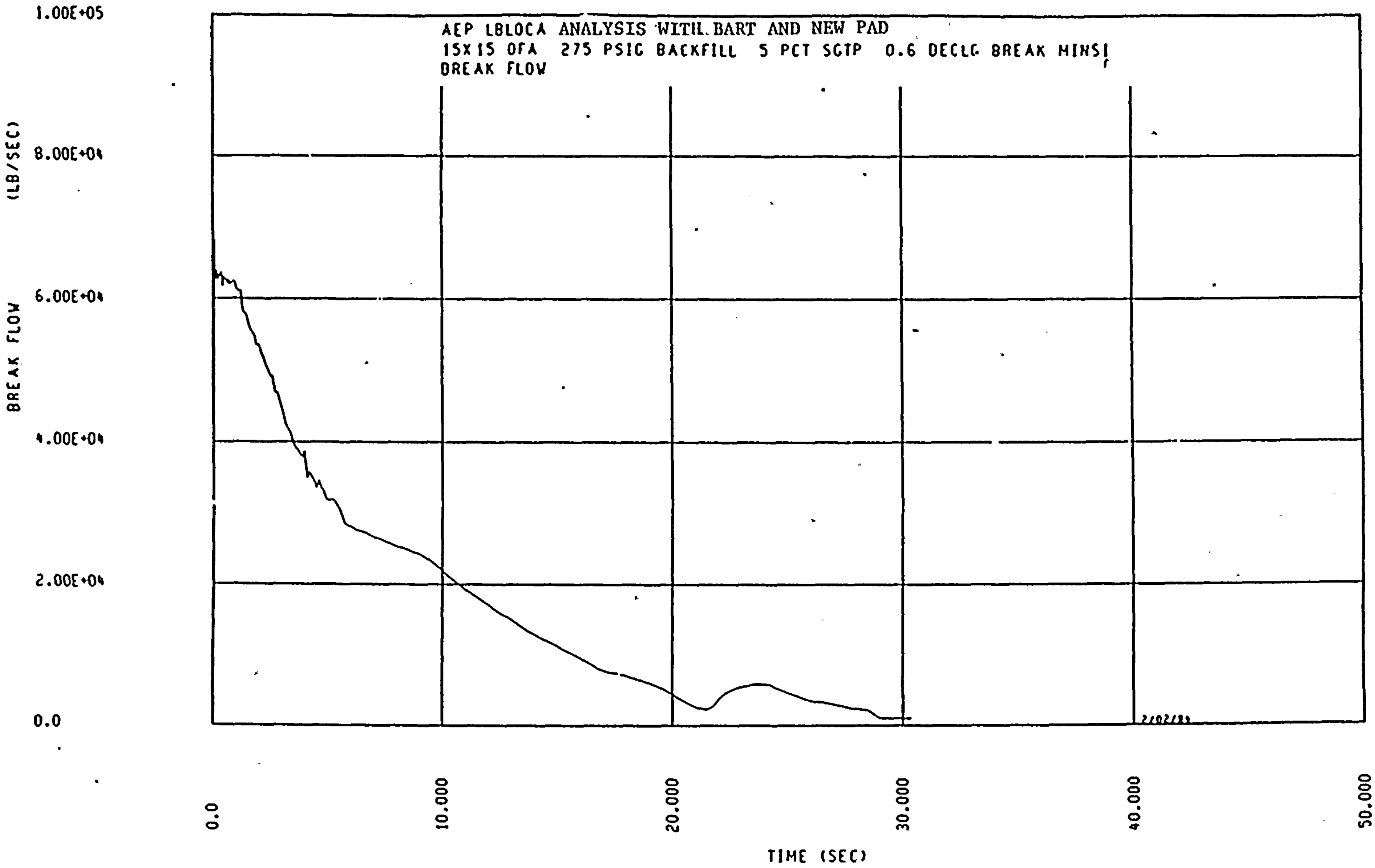

FIGURE 14.D -18 BREAK FLOW RATE, DECLG (C_D=0.6) MIN SI

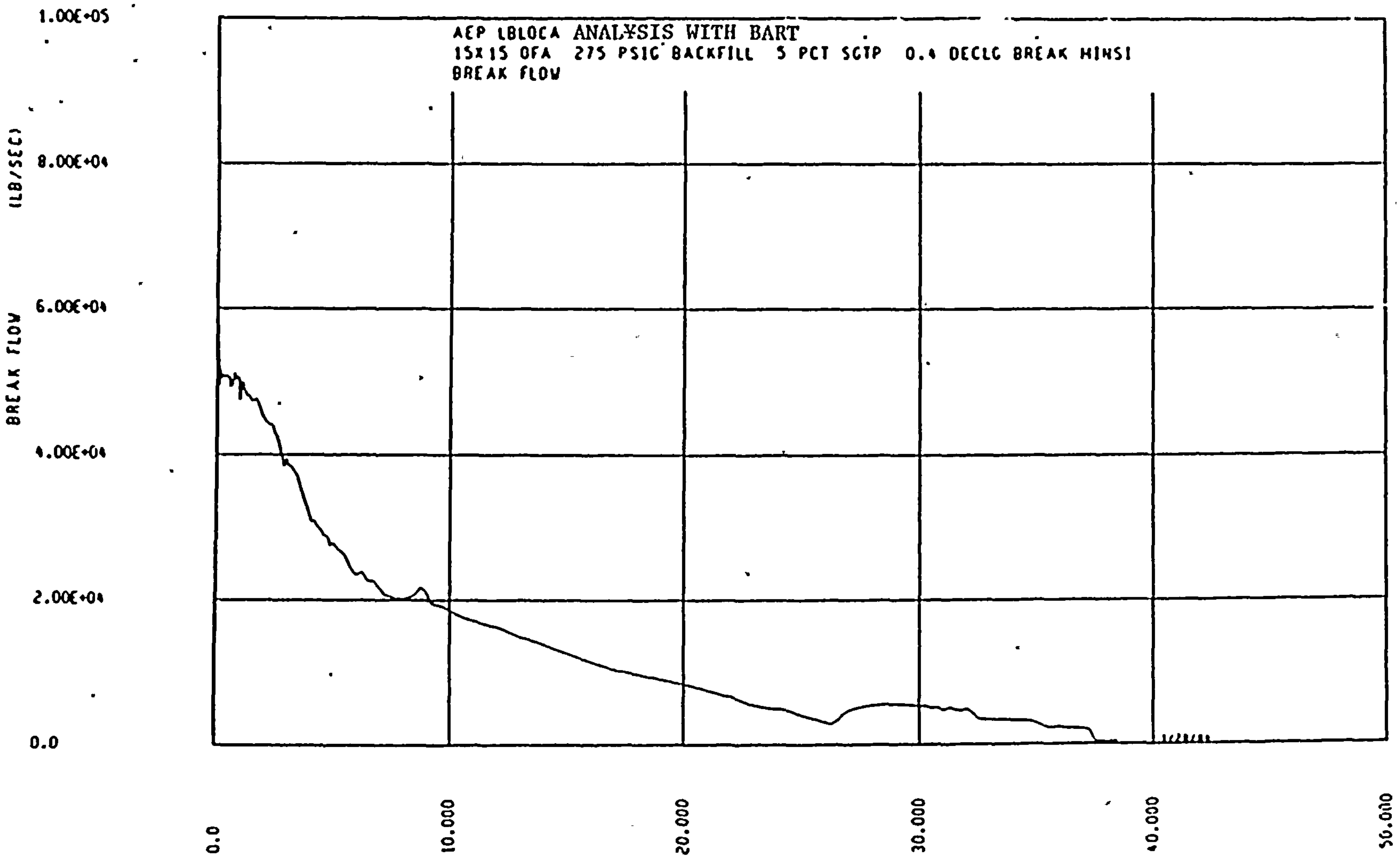

FIGURE 14.D -19 BREAK FLOW RATE
DECLG (C_D=0.4) MIN SI

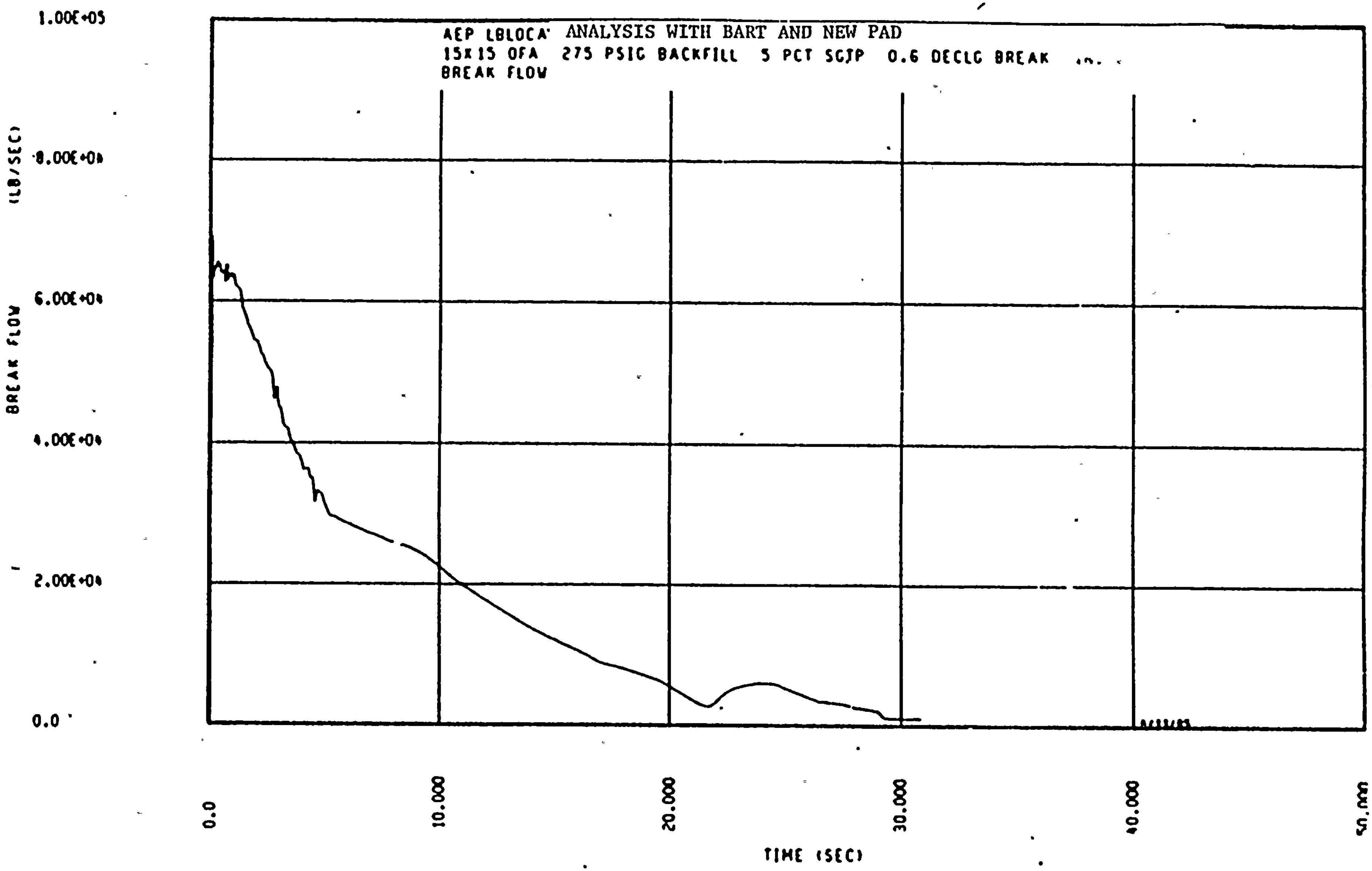

FIGURE 14.D -20 ; BREAK FLOW RATE, DECLG (C_D=0.6) MAX SI

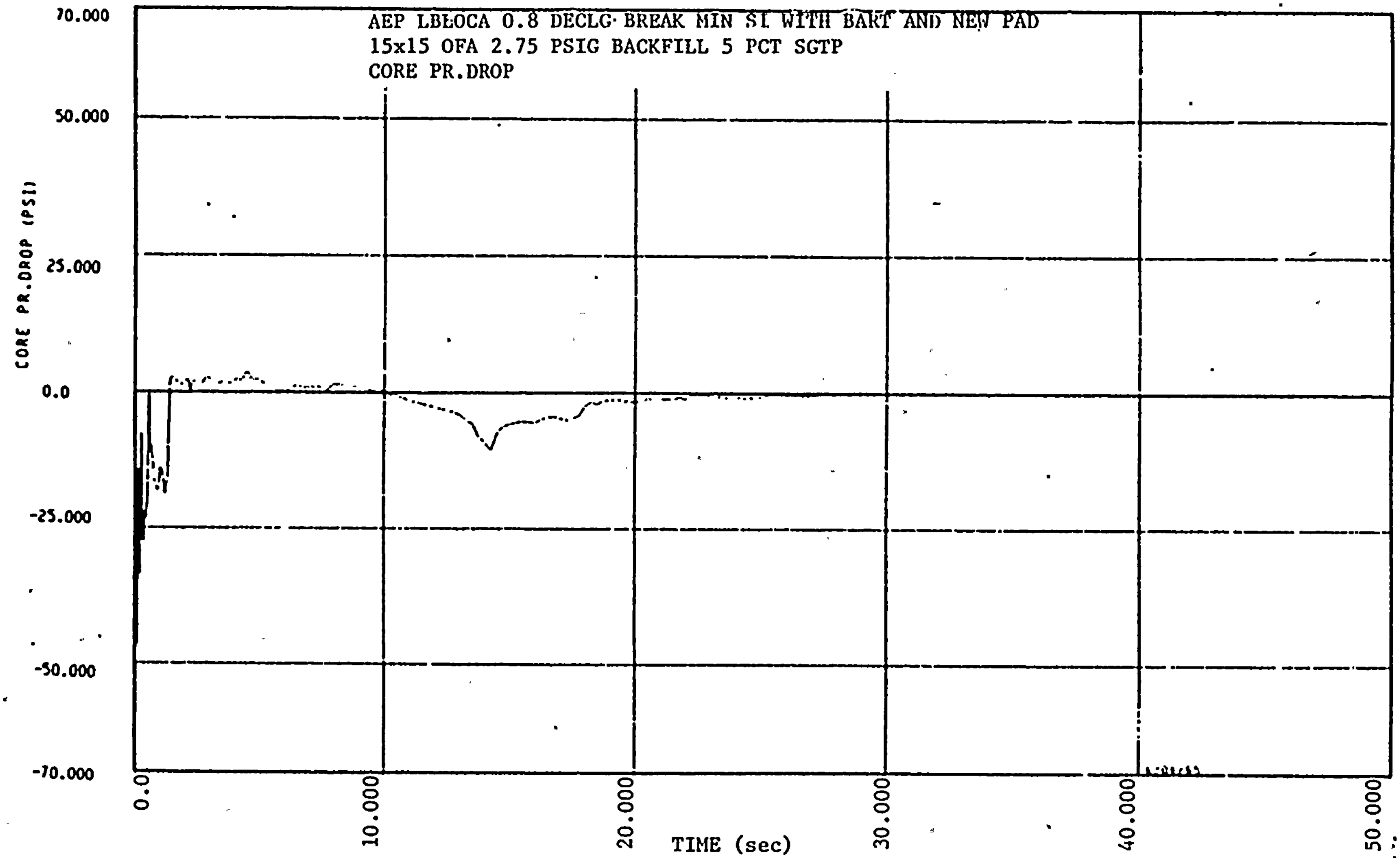

FIGURE 14.D .-21 CORE PRESSURE DROP, DECLG (C_D=0.8) MIN SI

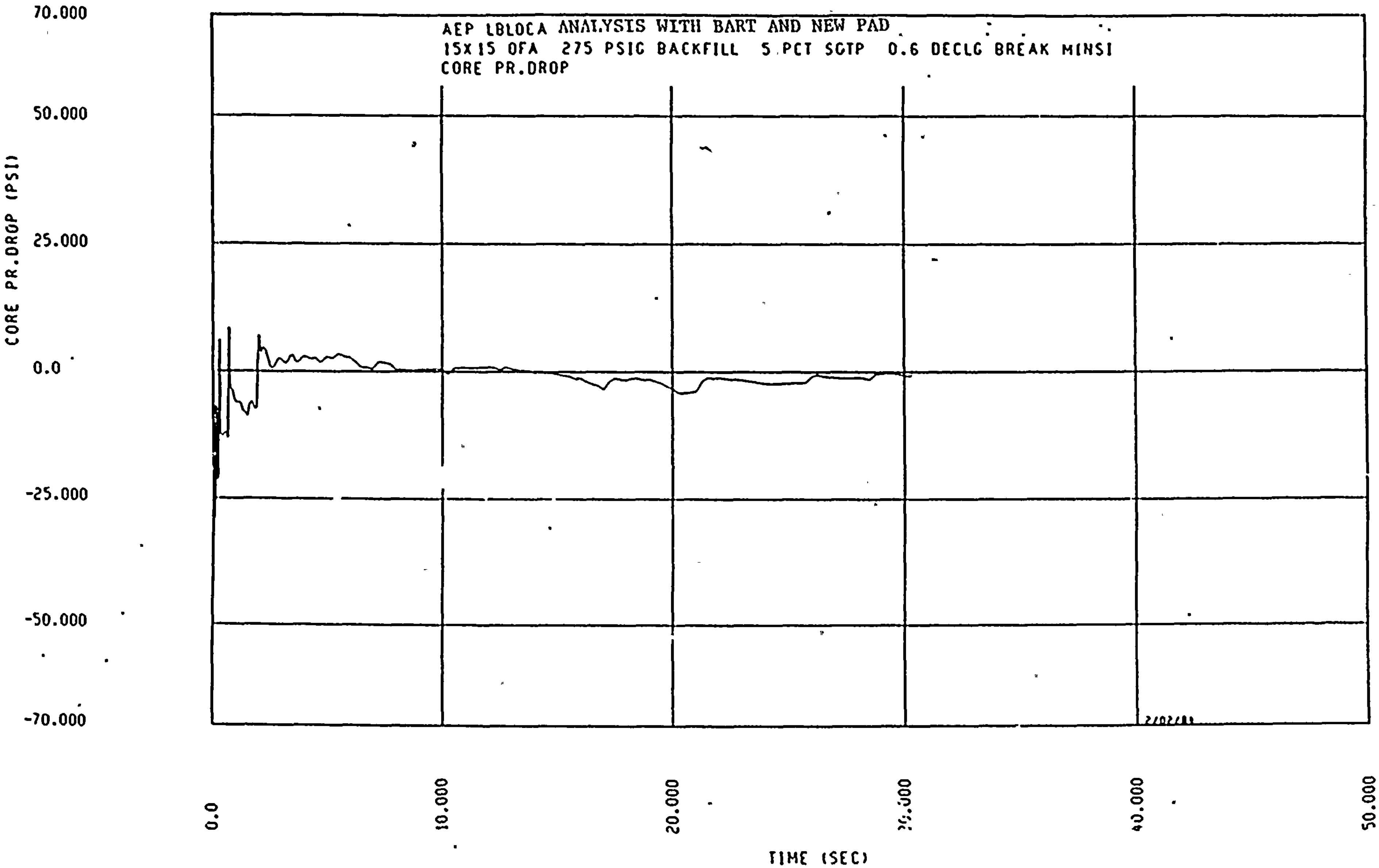

FIGURE 14.D -22 CORE PRESSURE DROP
DECLG (C_C=0.6) MIN SI

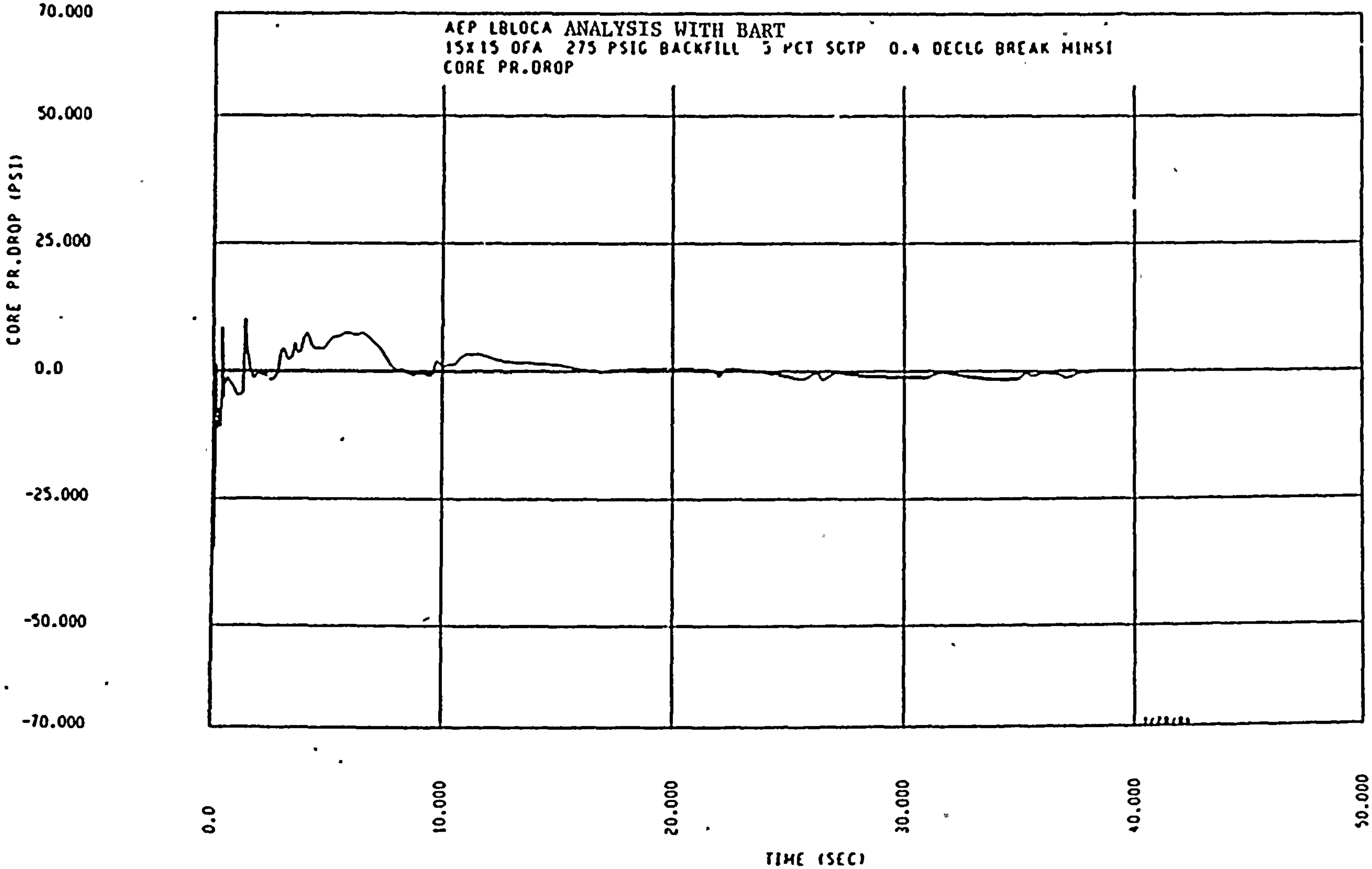

FIGURE 14.D -23 CORE PRESSURE DROP
DECLG (C_D=0.4) MIN SI

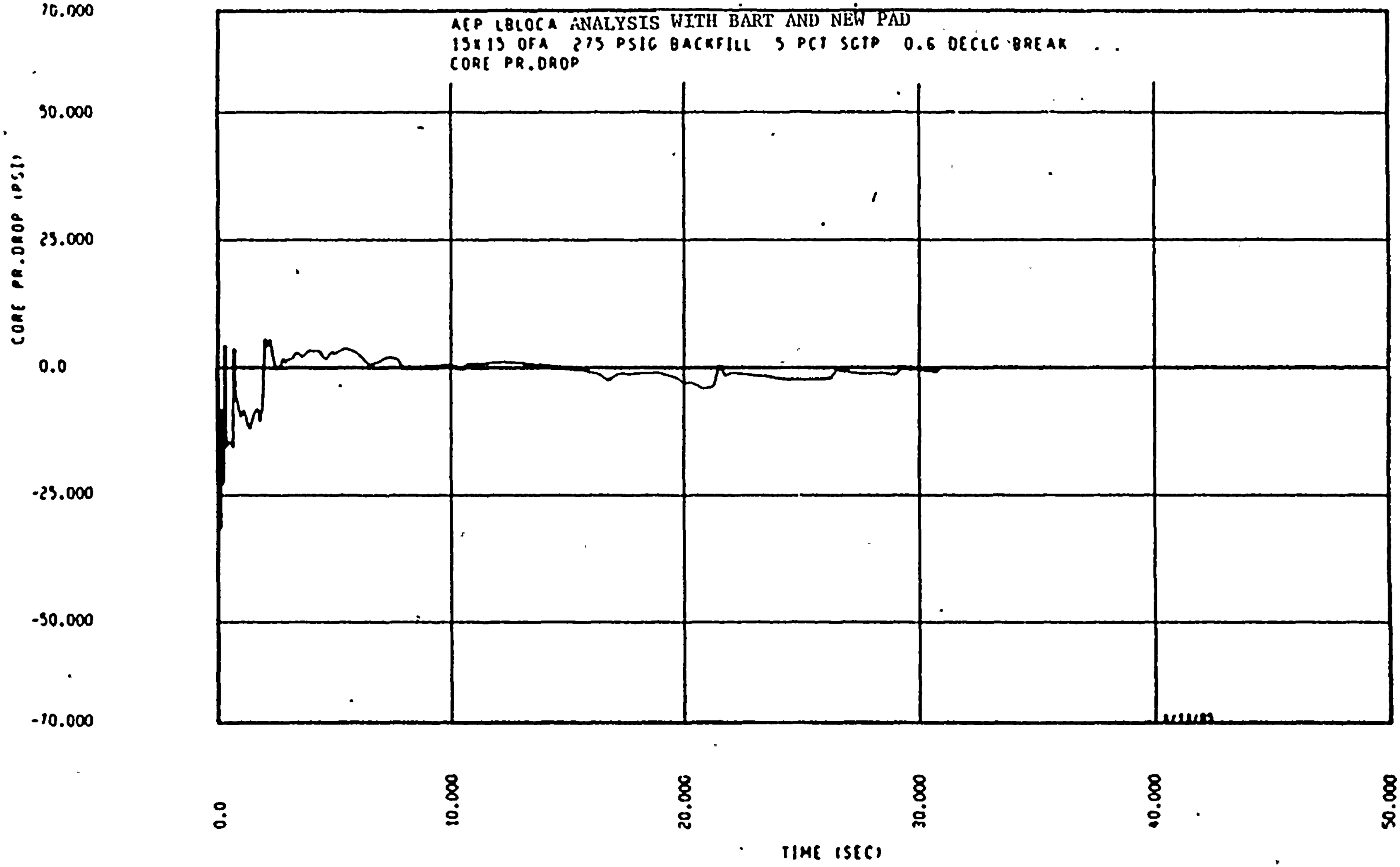

FIGURE 14.D -24 CORE PRESSURE DROP
DECLG (C_D=0.6) MAX SI

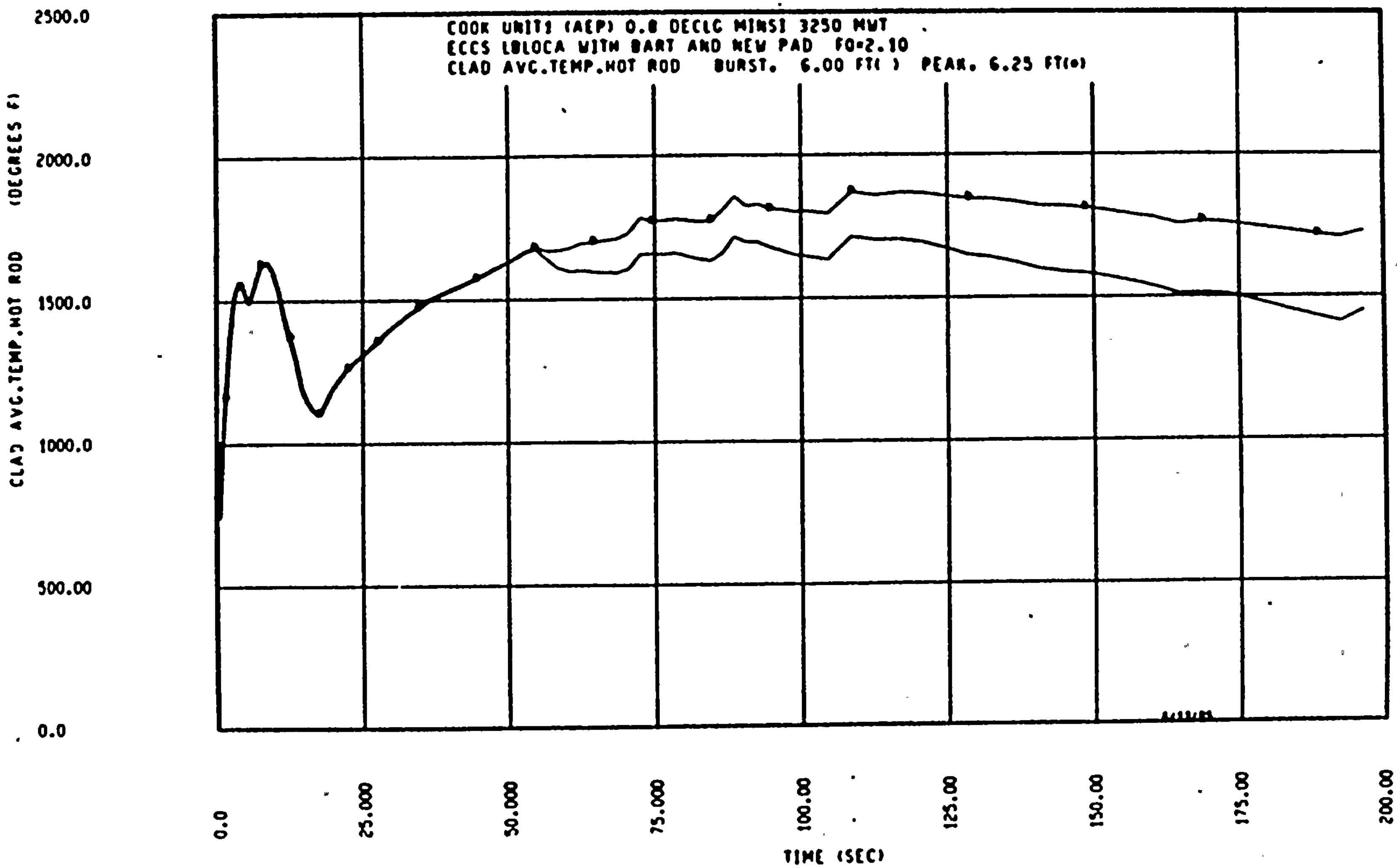

FIGURE 14.D -25 PEAK CLAD TEMPERATURE, DECLG (C_D=0.8) MIN SI

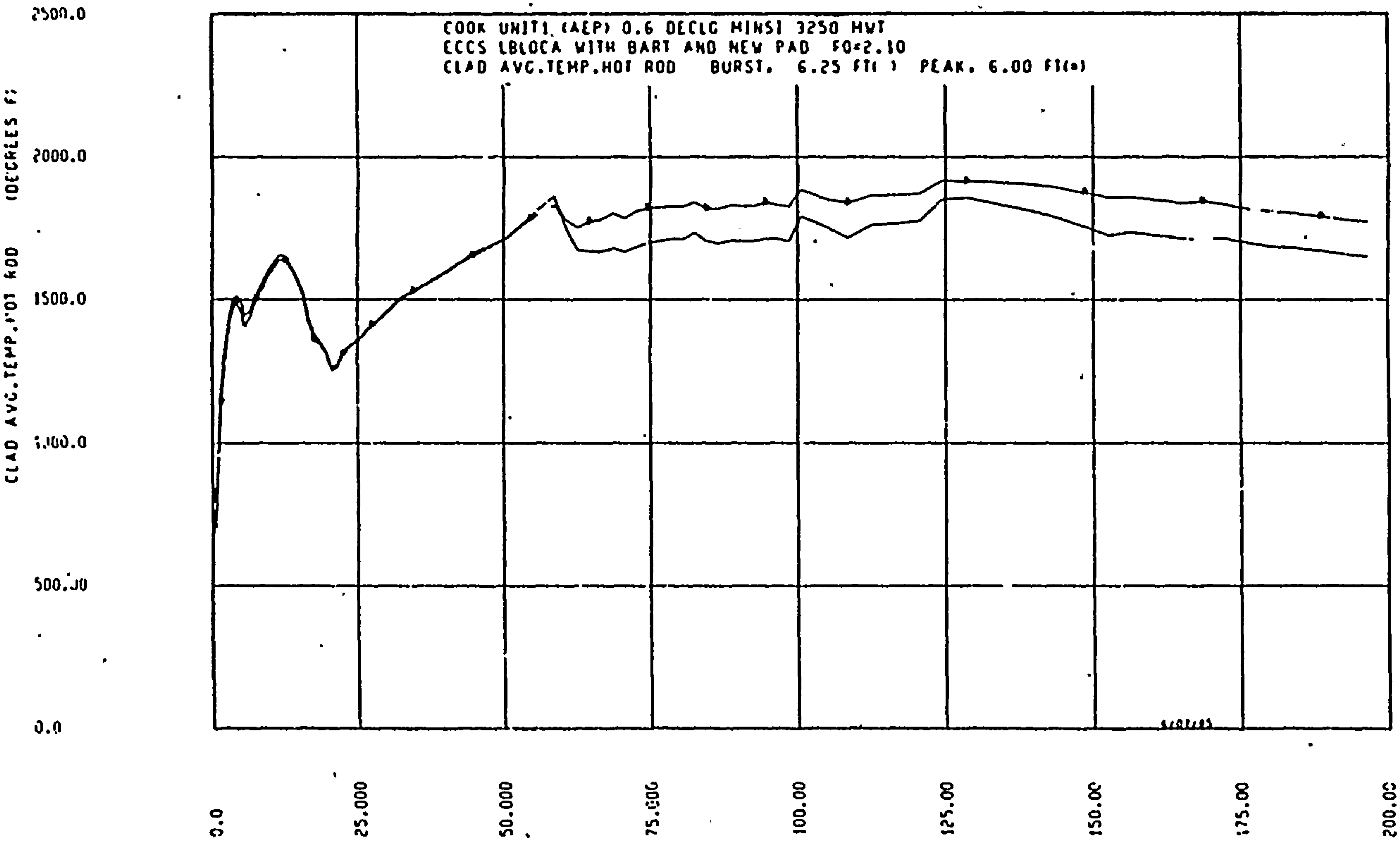

FIGURE 14.D .-26 PEAK CLAD TEMPERATURE, DECLG (C_D=0.6) MIN SI

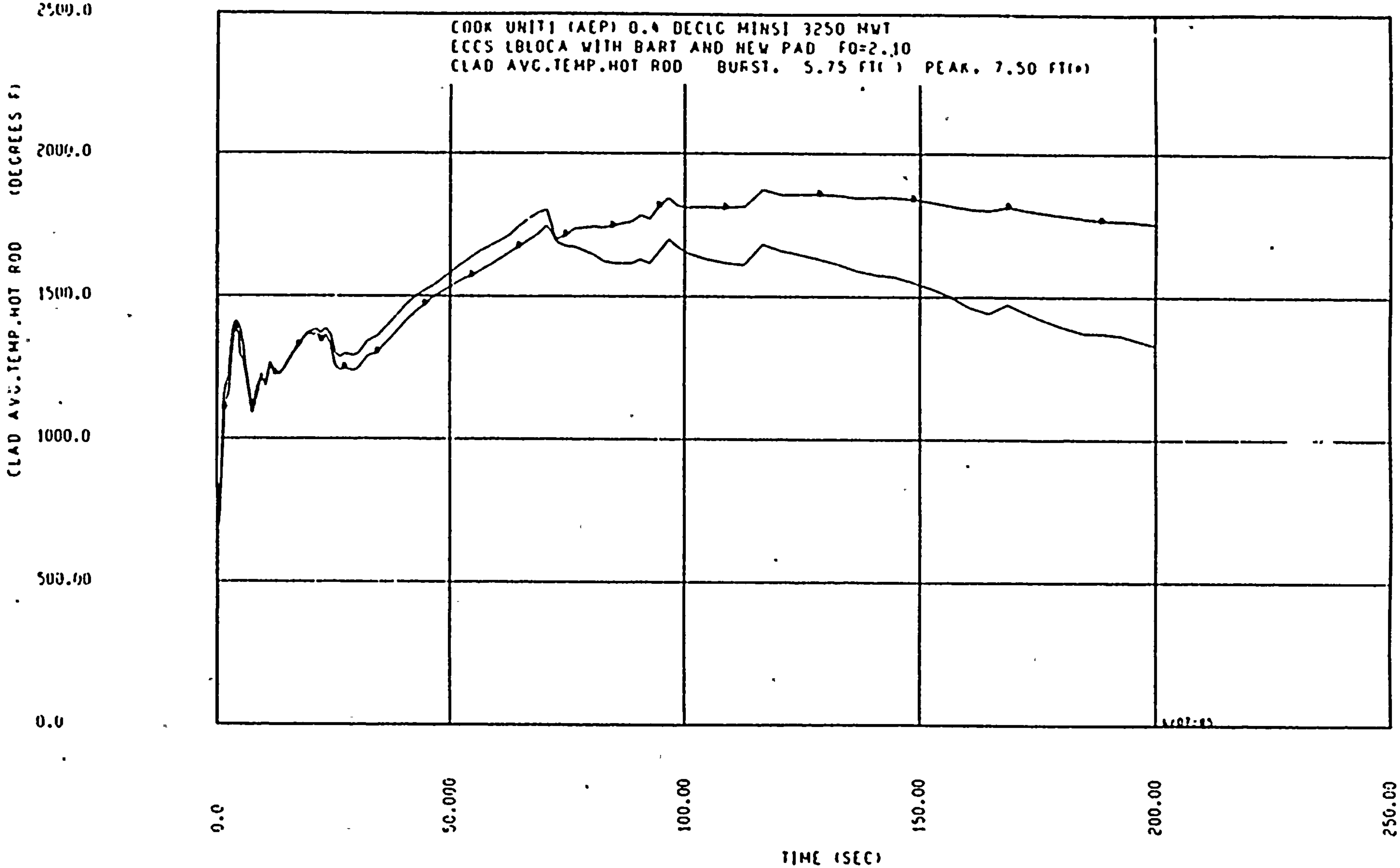

FIGURE 14.D -27 PEAK CLAD TEMPERATURE, DECLG (C_D=0.4) MIN SI

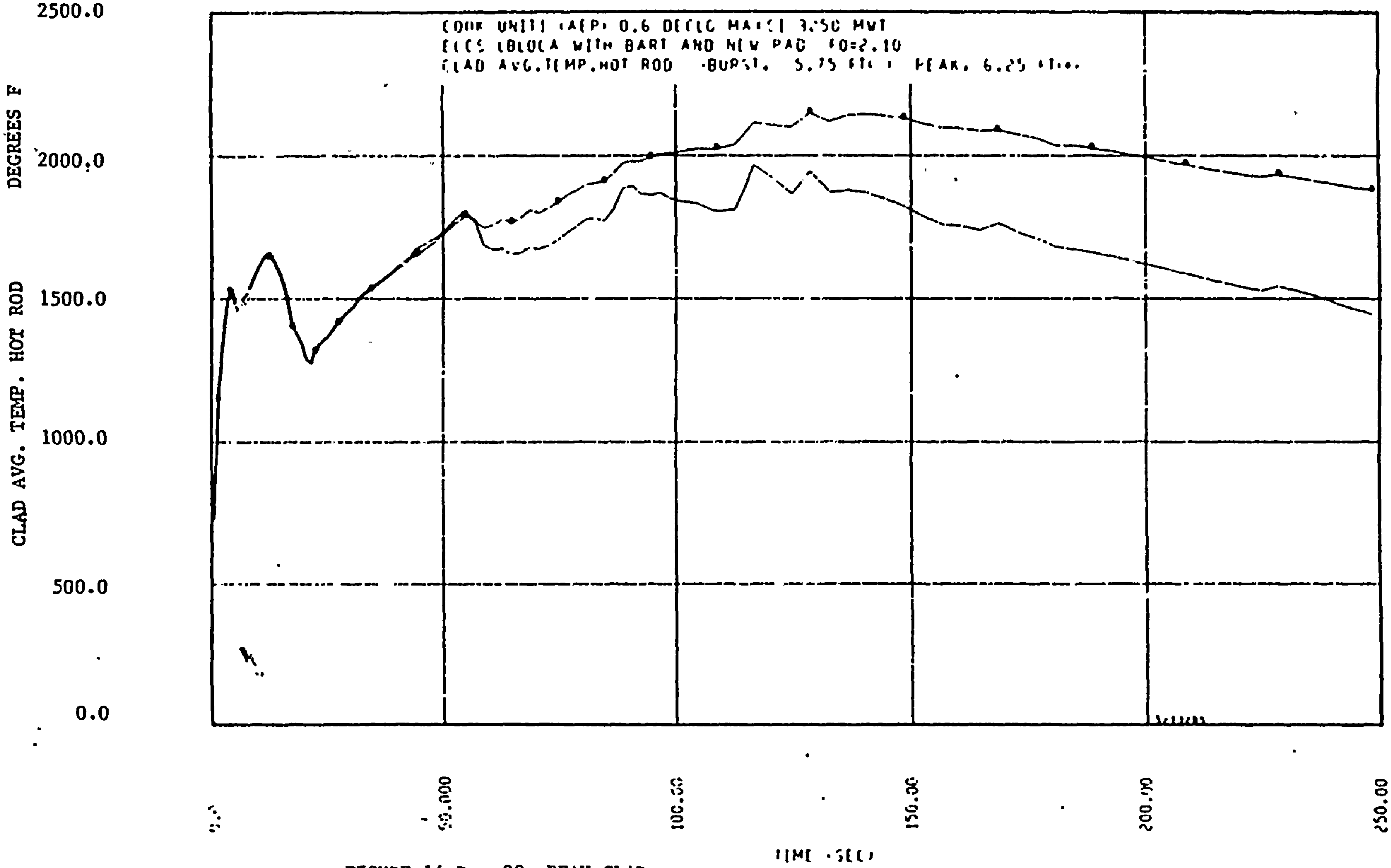

FIGURE 14.D -28 PEAK CLAD
TEMPERATURE
DECLG (C_D=0.6) MAX SI

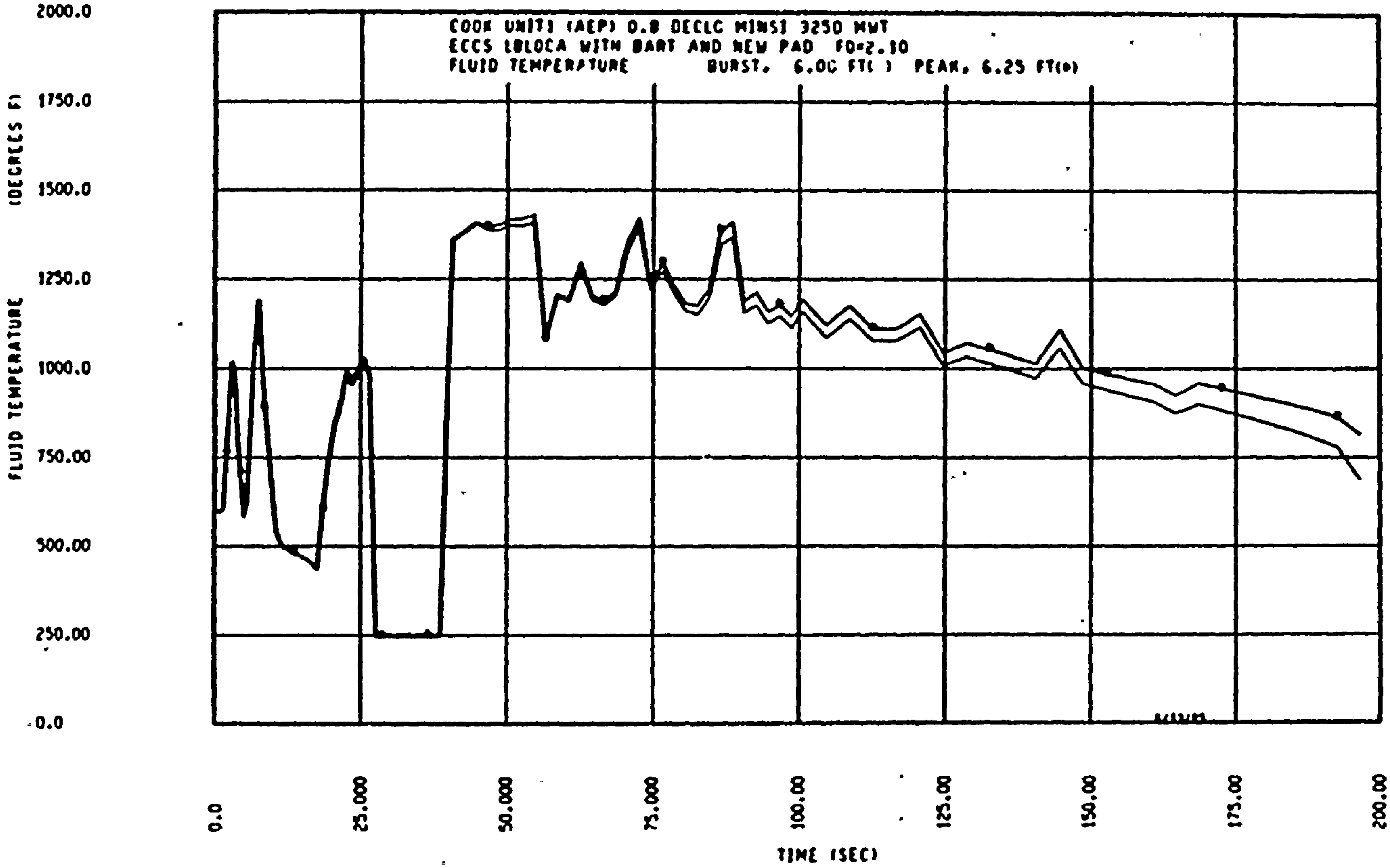

FIGURE 14.D -29 FLUID TEMPERATURE
DECLG (C_D=0.8) MIN SI

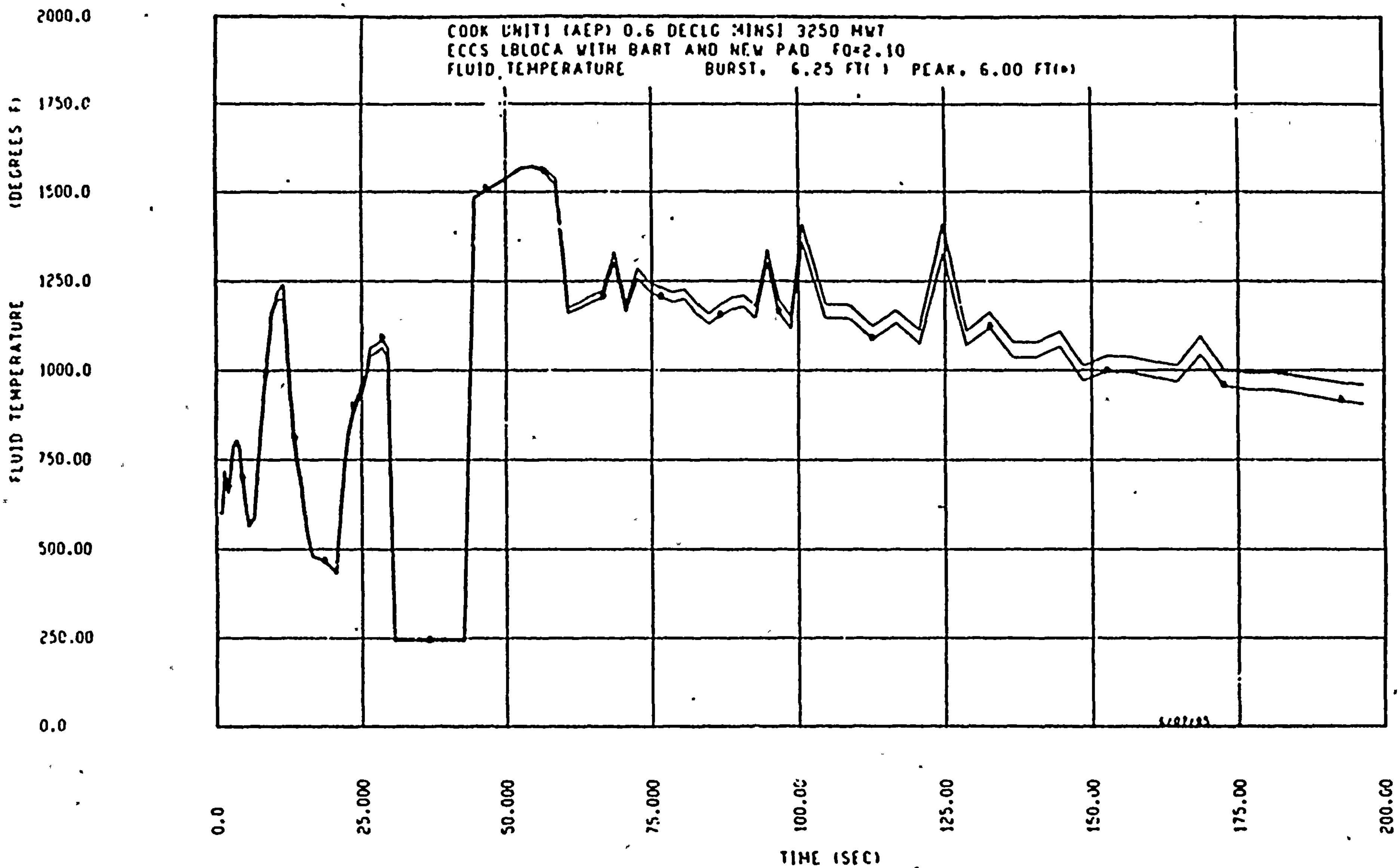

FIGURE 14.D -30 FLUID TEMPERATURE
DECLG (C_D=0.6) MIN SI

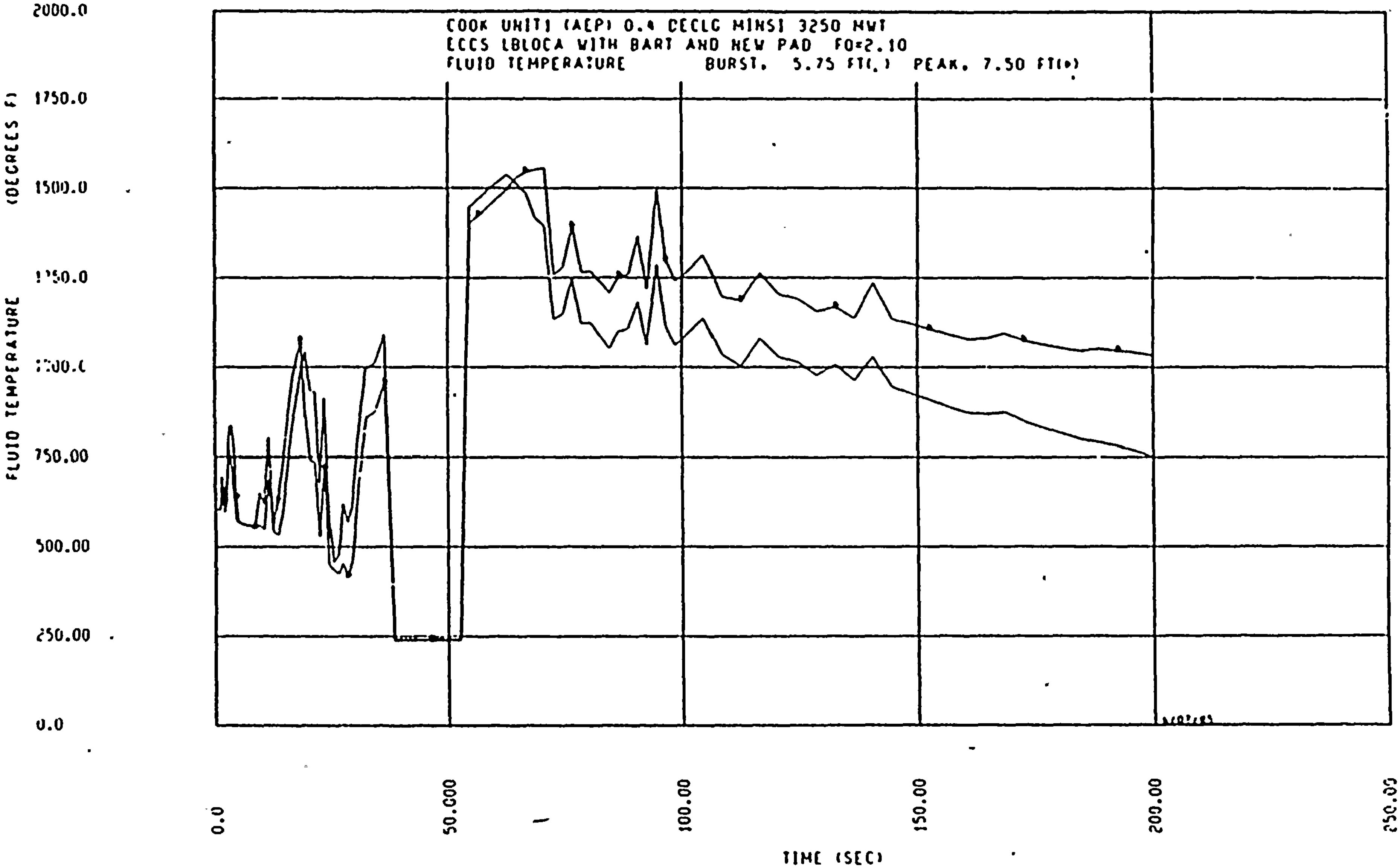

FIGURE 14.D -31 FLUID TEMPERATURE
DECLG (C_D=0.4) MIN SI

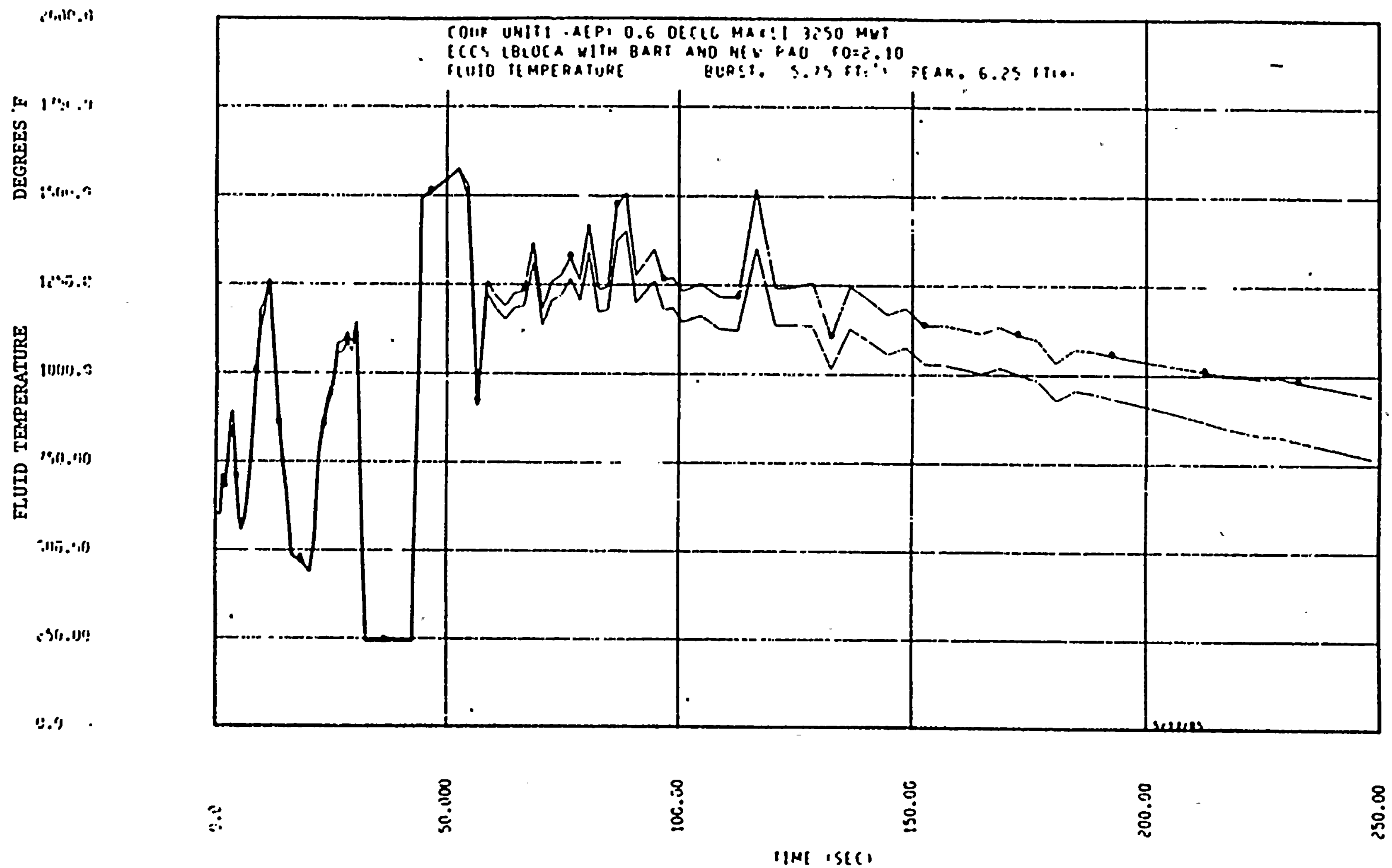

FIGURE 14.D -32 FLUID TEMPERATURE
DECLG (C_D=0.6) MAX SI

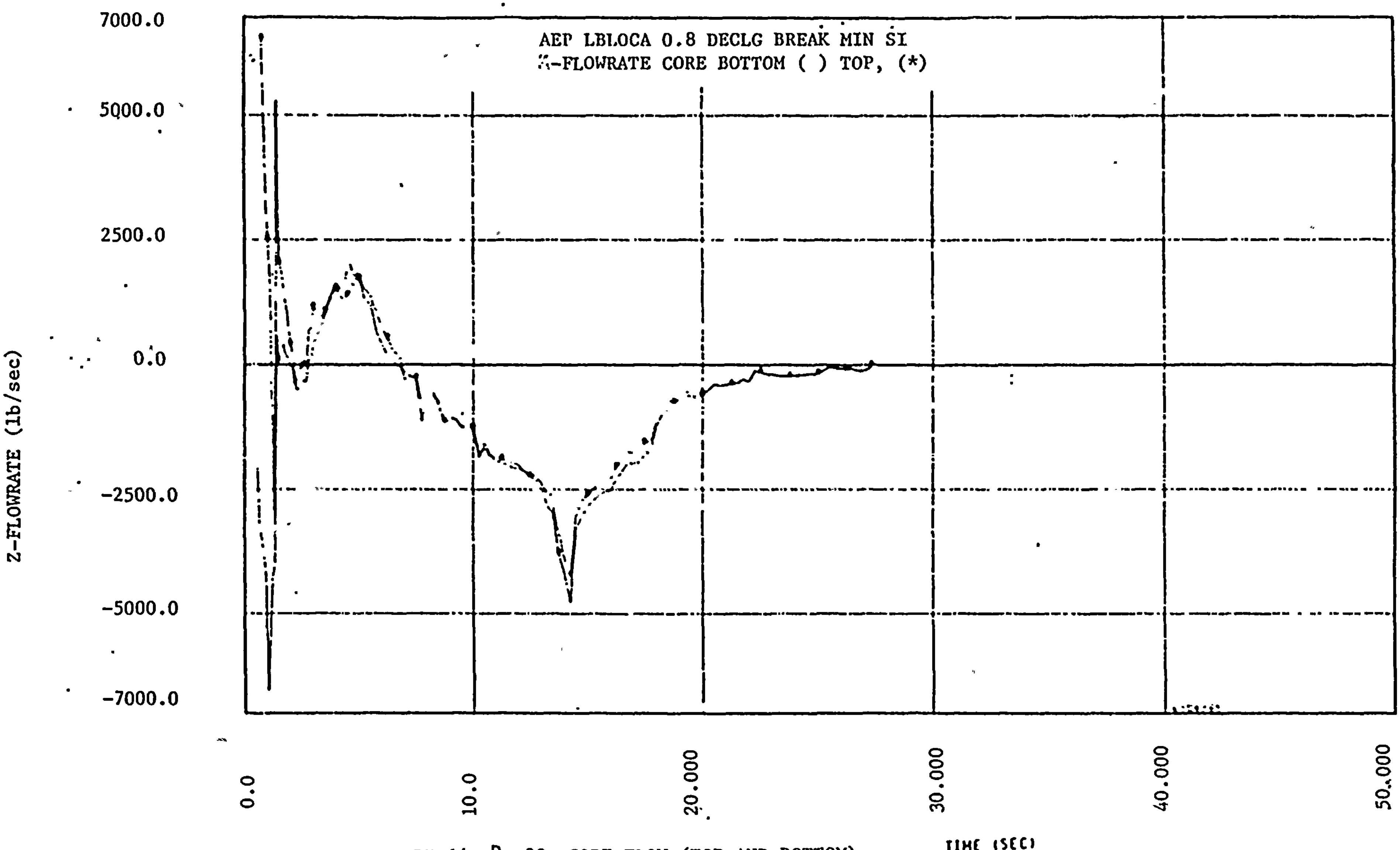

FIGURE 14. D.-33 CORE FLOW (TOP AND BOTTOM)
DECLG (C_D=0.8) MIN SI

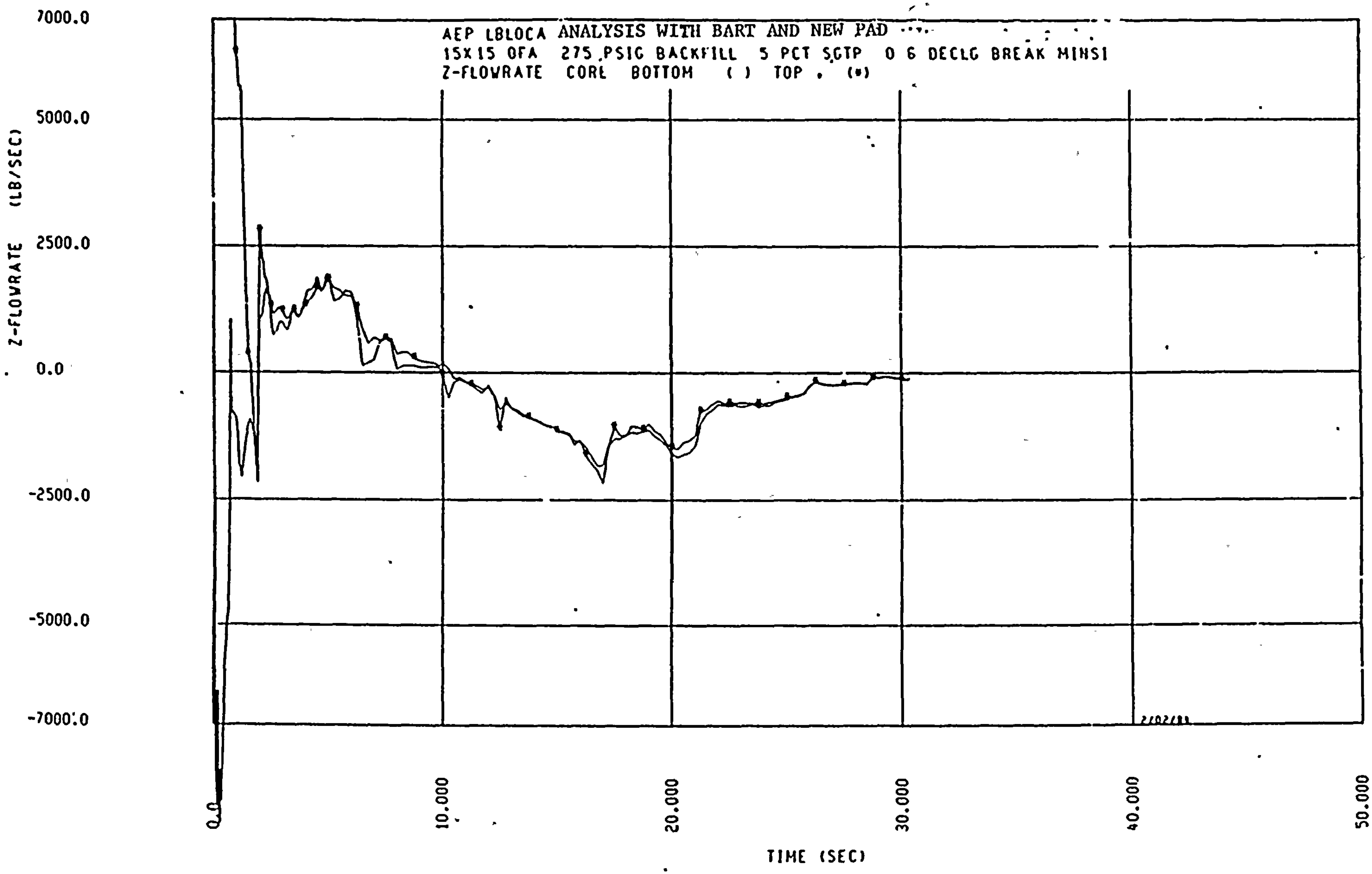

FIGURE 14.D .-34 CORE FLOW (TOP AND BOTTOM)
DECLG (C_D=0.6) MIN SI

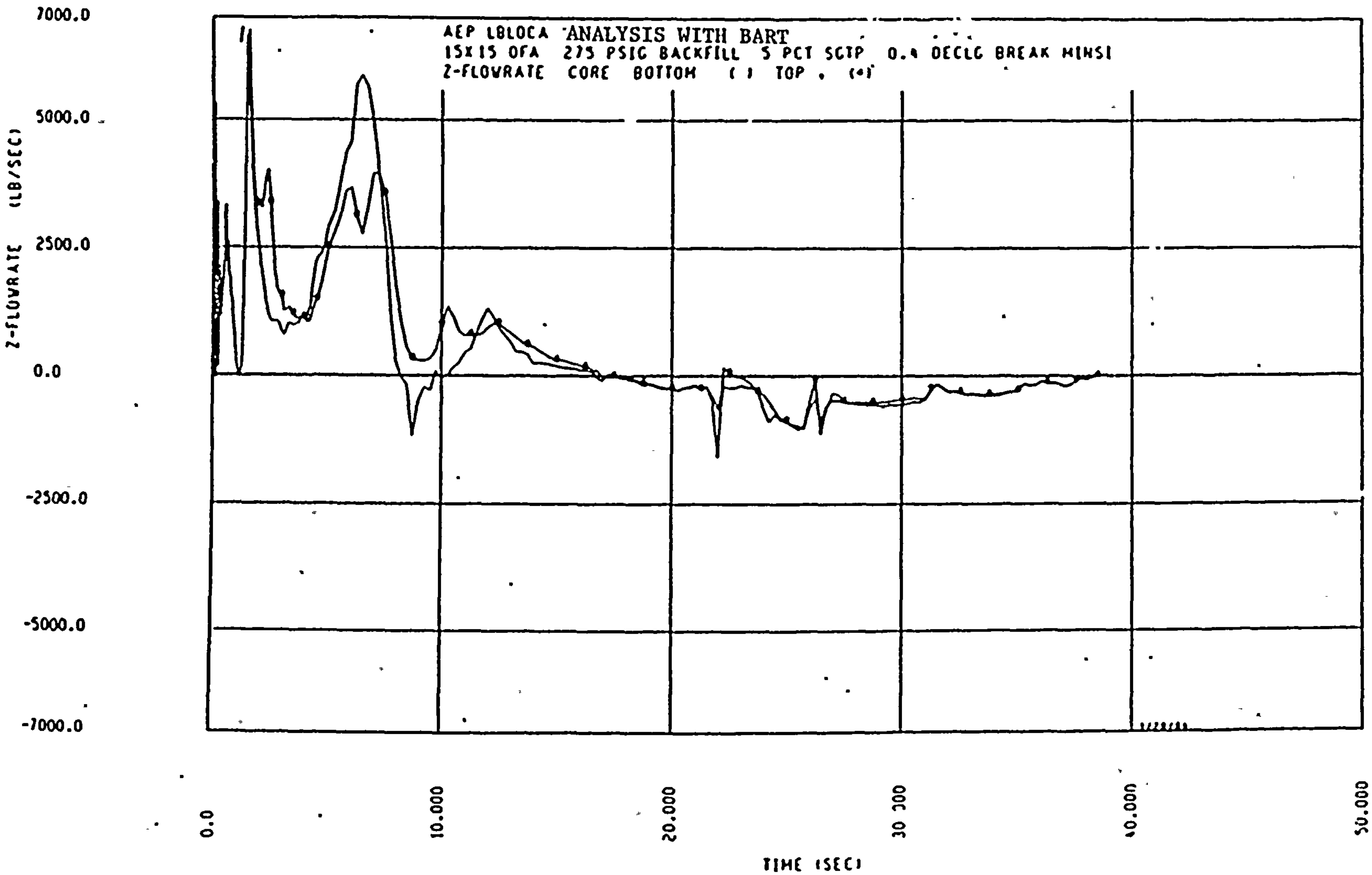

FIGURE 14.D -35 CORE FLOW (TOP AND BOTTOM)
DECLG (C_D=0.4) MIN SI

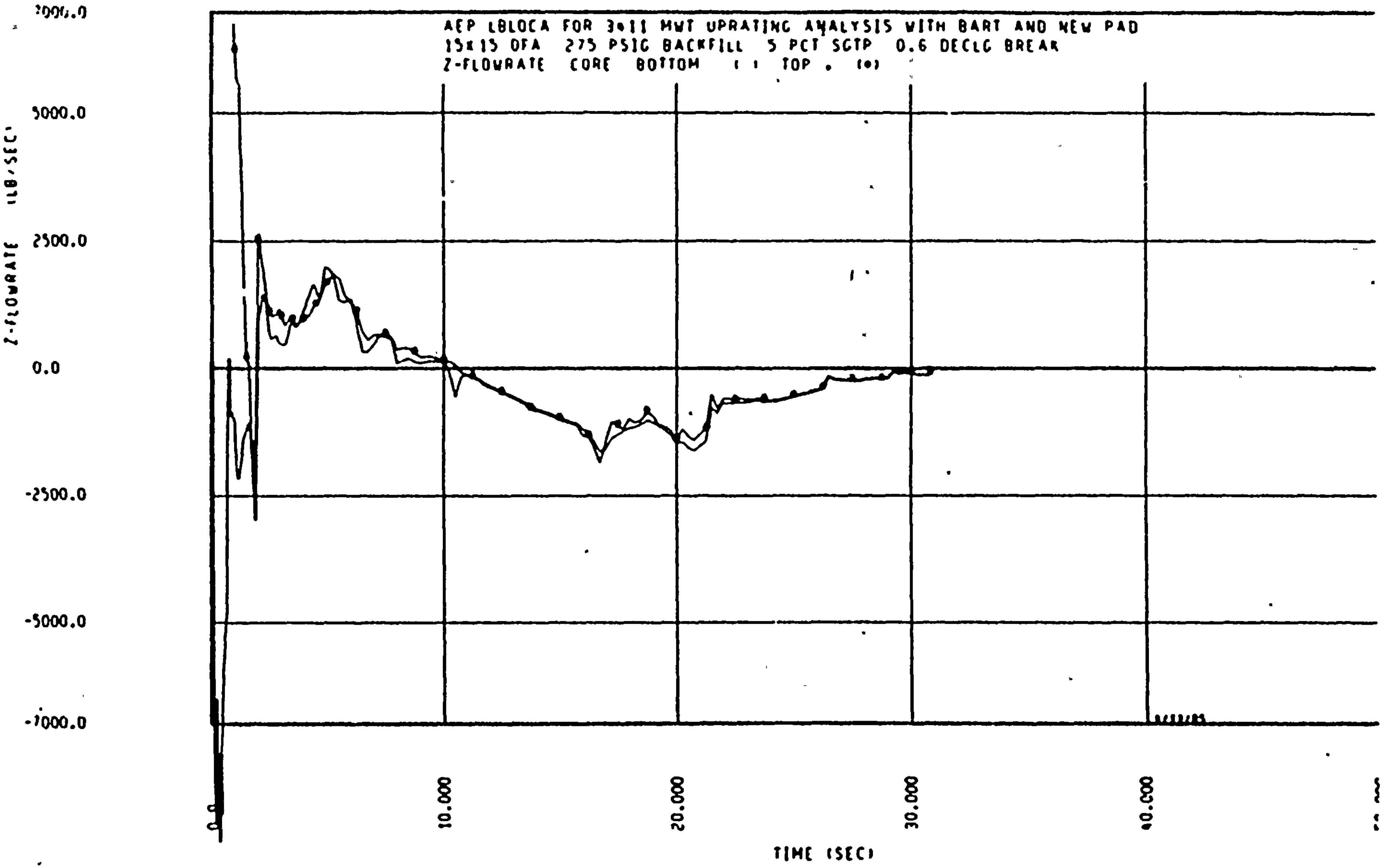

FIGURE 14.D -36 CORE FLOW
(TOP AND BOTTOM)
DECLG (C_D=0.6) MAX SI

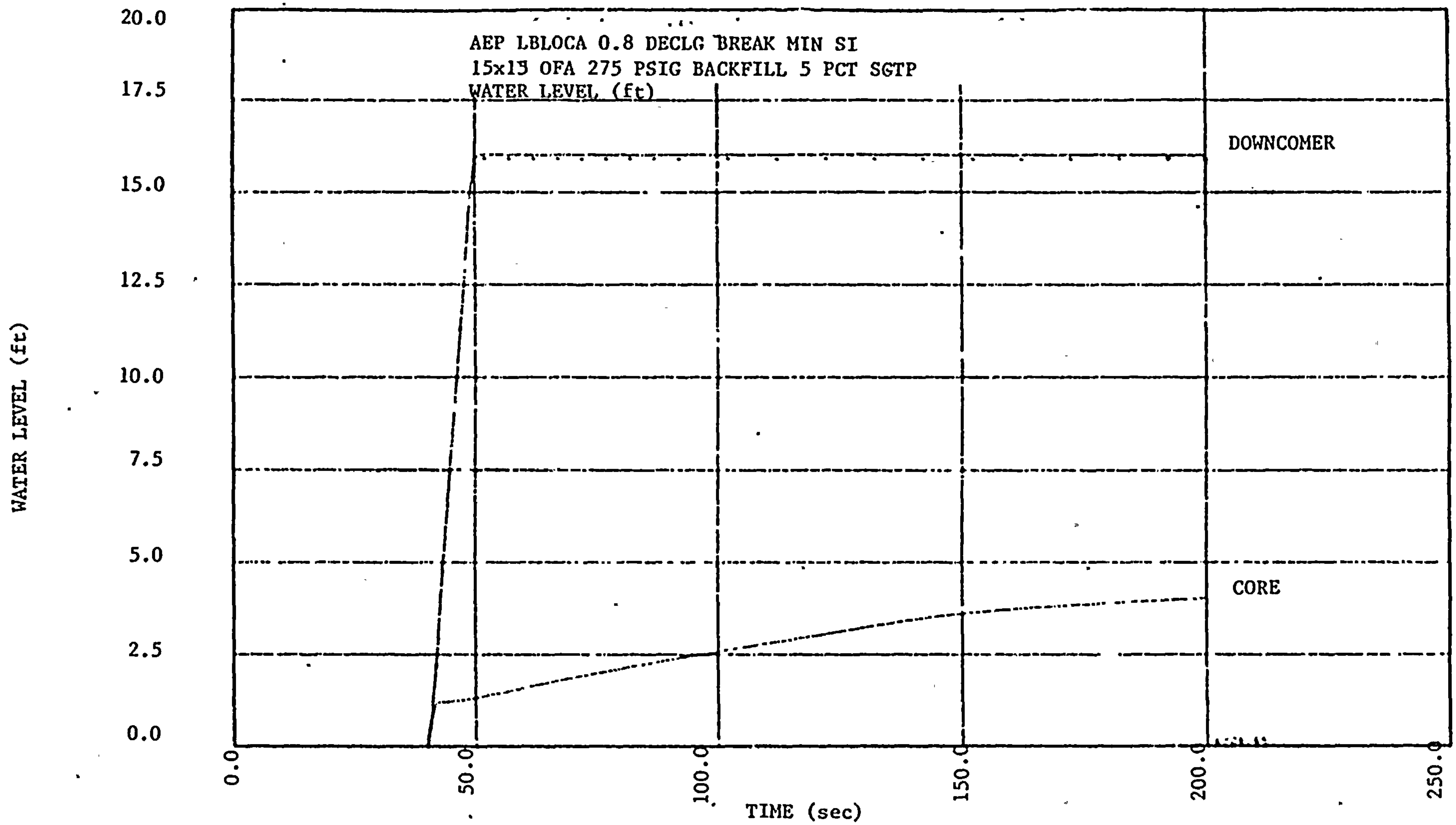

FIGURE 14.D -37 REFLOOD TRANSIENT - CORE & DOWNCOMER WATER LEVELS
DECLG (C_D=0.8) MIN SI

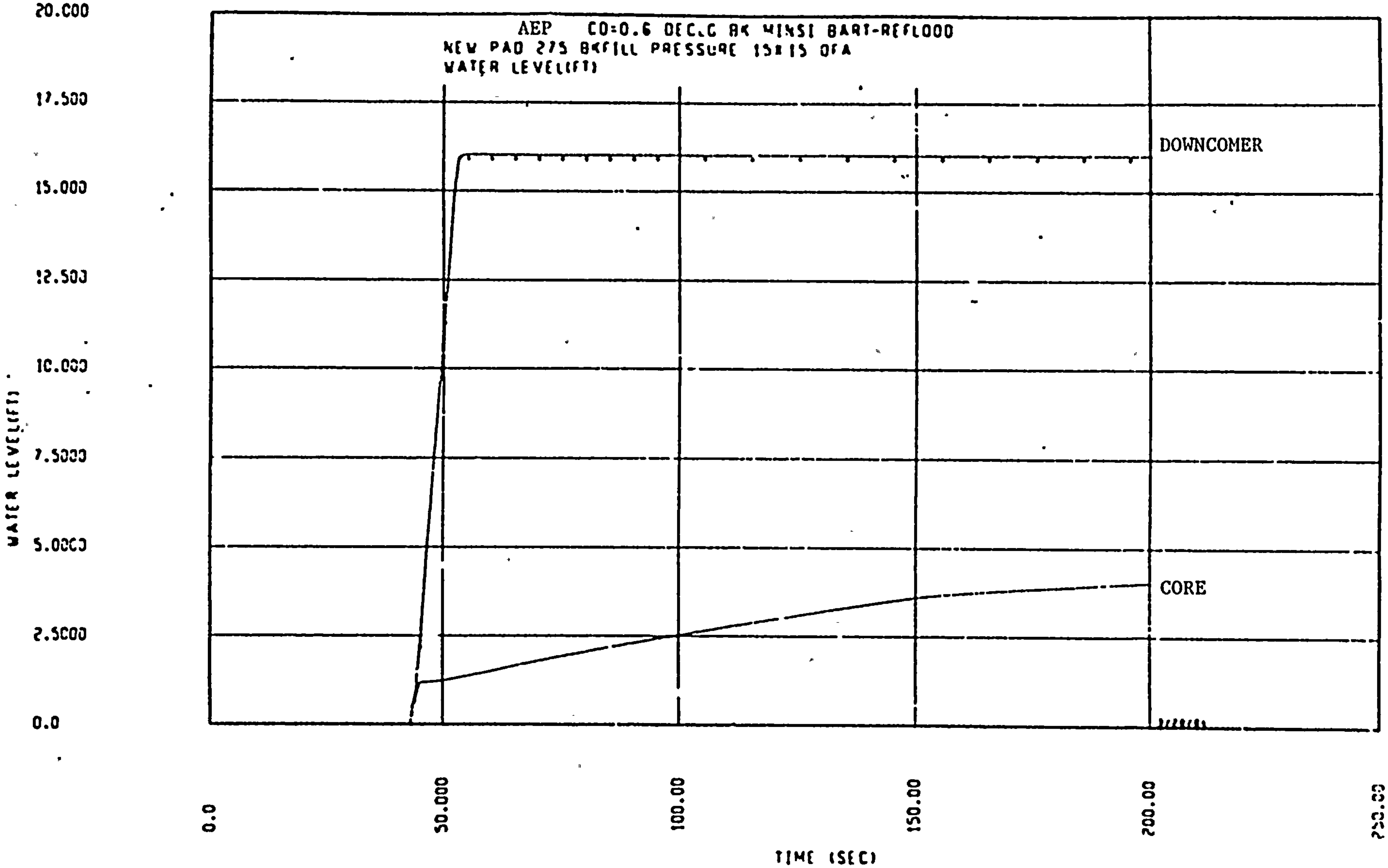

FIGURE 14.D .-38 REFLOOD TRANSIENT – CORE & DOWNCOMER WATER LEVELS
DECLG (C_D=0.6) MIN SI

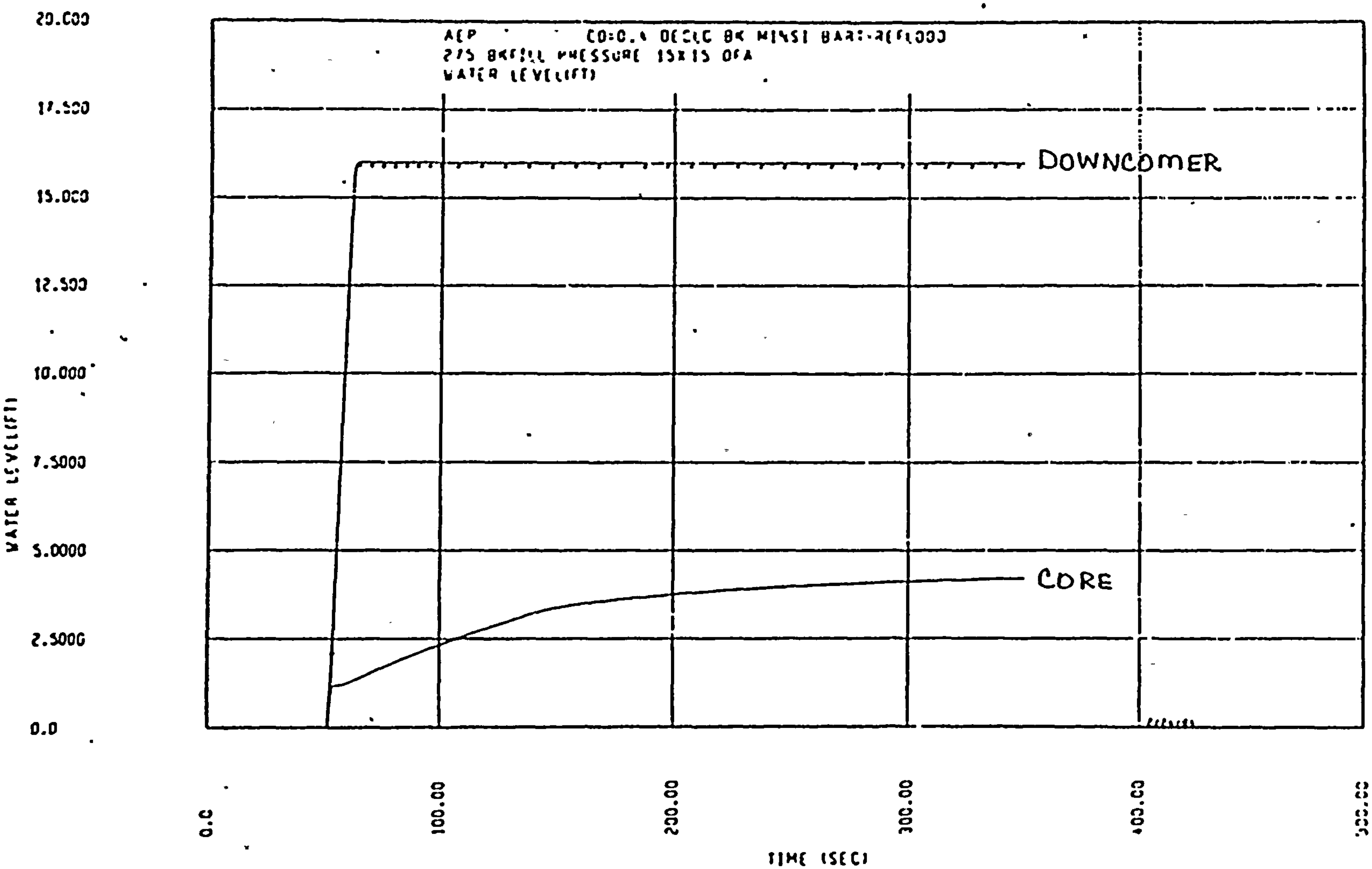

FIGURE 14.D -39 REFLOOD TRANSIENT - CORE & DOWNCOMER WATER LEVELS
DECLG (C_D=0.4) MIN SI

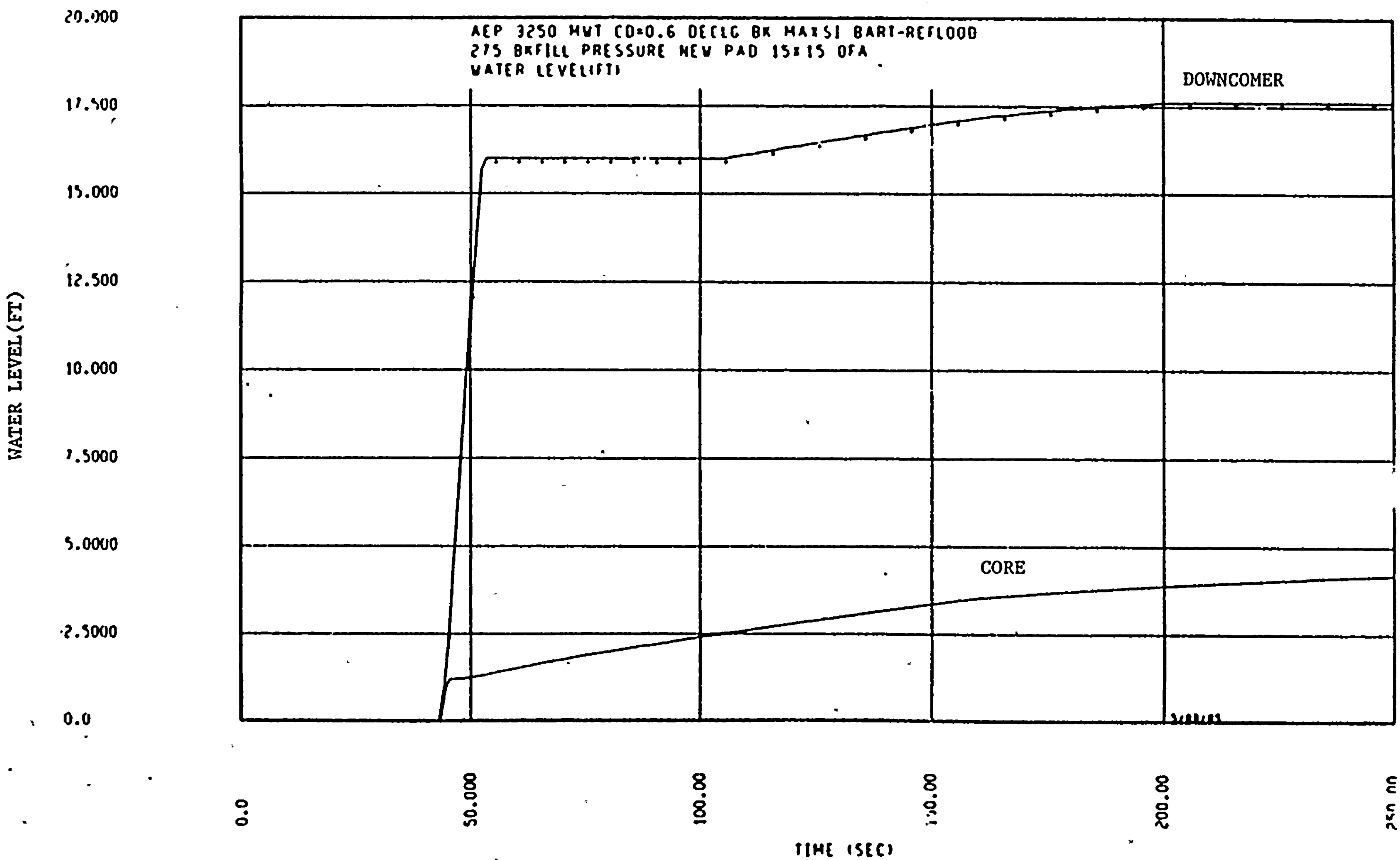

FIGURE 14.D -40 REFLOOD TRANSIENT - CORE & DOWNCOMER WATER LEVELS
DECLG (C_D=0.6) MAX SI

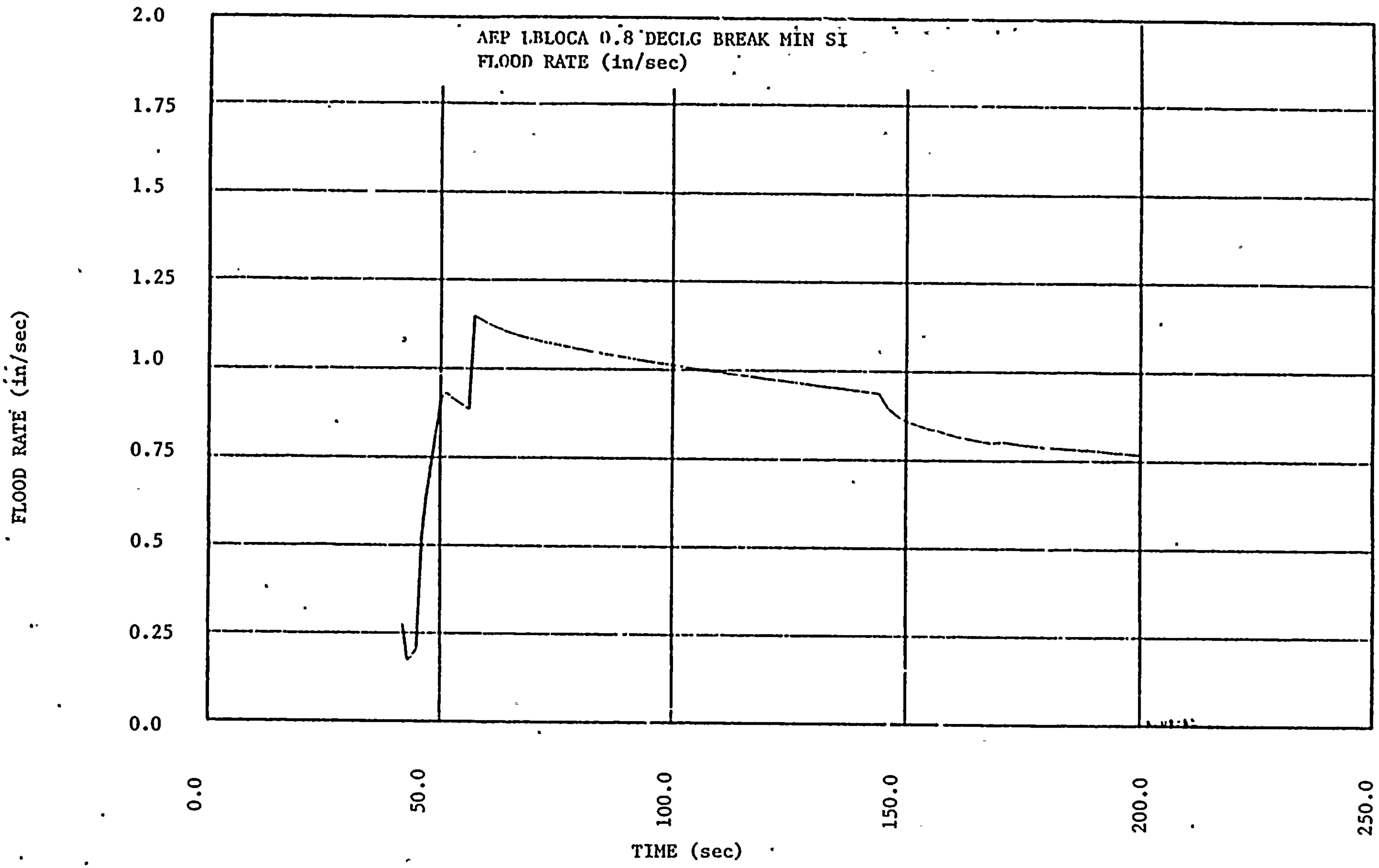

FIGURE 14.D -41 REFLOOD TRANSIENT, CORE INLET VELOCITY DECLG (C_D=0.8) MIN SI

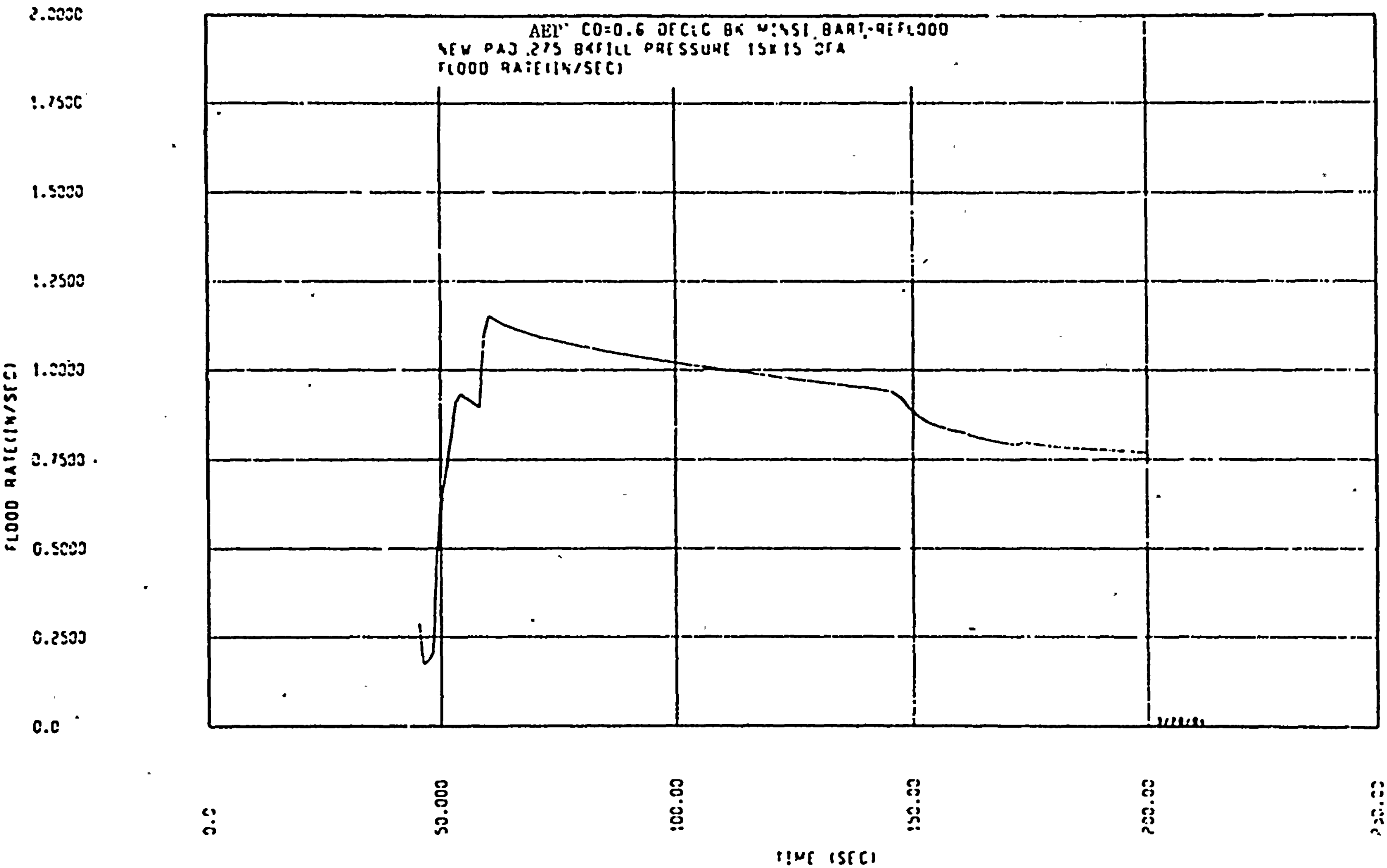

FIGURE 14.D -42 REFLOOD TRANSIENT, CORE INLET VELOCITY
DECLG (C_D=0.6) MIN SI

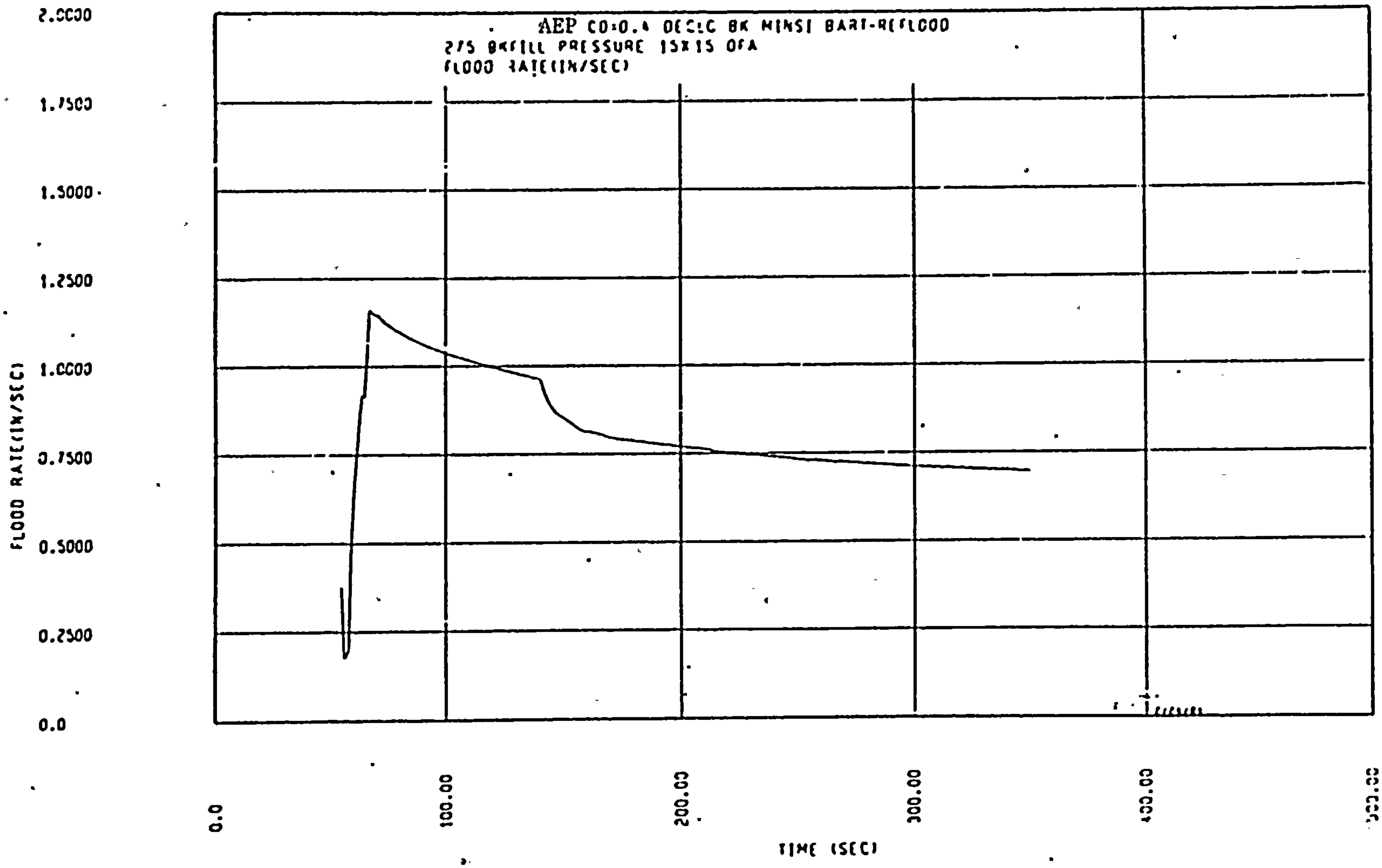

FIGURE 14.D .-43 REFLOOD TRANSIENT, CORE INLET VELOCITY
DECLG (C_D=0.4) MIN SI

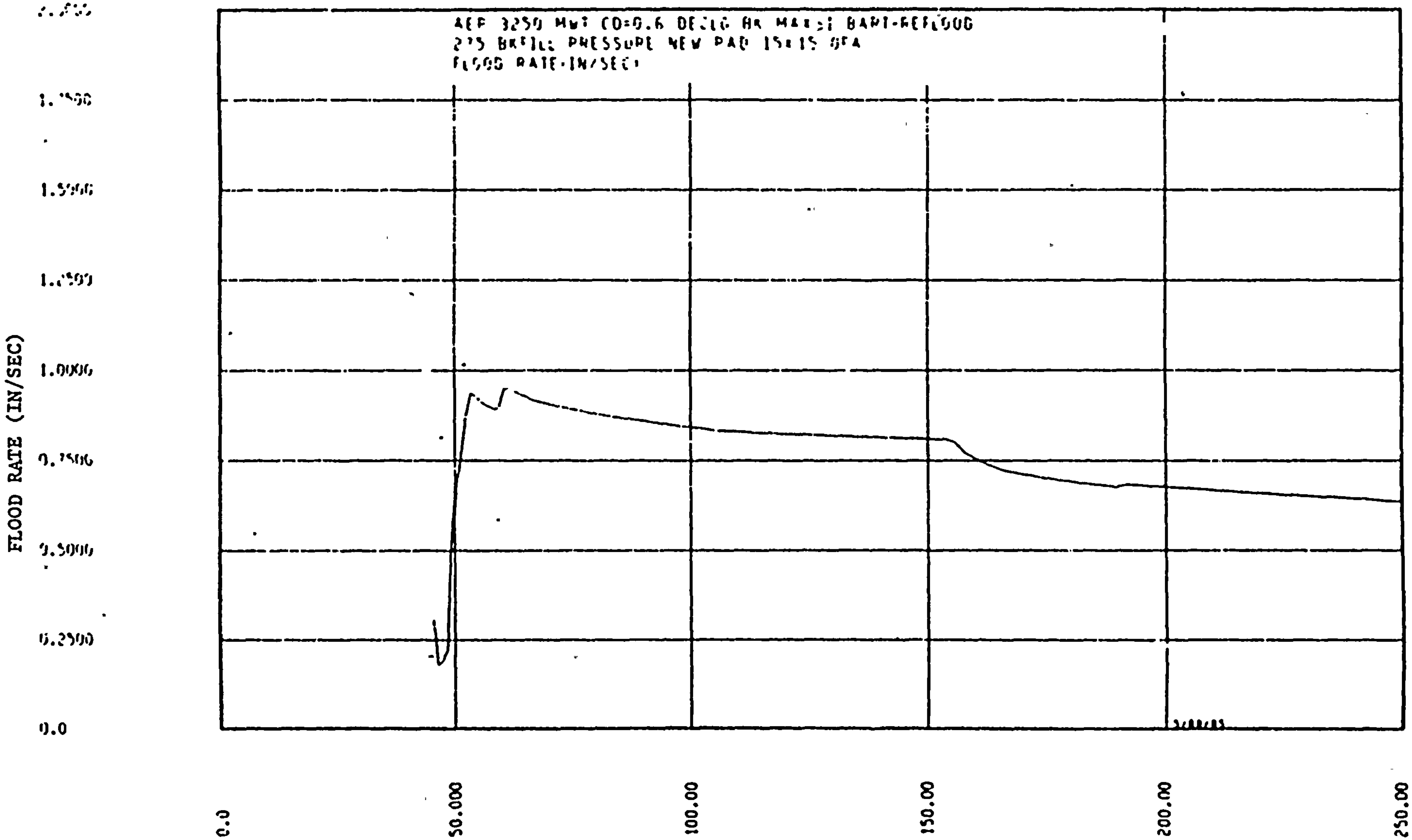

FIGURE 14.D. -44 REFLOOD TRANSIENT, CORE INLET VELOCITY
DECLG (CD=0.6) MAX SI

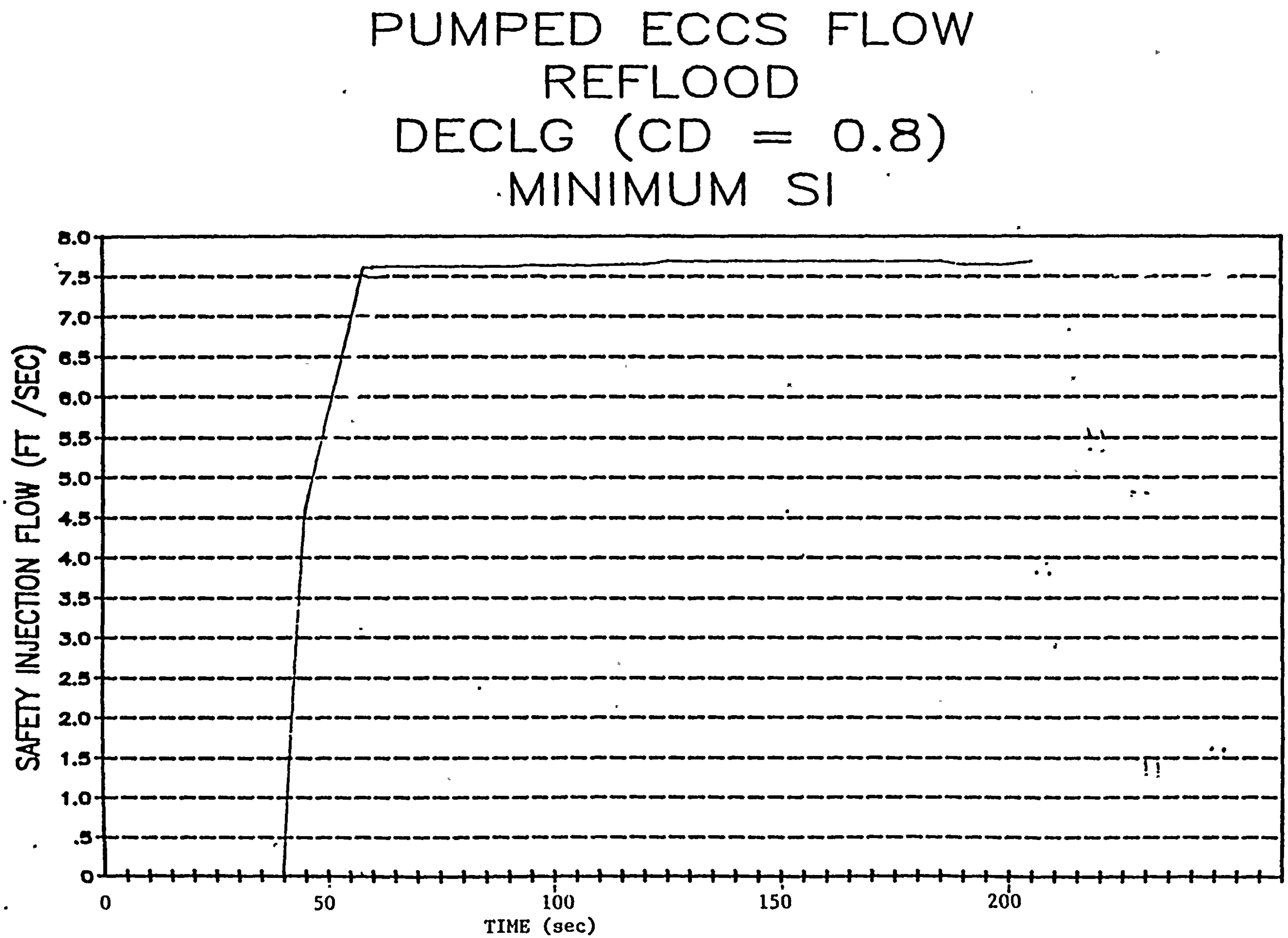

FIGURE 14.D-45 PUMPED ECCS FLOW (REFLOOD) DECLG (C_D=0.8) MIN SI

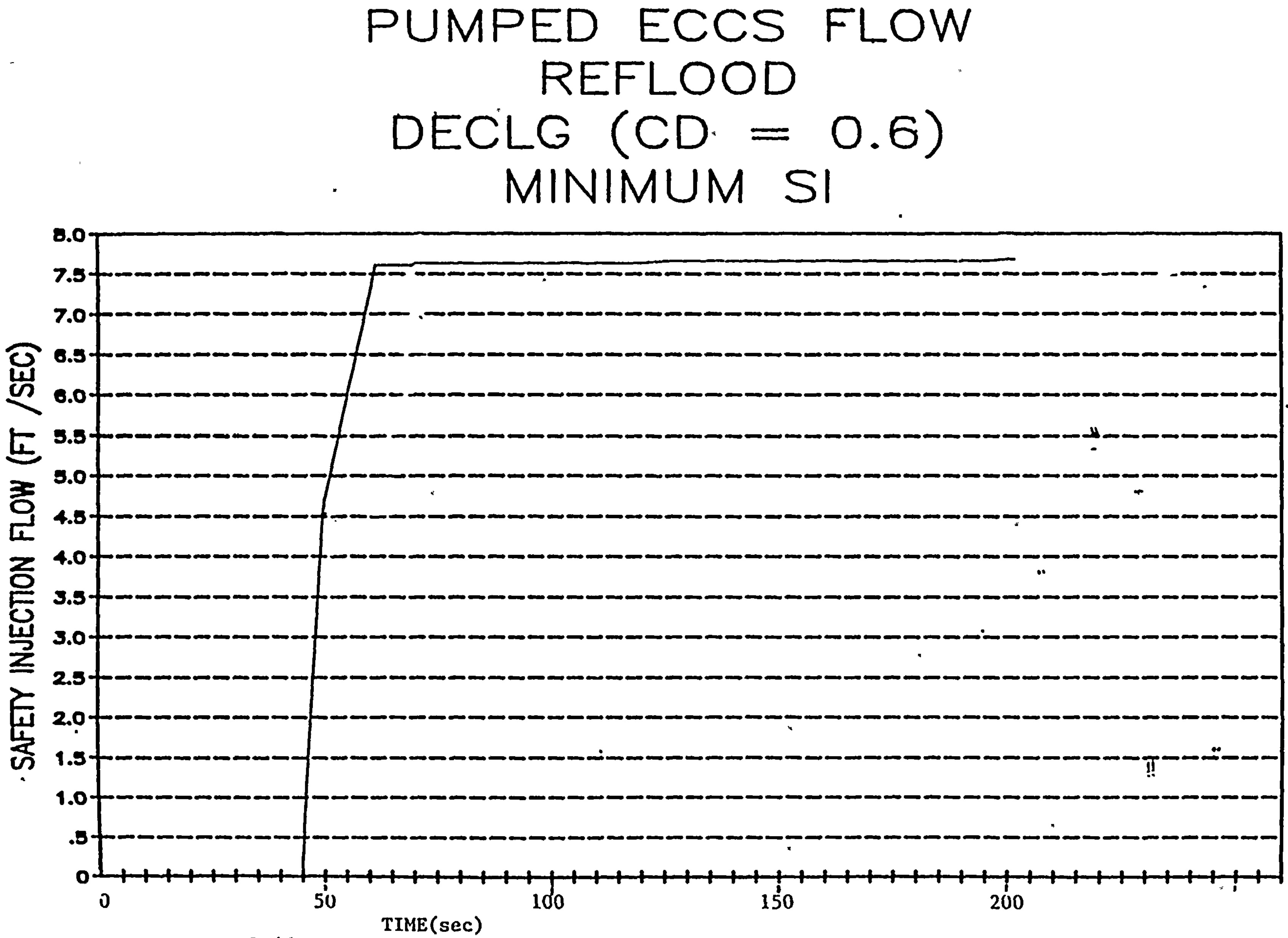

FIGURE 14.D-46 PUMPED ECCS FLOW (REFLOOD) DECLG (C_D=0.6) MIN SI

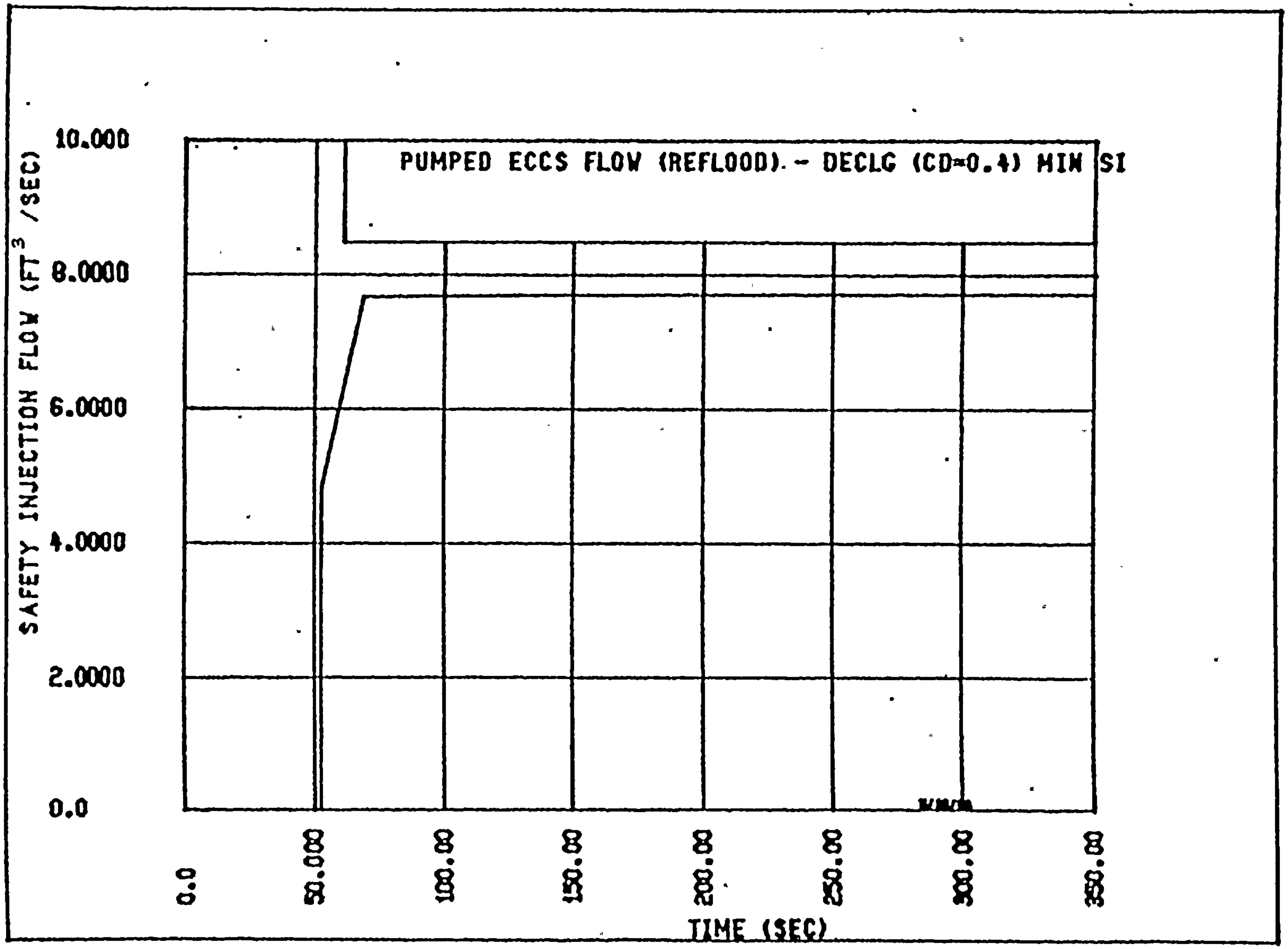

FIGURE 14.D -47 PUMPED ECCS FLOW (REFLOOD)
DECLG (C_D=0.4) MIN SI

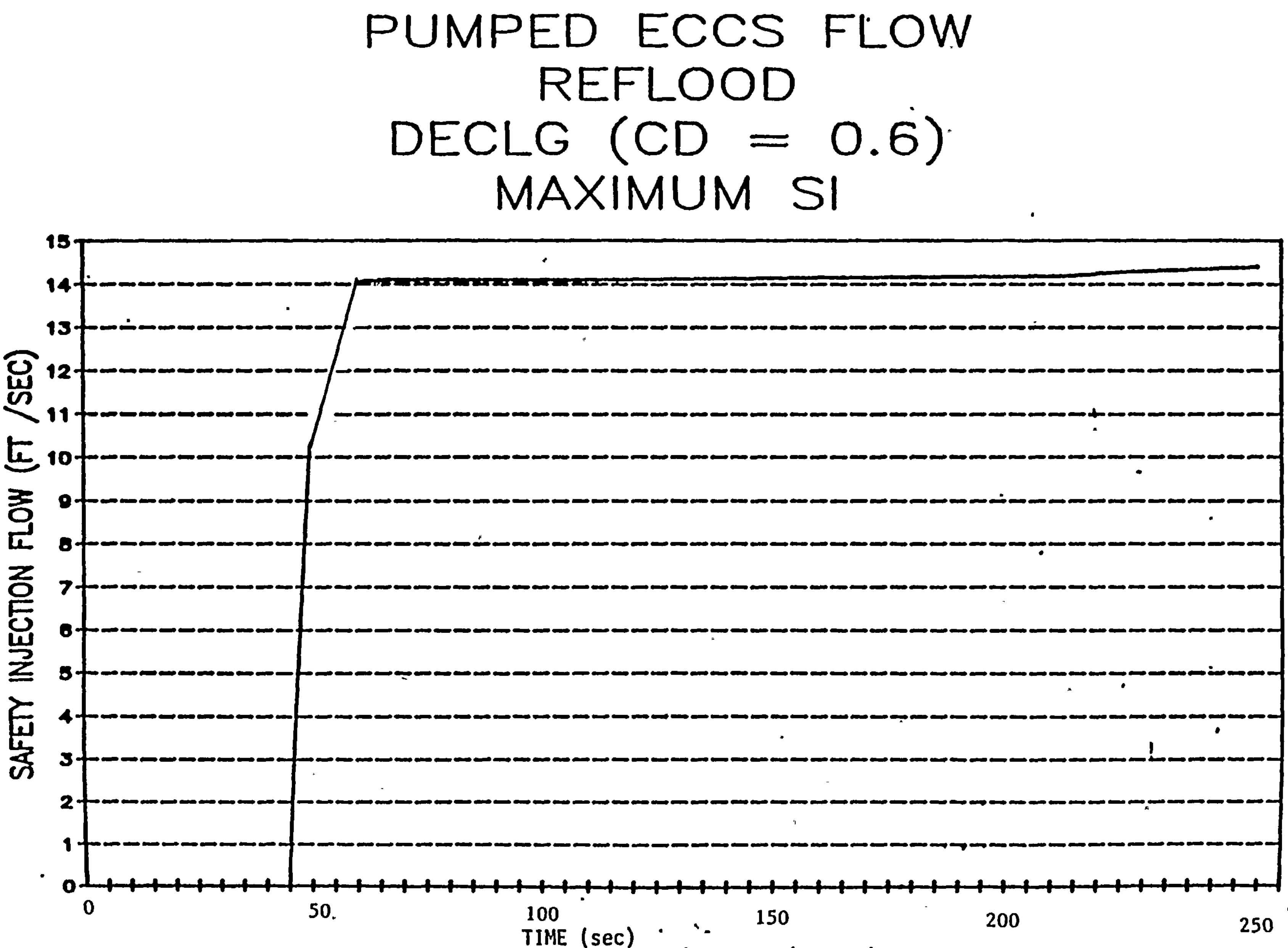

FIGURE 14.D-48 PUMPED ECCS FLOW (REFLOOD) DECLG (C_D=0.6) MAX SI

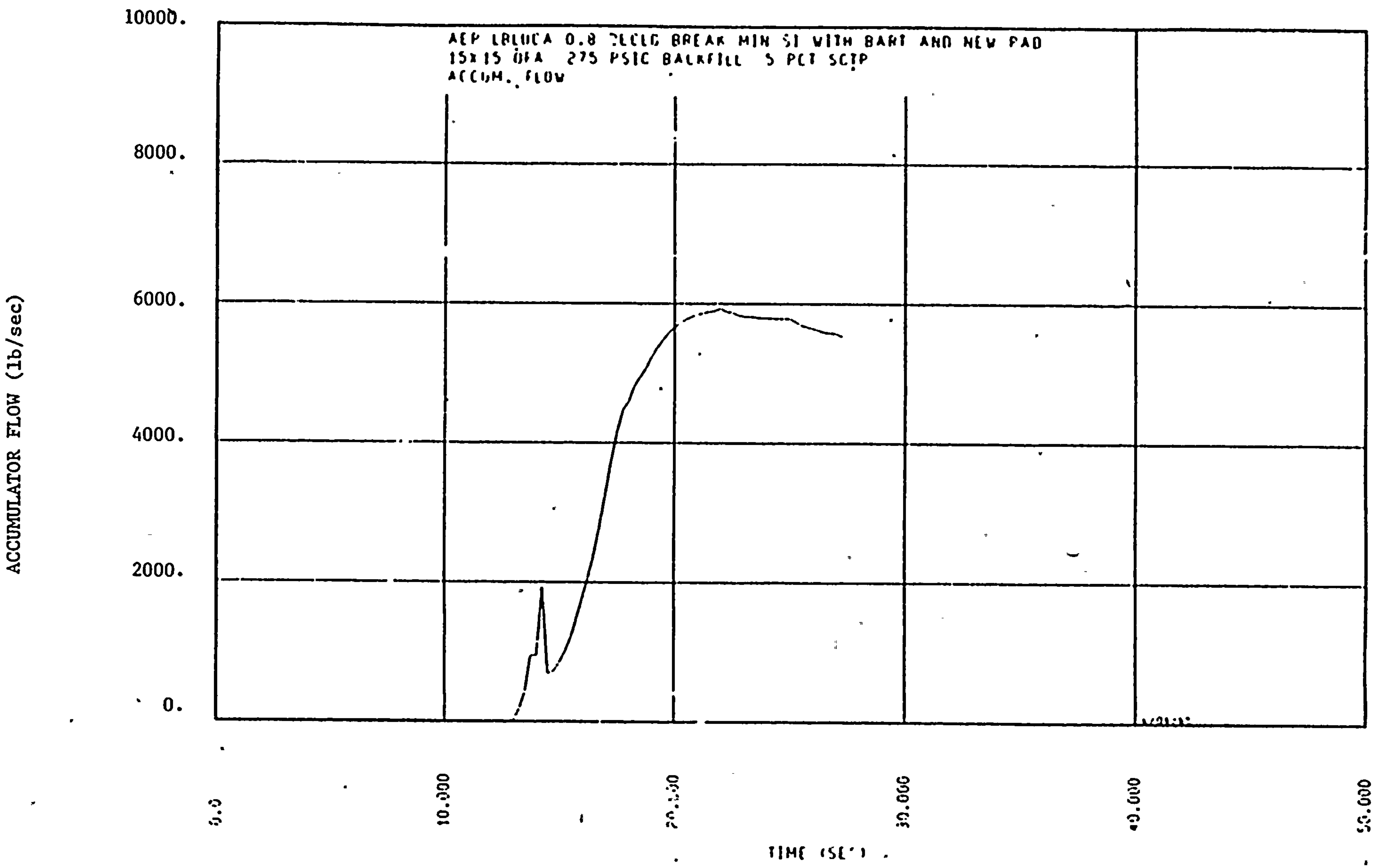

FIGURE 14.D -49 ACCUMULATOR FLOW (BLOWDOWN)
DECLG (C_D=0.8) MIN SI

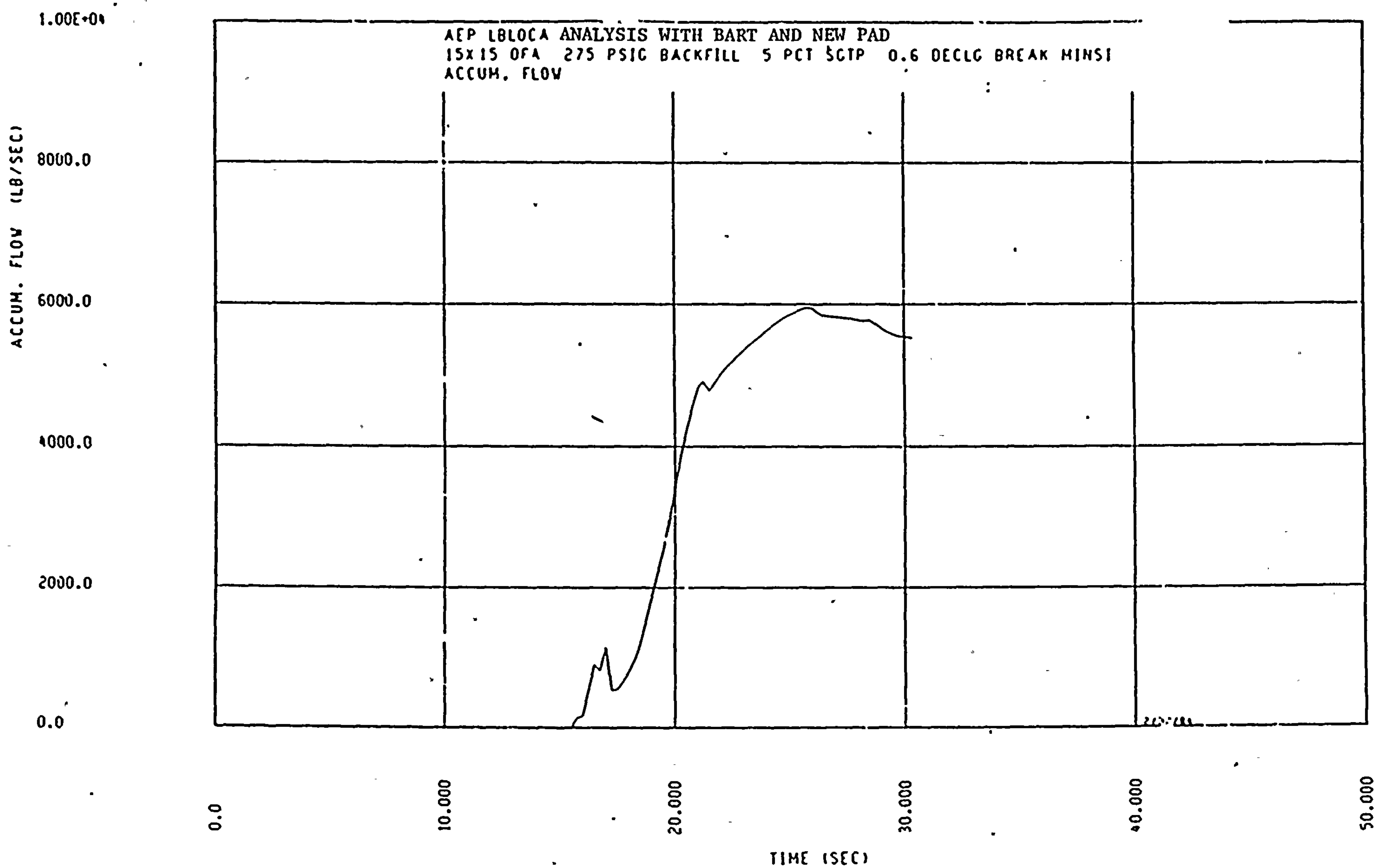

FIGURE 14.D -50 ACCUMULATOR FLOW (BLOWDOWN)
DECLG (C_D=0.6) MIN SI

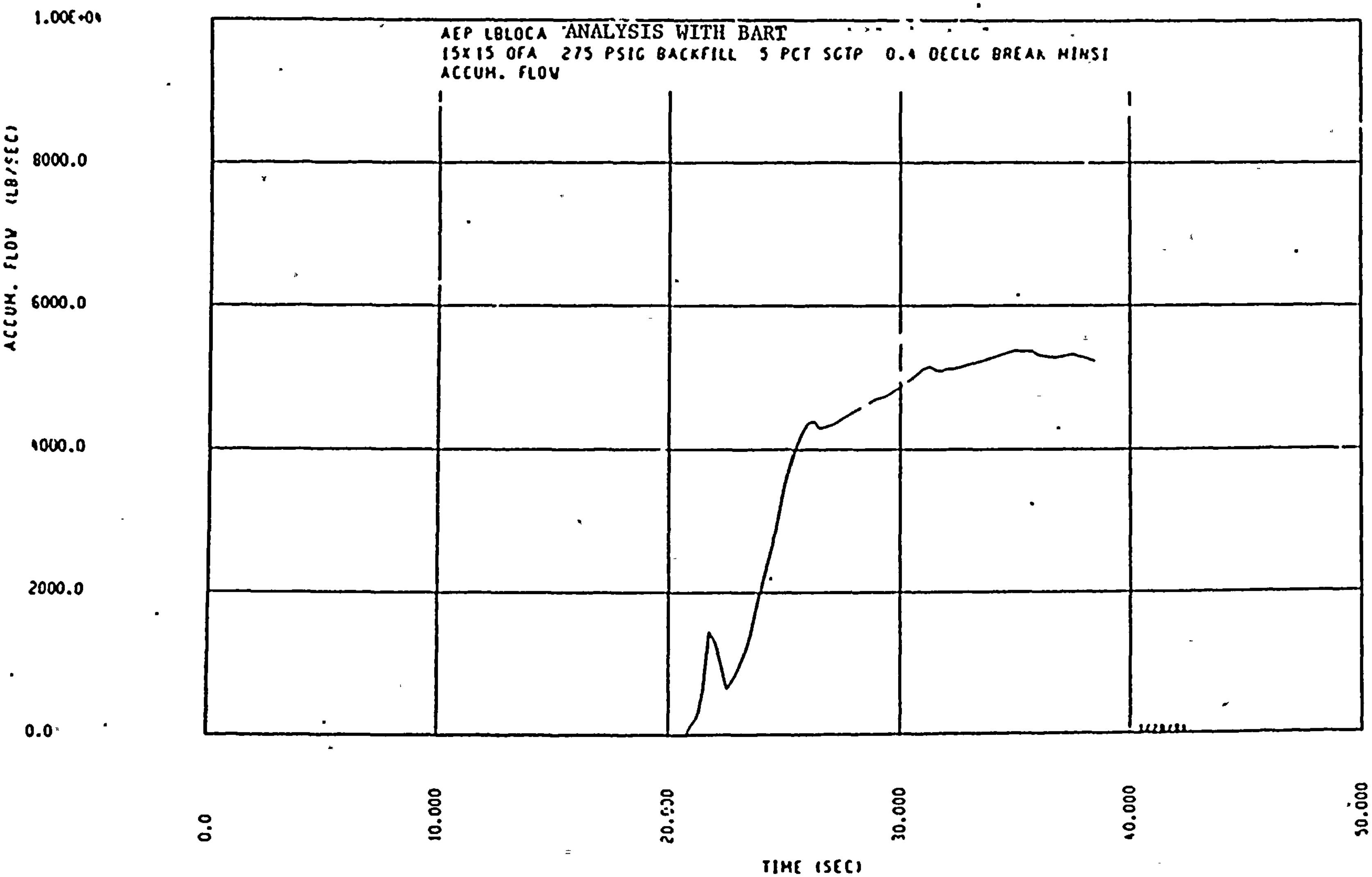

FIGURE 14.D -51 ACCUMULATOR FLOW (BLOWDOWN)
DECLG (C_D=0.4) MIN SI

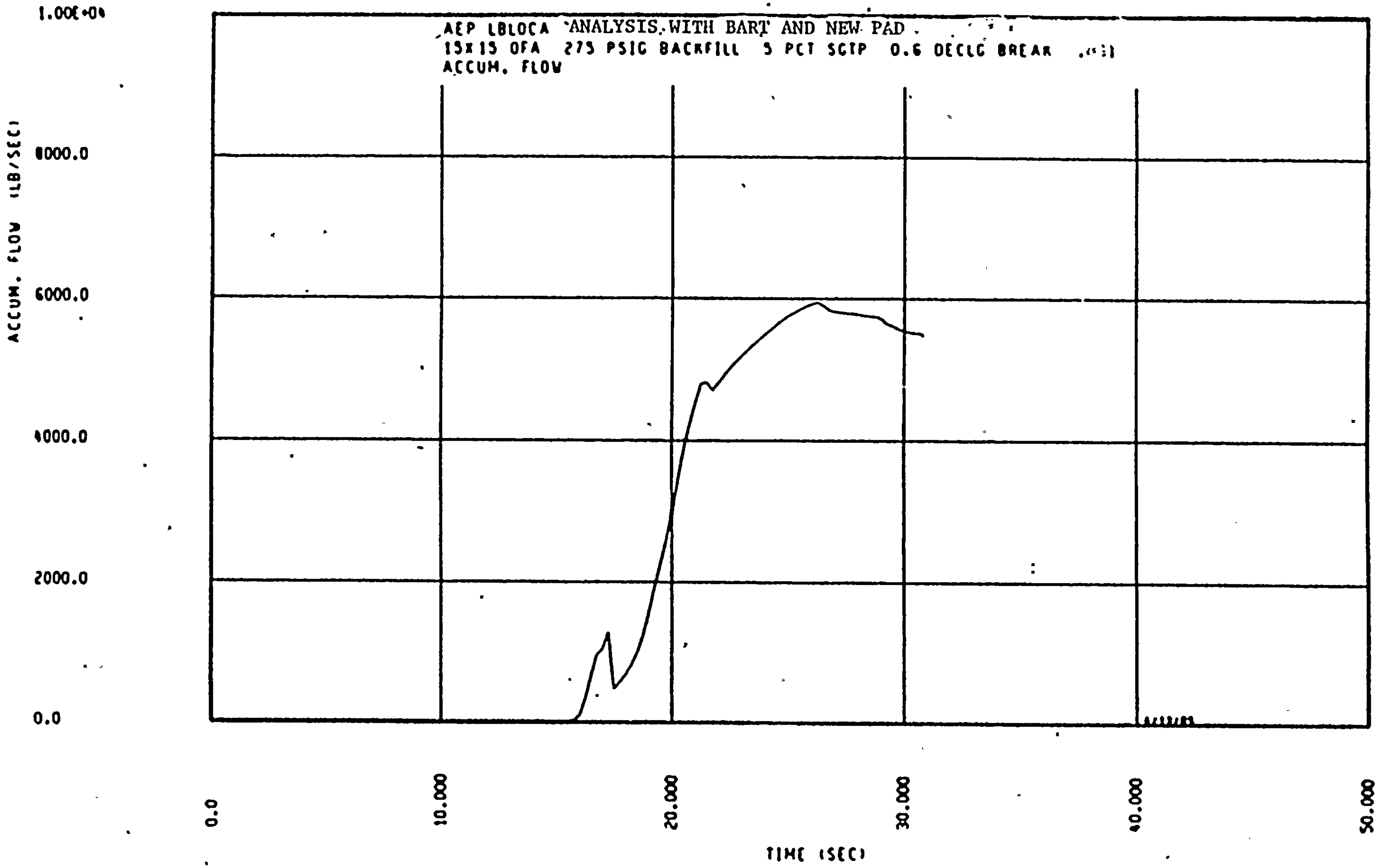

FIGURE 14.D -52 ACCUMULATOR FLOW (BLOWDOWN)
DECLG (C_D= 0.6) MAX SI

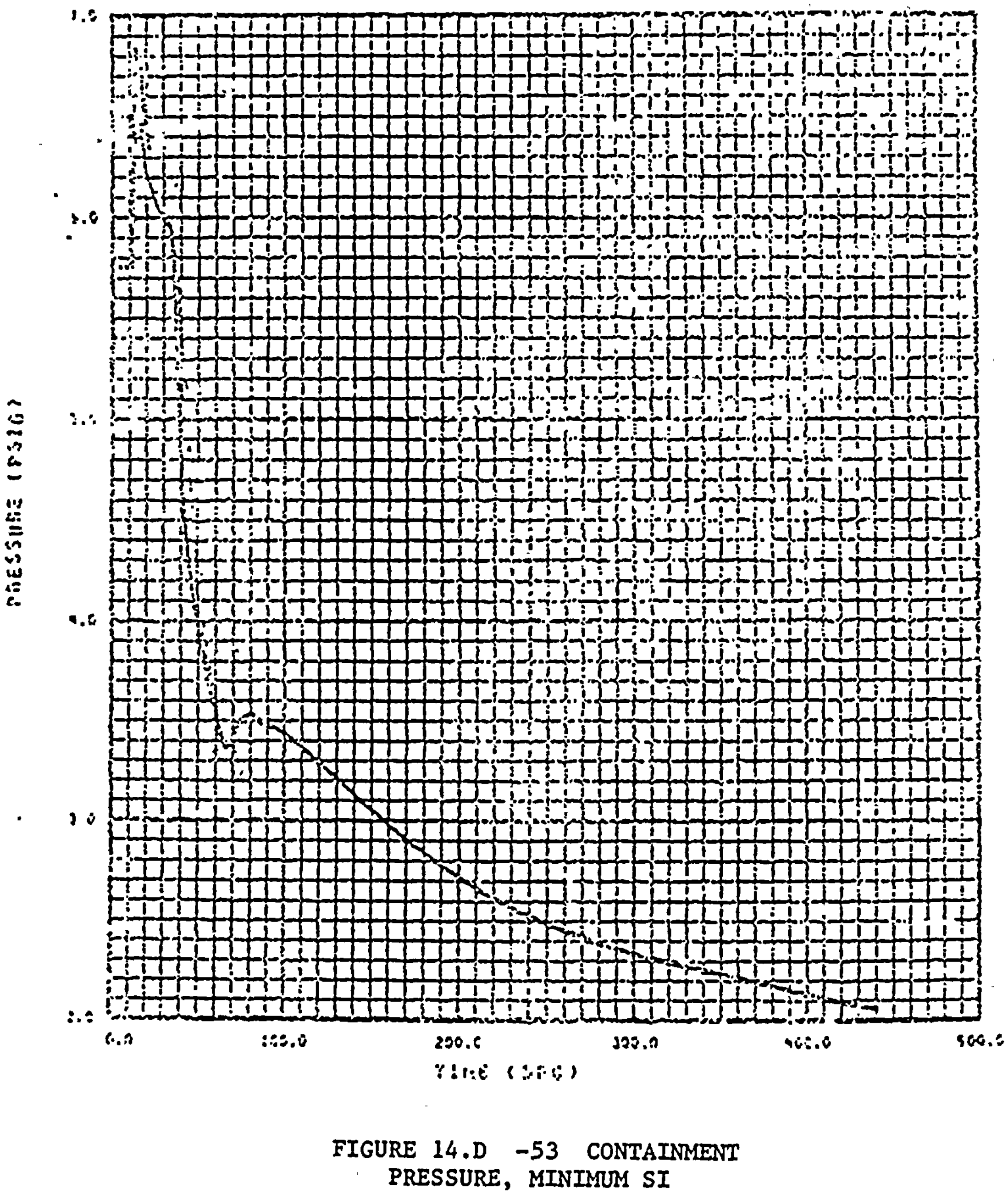

FIGURE 14.D -53 CONTAINMENT
PRESSURE, MINIMUM SI

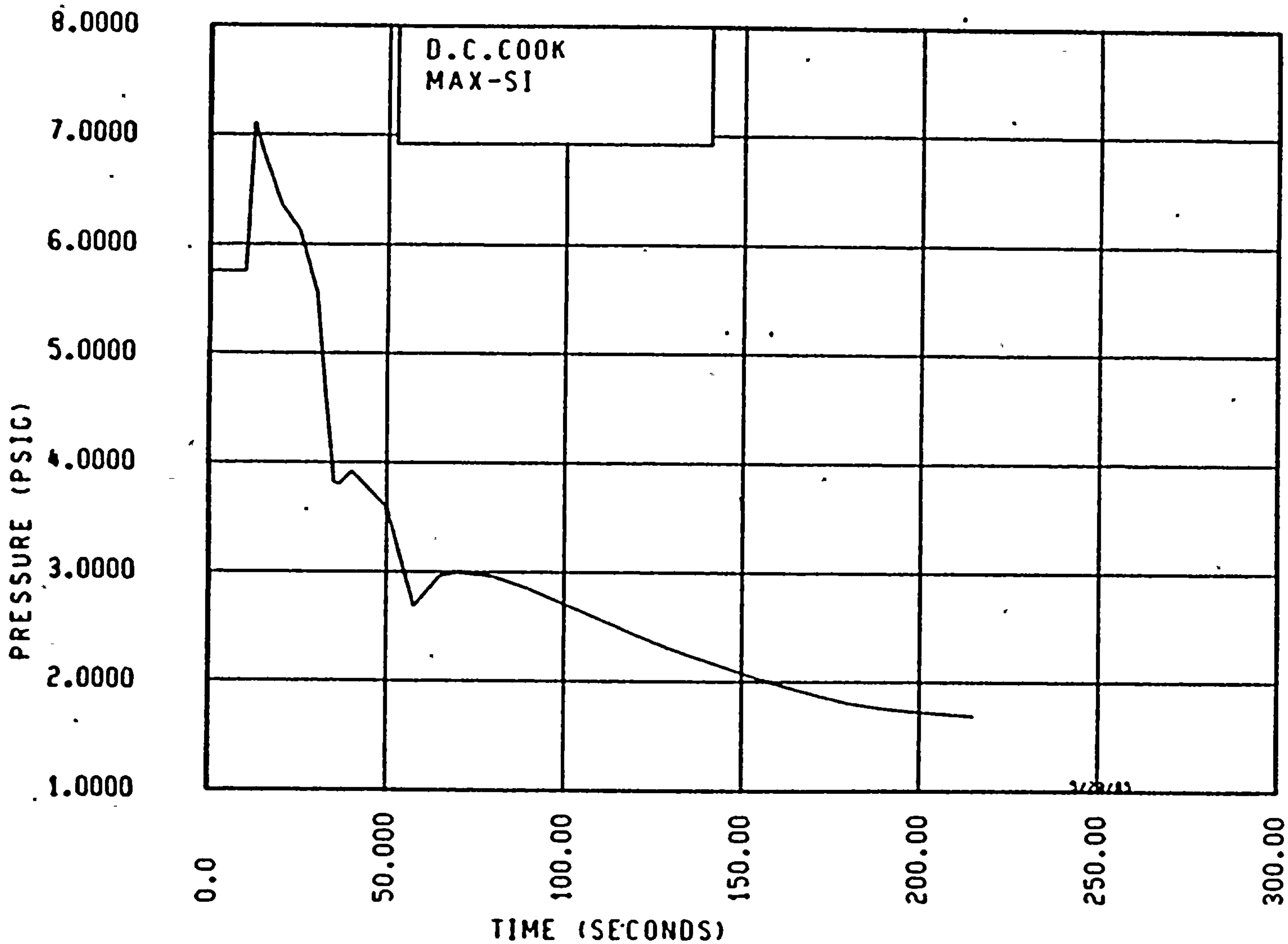

FIGURE 14.D -54 CONTAINMENT
PRESSURE, MAXIMUM SI

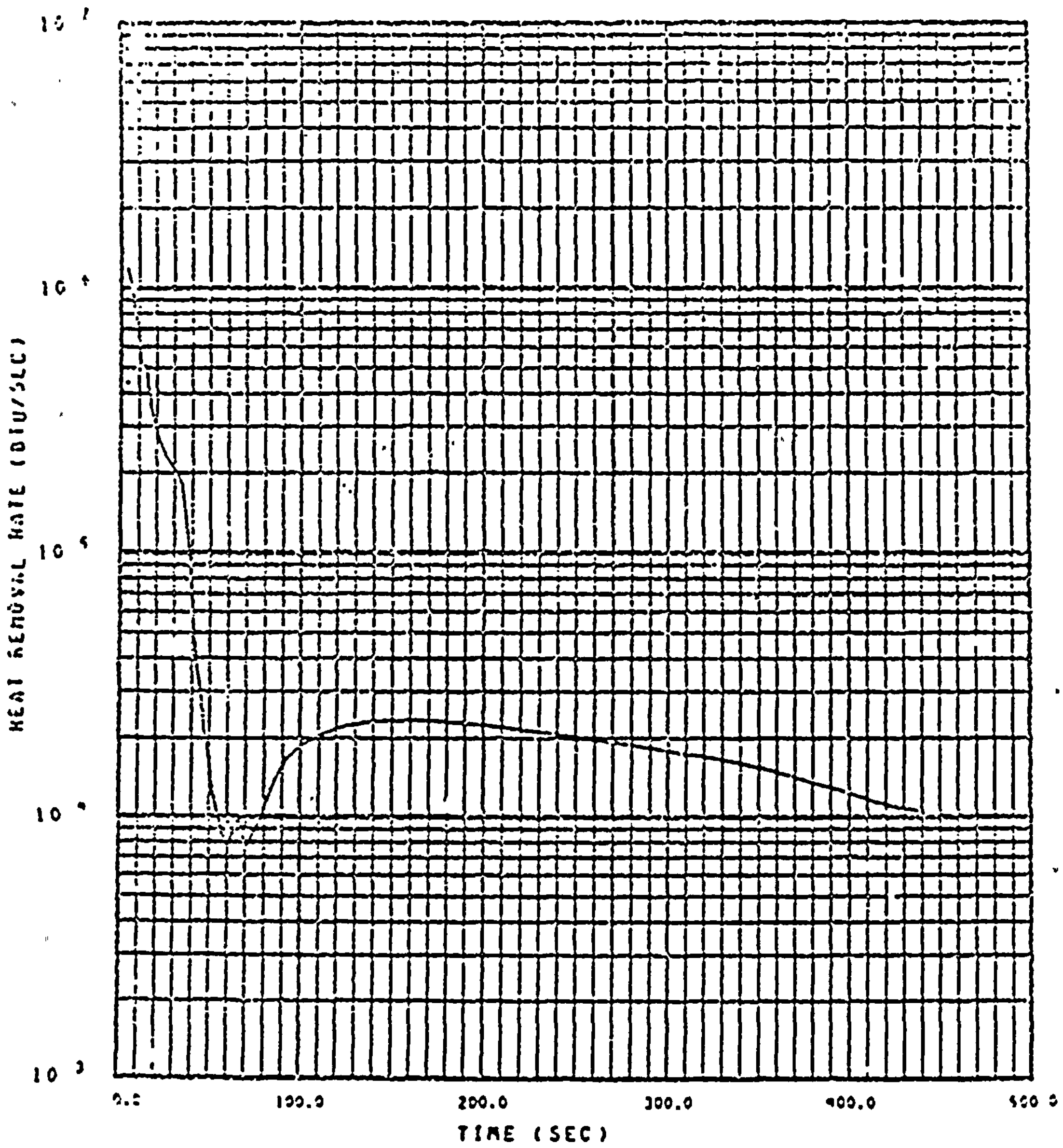

FIGURE 14.D -55 LOWER COMPARTMENT
STRUCTURAL HEAT REMOVAL RATE,
MINIMUM SI

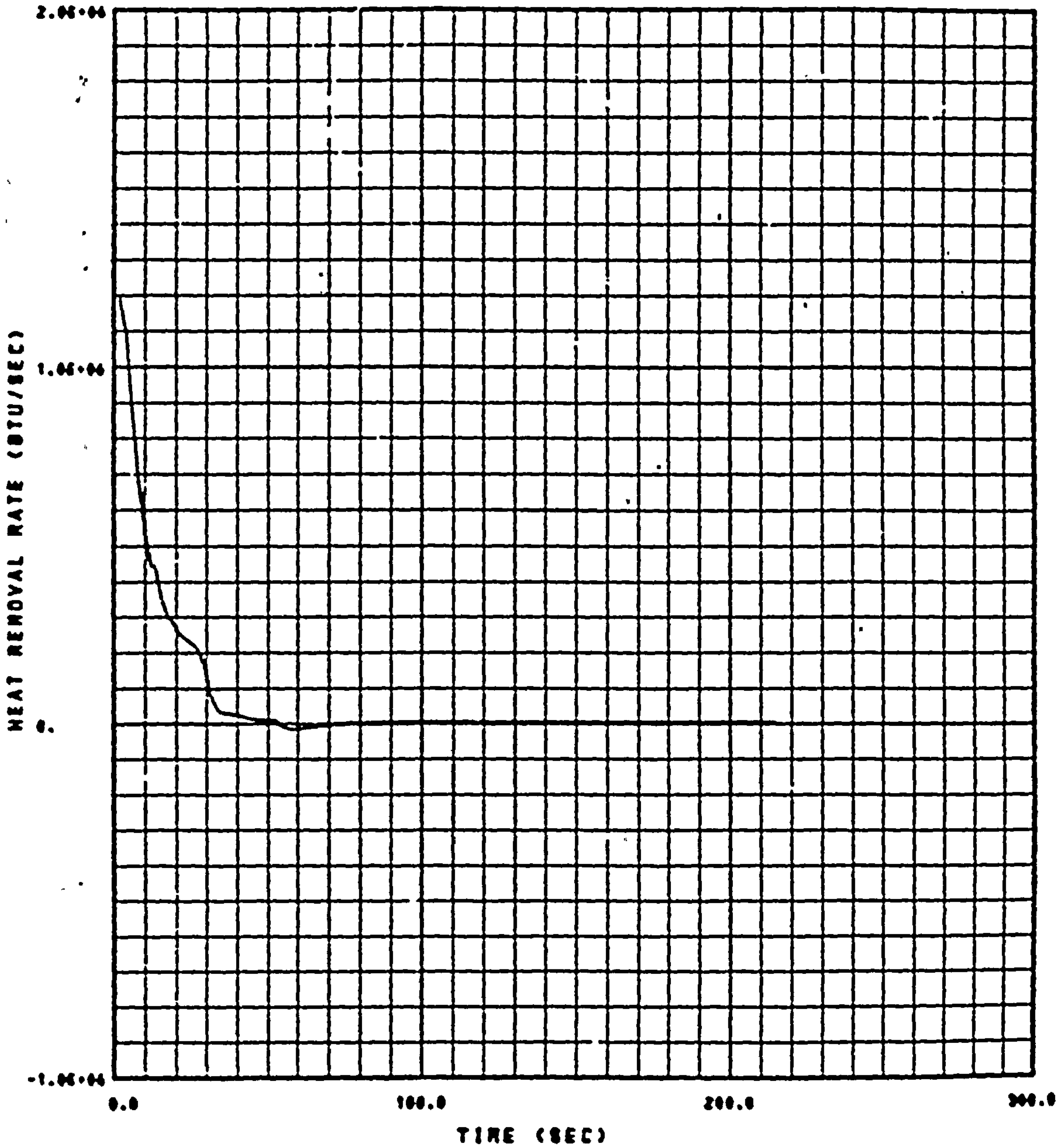

FIGURE 14.D" -56 LOWER COMPARTMENT STRUCTURAL HEAT REMOVAL RATE
MAXIMUM SI

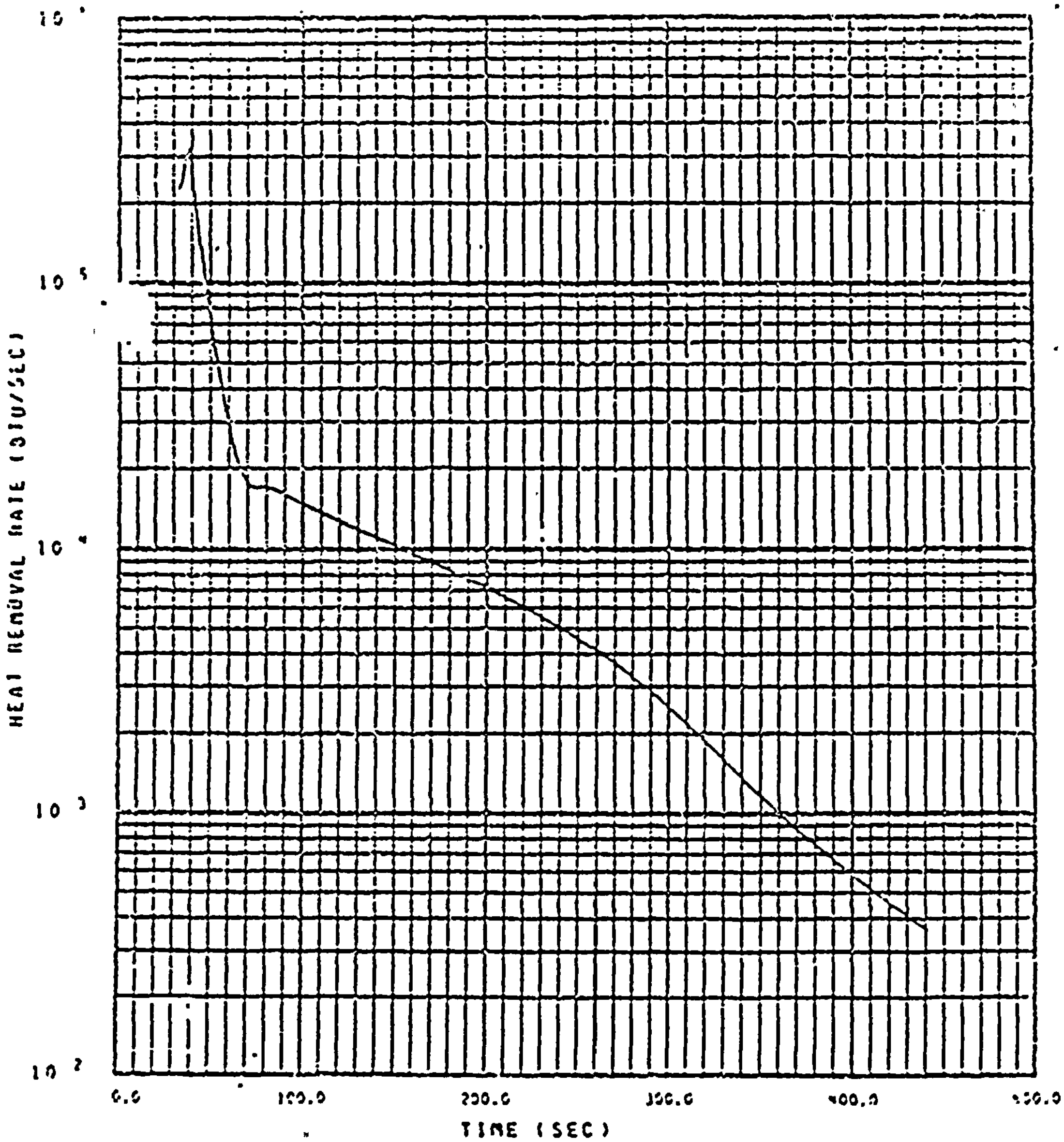

FIGURE 14.D -57 HEAT REMOVAL BY
LC DRAIN
MINIMUM SI

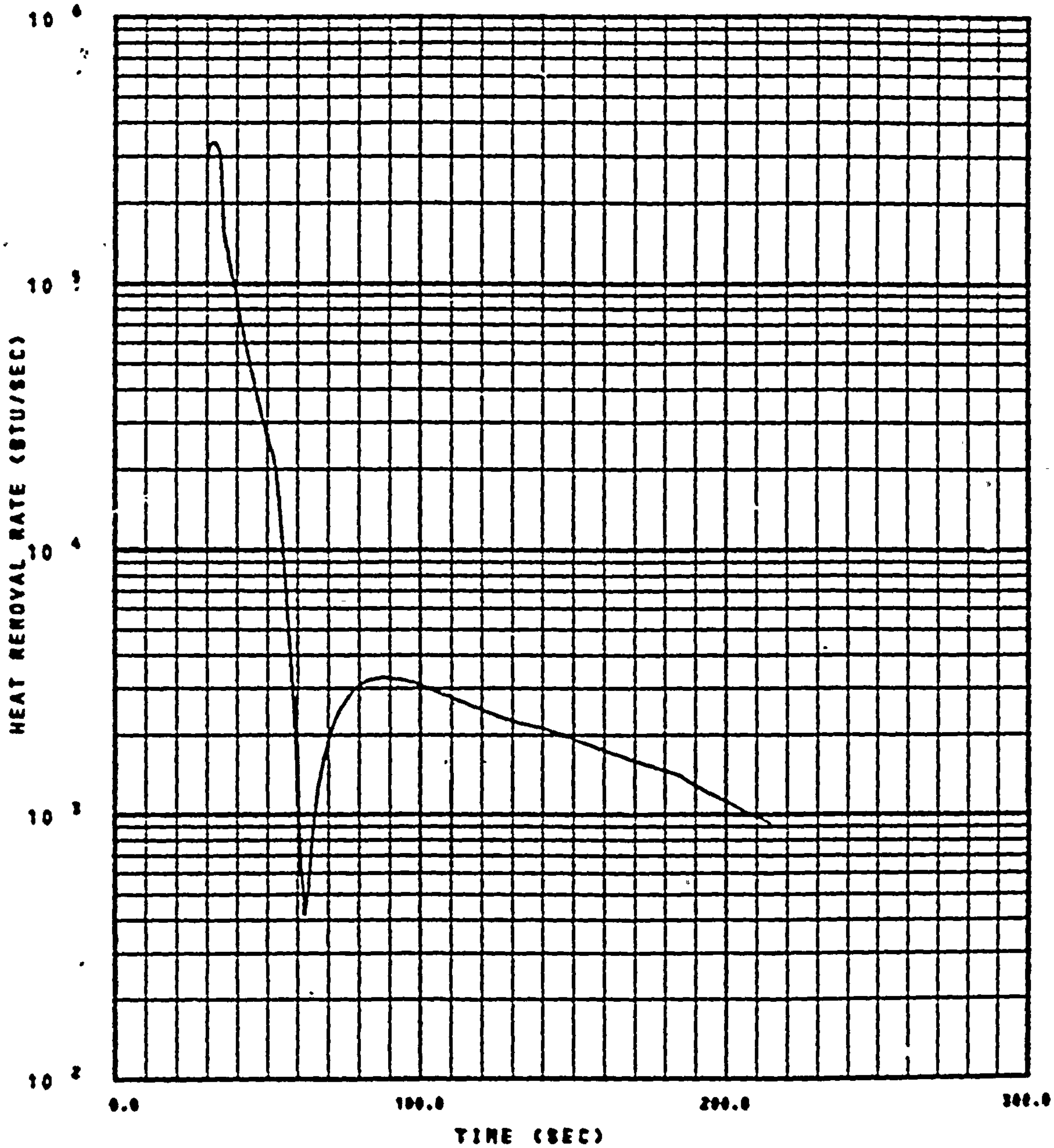

FIGURE 14.D -58 HEAT REMOVAL BY LC DRAIN

MAXIMUM SI

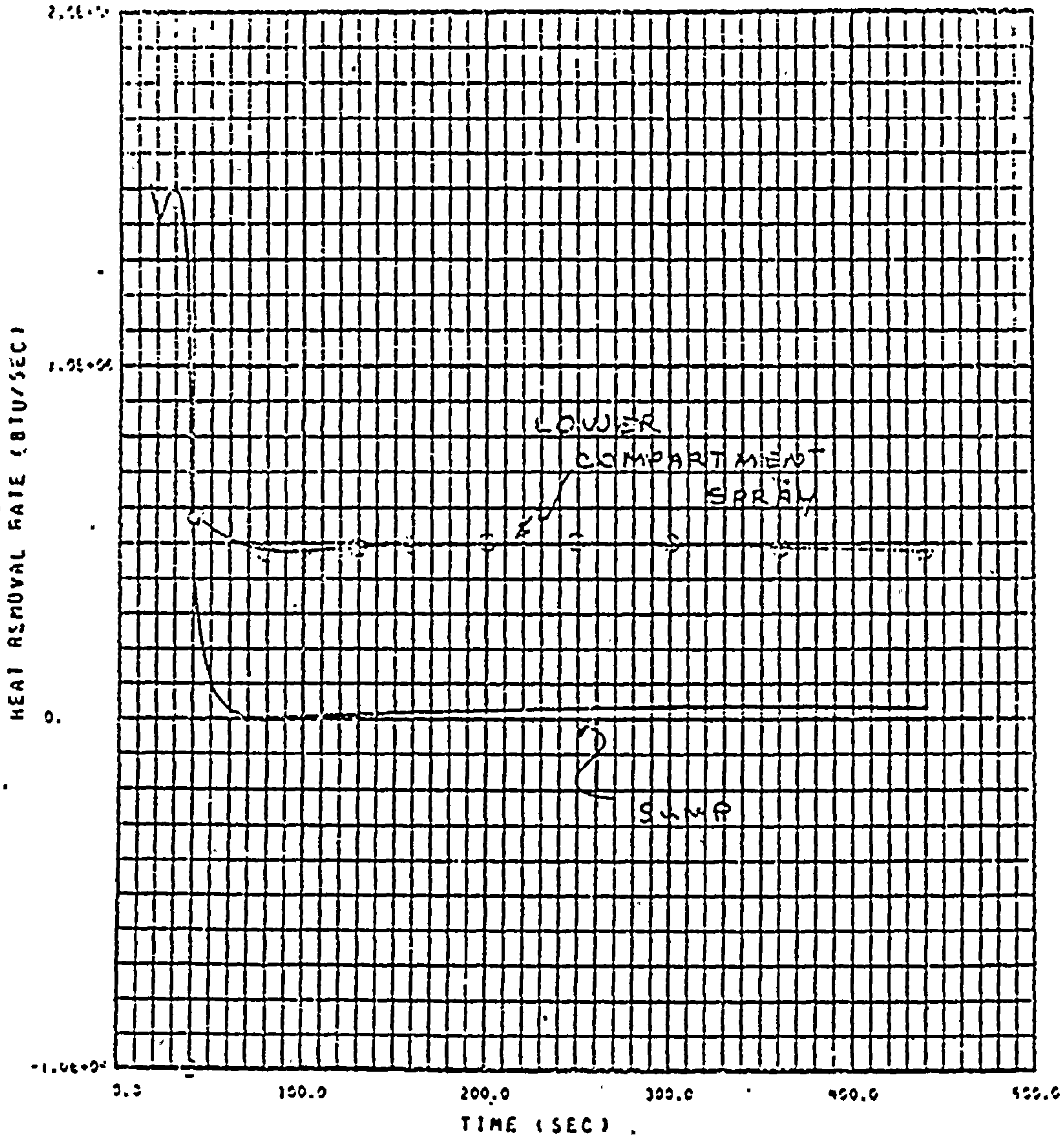

FIGURE 14.D -59 HEAT REMOVAL BY
SUMP AND LC SPRAY
MINIMUM SI

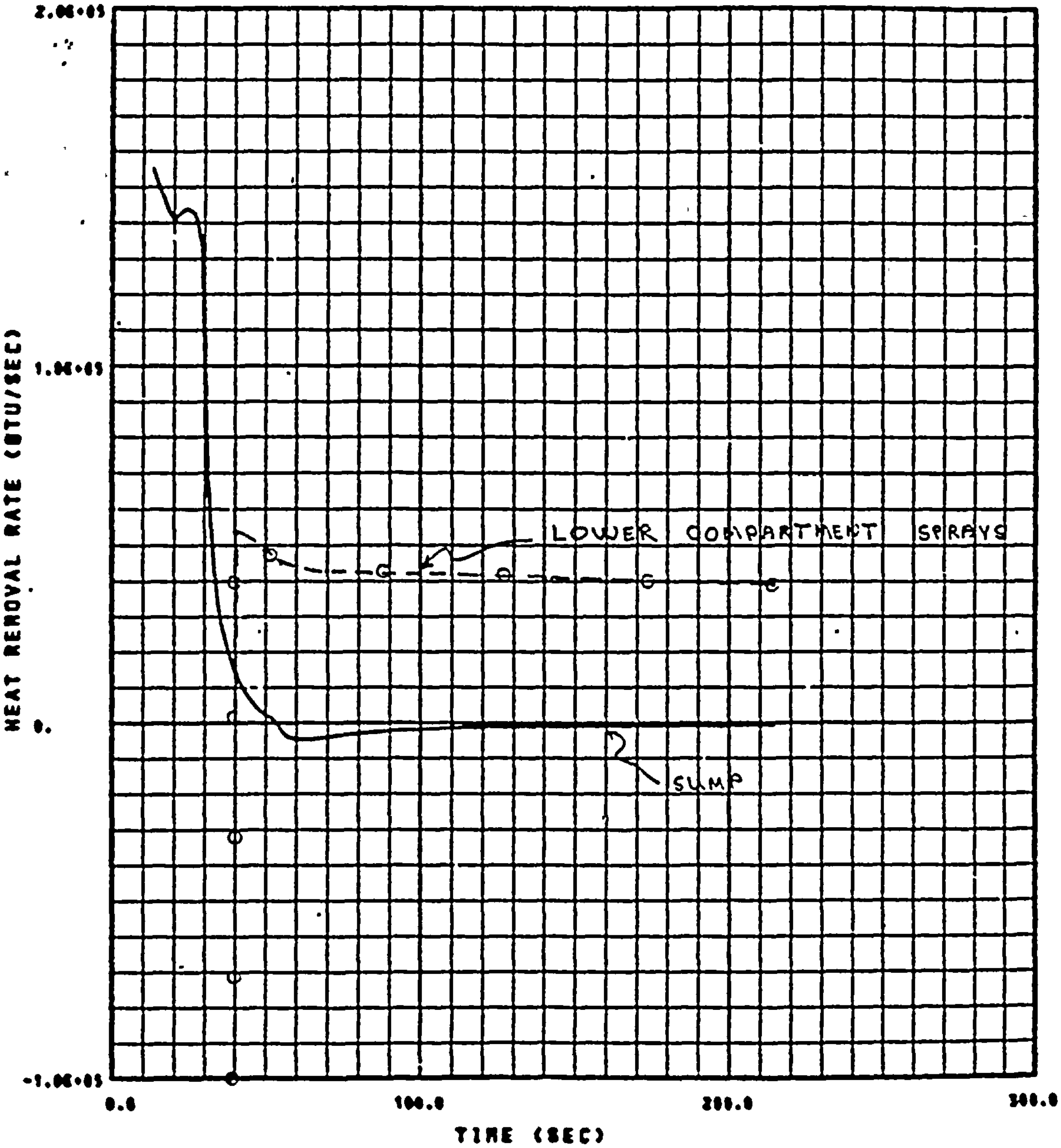

FIGURE 14.D -60 HEAT REMOVAL BY
SUMP AND LC SPRAY
MAXIMUM SI

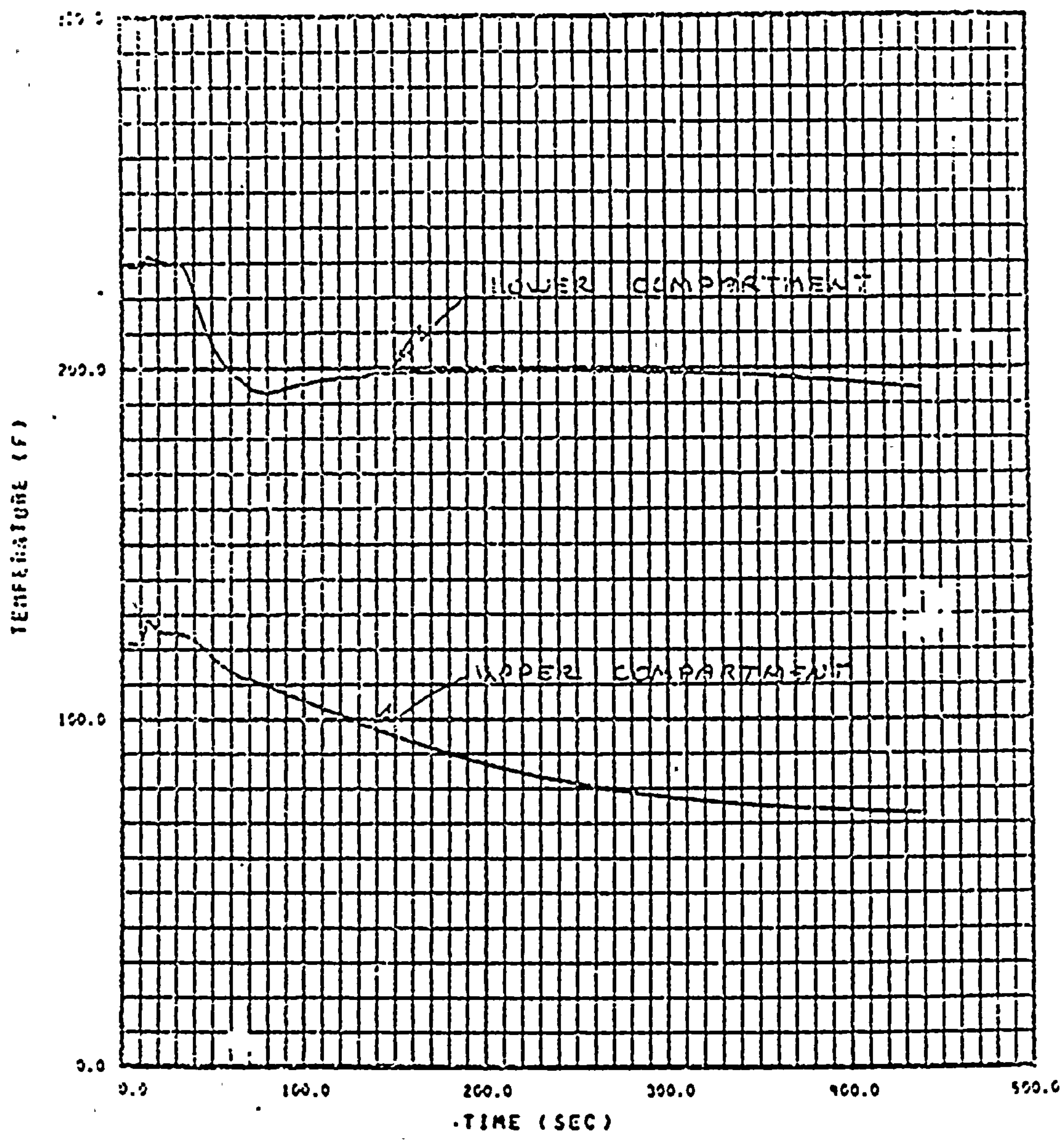

FIGURE 14.D .-61 COMPARTMENT
TEMPERATURE,
MINIMUM SI

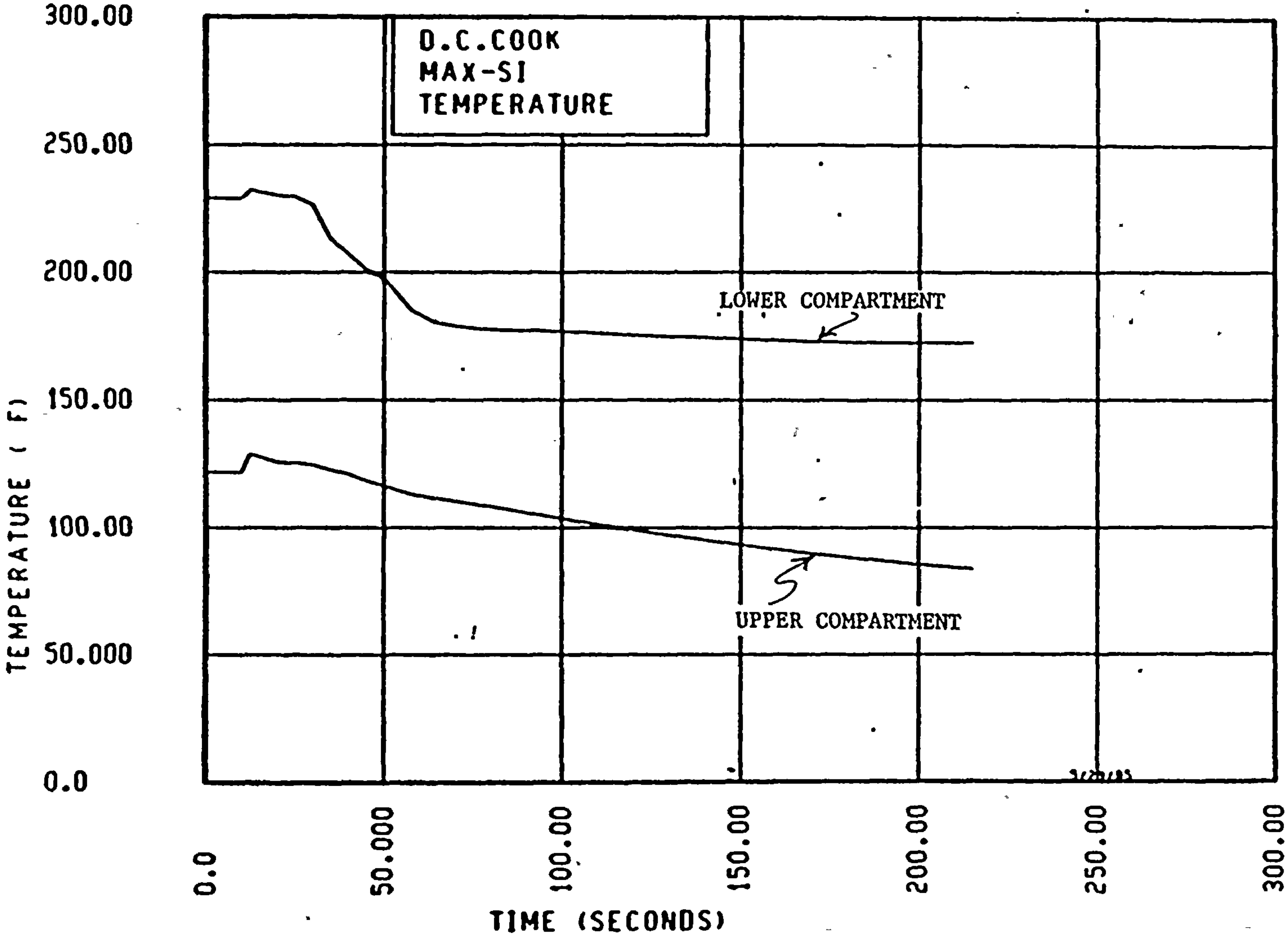

FIGURE 14.D -62 COMPARTMENT
TEMPERATURE,
MAXIMUM SI

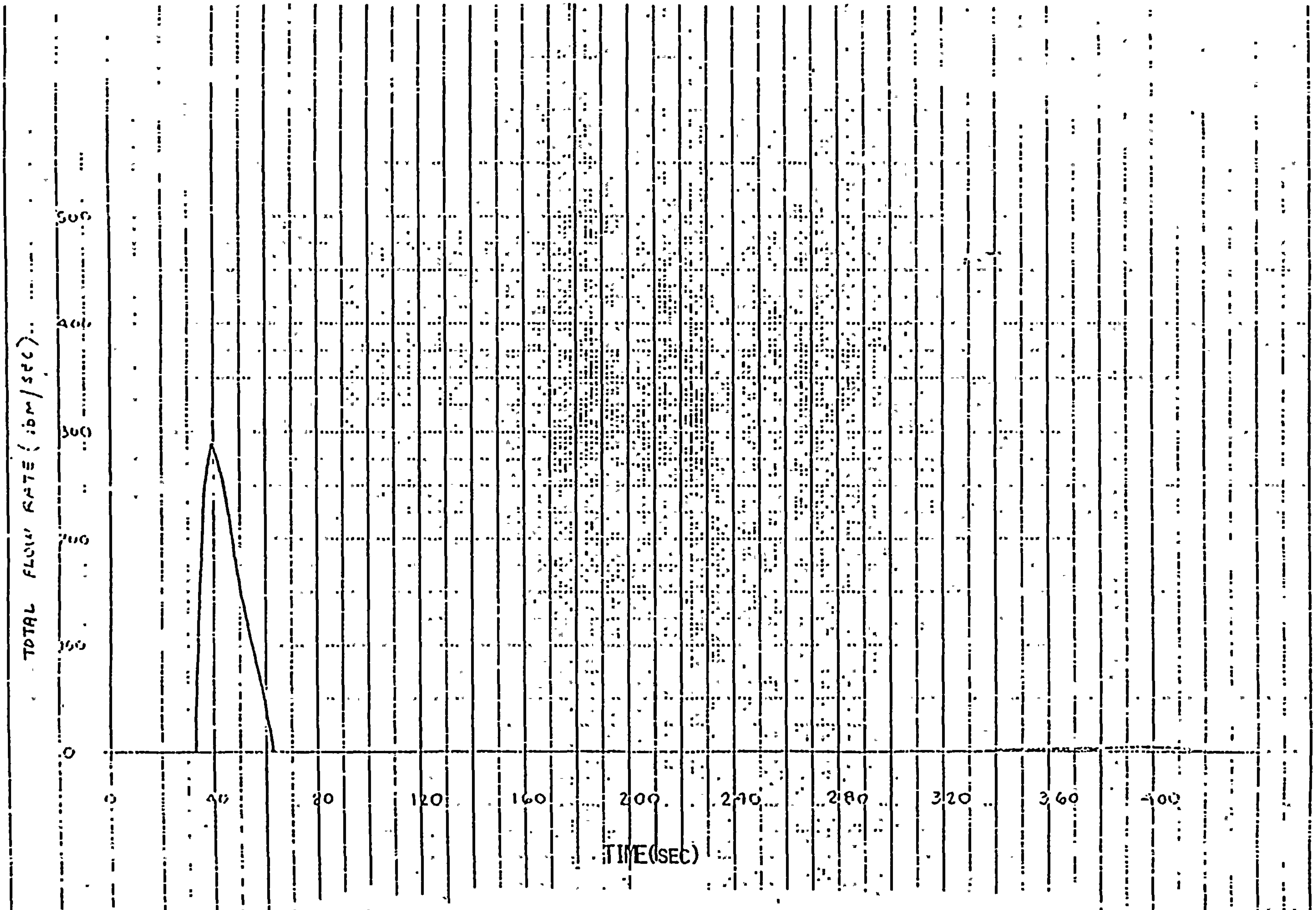

FIGURE 14.D. -63 FLOW FROM UPPER TO LOWER COMPARTMENT

MINIMUM ST

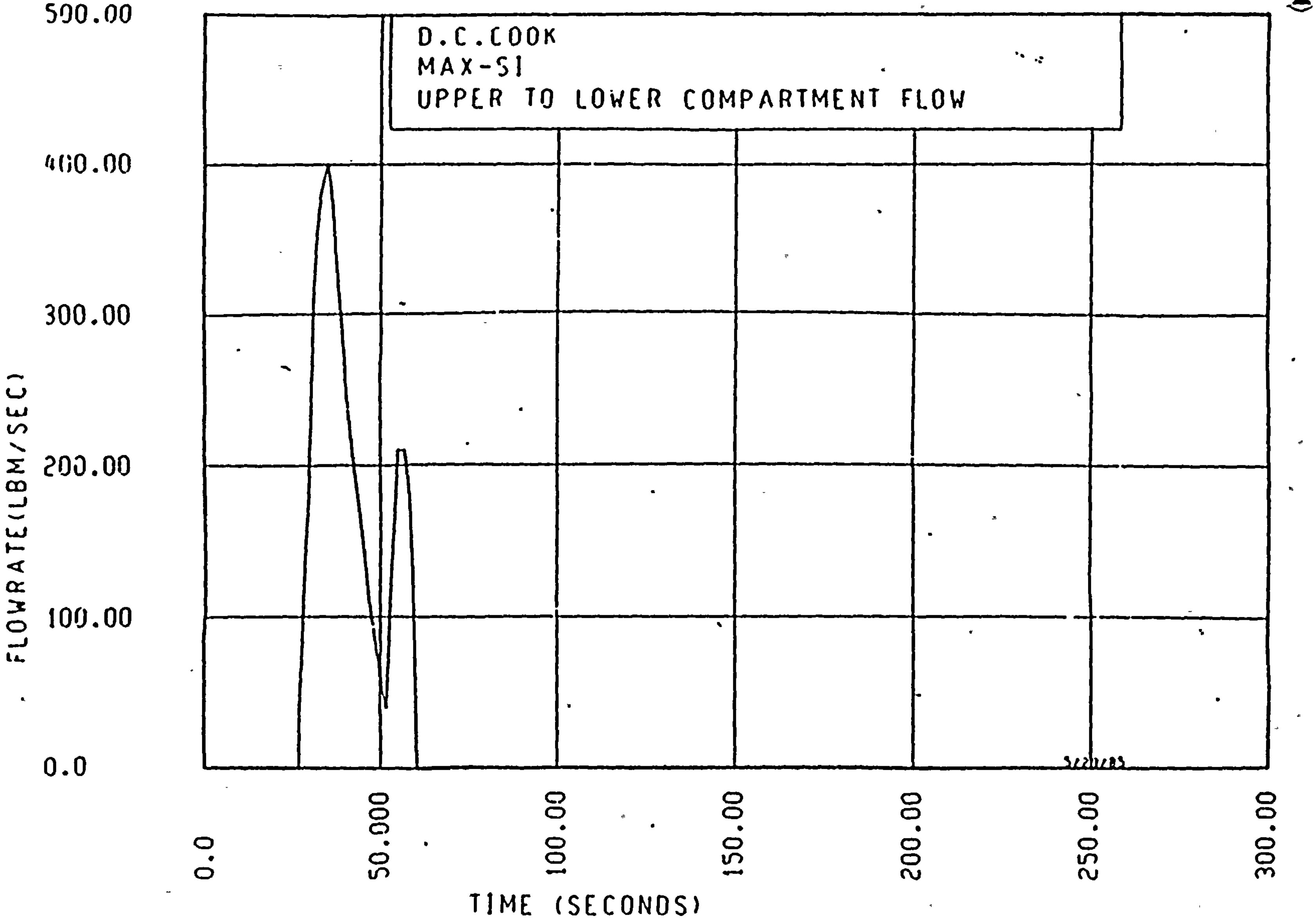

FIGURE 14.D -64 FLOW FROM UPPER
TO LOWER COMPARTMENT