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SUBJECT: Forwards fire protection safe shutdown analysis per 821207 telcon discussion.Analysis utilizes automatic depressurization sys & RHR Loop B not RCIC & Loop B to achieve shutdown.Specific FSAR revs being prepared.

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[illegible] Licensing Branch 2

SUBJECT: Forwards fire protection safe shutdown analysis per [illegible] telcon discussion. Analysis utilizes automatic depressurization sys & RHR Loop B not HPCS & Loop [illegible] to achieve shutdown. Specific [illegible] revs being pre areas.

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March 21, 1983
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NS-L-02-PLP-83-018

Docket No. 50-397

Director of Nuclear Reactor Regulation
Attention: Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Schwencer:

Subject: NUCLEAR PROJECT NO. 2
FIRE PROTECTION SAFE SHUTDOWN ANALYSIS (ATTACHED)

As discussed during a phone conversation on December 7, 1982, between Messrs. R. Auluck, J. Ridgely, and D. Kubicki of the NRC and R. Nelson, A. Kupinski, R. Vosburgh, E. Fredenburg, D. Evans, and D. Bush of the Supply System, the subject analysis is provided. Specific revisions to the FSAR and Fire Protection Evaluation Report reflecting this analysis are presently being prepared. In summary, the attached analysis utilizes ADS and RHR Loop B to achieve safe shutdown instead of a high pressure system (RCIC) and RHR Loop B as previously intended.

Should you have any questions, please contact Mr. R. M. Nelson, Manager, WNP-2 Licensing.

Very truly yours,

G. D. Bouchey

G. D. Bouchey
Manager, Nuclear Safety and Regulatory Programs

PLP/jca
Attachment

cc: R Auluck - NRC
WS Chin - BPA
D Kubicki - NRC
J Ridgely - NRC
A Toth - NRC Site

B002

1.0 Introduction

The purpose of this document is to provide the basis for compliance with Section III, Paragraph G of Appendix R, "Fire Protection of Safe Shutdown Capability" utilizing a revised dedicated shutdown path. The applicable FSAR sections and the Fire Protection Evaluation report will be revised to reflect this mode of shutdown cooling.

The revised shutdown path utilizes the ADS plus RHRB as a dedicated system to achieve safe shutdown instead of a high pressure system (RCIC) plus RHRB as currently documented in the FSAR. The enclosed analysis demonstrates compliance with Section III, paragraph G of Appendix R to fulfill safe shutdown requirements based on analyses documented in NEDO-24708A, "Additional Information Required for NRC Staff Generic Report on Boiling Water Reactors," vol. 1 and 2. Revision 1 of NEDO 24708A was provided to the NRC to include BWRs not included in the original document.

2.0 Summary and Conclusion

Appendix R requires that a fire must be considered with a simultaneous loss of off-site power which, in turn, dictates that safe shutdown be accomplished by systems utilizing the suppression pool for reactor depressurization. In the WNP-2 Fire Protection Evaluation Report, safe shutdown was accomplished utilizing a high pressure system for core cooling from event initiation to hot shutdown and a dedicated low pressure system (RHRB) in the shutdown cooling mode from hot to cold shutdown. The mode of depressurization used in the following analysis is based on a rapid depressurization (ADS) in going from event initiation directly to cold shutdown where a dedicated low pressure system (RHRB) is utilized in the alternate shutdown cooling mode.

The analyses demonstrate that peak clad temperatures remain well below any safety limit and the suppression pool temperature limits are not exceeded. The fuel clad temperature and water level response is determined from analyses presented in NEDO 24708A. The peak fuel-clad temperature will not significantly exceed saturation temperature, although water level momentarily drops below the top of the core. The suppression pool temperature response remains below safety limits as inferred from several sources, including A GE sensitivity study performed for this situation.

3.0 Discussion and Analysis

3.1 Method

3.1.1 General-Safe Shutdown Path Selection

A single fire is postulated to occur in only one fire area. The WNP-2 Fire Hazards Analysis uses a combination of the Fire Area Method and the Dedicated Shutdown Method. It utilized the Dedicated Shutdown Approach

3.0 Discussion and Analysis (Cont.)

3.1 Method (Cont.)

3.1.1 General-Safe Shutdown Path Selection (Cont.)

where safe shutdown systems are in one fire area without provisions for separation in accordance with Appendix R and the Fire Area Method where safe shutdown equipment is located in redundent fire areas.

In accordance with Appendix R requirements, loss of offsite power is assumed simultaneously with a fire. The primary impact of this assumption is the closure of the MSIVs immediately upon loss of the grid, thereby, eliminating the main condenser as the heat sink. Therefore, the flow path selection for reactor depressurization must utilize the suppression pool as a heat sink.

As demonstrated in the following sections, an acceptable shutdown cooling path is to depressurize rapidly from event initiation to cold shutdown conditions. This mode of shutdown utilized the ADS plus RHR Loop B and associated service water for the Loop B heat exchanger. Specific equipment requirements will be provided following revisions to the FSAR and Fire Protection Evaluation Report.

3.2 Reactor Response

A catastrophic fire of sufficient magnitude to result in loss of all high pressure injection capability, i.e., HPCS, RCIC, CRD, and Feedwater, is an extremely low probability event. However, scenarios of this type have been analyzed for different initiating events by the General Electric Co. in NEDO 24708A. By providing thermal barrier protection for the ADS and RHR Loop B Systems, WNP-2 assures that core cooling is maintained and the scenario of a fire plus loss of offsite power is bounded by the analysis provided in the NEDO 24708A.

The loss of offsite power and loss of normal feedwater assumptions assure that an immediate reactor scram occurs. The negative reactivity available due to control and safety rod injection upon scram will maintain subcriticality from event initiation to cold shutdown. Vessel isolation occurs as the water level decreases and no high pressure make-up systems are available. Upon isolation, the vessel pressure increases resulting in the safety relief valve opening and discharging steam to the pool. The water level continues to decrease due to steaming through the safety relief valves. The conditions facing the operator at this time can, therefore, be summarized as: A loss of offsite power, reactor scram and vessel isolation, steaming through the safety relief valves increasing suppression pool temperature, vessel water level decreasing, no high pressure makeup systems responding, and very high secondary containment temperatures due to the fire.

3.0 Discussion and Analysis (Cont.)

3.2 Reactor Response (Cont.)

According to WNP-2 Emergency Operating Procedures, manual ADS will be accomplished by the operator upon recognition of the following conditions:

- Low water level in the vessel, or
- Suppression pool temperature reaches 120° F, or
- High temperature exists in two or more areas of the secondary containment.

Therefore, adequate indication is immediately available for the operator to initiate ADS. However, assuming the operator waits until the vessel water level drops to near the top of the active core region, NEDO 24708A (see figure 3.5.2.1-12.1 through 12.8, reproduced here as figures 1 through 8) shows top of core uncovery is brief and fuel temperature never exceeds normal operating temperatures. Greater than 10 minutes exists for the operator to manually initiate ADS, prior to the level falling below the top of the active core.

Although Figures 1 through 8 were analyzed for a BWR 4, a straight forward mass energy balance analysis for WNP-2 indicates the time available before the water level drops to the top of the active core is also 1150 seconds. As noted throughout the NEDO report, the analysis was done in a generic fashion where possible and for this scenario, BWR 4s and 5s respond similarly. The transient depicted in Figures 1 through 8 are for a very small liquid break (.001 $ft.^2$) which does not alter the sequence timing significantly for the fire protection scenario.

3.3 Suppression Pool Response

The containment suppression pool temperature response is expected to remain below 196° F during this type of transient. Several studies exist which validate this conclusion. The containment suppression pool transient analysis (FSAR Appendix G Ref. 3.1-7) contains an analysis of reactor isolation/scram with only one RHR available. The peak suppression pool temperature for this case was 196° F (Figure 9).

A sensitivity study has been performed by the General Electric Company (GE) for the Supply System on peak suppression pool temperature as a function of the important input assumptions and parameters. The results of this analysis are presented in Table 1.

The worst case assumption that could potentially increase peak suppression pool temperature is a 20% reduction of heat exchanger effectiveness with a long delay in closing the RHR heat exchanger bypass valve. Although some heat exchanger effectiveness decrease is expected with the reduced flow due to circulation through the ADS valves, it is not expected

3.0 Discussion and Analysis (Cont.)

3.3 Suppression Pool Response

to be 20% (10%-15% maximum). However, even the most conservative potential increase would be offset by any one of the following realistic assumptions: A 5° F decrease in both the initial pool temperature and service water temperature, rapid vessel depressurization instead of a controlled cool down, or a realistic decay heat assumption. The analyses in NEDO 24708A are based upon a realistic decay heat. Furthermore, the flow of coolant to the pool through the safety relief valves and quenchers would be liquid long before a peak pool temperature would be reached and, therefore, no unstable steam condensation problems would be encountered.

3.4 Long-Term Response

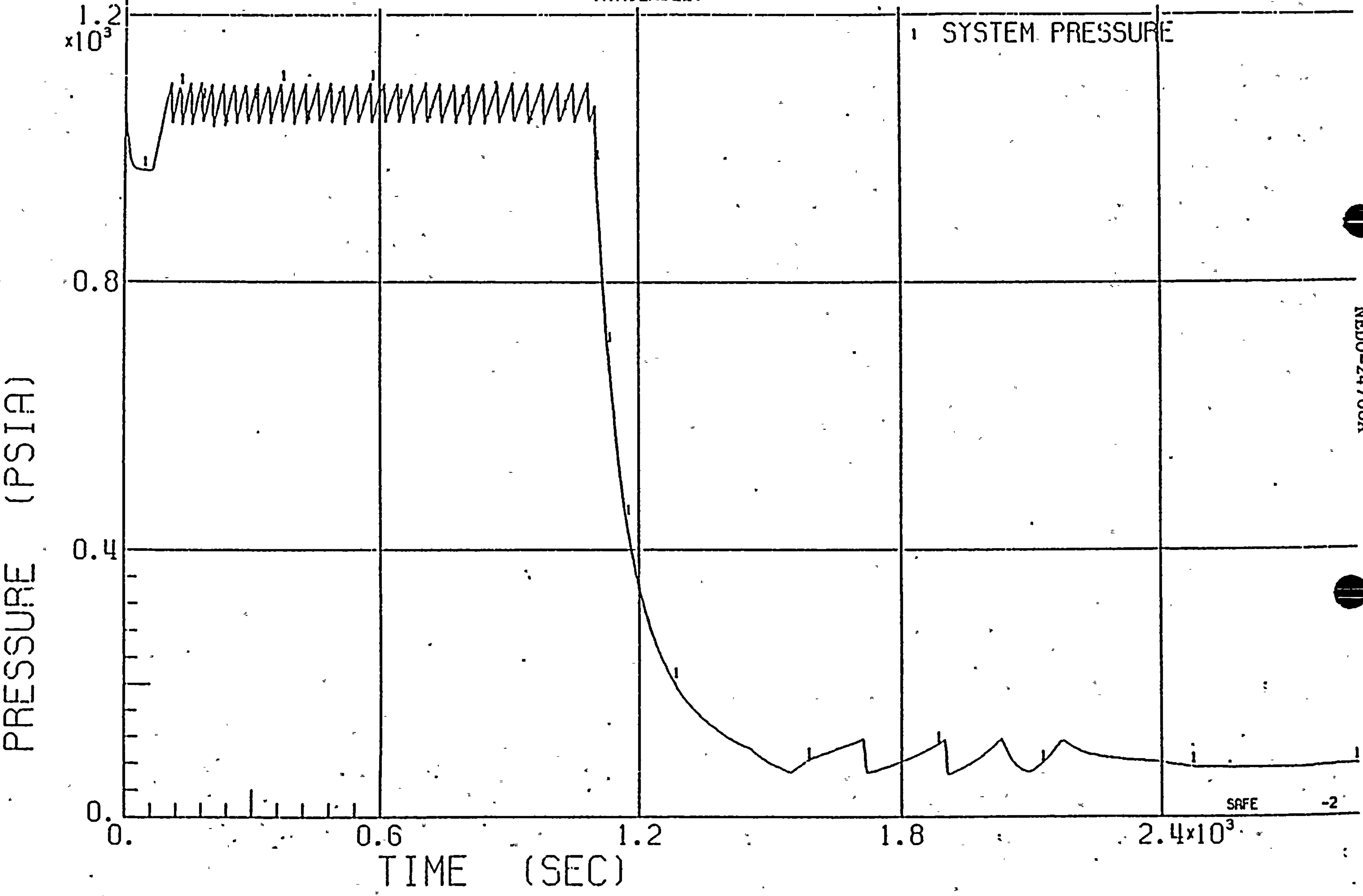
As demonstrated in the previous sections, the alternate shutdown cooling mode provides sufficient cooling capability to remove decay heat and maintain the suppression pool temperature below limits. Therefore, the operator may wish to remain in this cooling mode until offsite power is restored, additional equipment becomes available, etc. However, by approximately 300 minutes, the level decrease would be slow enough to permit the operator to switch over to the normal shutdown coding mode provided adequate valving is available. This switchover would terminate mass and energy additions to the suppression pool and increase the effectiveness of the RHR heat exchanger.

3.5 Process Monitoring and Operator Actions

Due to the catastrophic failures assumed for this scenario, the operator's mitigating actions and process monitoring needed to perform those actions become very basic. The minimum process variables required are reactor vessel water level, reactor vessel pressure, suppression pool temperature, and suppression pool water level. The operator would receive high temperature readings from the secondary containment areas; however, after initiation of the event, these indications are not required.

With the process variable information available, the operator must utilize the ADS for depressurization upon noting that water level continues to decrease below the high pressure systems actuation setpoints. The operator then closes the RHR heat exchanger bypass valves to initiate the "Alternate Shutdown" cooling mode. In the long term, the operator may choose to switch over from alternate shutdown cooling to recirculation shutdown cooling mode, if actuation of the outboard isolation valve on the recirculation line is available (not a Division II powered valve).

FIGURE 1---12.1 SYSTEM PRESSURE VS TIME FOR A 0.001 FT² SUCTION BREAK WITH ONE LPCI AVAILABLE.



BWR/4-218

FIGURE 2---12.2- WATER LEVEL VS TIME FOR A 0.001 FT² SUCTION BREAK WITH ONE LPCI AVAILABLE.

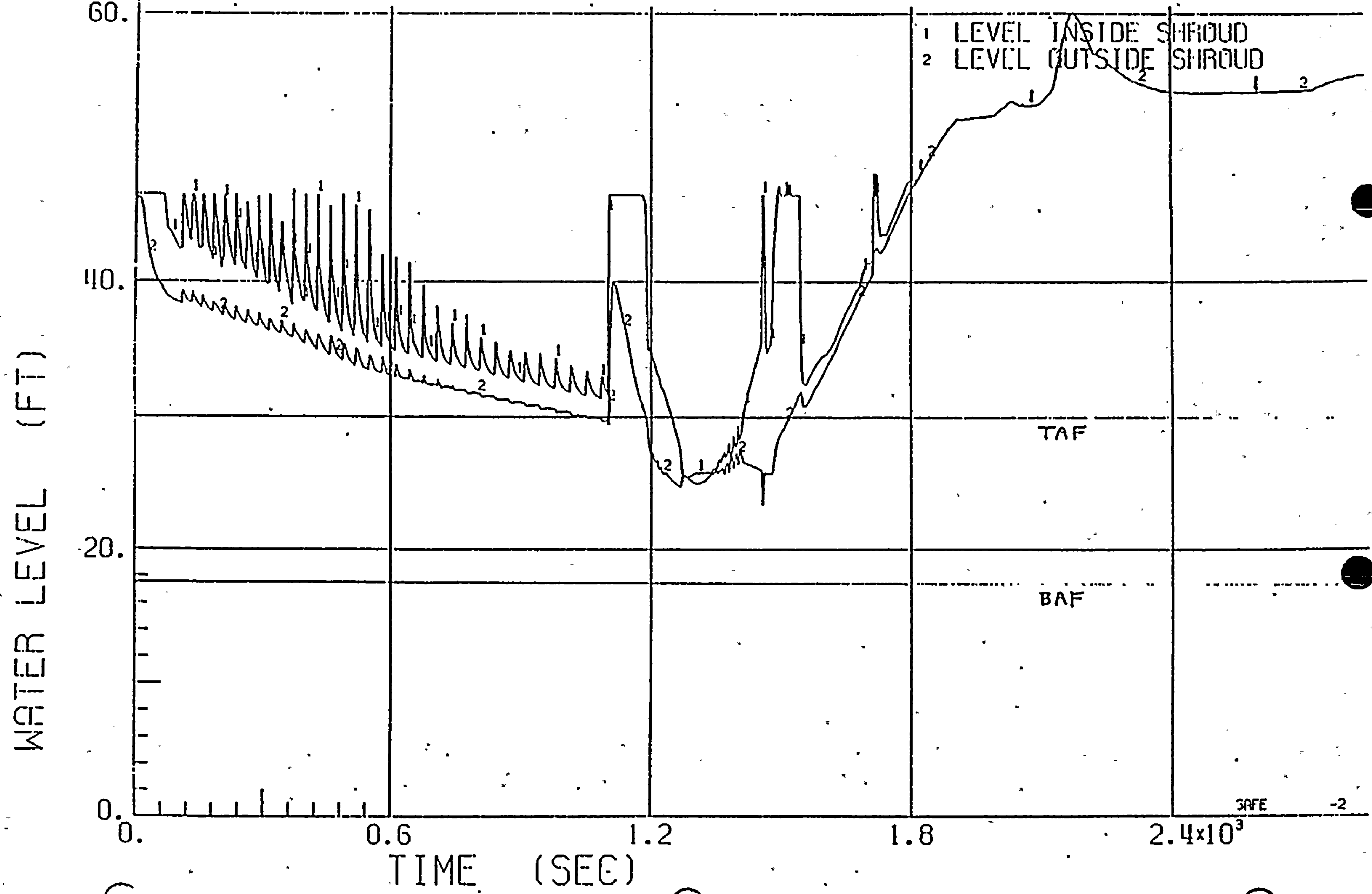


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FIGURE 3-12.3 SYSTEM FLOW RATES VS TIME FOR A 0.001 FT² SUCTION BREAK WITH ONE LPCI AVAILABLE.

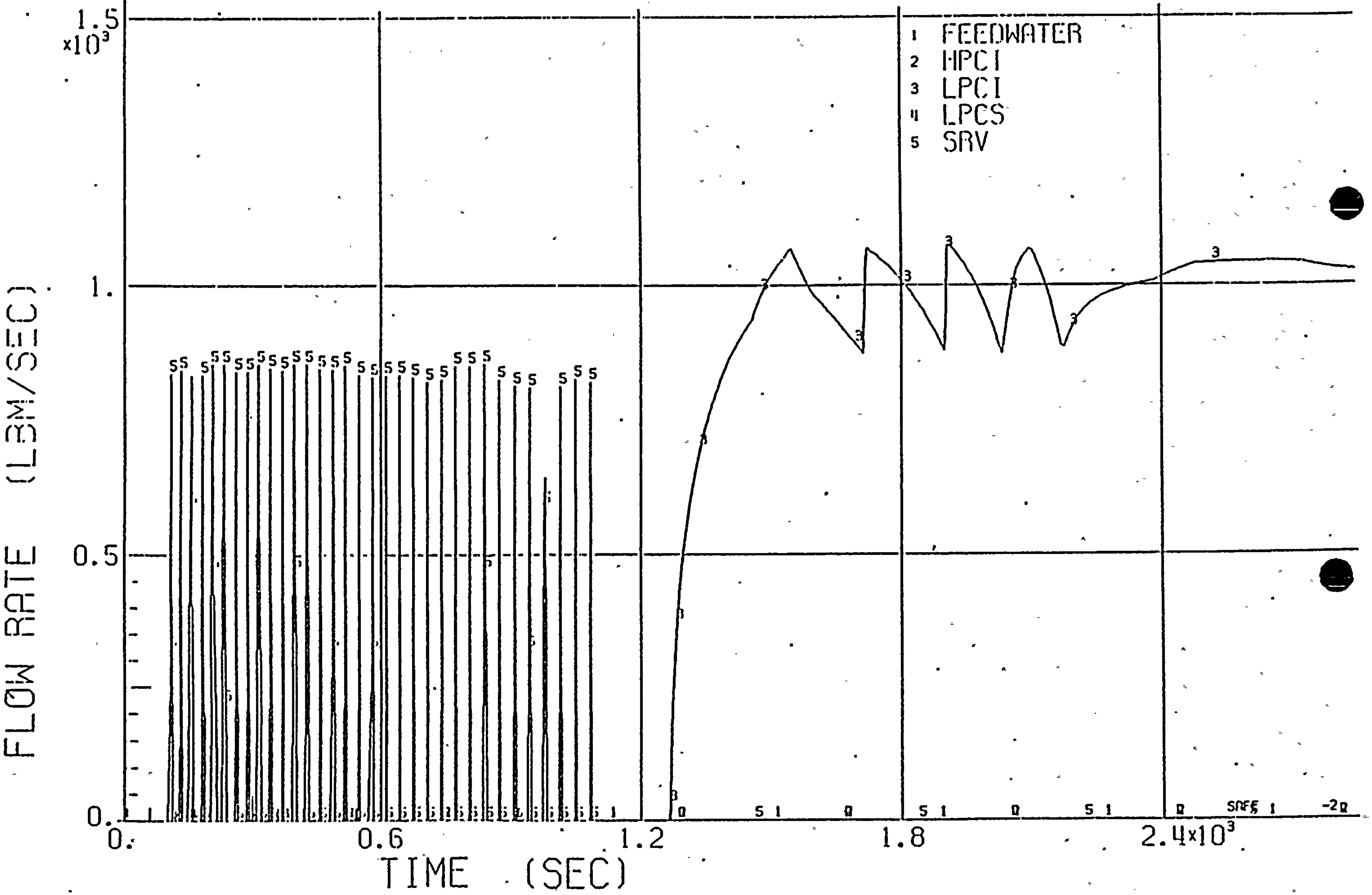

FIGURE 4 - 12.4 FLOW RATES VS TIME FOR A 0.001 FT² SUCTION BREAK WITH ONE LPCI AVAILABLE.

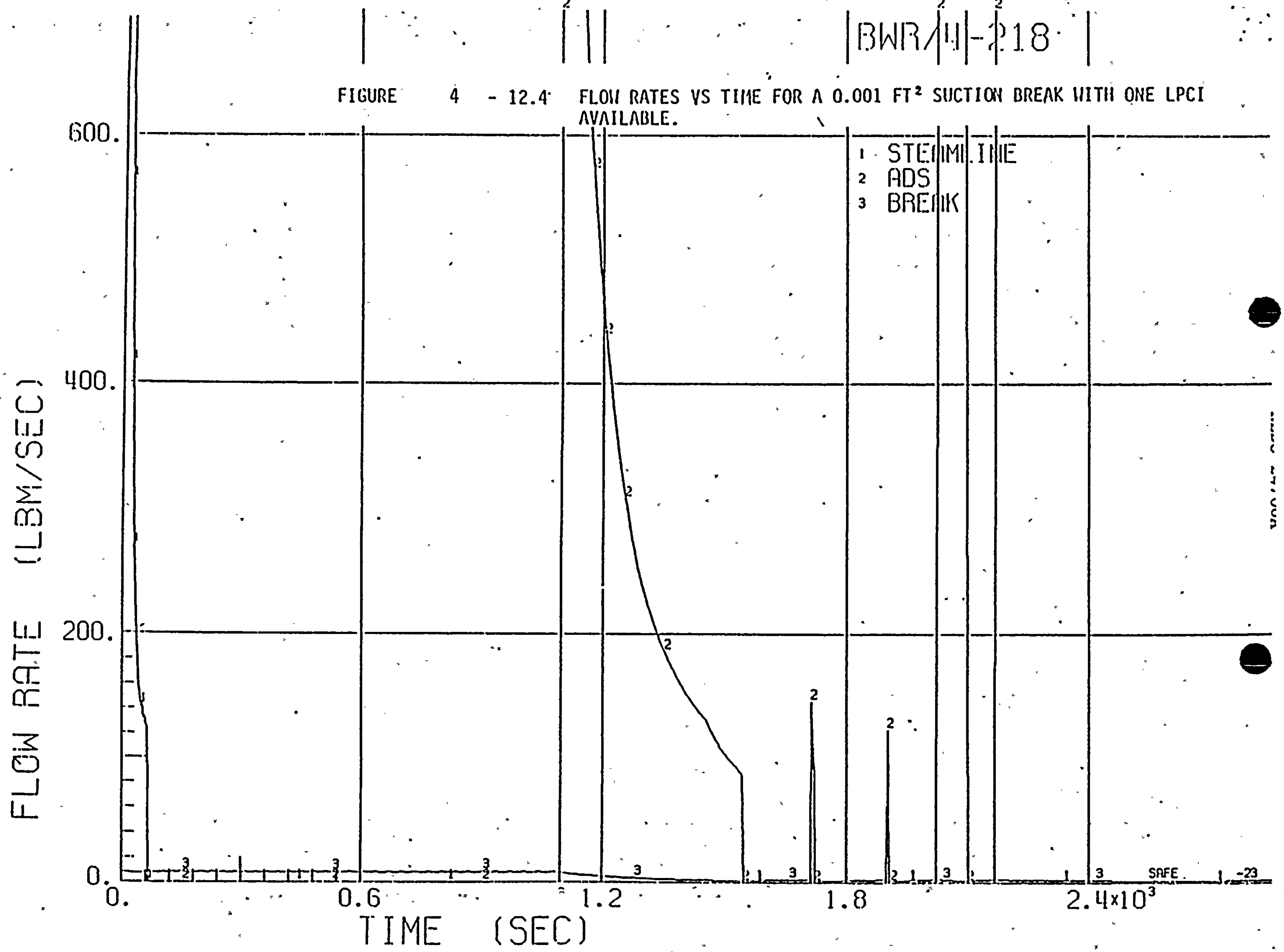

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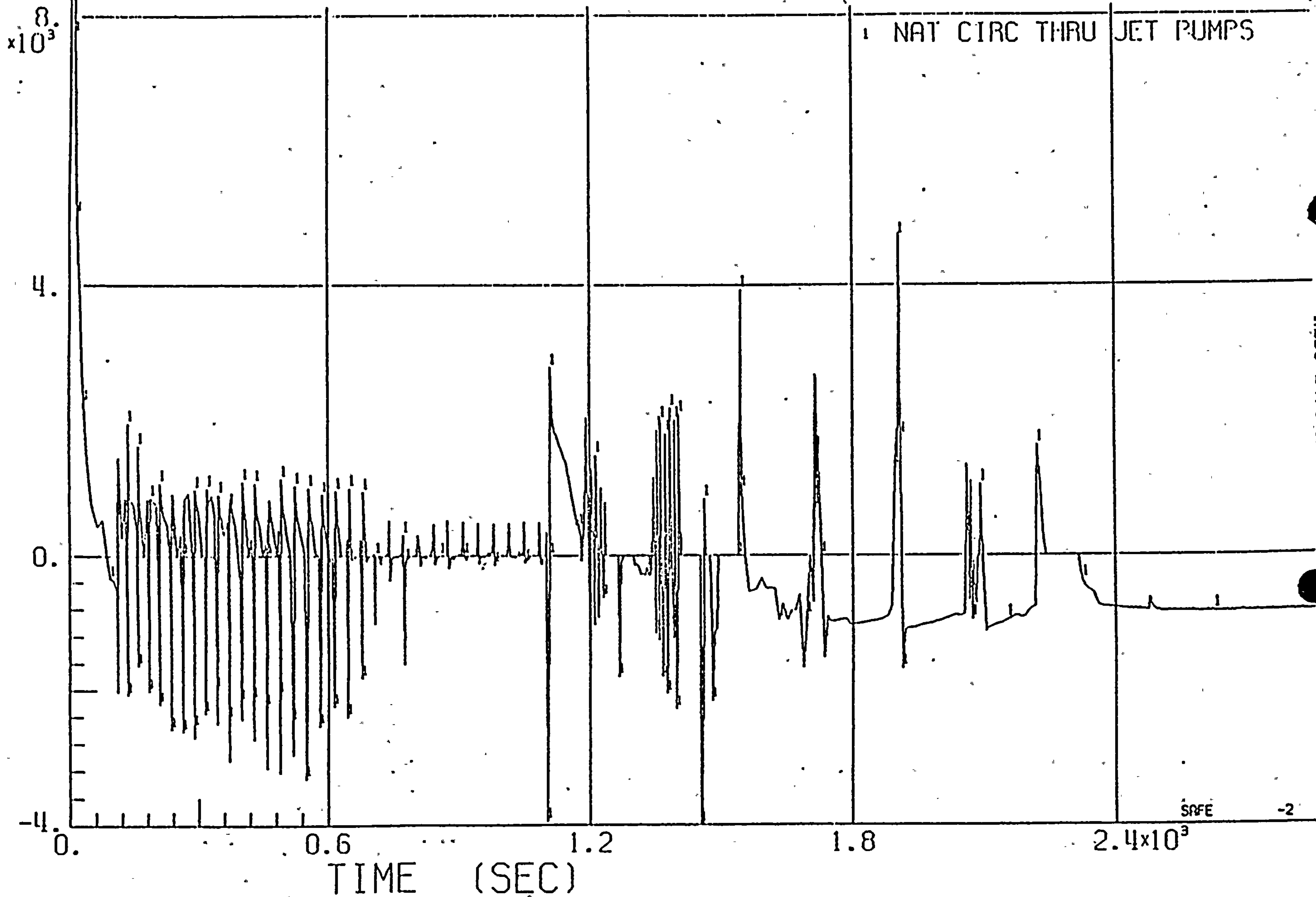
FIGURE 5 - 12.5 NATURAL CIRCULATION FLOW RATE VS TIME FOR A 0.001 FT^2 SUCTION BREAK WITH ONE LPCI AVAILABLE.



NEDO-24708A

FIGURE 6-–-12.6 TEMPERATURE VS TIME FOR A 0.001 FT² SUCTION BREAK WITH ONE LPCI AVAILABLE.

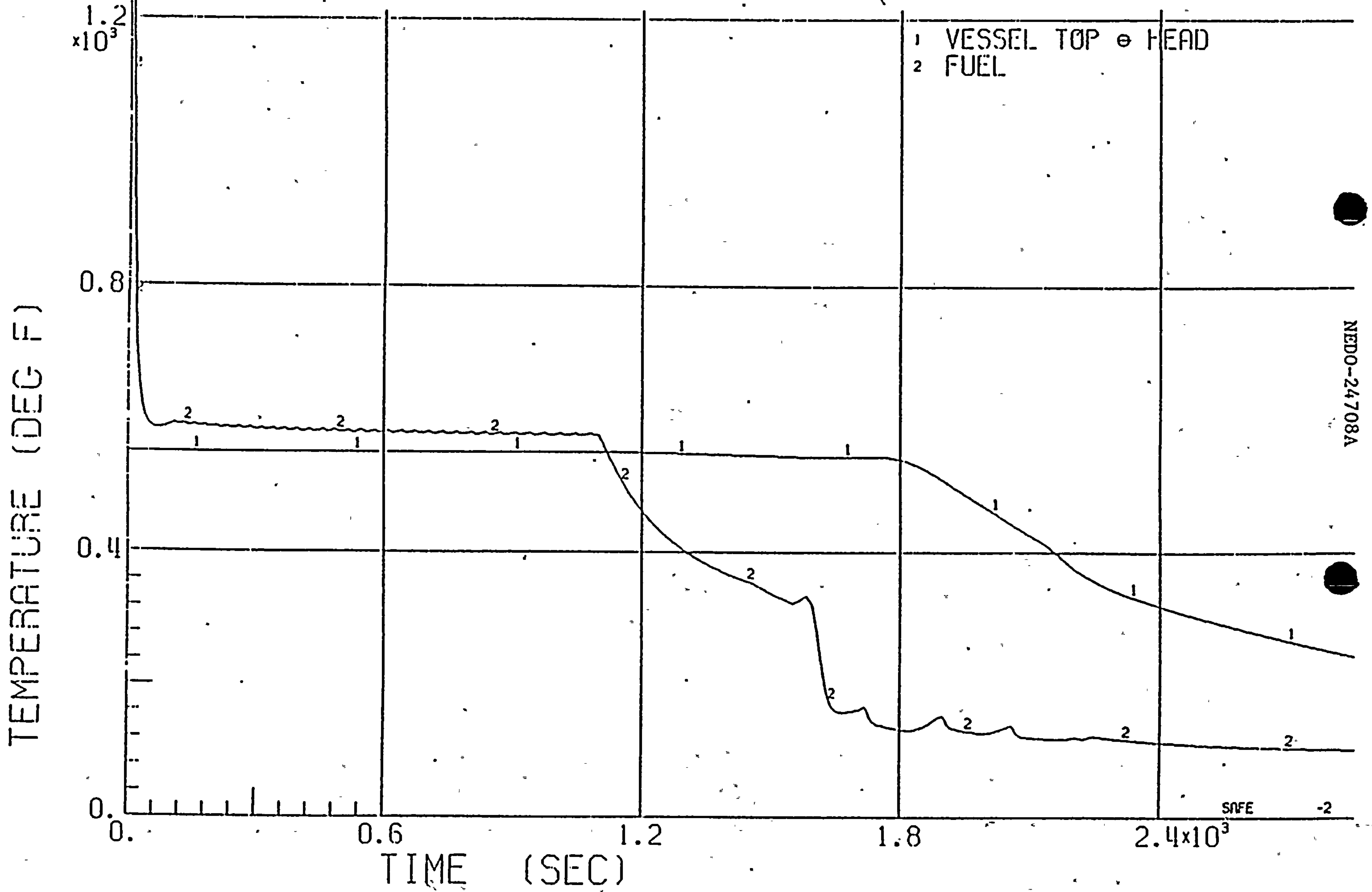


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FIGURE 7.-.12.7. ENTHALPY VS TIME FOR A 0.001 FT² SUCTION BREAK WITH ONE LPCI AVAILABLE.

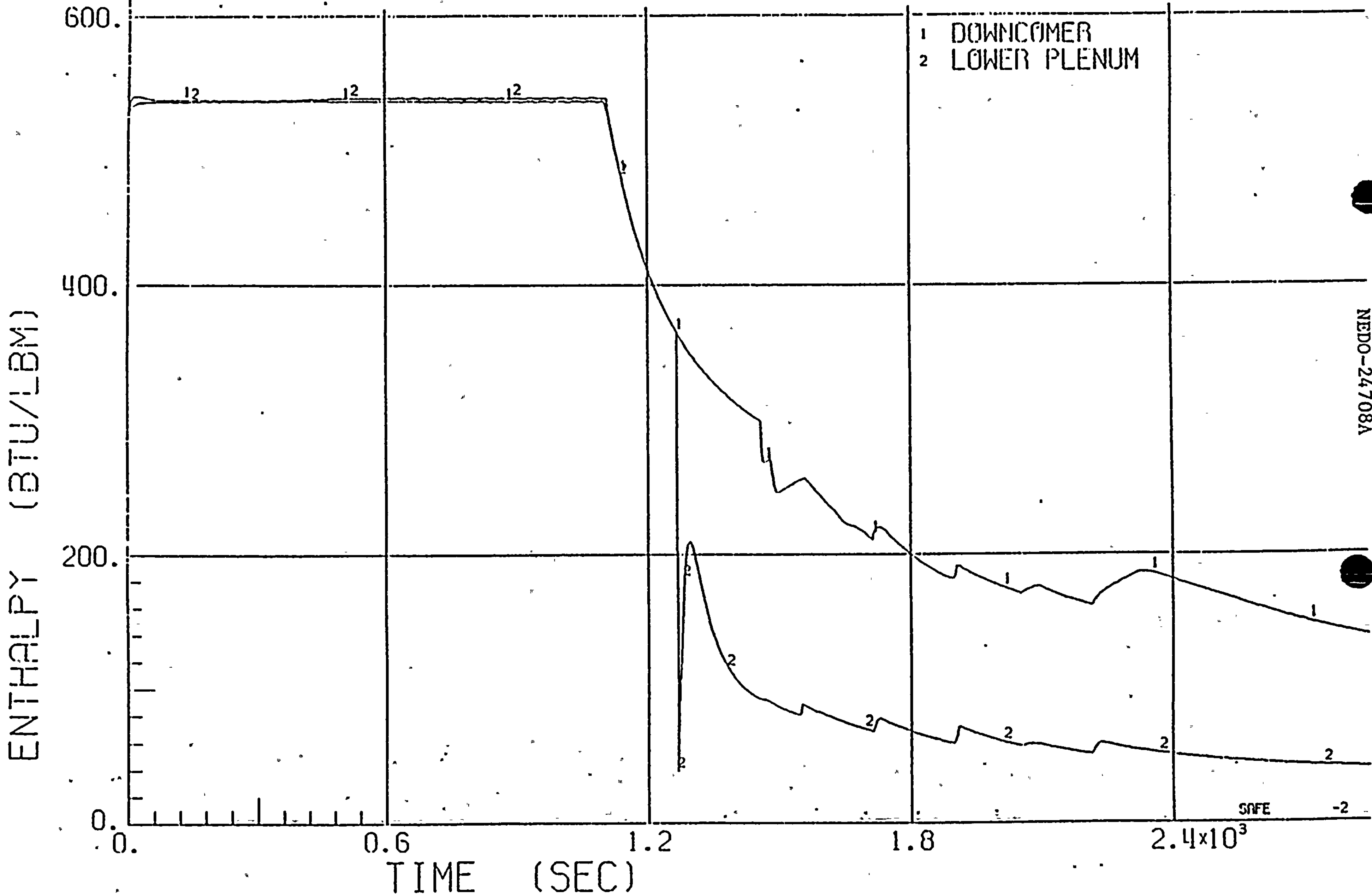

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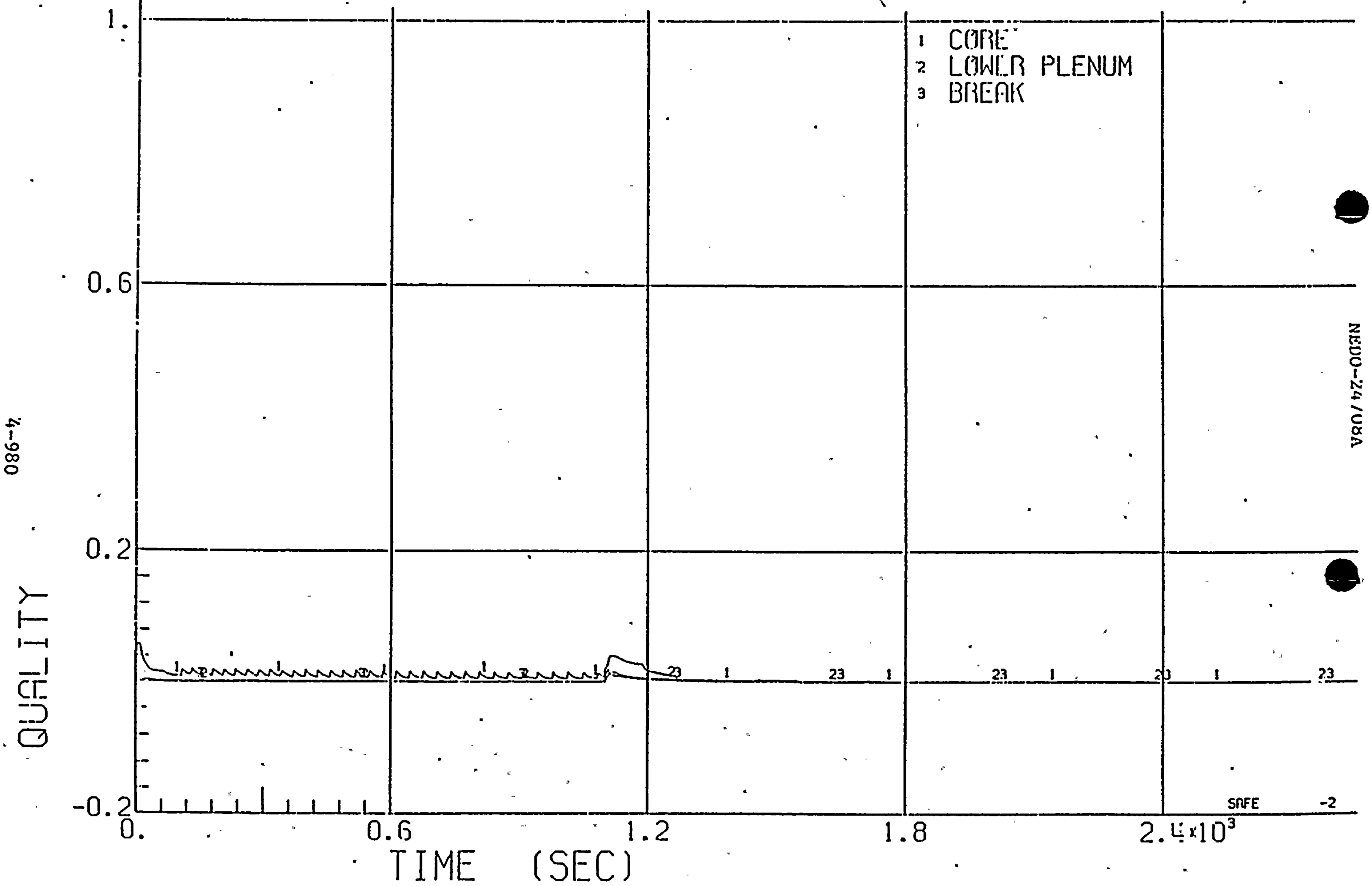
FIGURE 8-12.8 QUALITY VS TIME FOR A 0.001 FT^2 SUCTION BREAK WITH ONE LPCI AVAILABLE.



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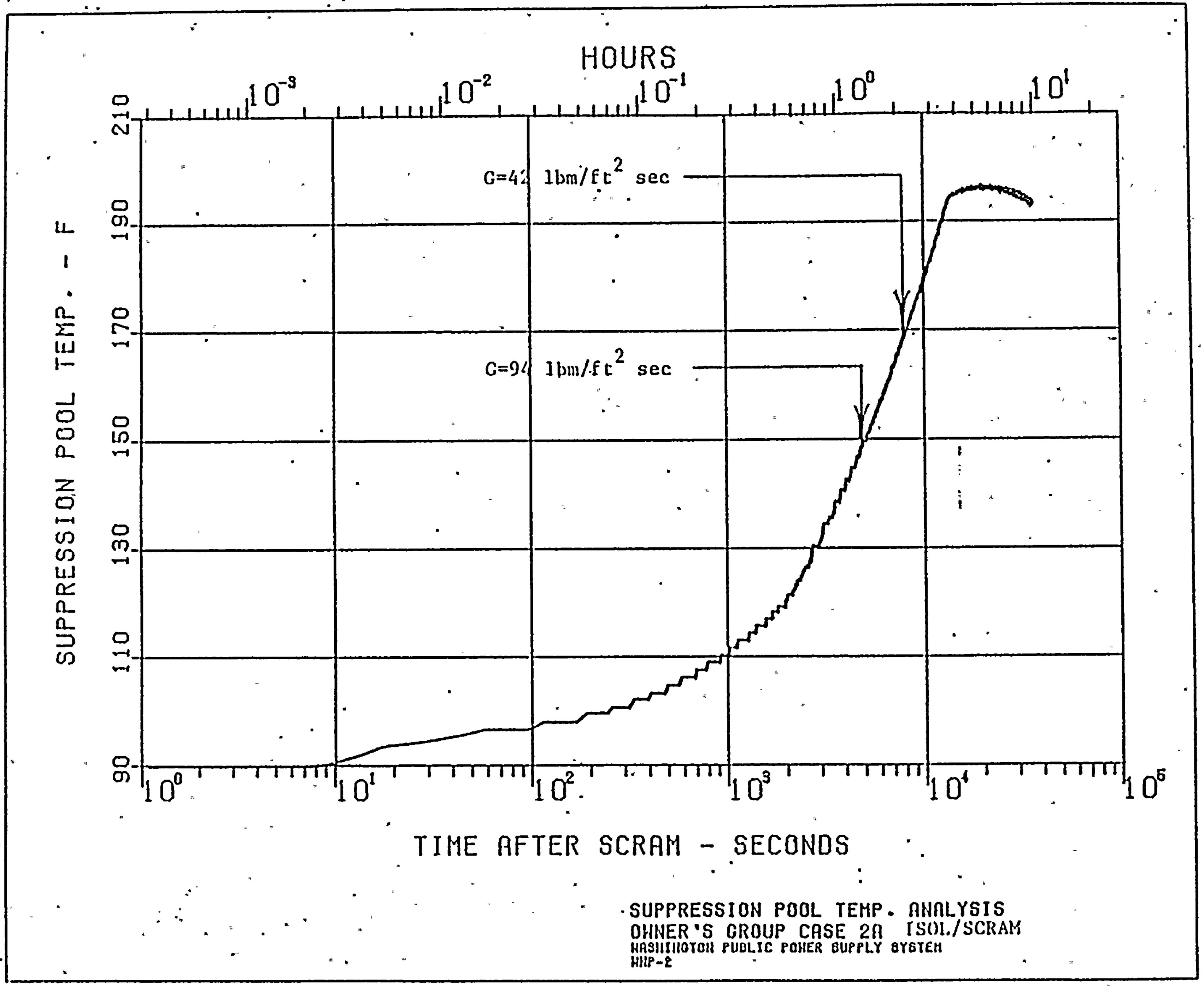
HOURS
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
SUPPRESSION POOL TEMP. - F
210
190
170
150
130
110
90
G=42 lbm/ft^2 sec
G=94 lbm/ft^2 sec
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
TIME AFTER SCRAM - SECONDS
SUPPRESSION POOL TEMP. ANALYSIS
OWNER'S GROUP CASE 2A ISOL/SCRAM
WASHINGTON PUBLIC POWER SUPPLY SYSTEM
WNP-2

Fig. 9

TABLE I

SL-4/5

EFFECT OF ASSUMPTIONS UPON
MAXIMUM SUPPRESSION POOL TEMPERATURE

Case No.	Normalized S.P.ΔT°**	Case Description
1	1.0	Base Case. Isolation-scram 1 RHR 100°F/hr cooldown from TSP - 120°F, 16 minute delay from $P_{ves} = P_{S.D.}$ for start of shutdown cooling (See Table II).
2	1.026	Case I, with 10% reduction in K for "alternate shutdown" cooling mode.
3	1.055	Case 1, with 20% reduction in K for "alternate shutdown mode.
4	0.935	Case 1, with 5°F reduction in initial pool temperature and service water temperature.
5	0.998	Case 1, with pump heat for 1 RHR pump only.
6	0.762	Case 1, with ANS 5.1 decay heat.
7	1.011	Case 1, with "alternate shutdown" cooling on at 20 minutes.
8	1.022	Case 1, with "alternate shutdown" cooling on at 30 minutes.
9	0.900	Case 1, with rapid vessel depressurization at TSP - 120°F, SD cooling at 6900 seconds.*
10	1.074	Case 1 as modified by Cases 3, 4, 5 and 9.*
11	0.950	Case 1 as modified by Cases 3, 4, 5, 6 and 9.*

* Time of switchover to shutdown cooling not optimized.

** Defined as $(T_{S.P.F} - T_{S.P,\ int})_{i\ case} / (T_{SP,F} - T_{SP,\ int})$

where $T_{SP,F}$ = Maximum Suppression Pool Temperature, Case 1 $T_{SP,\ int}$ = Initial Suppression Pool Temperature.

4 of