Offshore Power Systems

SUMMARY OF ANALYSES OF D.C. COOK CONTAINMENT RESPONSE TO HYDROGEN TRANSIENTS

REPORT NO. 36A05

DECEMBER 1980

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SUMMARY OF ANALYSIS

OF

D. C. COOK CONTAINMENT RESPONSE

TO

HYDROGEN BURN TRANSIENTS

PREPARED FOR

WESTINGHOUSE ELECTRIC CORPORATION

NUCLEAR TECHNOLOGY DIVISION

OFFSHORE POWER SYSTEMS

P. O. BOX 8000

JACKSONVILLE, FLORIDA

REPORT NO. 36A05

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INTRODUCTION

The containment pressure response to hydrogen combustion has been analyzed with the CLASIX computer code for the Sequoyah plant, Reference 1, and the McGuire Plant, Reference 2. From these analyses, certain general results may be applied to all present ice condenser designs. (See Reference 2.) The D. C. Cook plants have lower compartment sprays, while the plants previously analyzed do not. Therefore, the analyses described in this report were undertaken for the D. C. Cook plants to determine the effect of lower compartment sprays on ice condenser containment response to hydrogen combustion and to provide plant specific CLASIX analyses for the D. C. Cook plants.

CLASIX MODEL

The CLASIX Model of the D. C. Cook ice condenser containment is shown in Figure 1. This model is slightly changed from the Sequoyah and McGuire models in that the fan/accumulator rooms are separated from the dead ended volume. This results in a model with five compartments or volumes instead of the four used in previous analyses.

COOK PLANT PARAMETERS

Input parameters for the Cook analysis include MARCH output data for the mass and energy releases from the break, LOTIC output data for containment conditions prior to the onset of hydrogen production,

and parameters for containment geometry and system descriptions. LOTIC data for the Cook analysis are summarized in Tables 1 and 2. Parameters for the Cook spray system and air return fans are given in Table 3. Flow path parameters for the Cook containment are given in Table 4. Parameters not specifically identified in Tables 1 through 4 are identical to those used in the base case of Reference 1.

COOK ANALYSIS

A series of calculations were performed for the Cook containment design in which both system parameters and burn parameters were varied. The first case was run with nominal containment safeguards without lower compartment sprays. This case was run for comparison with the previous results. The final three cases were run with nominal containment safeguards including lower compartment sprays, each run with different burn parameters. In all cases, the flame speed was assumed to be 6 feet per second and burn initiation was suppressed in the ice condenser.

All four cases are summarized in Table 5. The first two cases analyzed for the Cook plant, identified as JVAC1 and JVAC2 respectively, have burn parameters identical to those used in the base case of Reference 1, JV900. Specifically, a burn is assumed to initiate at a hydrogen concentration of 10 percent by volume (V/O), to propagate to any adjacent compartment with a hydrogen concentration of 10 V/O or more, and to have complete combustion. In the third case, identified as

JVAC3, ignition occurs at 10 V/O and propagation at 8 V/O hydrogen. The burn fraction is 1.0 for the 10 V/O burns and 0.5 for the 8 V/O burns. In the fourth case, identified as JVAC4, the hydrogen concentration for ignition and propagation is 8 V/O and the burn fraction is 0.5. The burn parameters for cases JVAC3 and JVAC4 are the same as those in cases JV913 and JV901, respectively, of Reference 1.

COOK RESULTS

The results from the four runs are shown in Table 5 and Figures 2 through 41. A comparison between the first case, JVAC1, and the corresponding cases from Reference 1, JV900, and Reference 2, JVD12, reflects some minor differences in the hydrogen transient in the Sequoyah, McGuire and Cook containments. These differences occur in the number and magnitude of burns, the peak temperature and pressure, and the amount of ice melt. These differences are attributed primarily to the dissimilarities in the fan systems and in the lower compartment geometry designs. Even though there are minor differences, the general nature of the transient, for these cases, is very similar among the three plants.

The only significant deviation between the results of the Cook analysis and the previous analyses for Sequoyah and McGuire occurs in the final three runs, JVAC2 through JVAC4, where sprays are present in the lower compartment. As can be seen in Table 5, the runs with lower compartment sprays show a decrease in peak temperatures by a factor of

at least 2 and a significant reduction in the amount of ice melt compared to the corresponding reference cases without lower compartment sprays. The temperatures between burns are also reduced by a factor of about 2 or more.

REFERENCES

1. Offshore Power Systems Report Number 28A52, "Summary of Analyses of Ice Condenser Containment Response To Hydrogen Transients," September 1980.

2. Offshore Power Systems Report Number 28A54, "Summary of Analyses of McGuire Containment Response To Hydrogen Transients," October, 1980.

TABLE 1

SUBCOMPARTMENT PARAMETERS*
D. C. COOK CLASIX ANALYSES
TRAIN - UC SPRAY

	LOWER COMPARTMENT **	ICE CONDENSER	UPPER COMPARTMENT +	DEAD ENDED REGION	F/A
VOLUME (FT^3)	2.63×10^5	8.53×10^4	7.46×10^5	6.17×10^4	5.28×10^4
O_2 PRESSURE (PSIA)	3.02	3.43	3.64	3.25	3.64
N_2 PRESSURE (PSIA)	11.42	12.96	13.75	12.28	13.75
H_2O PRESSURE (PSIA)	4.17	2.22	1.22	3.08	1.22
TEMPERATURE (F)	155	130	108	138	108
ICE MASS (LBM)		1.65×10^6			
ICE HEAT TRANSFER AREA		1.99×10^5			

* BASED ON LOTIC RESULTS AT 3480 SECONDS.

** INCLUDES MELTED OUT PORTION OF ICE CONDENSER

+ INCLUDES ICE CONDENSER UPPER PLENUM

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TABLE 2

SUBCOMPARTMENT PARAMETERS*
D. C. COOK CLASIX ANALYSES
JVAC2-4-UC + LC SPRAY

	LOWER COMPARTMENT **	ICE CONDENSER	UPPER COMPARTMENT +	DEAD ENDED REGION	F/A
VOLUME (FT^3)	2.36×10^5	9.54×10^4	7.46×10^5	6.17×10^4	5.28×10^4
O_2 PRESSURE	3.06	3.46	3.67	3.29	3.67
N_2 PRESSURE (PSIA)	11.56	13.07	13.87	12.42	13.87
H_2O PRESSURE (PSIA)	4.13	2.22	1.20	3.04	1.20
TEMPERATURE (F)	154	130	108	137	108
ICE MASS (LBM)		1.84×10^6			
ICE HEAT TRANSFER AREA		2.22×10^5			

* BASED ON LOTIC RESULTS AT 3480 SECONDS

** INCLUDES MELTED OUT PORTION OF ICE CONDENSER

+ INCLUDES ICE CONDENSER UPPER PLENUM

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TABLE 3

SYSTEM PARAMETERS
D. C. COOK CLASIX ANALYSES

SPRAY SYSTEM		
NUMBER OF TRAINS		2
FLOW RATE PER TRAIN (GPM)	UC	2000
	LC	900
	F/A	264
TEMPERATURE (F)		125
DROP DIAMETER (μ)		700
FALL TIME (SEC)	UC	10.66
	LC	5.75
	F/A	1.68
HEAT TRANSFER COEFFICIENT (BTU/HR FT^2 F)		20
INITIATION TIME		DURING LOTIC
AIR RETURN SYSTEM/HYDROGEN SKIMMER SYSTEM		
NUMBER OF FANS		2
FLOW RATE PER FAN (CFM)		41800
INITIATION TIME (SEC)		DURING LOTIC

TABLE 4

FLOW PATH PARAMETERS*
D. C. COOK CLASIX ANALYSES

	LC-IC	IC-UC	UC-LC	DE-LC	F/A-LC
FLOW AREA (FT^2)	*	*	2.2	20.0	308.0
FLOW LOSS COEFFICIENT	2.05	3.04	1.5	3.0	4.2

* FUNCTION OF DOOR OPENING

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TABLE 5

SUMMARY OF RESULTS
D. C. COOK CLASIX ANALYSES

		JVAC1 10 V/O 100% BURN UC SPRAY	JVAC2 10 V/O 100% BURN LC+UC SPRAY	JVAC3 10-8 V/O 100/50% BURN LC+UC SPRAY	JVAC4 8 V/O 50% BURN LC+UC SPRAY
NUMBER OF BURNS	LC	9	8	3	15
	IC	1	2	3	12
	UC	0	0	2	0
MAGNITUDE OF BURNS	LC	100	100	100	50
	IC	40	55	30	20
	UC	-	-	235	-
TOTAL H_2 BURNED (LBM)		900	880	880	1000
H_2 REMAINING (LBM)		650	670	670	550
PEAK TEMPERATURE (F)	LC	2000	1000	1000	280
	IC	1500	1300	760	700
	UC	160	165	290	140
PEAK PRESSURE (PSIA)	LC	26.0	24.5	26.5	22.5
	IC	29.0	27.5	31.0	25.0
	UC	29.0	27.0	33.5	24.0
ICE REMAINING (LBM)		3.4×10^5	8.4×10^5	9.6×10^5	8.2×10^5
FIGURES		2-11	12-21	22-31	32-41

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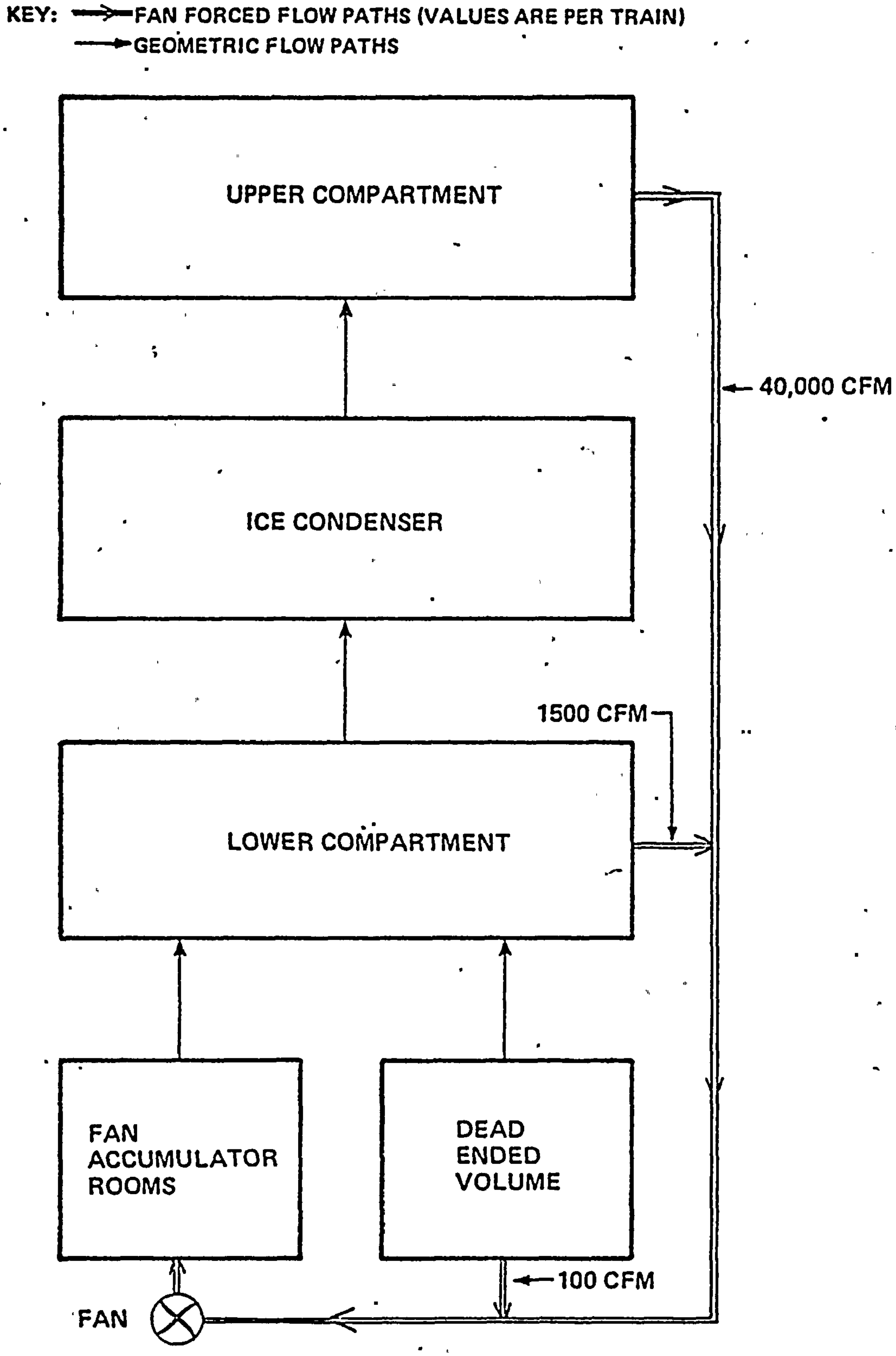
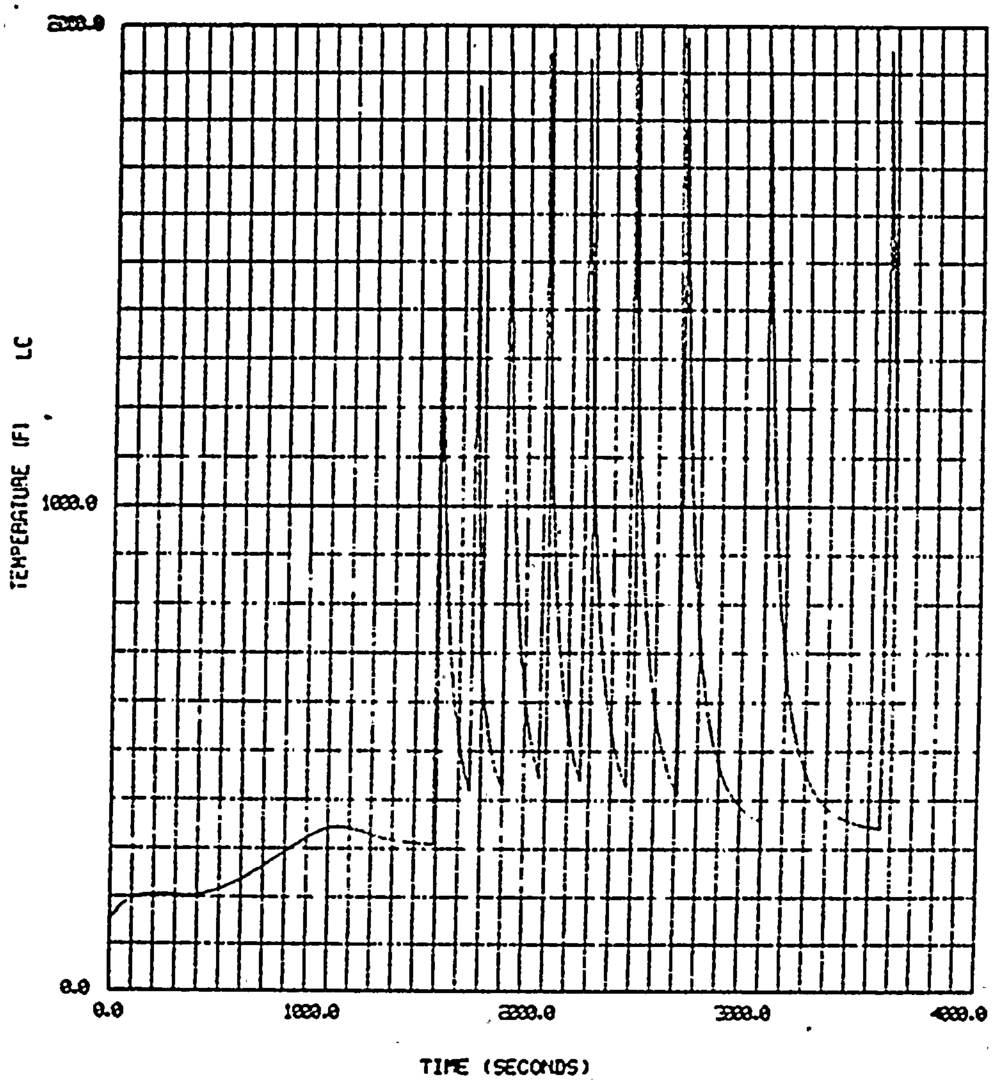
FIGURE 1



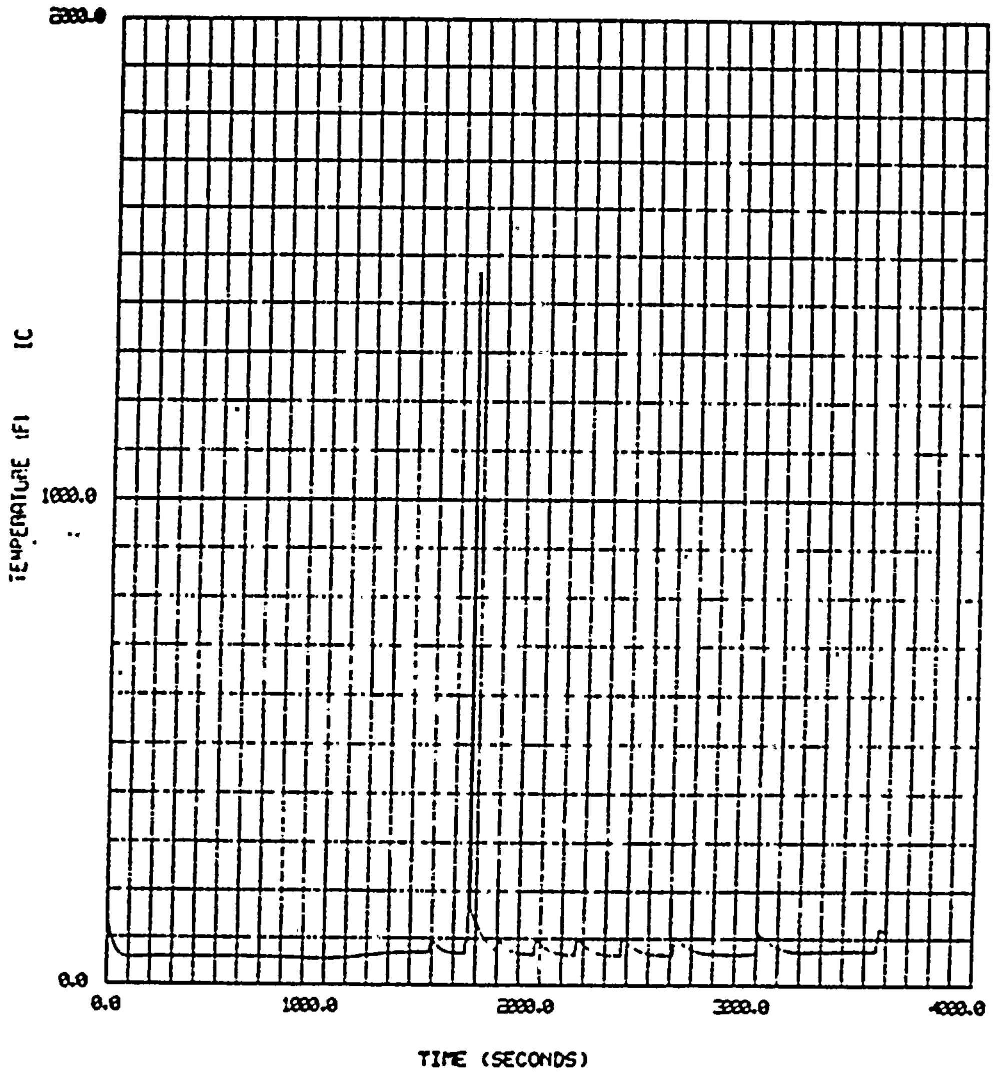
CLASIX MODEL OF ICE CONDENSER CONTAINMENT FOR D.C. COOK PLANT

FIGURE 2



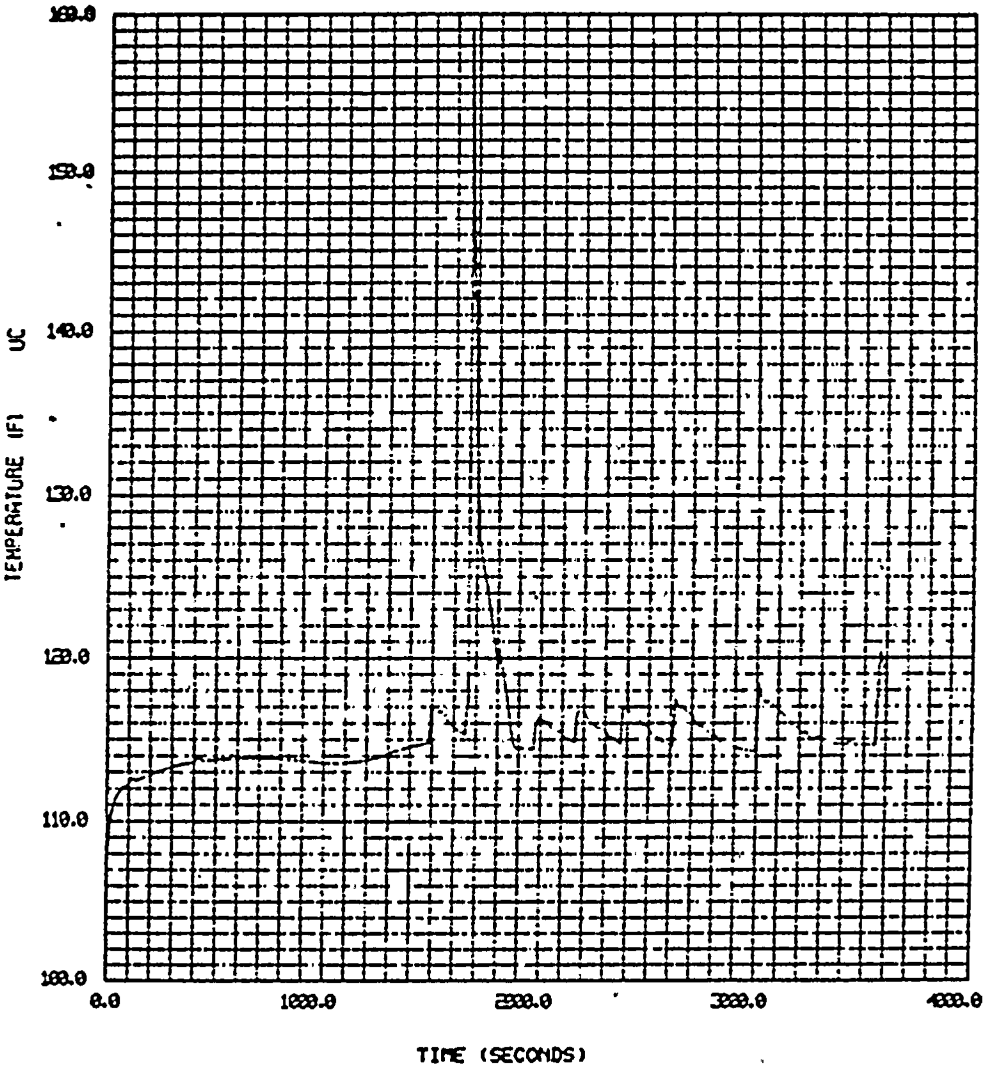
AEP S2D CASE1 80000 FAN 4000 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 3



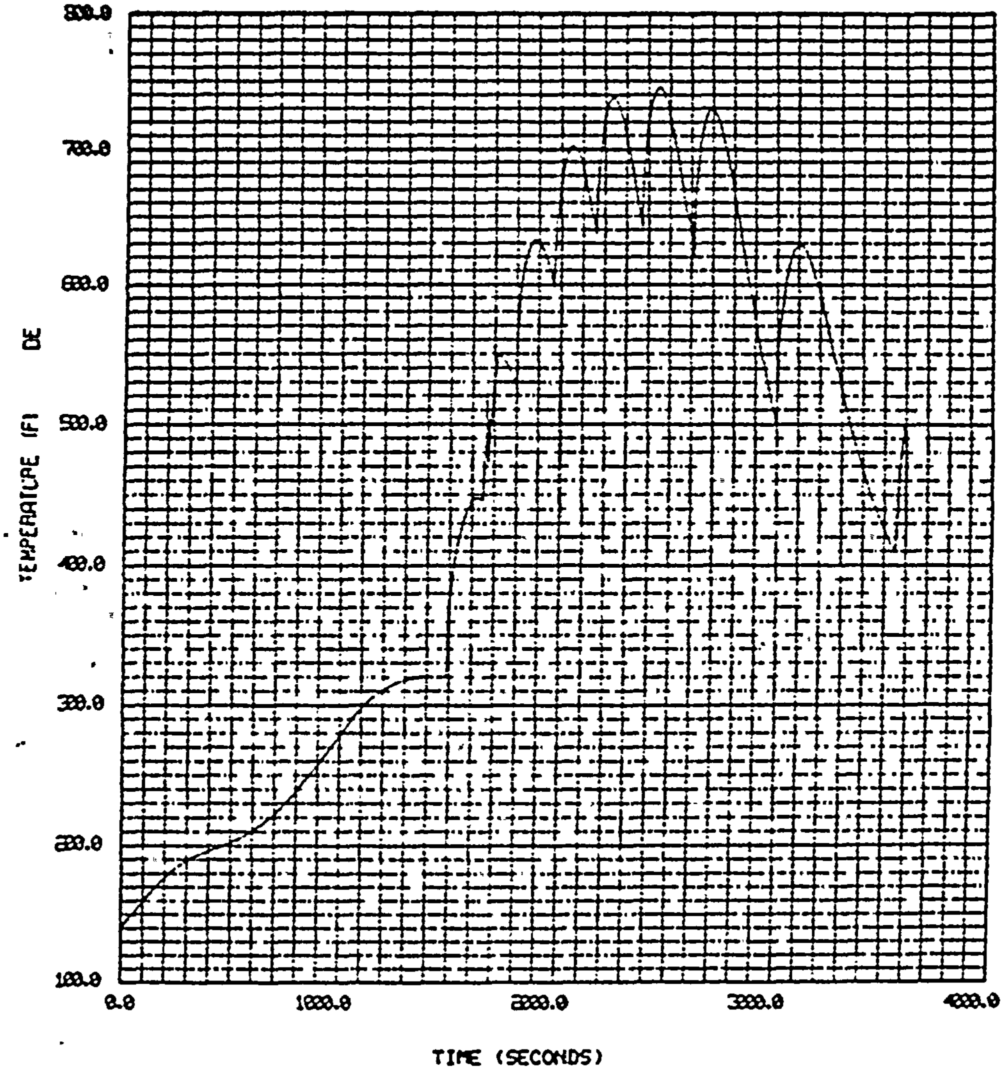
AEP S2D CASE1 80000 FAN 4000 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 4



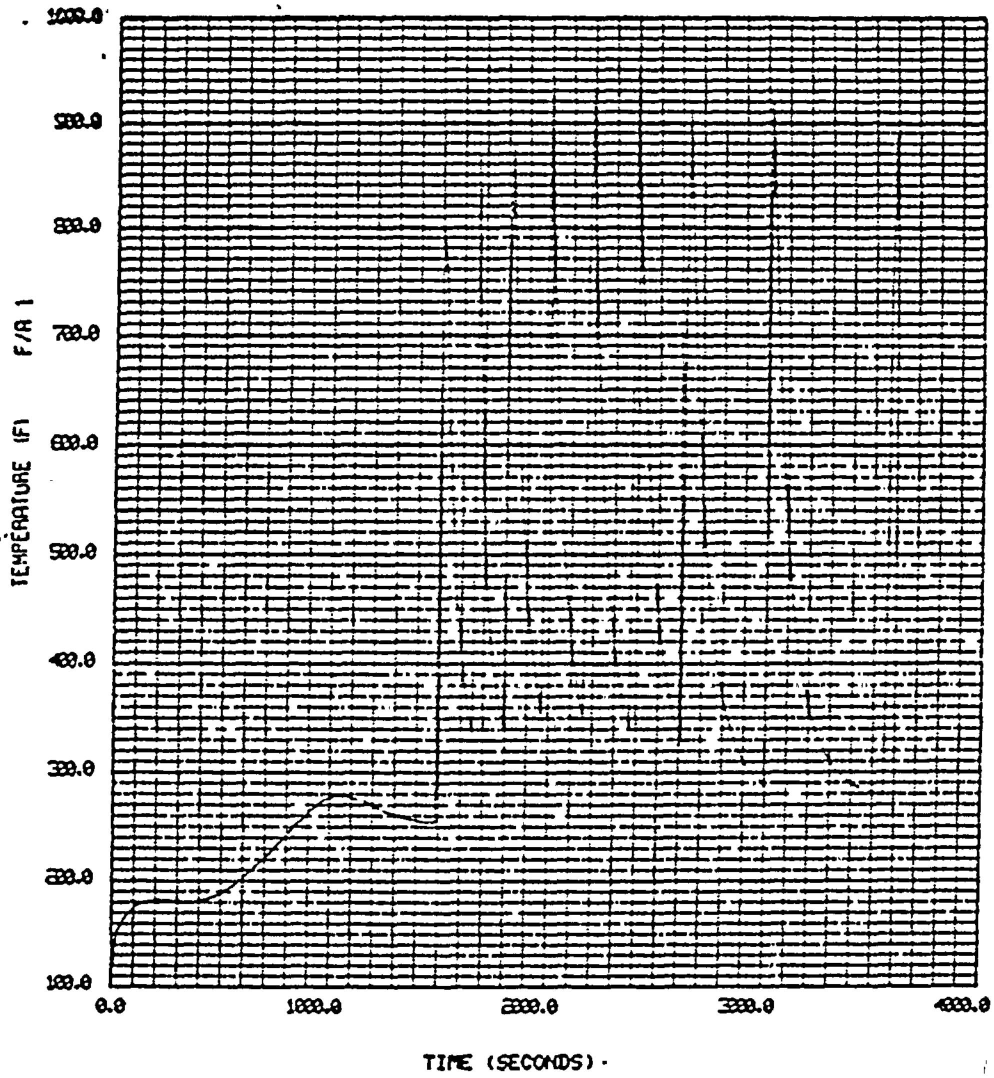
AEP S2D CASE1 80Ø90 FAN 4000 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 5



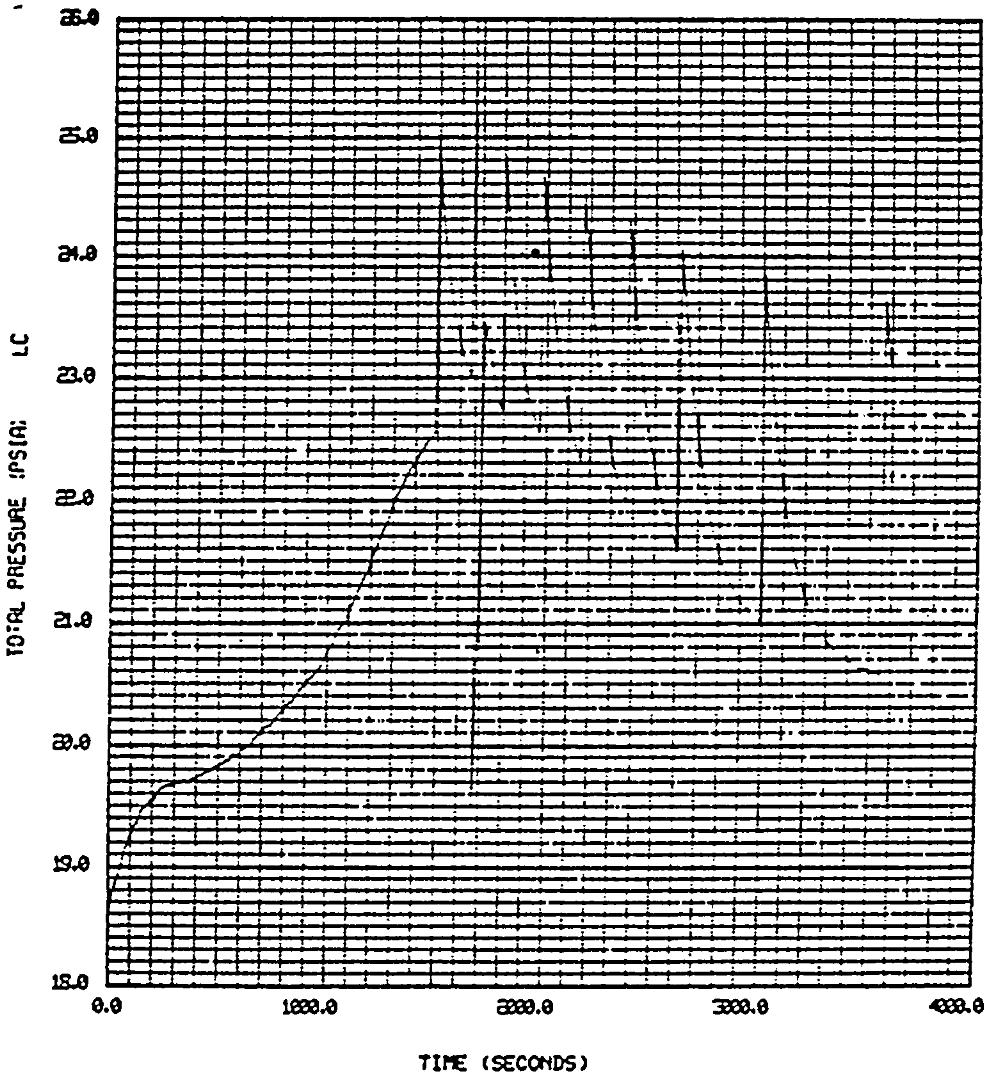
AEP S2D CASE1 80000 FAN 4000 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 6



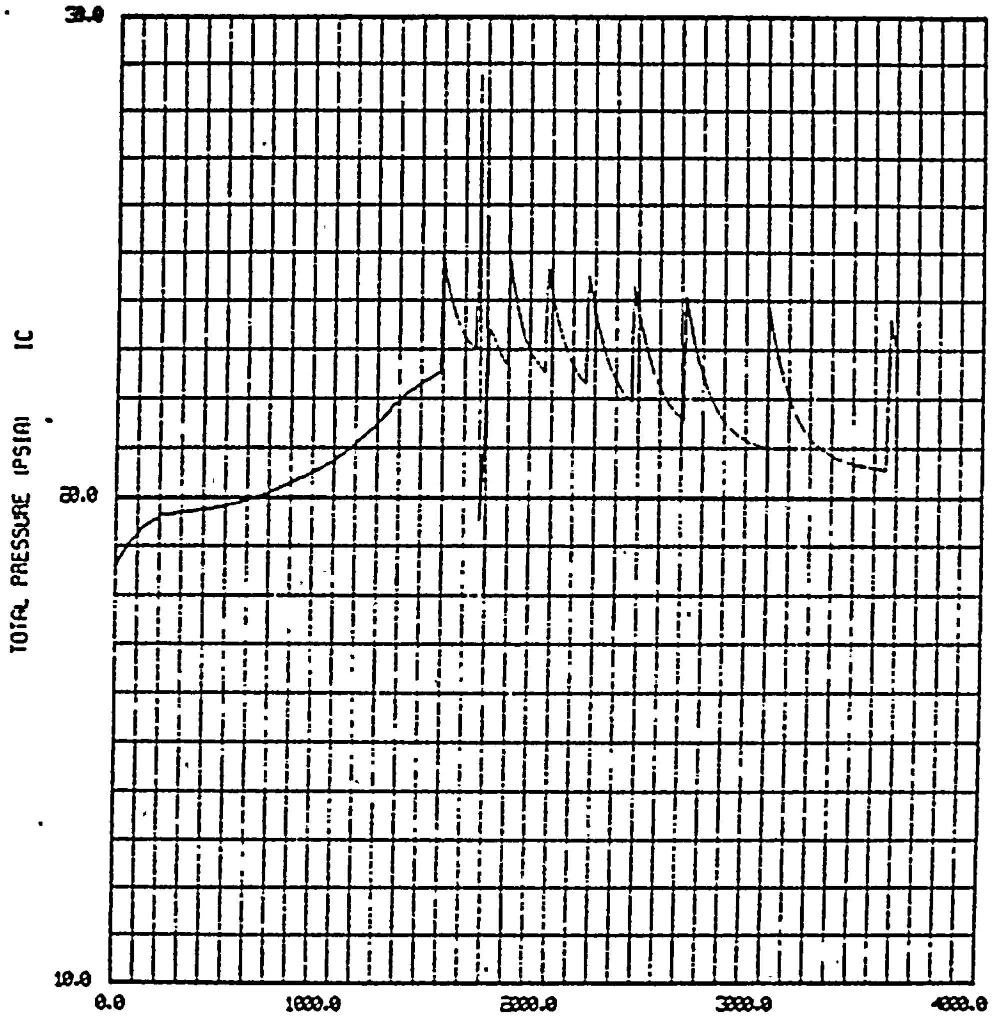
AEP S2D CASE1 80000 FAN 4000 SPRAY BURN 100 PCT AT 10 U/0 6 FPS T+3480

FIGURE 7



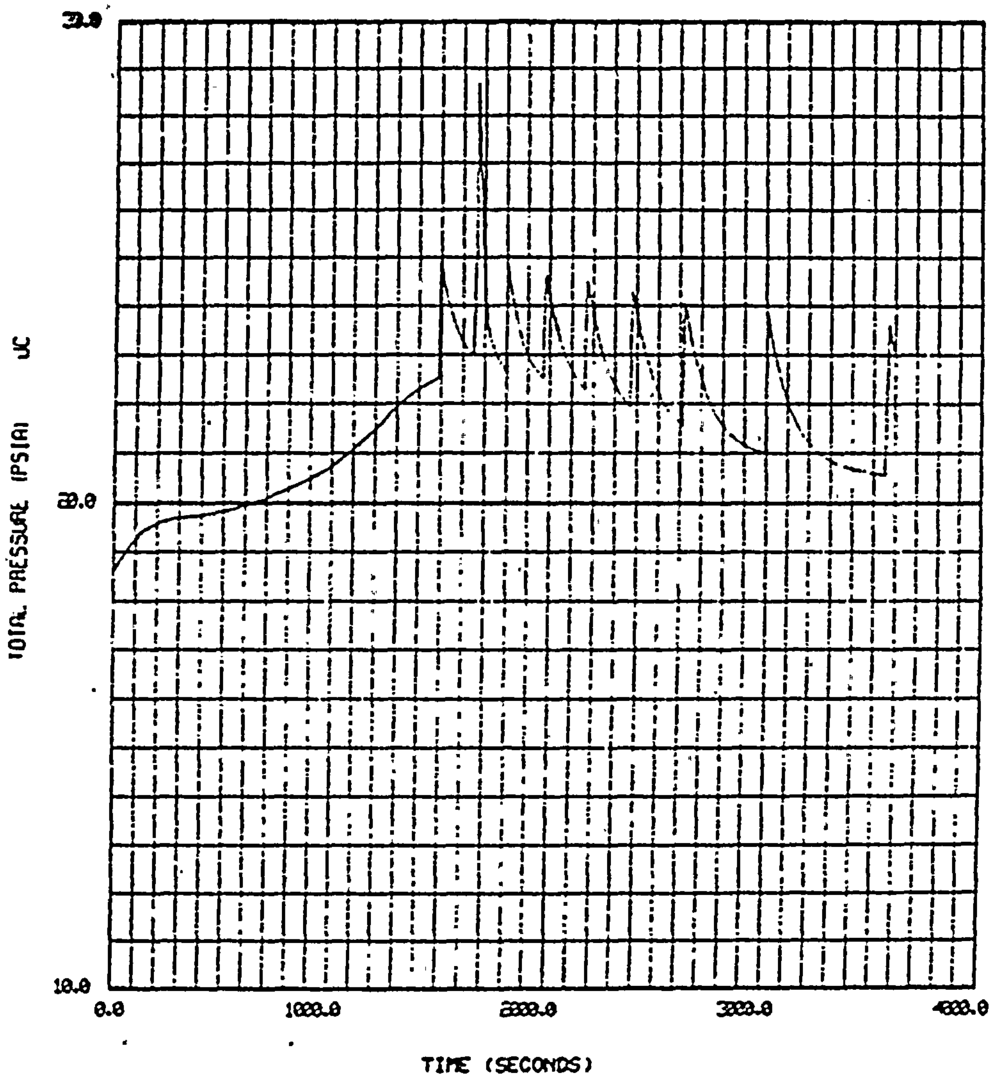
AEP S2D CASE1 80000 FAN 4000 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 8



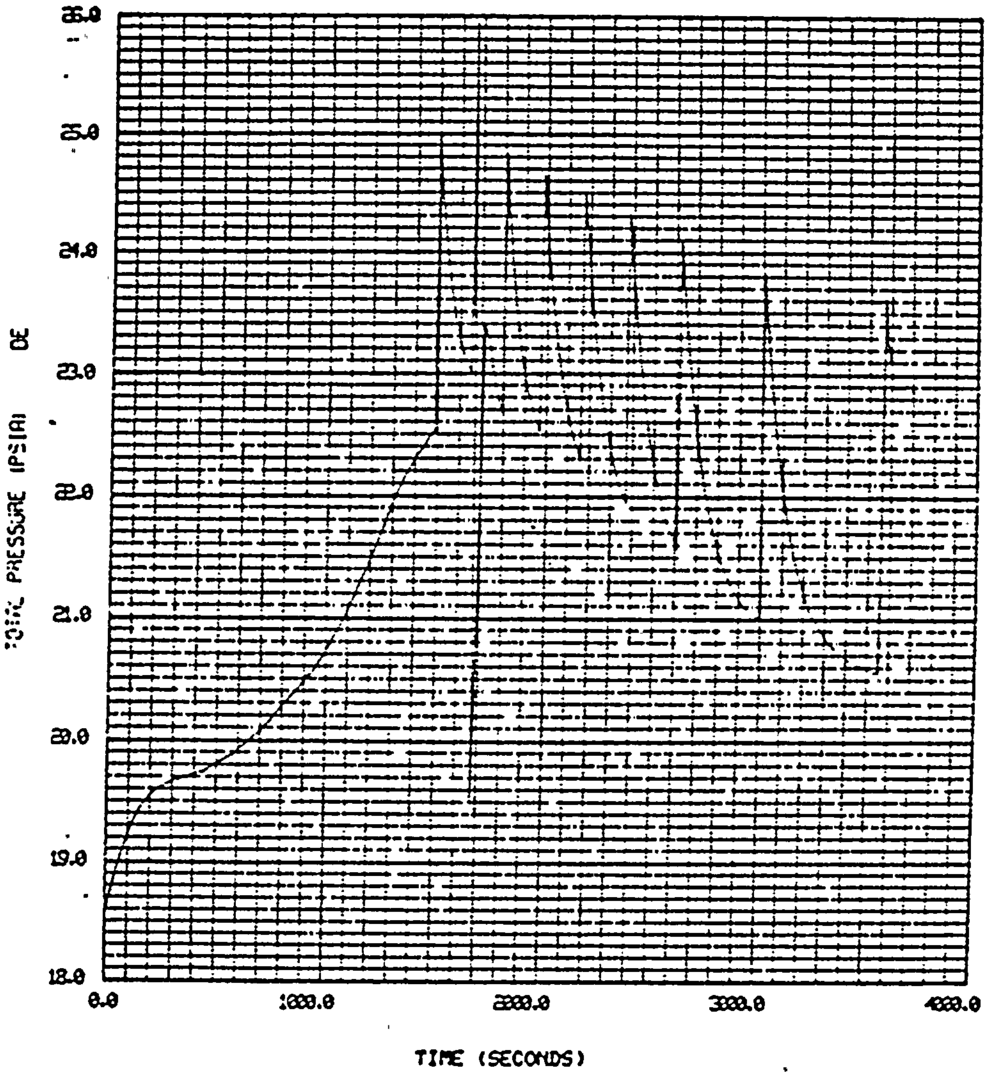
AEP S2D CASE1 80000 FAN 4000 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 9



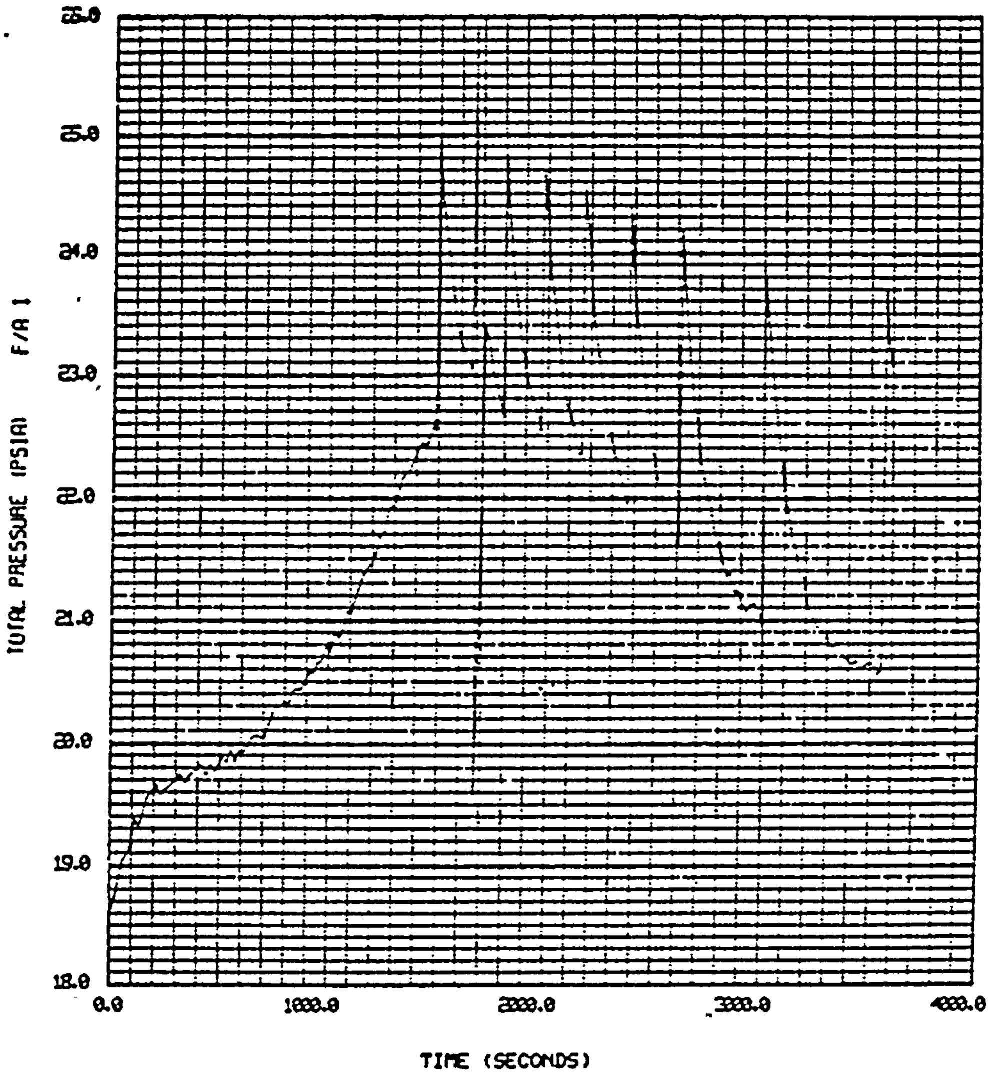
AEP S2D CASE1 80000 FAN 4000 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 10



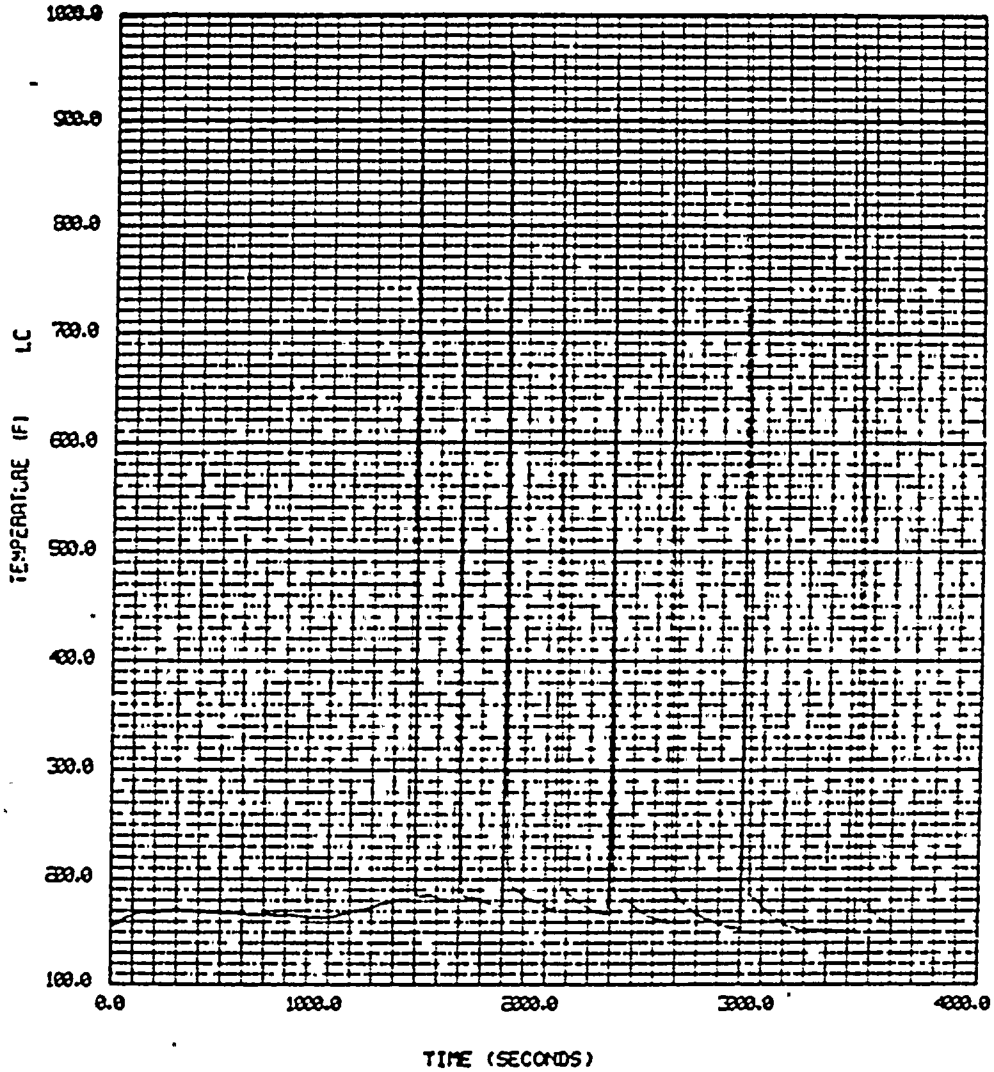
AEP S2D CASE1 80000 FAN 4000 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 11



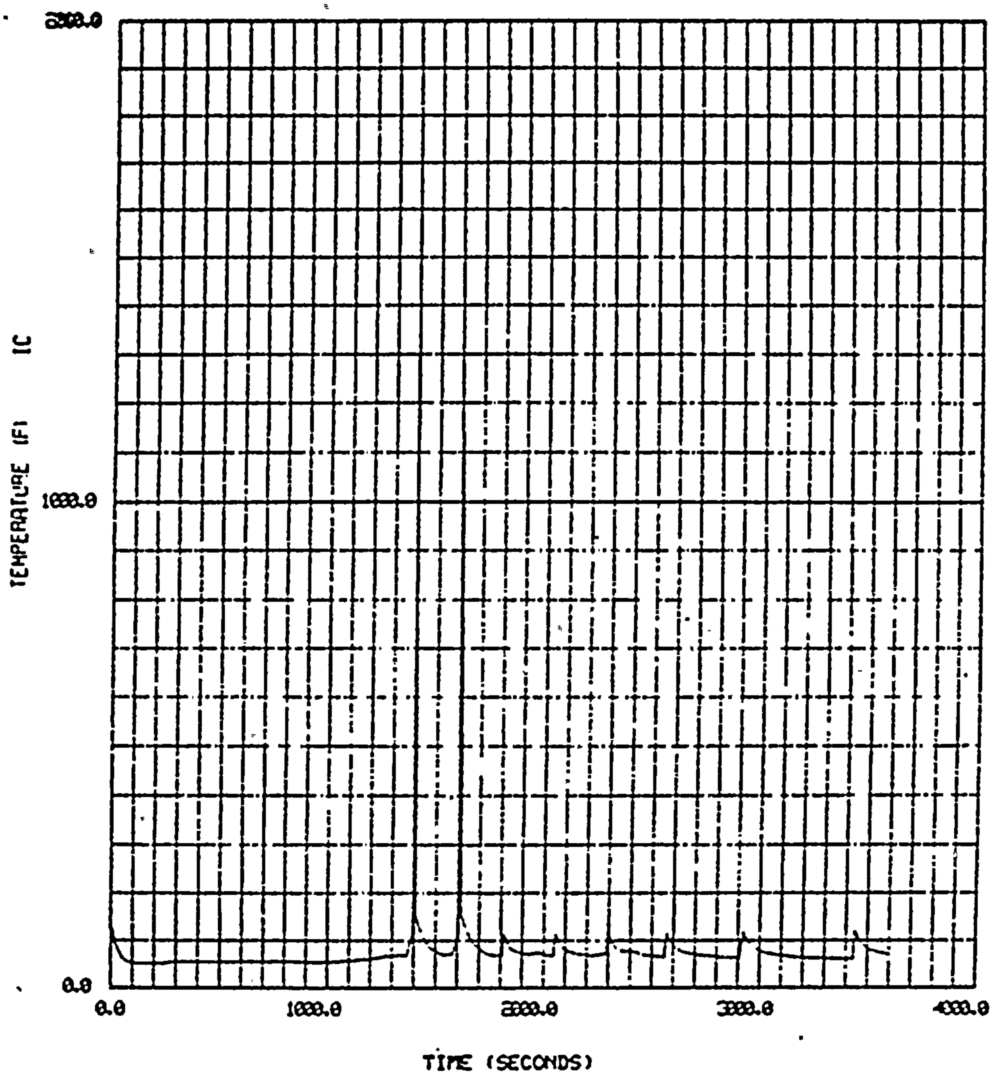
AEP S2D CASE1 80000 FAN 4000 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 12



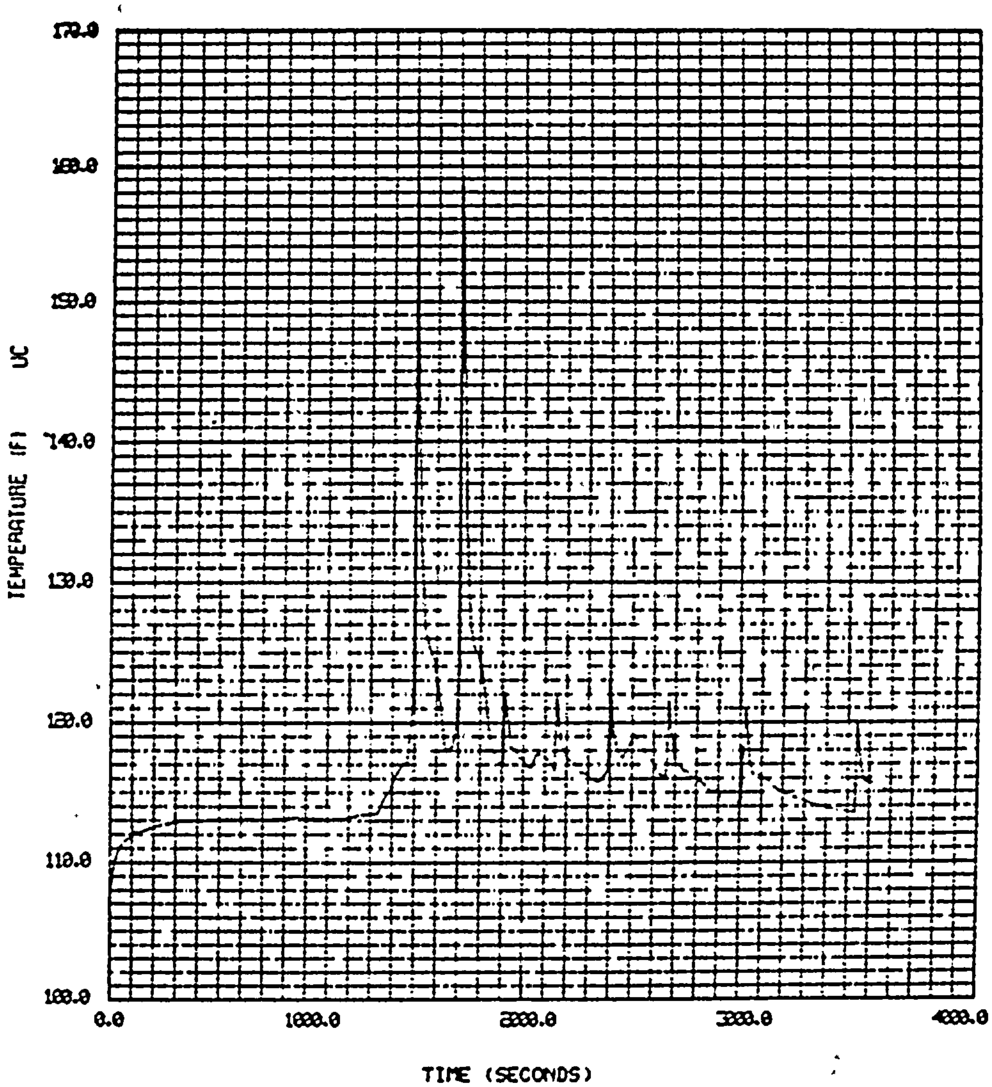
AEP S2D CASE2 80C00 FAN 6328 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 13



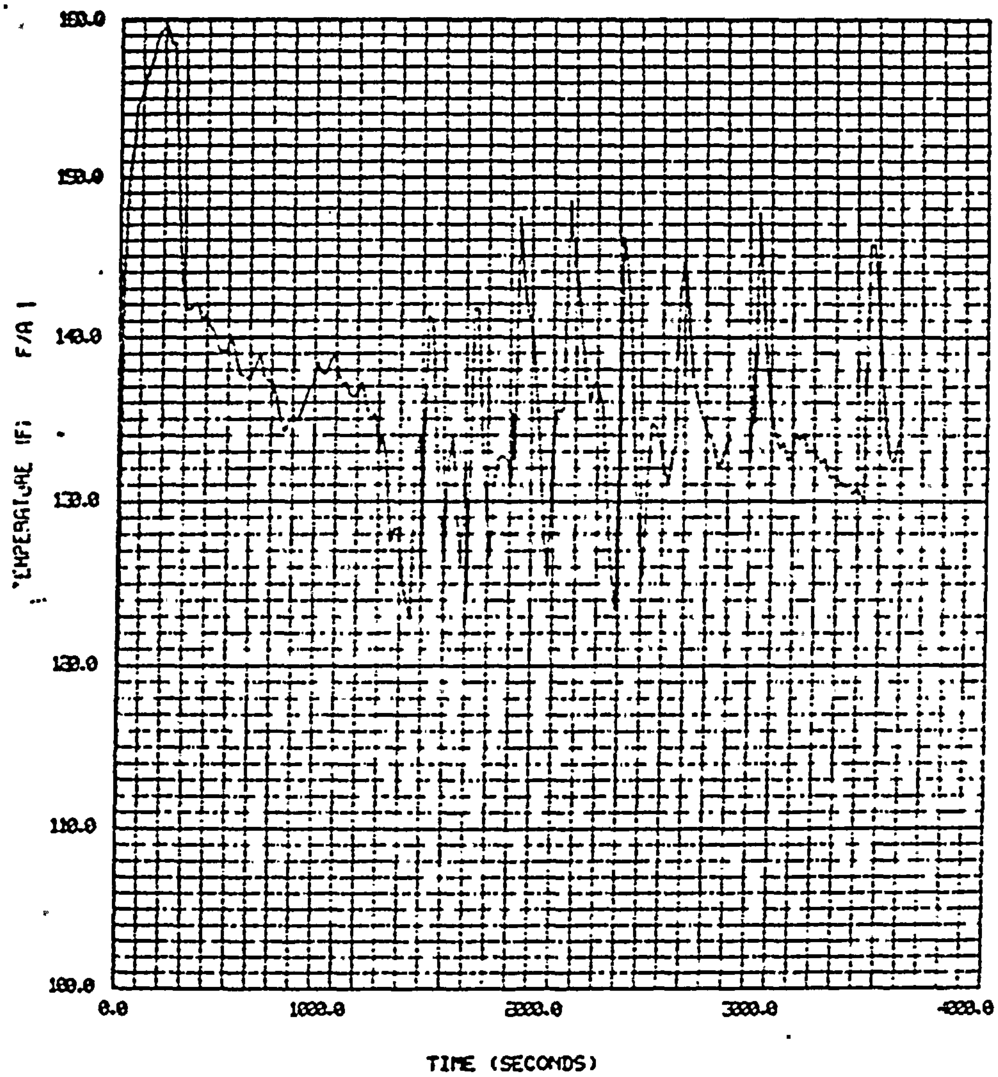
AEP S2D CASE2 80000 FAN 6328 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 14



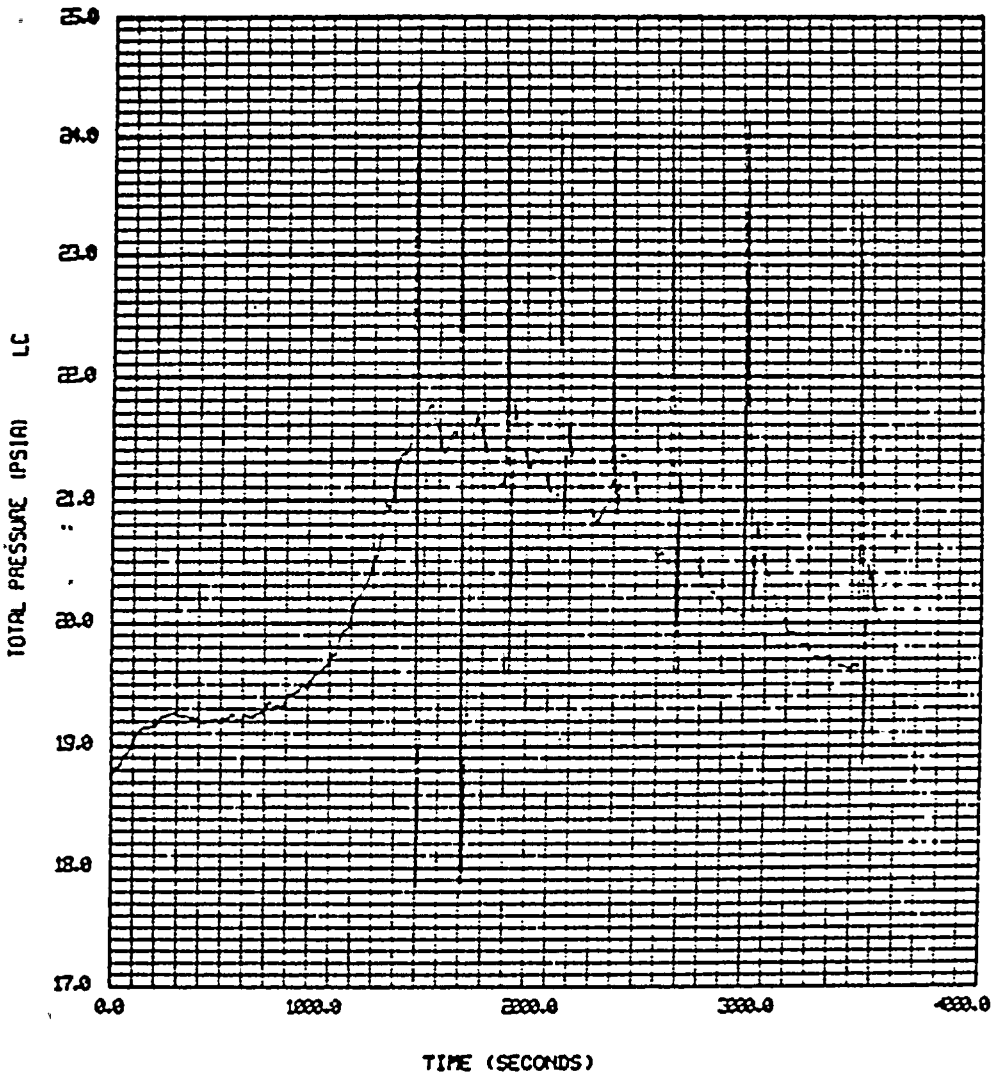
AEP S2D CASE2 80000 FAN 6328 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 16



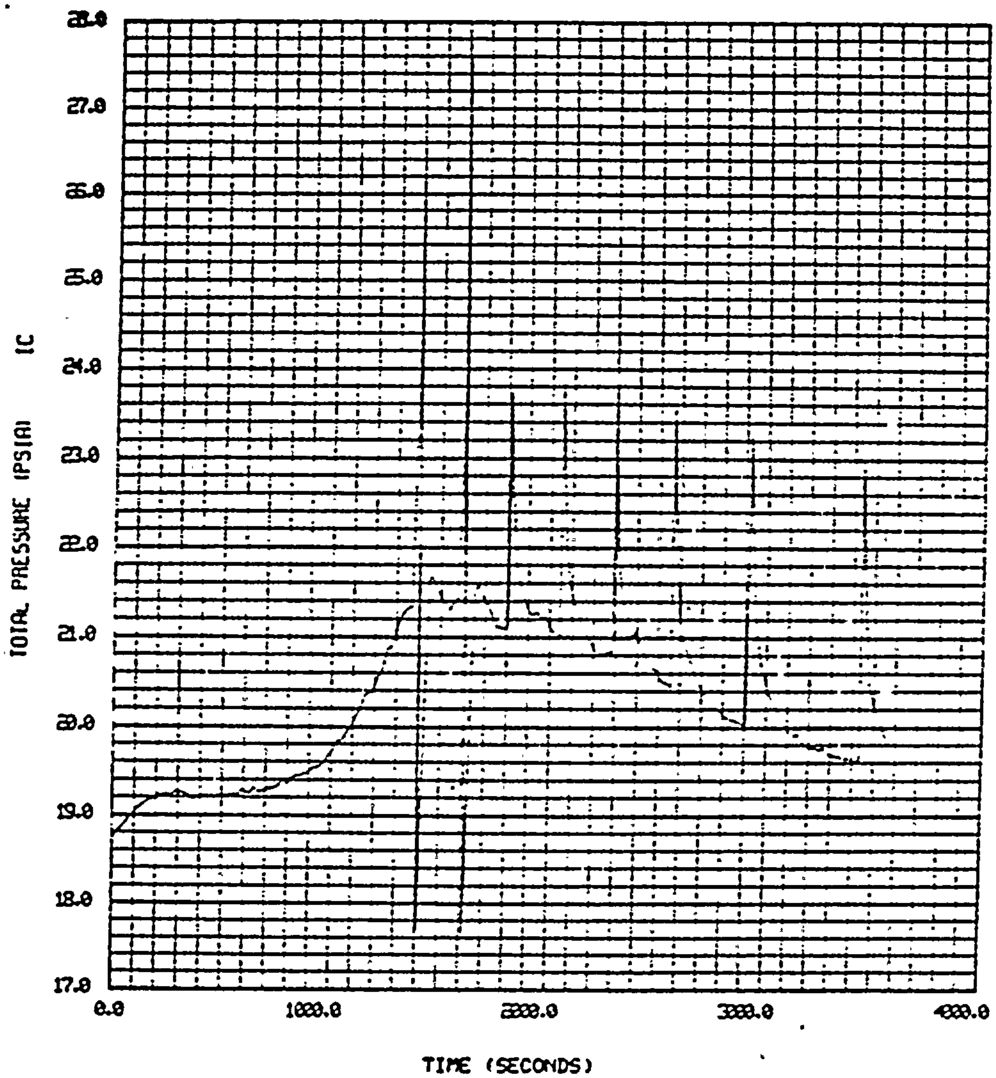
AEP S2D CASE2 80000 FAN 6328 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 17



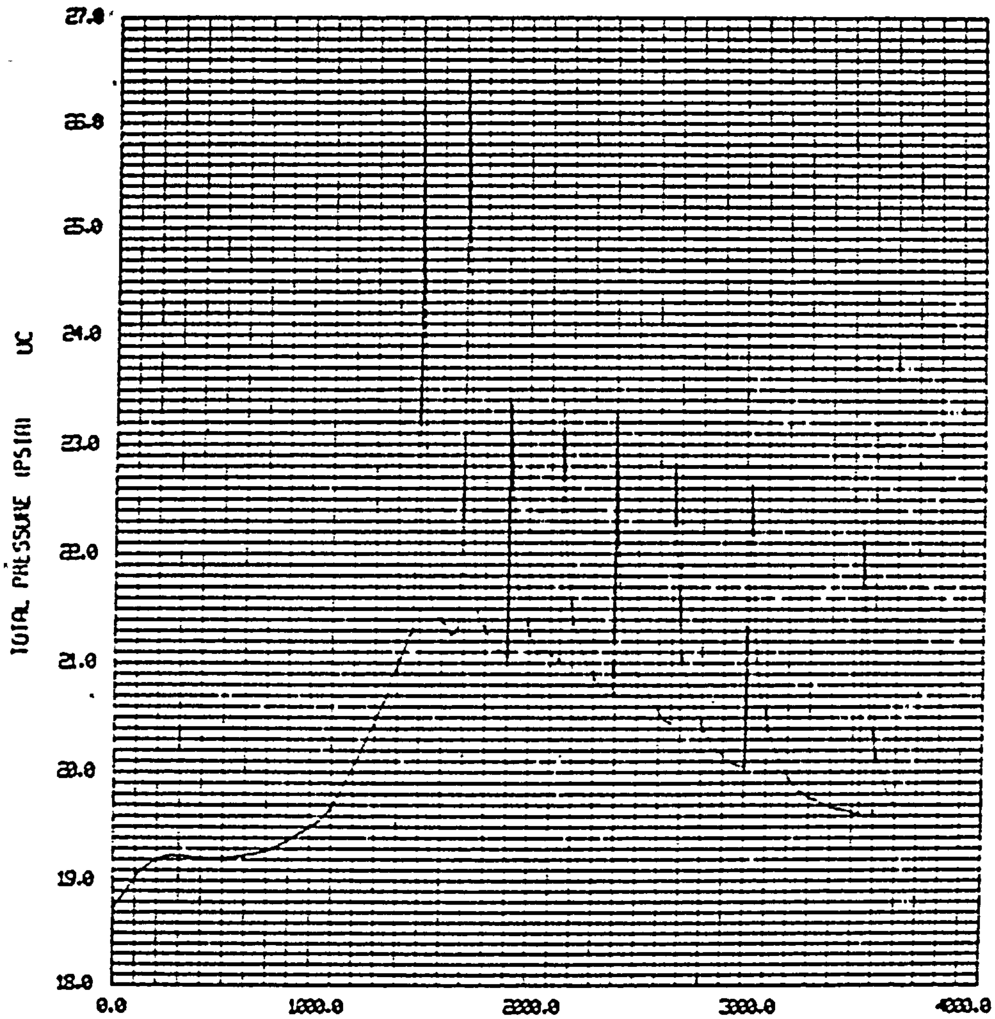
AEP S2D CASE2 S0000 FAN 6328 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 18



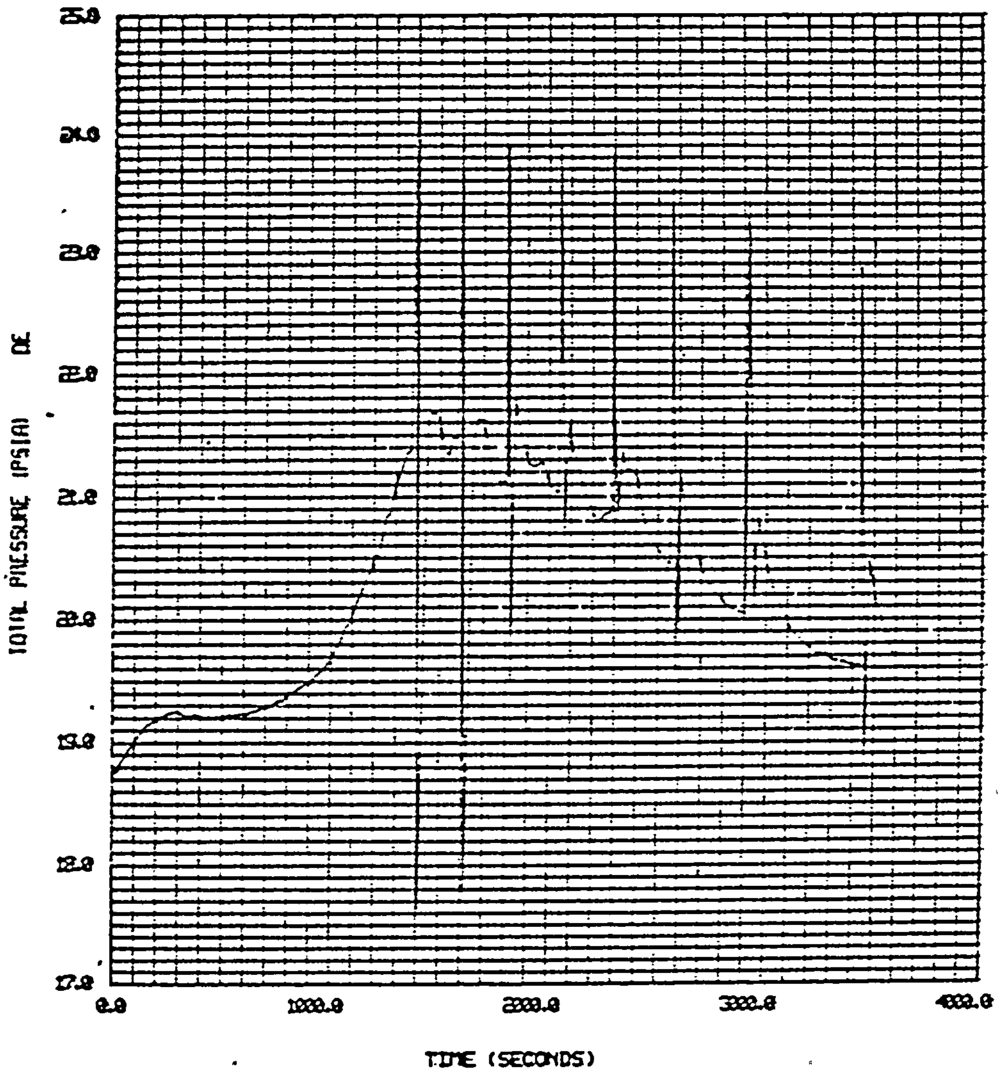
AEP S2D CASE2 80000 FAN 6323 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 19



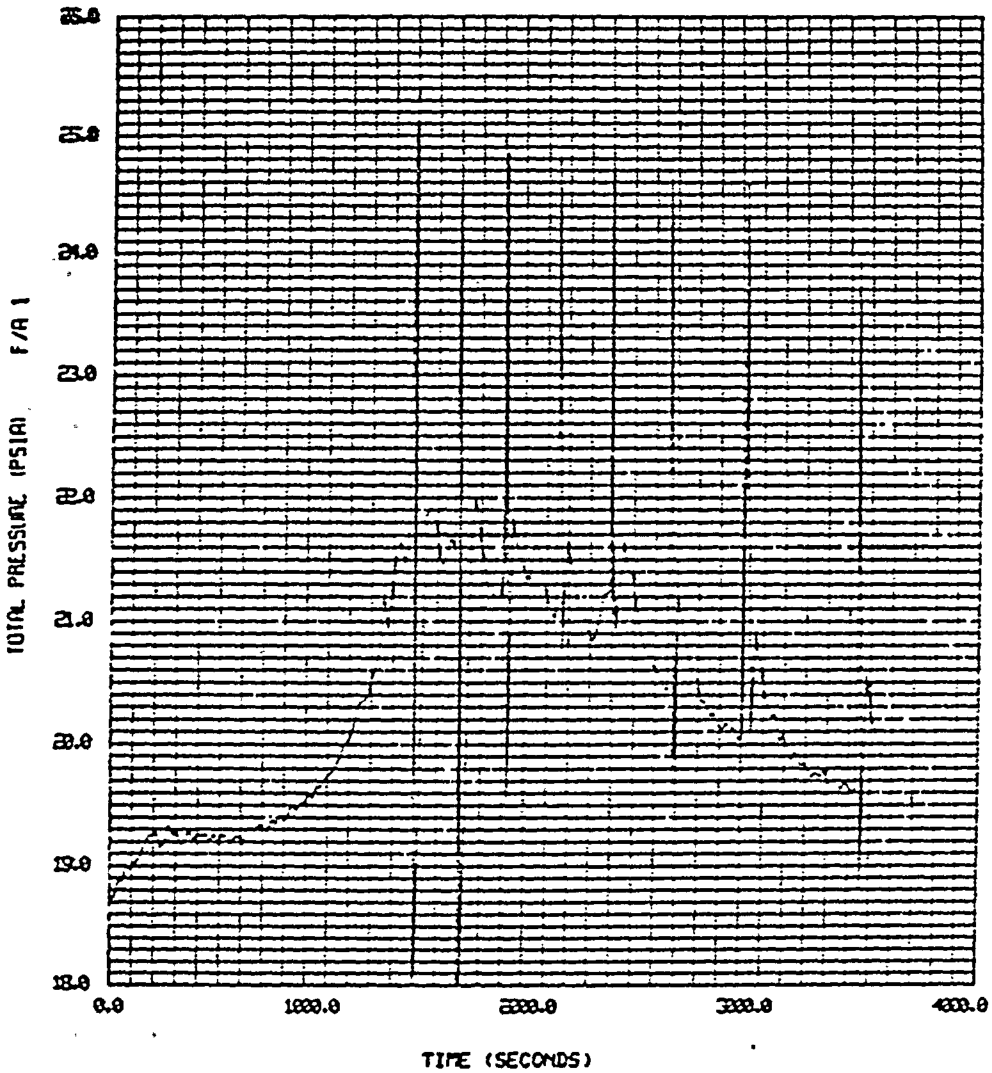
AEP S2D CASE2 80000 FAN 6328 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 20



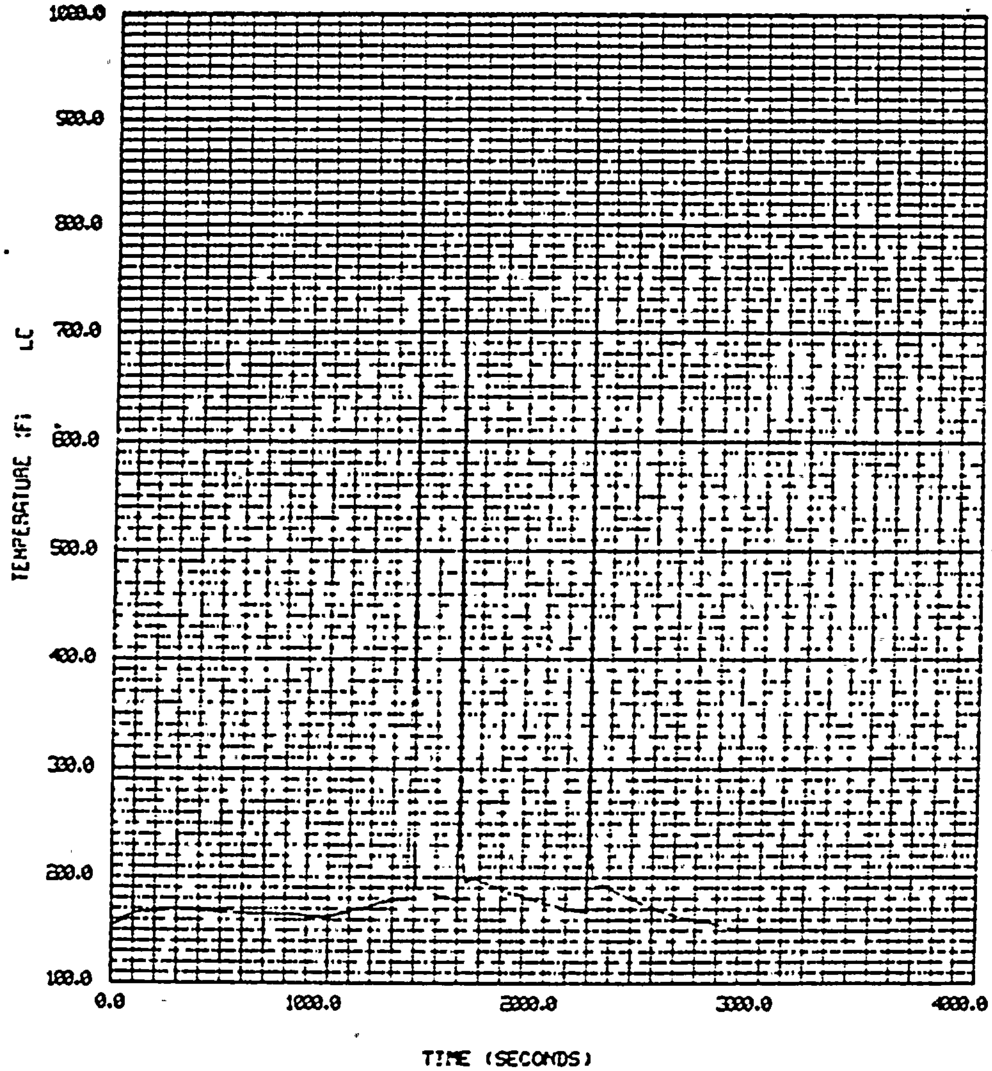
AEP S20 CASE2 80000 FAN 6320 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 21



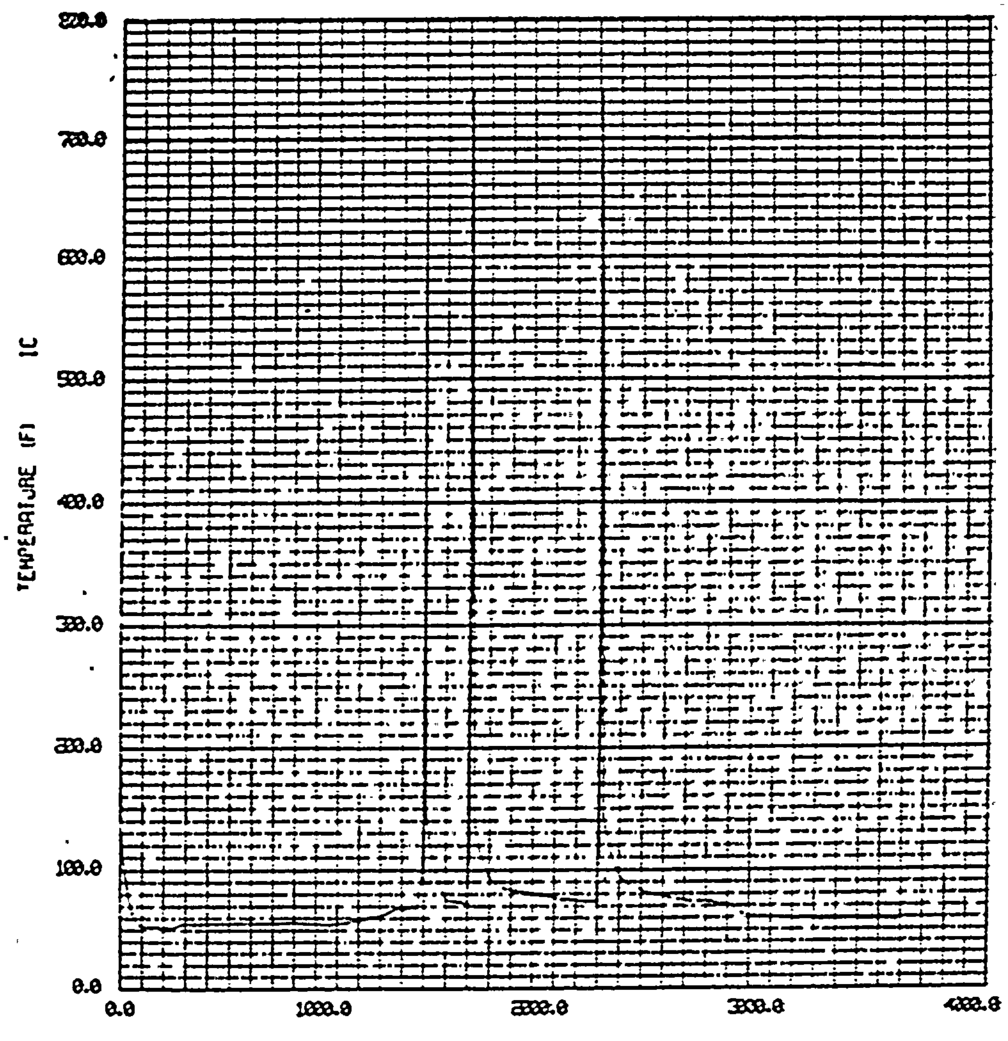
AEP 52D CASE2 80000 FAN 6328 SPRAY BURN 100 PCT AT 10 V/0 6 FPS T+3480

FIGURE 22



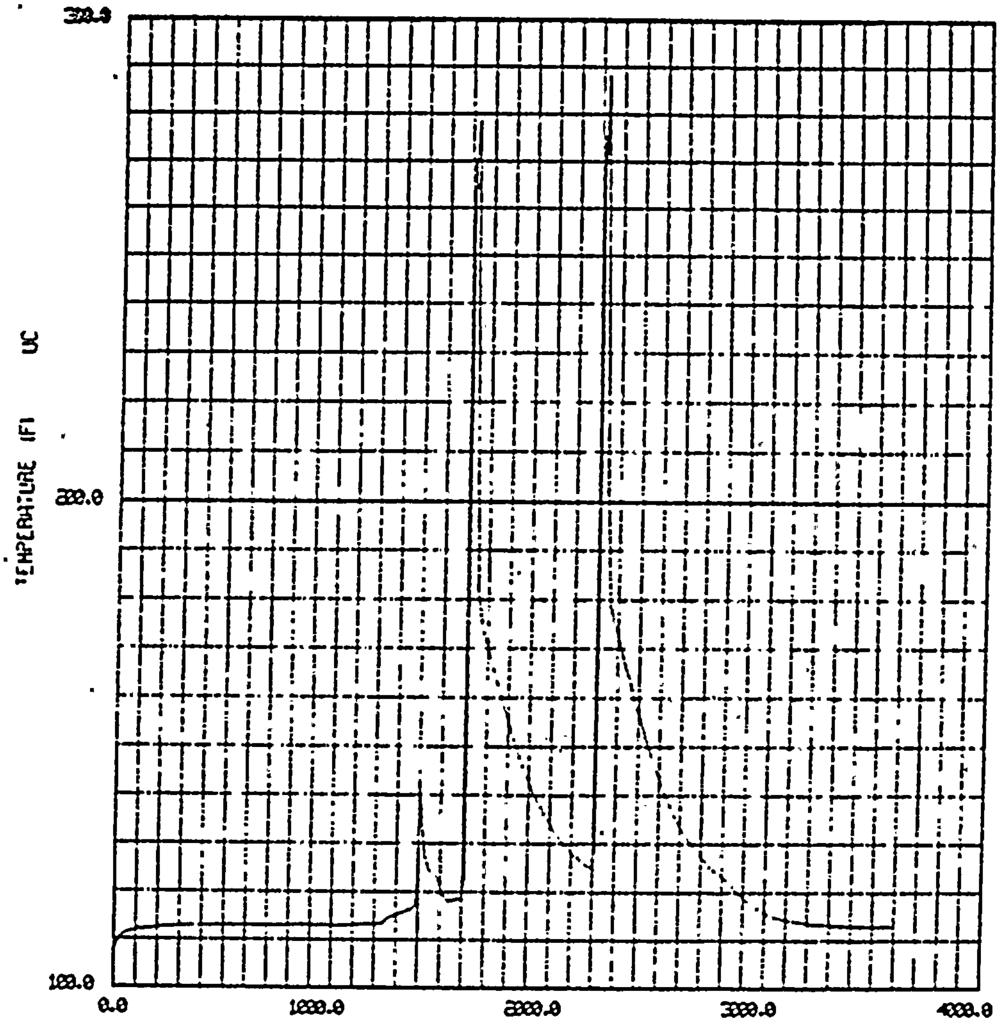
AEP S2D CASE3 80000 FAN 6328 SPRAY BURN 100-50 PCT AT 10-8 V/0 6 FPS T+3400

FIGURE 23



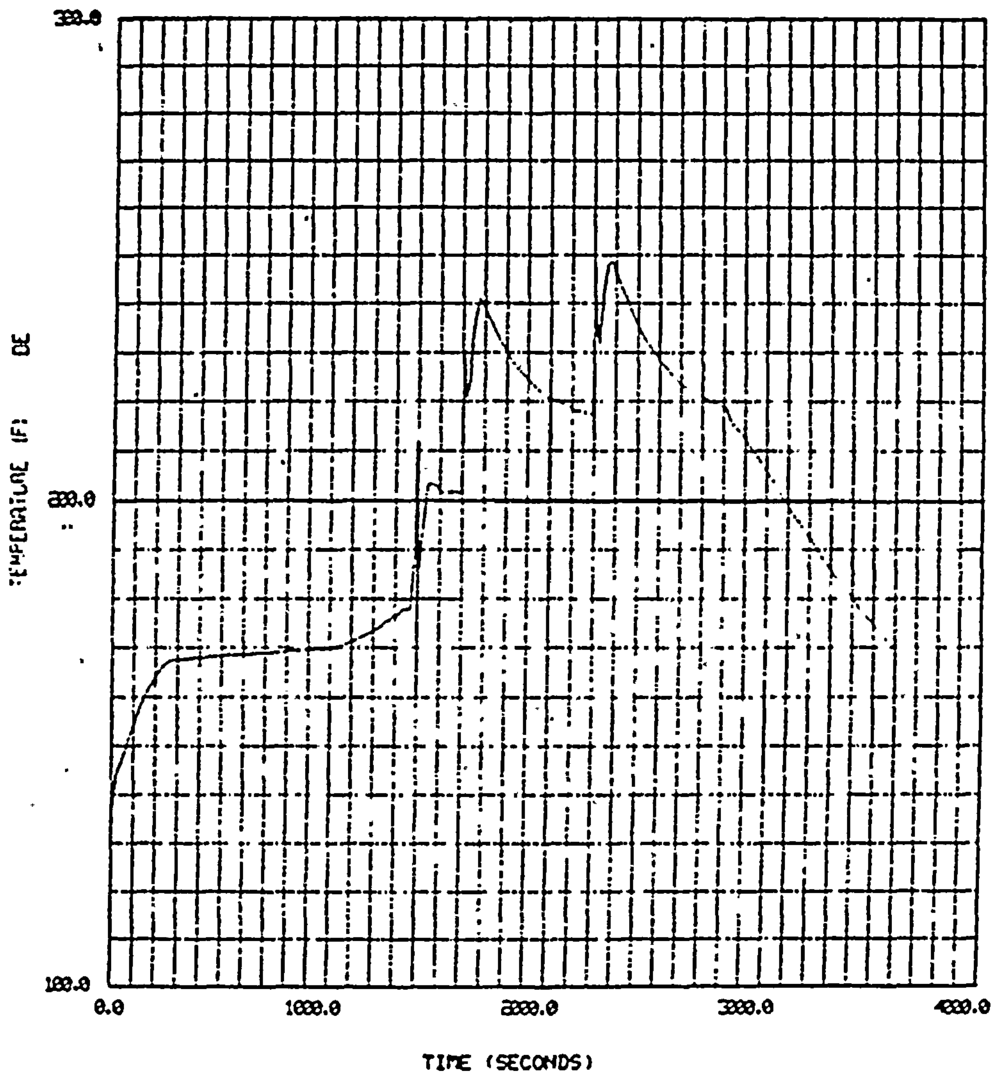
AEP S2D CASE3 80000 FAN 6328 SPRAY BURN 100-50 PCT.AT 10-8 W/8 6 FPS T+3480

FIGURE 24



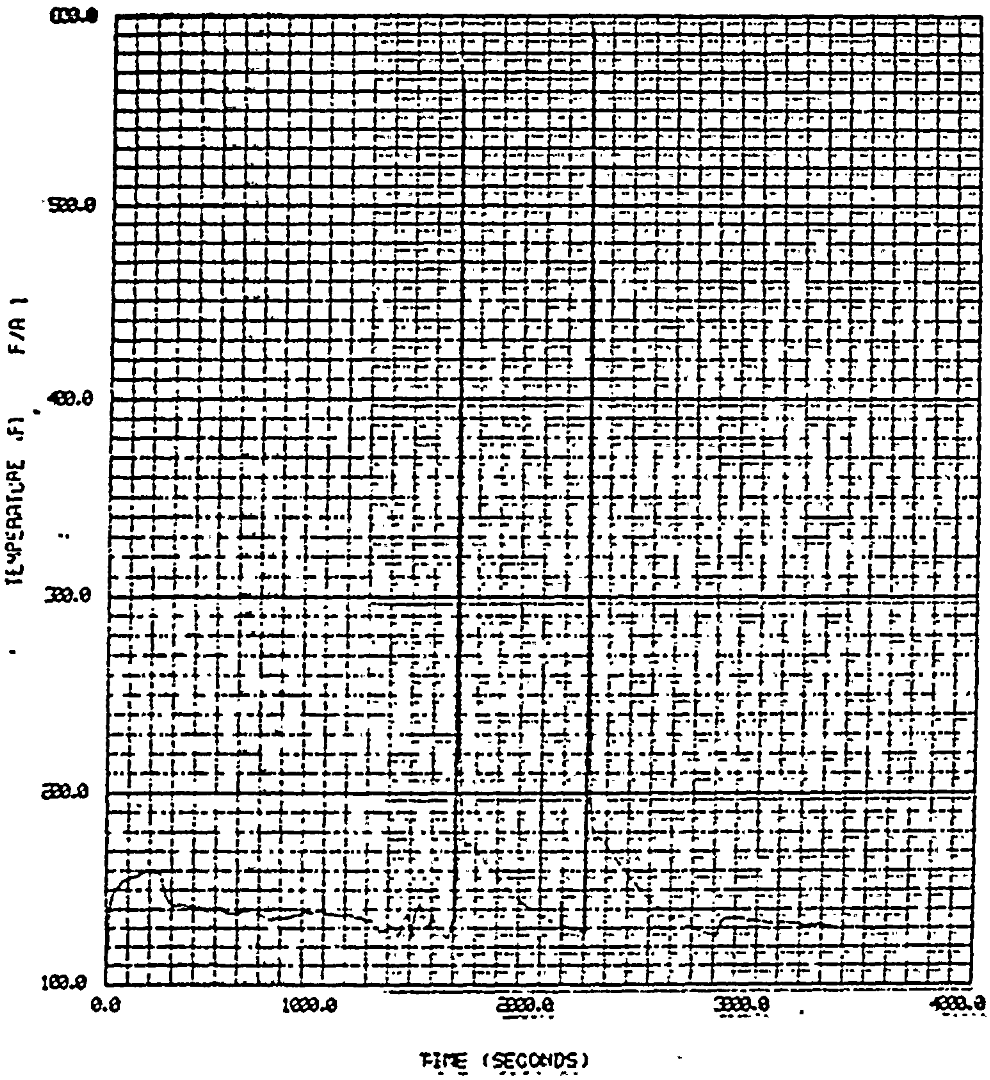
AEP S2D CASE3 80000 FAN 6328 SPRAY BURN 100-50 PCT AT 10-8 V/0 6 FPS T+3400

FIGURE 25



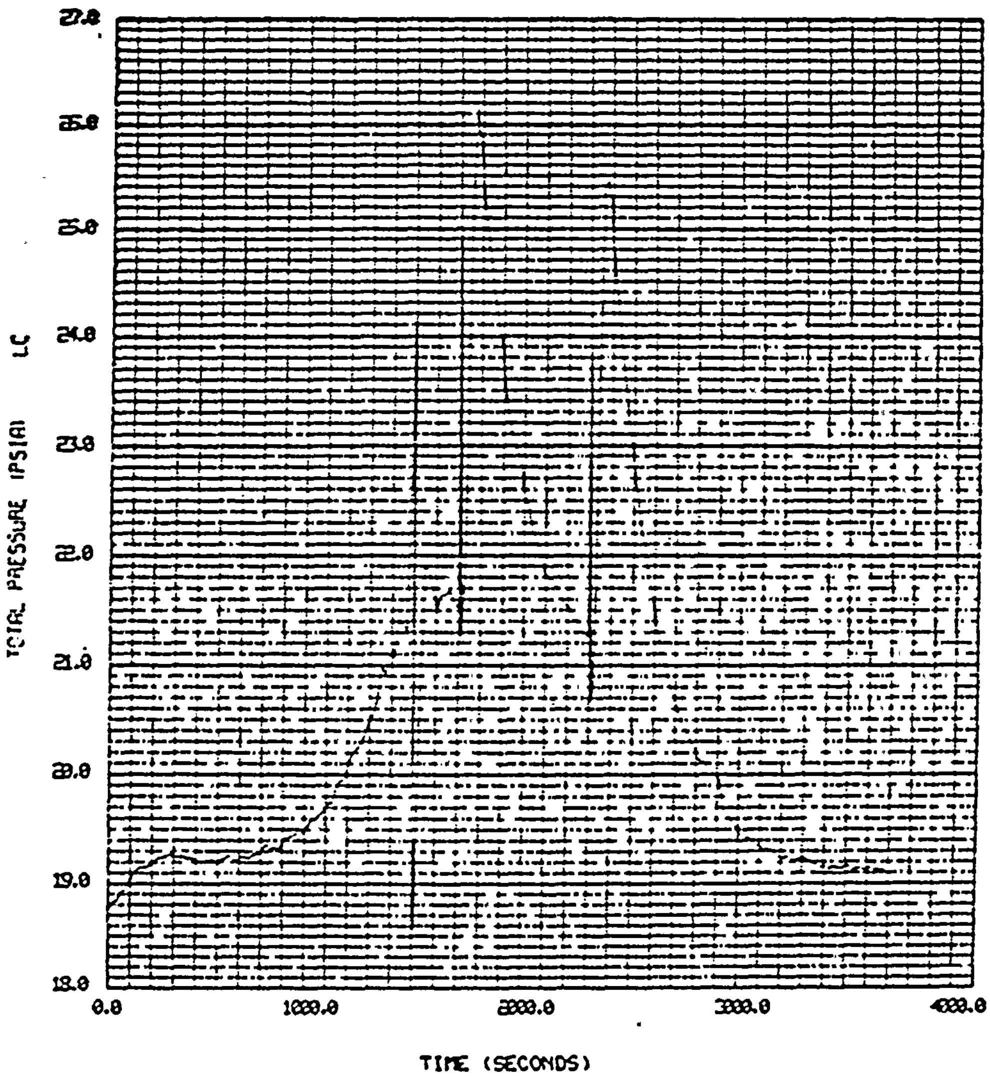
AEP 52D CASE3 80000 FAN 6328 SPRAY BURN 100-50 PCT AT 10-8 V/0 6 FPS T+3480

FIGURE 26



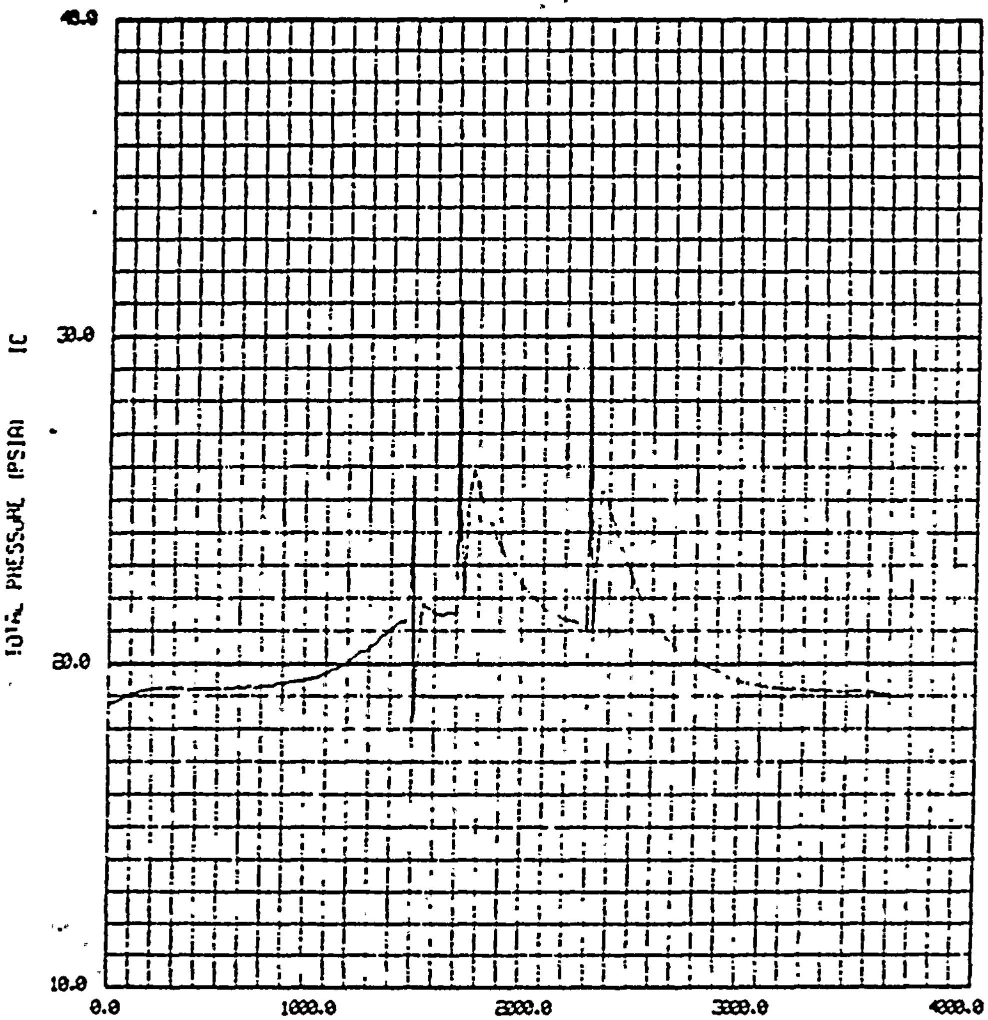
AEP S2D CASE3 80000 FAN 6328 SPRAY BURN 100=50 PCT AT 10=8 V/0 6 FPS T+3400

FIGURE 27



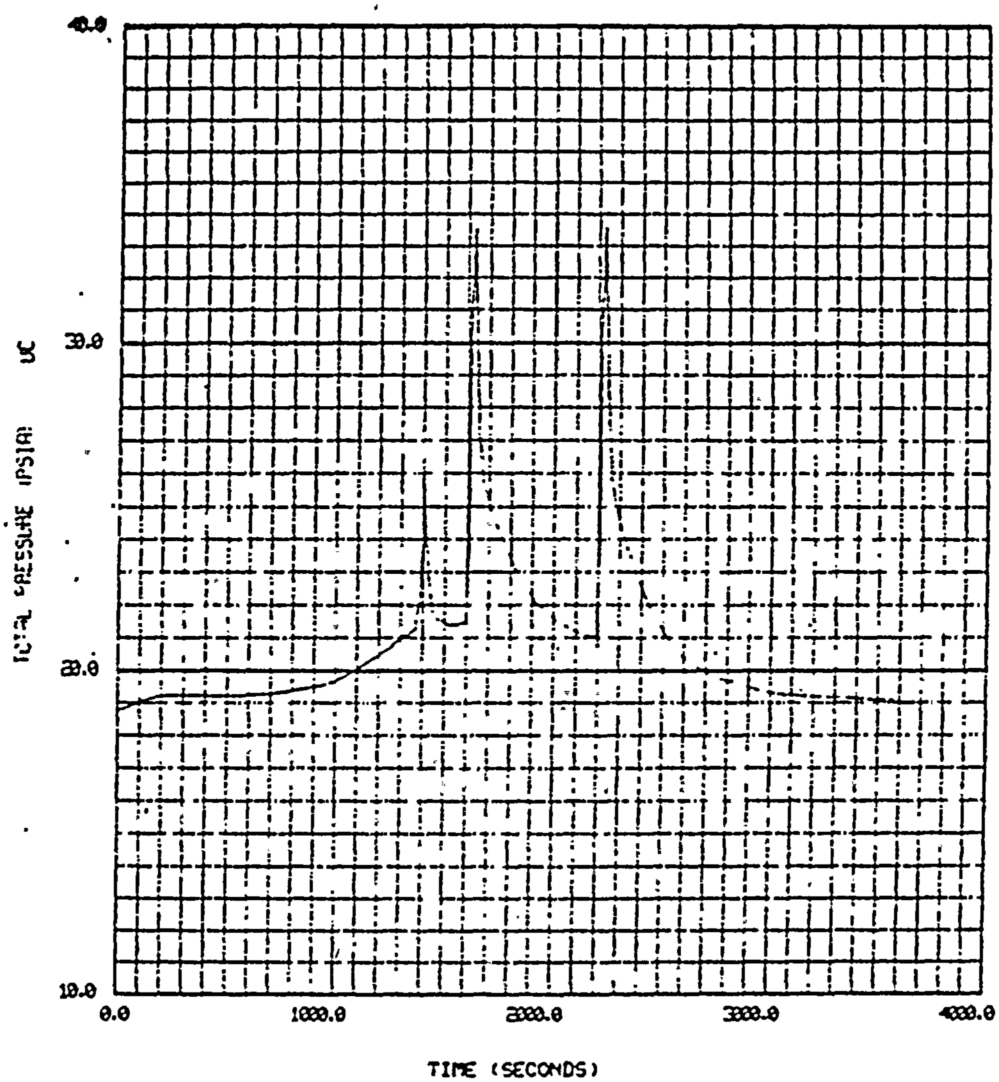
AEP S2D CASE3 20000 FAN 6328 SPRAY BURN 100-50 PCT AT 10-8 V/0 6 FPS T+3420

FIGURE 28



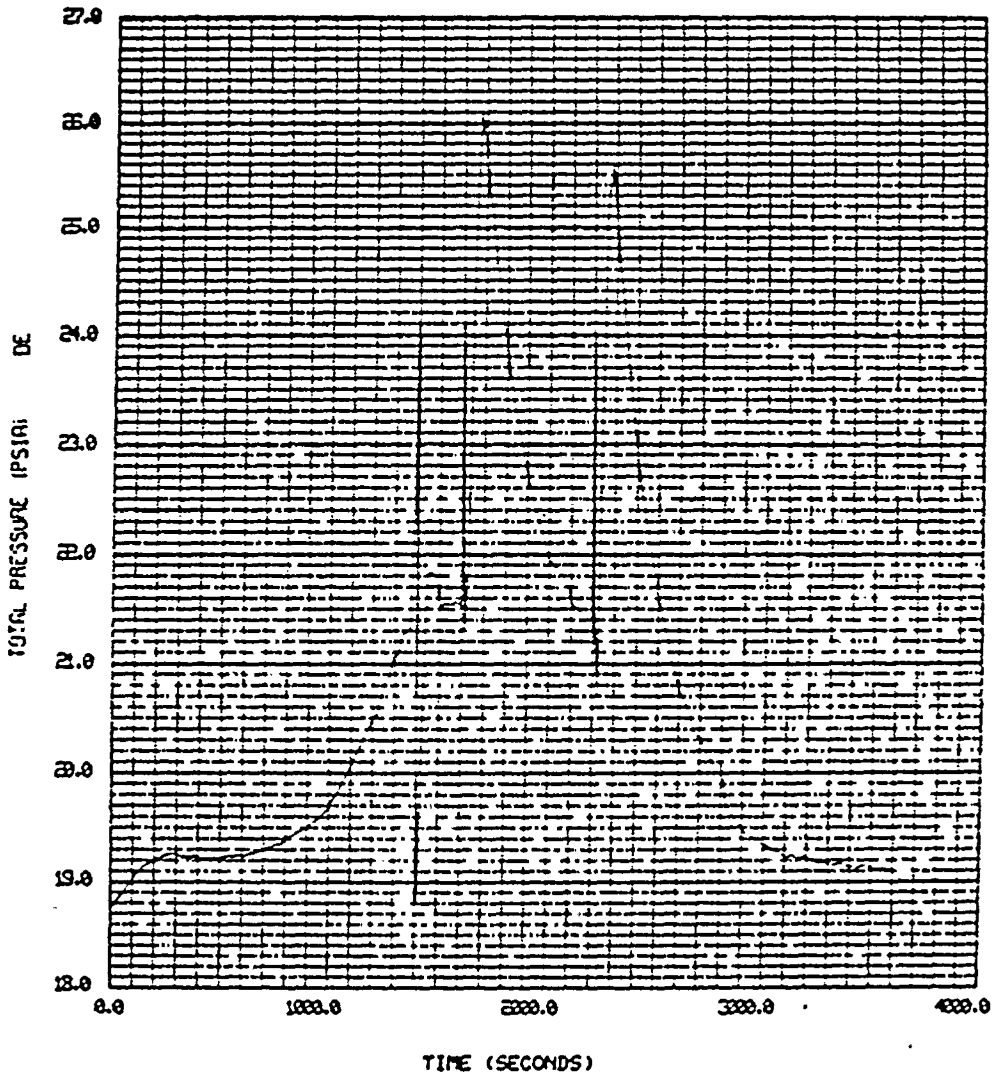
AEP S2D CASE3 80000 FAN 6328 SPRAY BURN 100-50 PCT AT 10-8 V/0 6 FPS T+3400

FIGURE 29



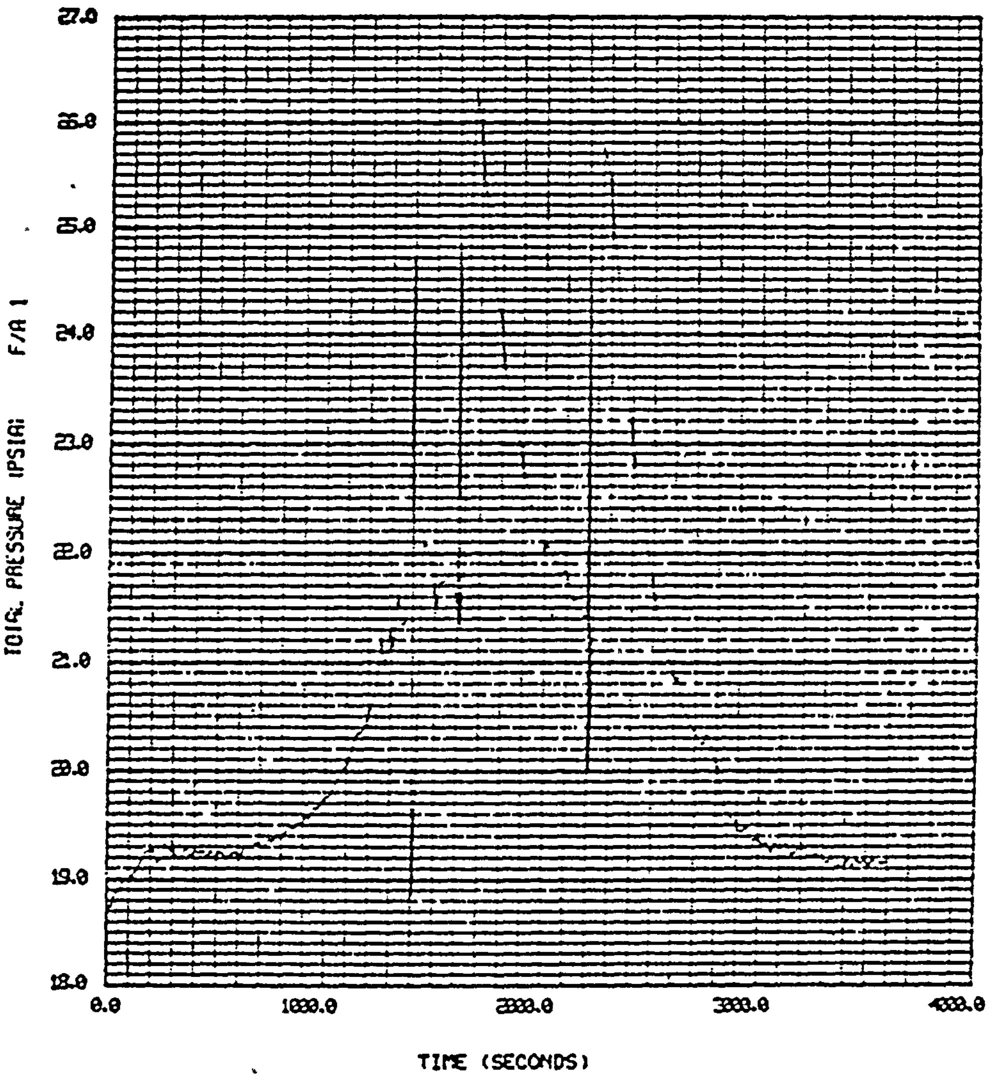
AEP S2D CASE3,80000 FAN 6328 SPRAY BURN 100-50 PCT AT 10-8 V/0 6 FPS T+3480

FIGURE 30



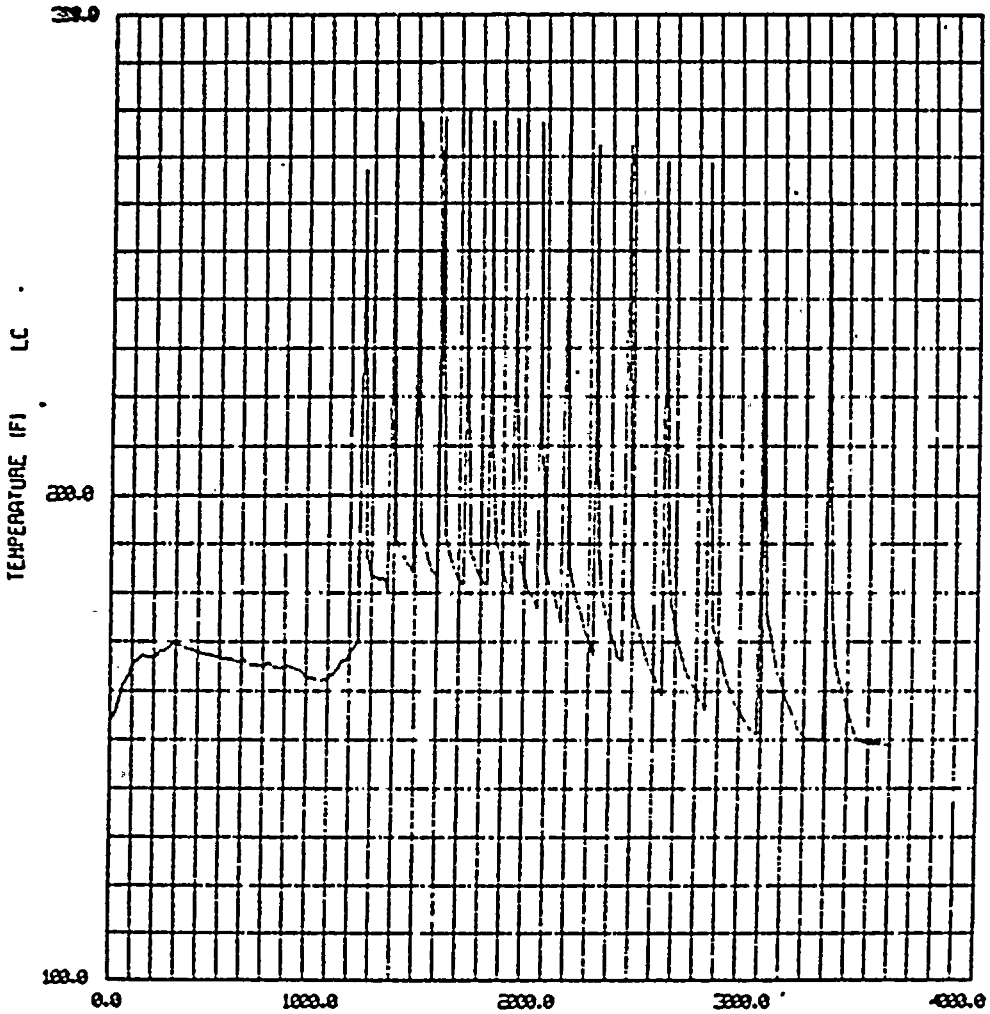
AEP S2D CASE3 80000 FAN 6328 SPRAY BURN 100-50 PCT AT 10-8 V/0 6 FPS T+3400

FIGURE 31



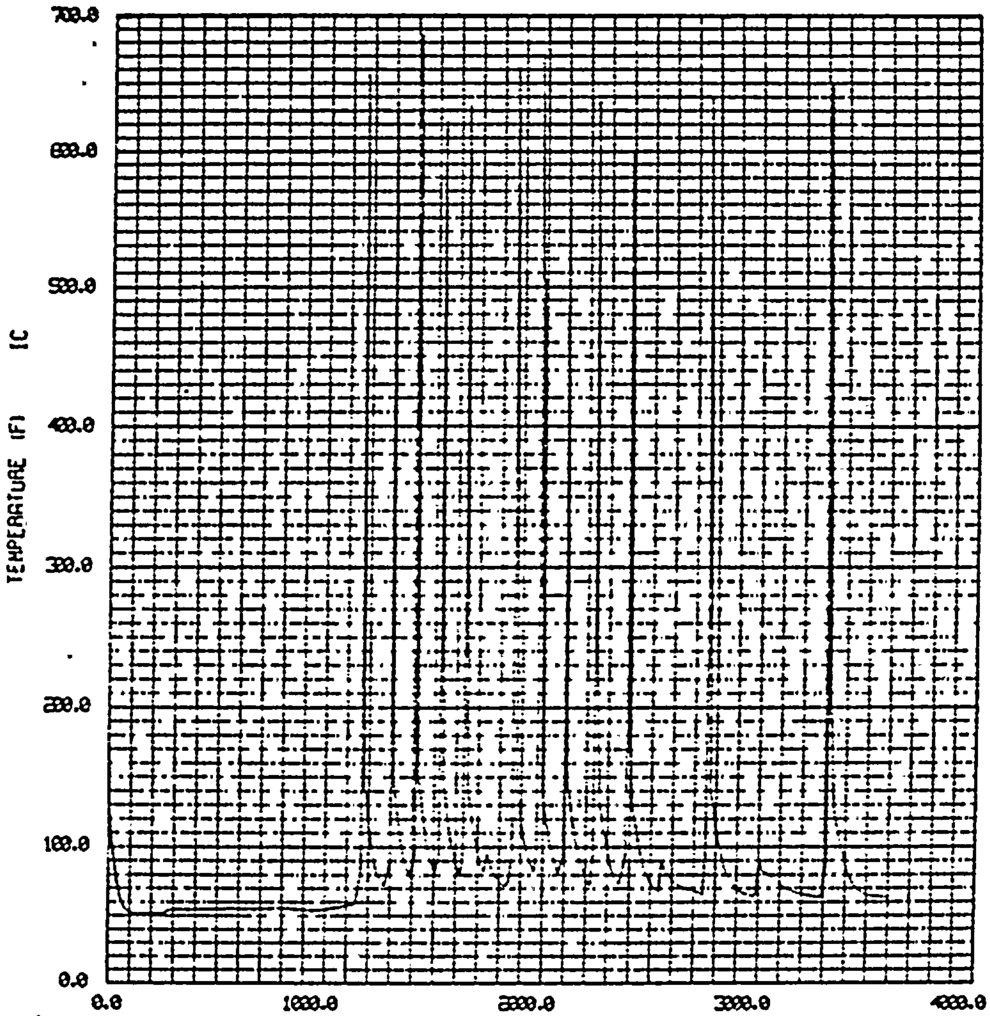
AEP S2D CASE3 80000 FAN 6328 SPRAY BURN 100-50 PCT AT 10-8 V/0 6 FPS T+3489

FIGURE 32



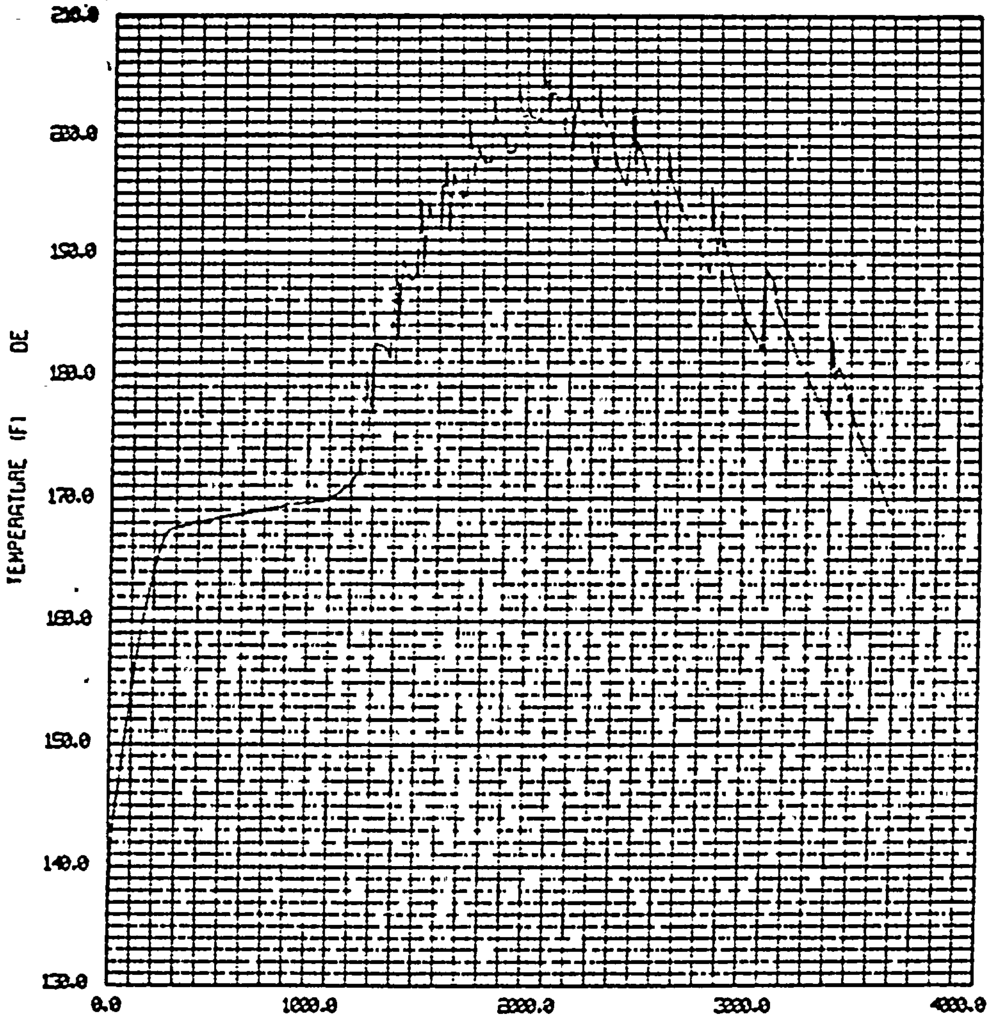
AEP S2D CASE4 80900 FAN 6328 SPRAY BURN 50 PCT AT 8-8 V/0 6 FPS T+3480

FIGURE 33



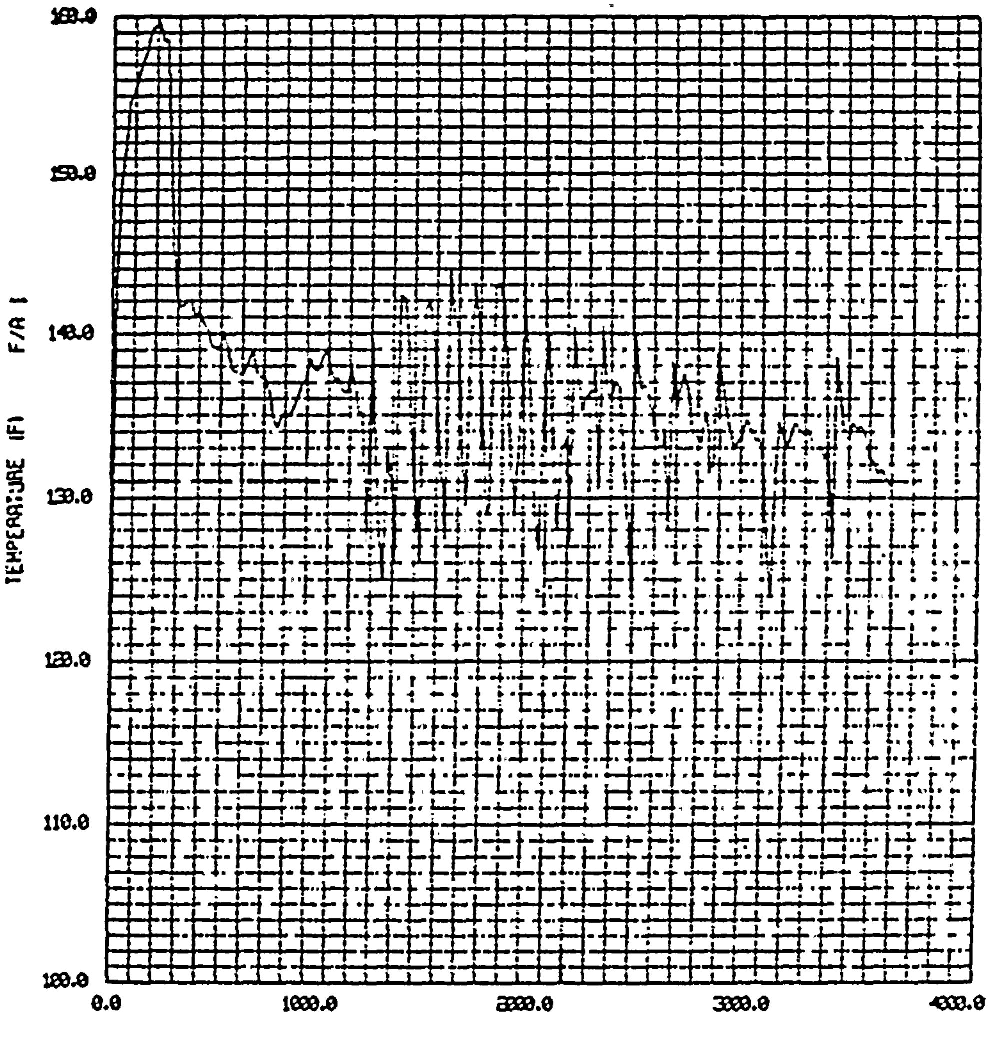
AEP S2D CASE4 89000 FAN 6328 SPRAY BURN 50 PCT AT 8-8 V/0 6 FPS T+3480

FIGURE 35



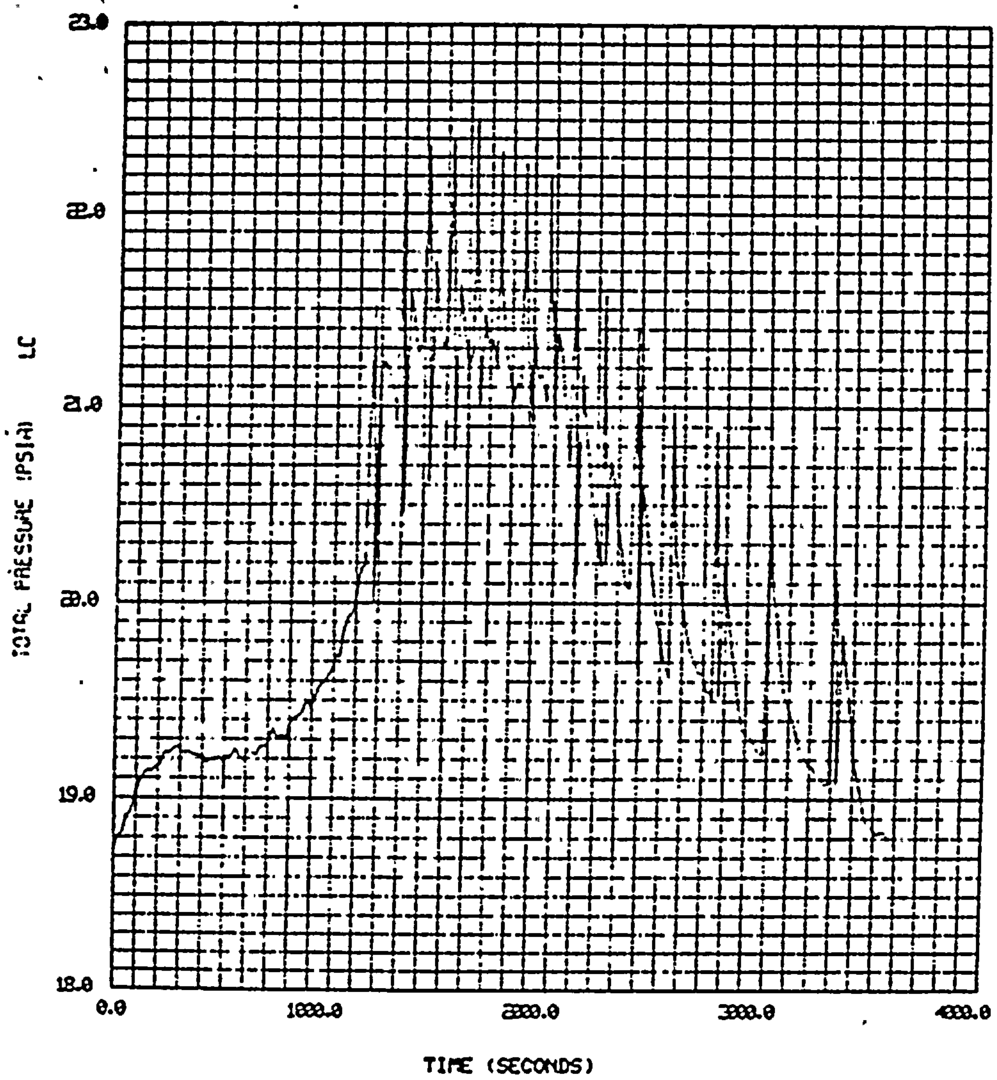
AEP S2D CASE4 80000 FAN 6328 SPRAY BURN 50 PCT AT 8-8 V/0 6 FPS T+3480

FIGURE 36



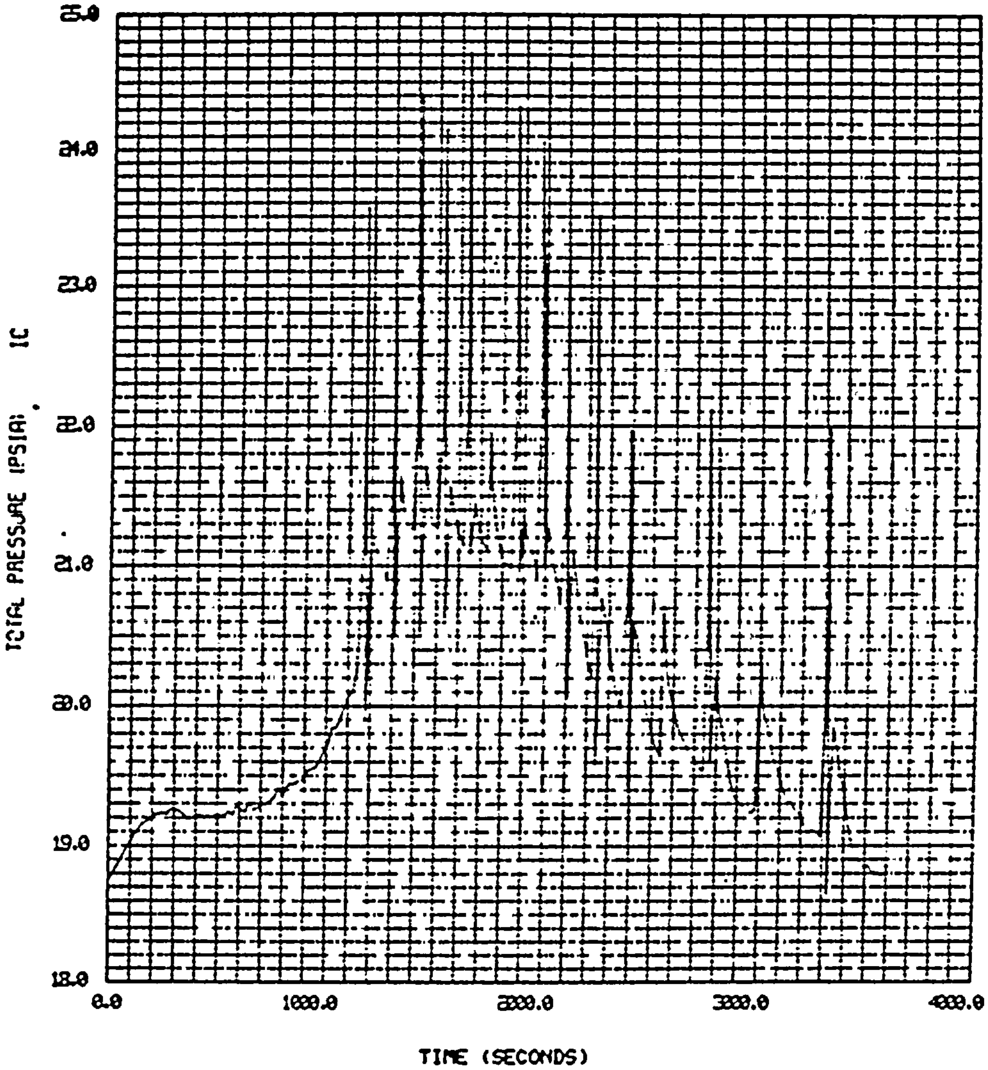
AEP S2D CASE4 80030 FAN 6328 SPRAY BURN 50 PCT AT 8-8 V/0 6 FPS T+3480

FIGURE 37



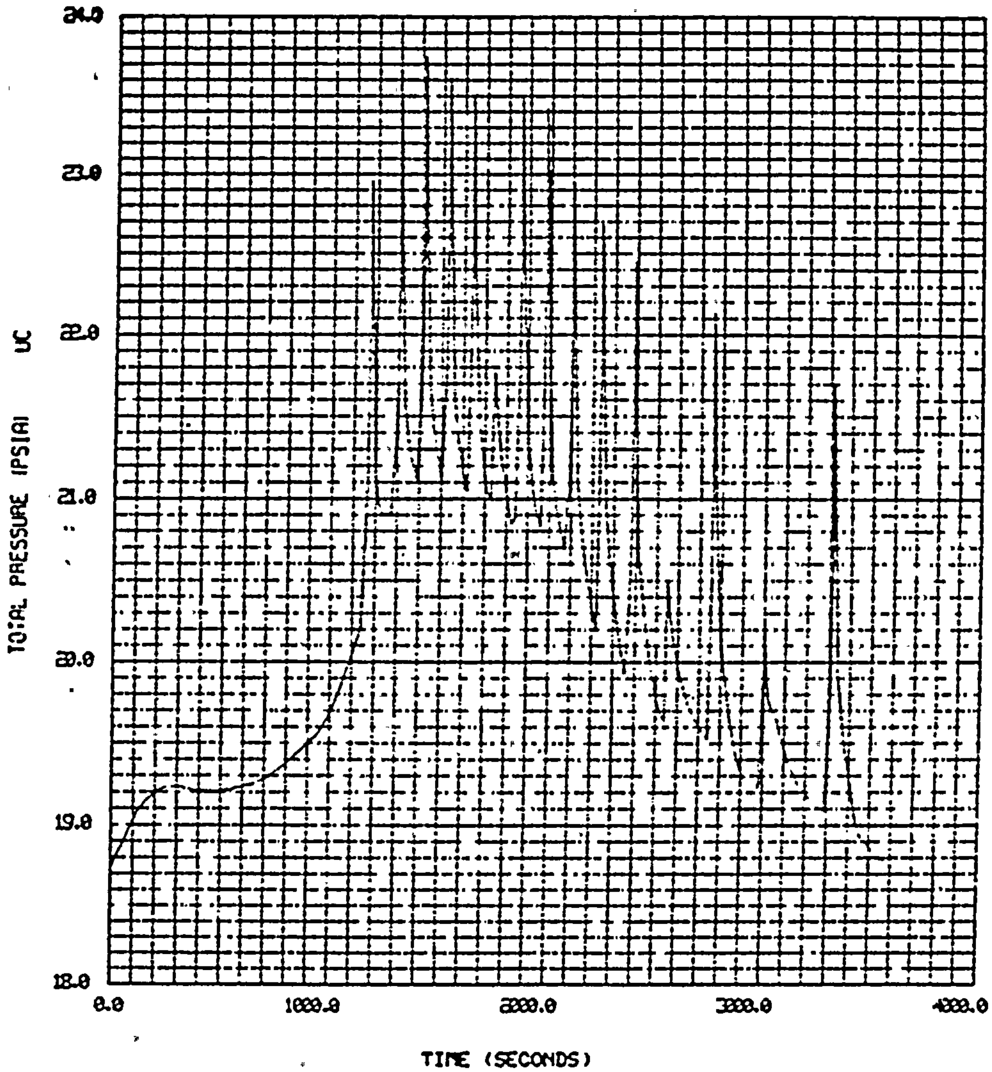
AEP S2D CASE4 80000 FAN 6328 SPRAY BURN 50 PCT AT 8-8 V/0 6 FPS T+3480

FIGURE 38



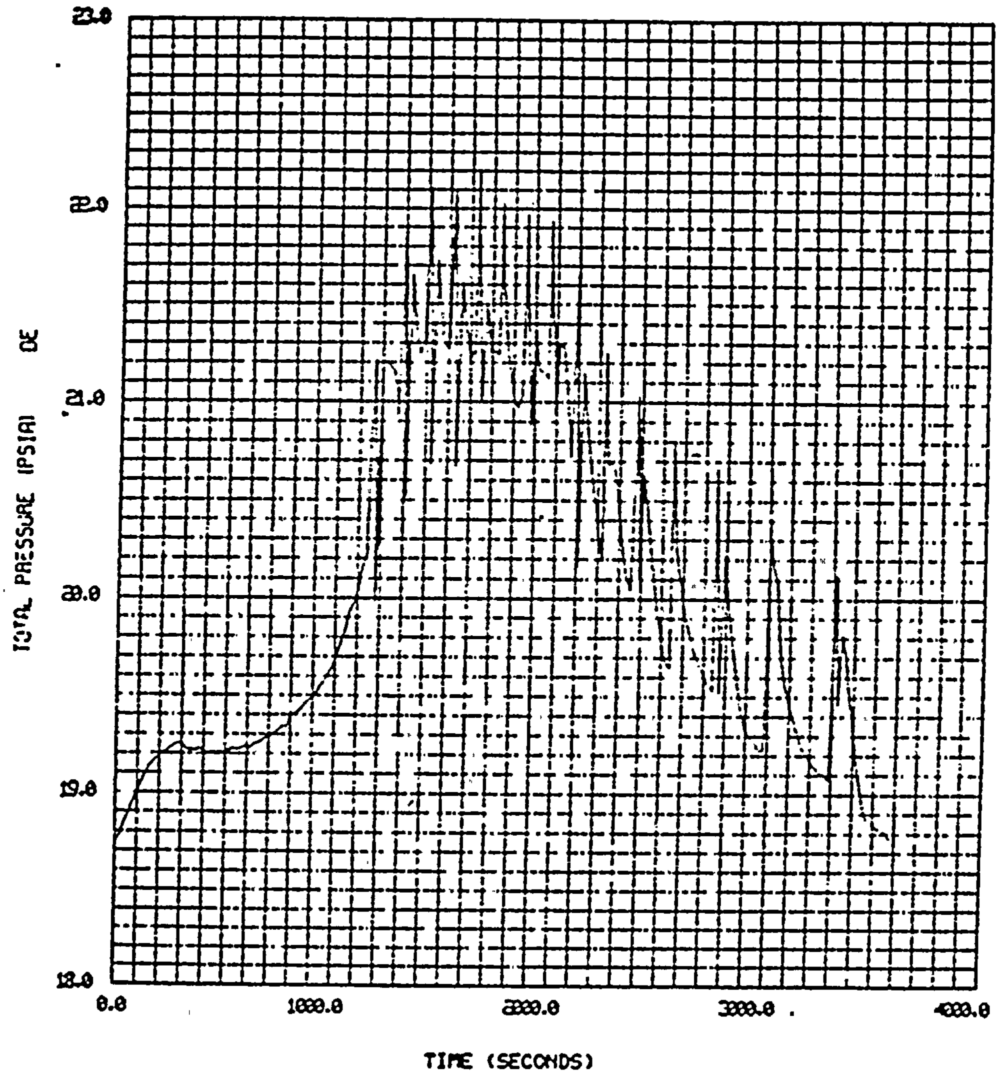
AEP S2D CASE4 80000 FAN 6320 SPRAY BURN 50 PCT AT 8-8 V/0 6 FPS T+3480

FIGURE 39



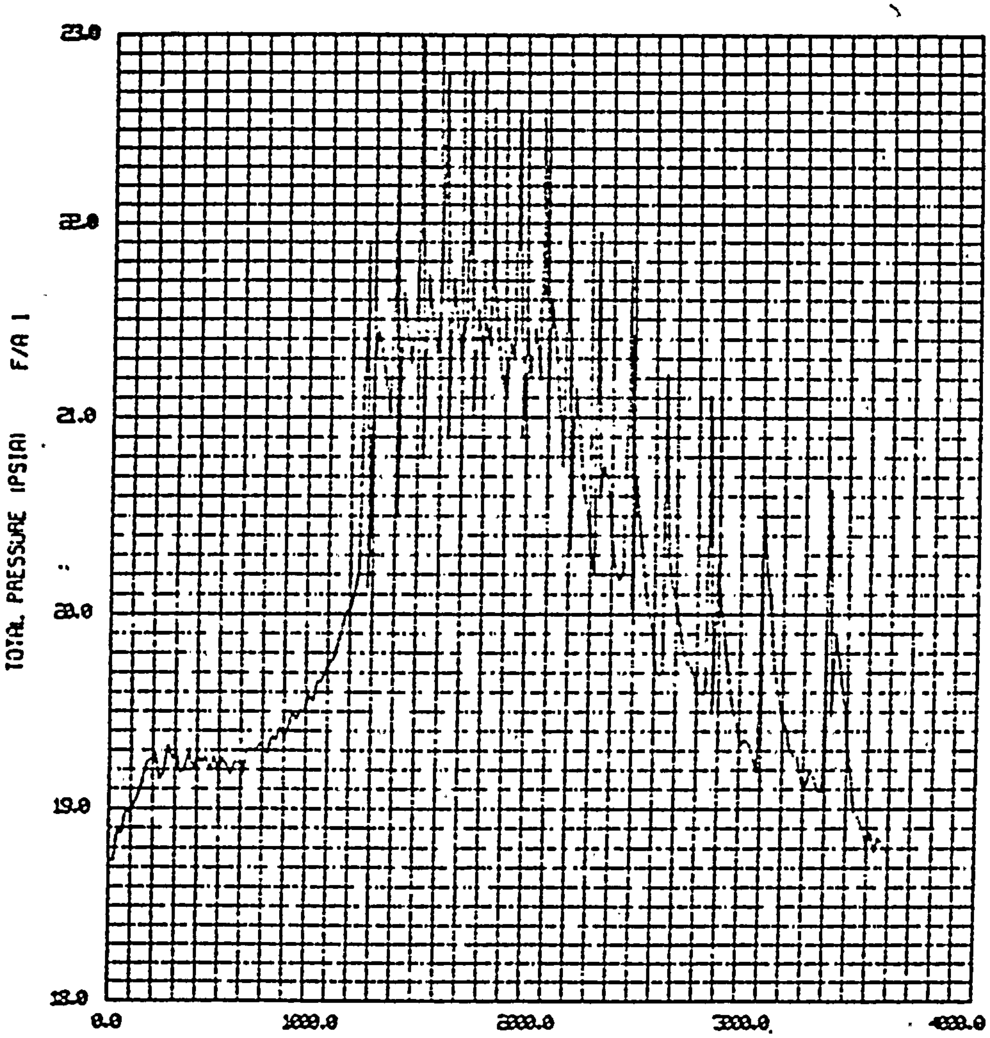
AEP S2D CASE4 80000 FAN 6328 SPRAY BURN 50 PCT AT 8-8 V/0 6 FPS T+3480

FIGURE 40



AEP S2D CASE4 80000 FAN 6328 SPRAY BURN 50 PCT AT 8-8 V/0 6 FPS T+3480

FIGURE 41



AEP S2D CASE4 80000 FAN 6328 SPRAY BURN 50 PCT AT 8-8 V/0 6 FPS T+3480

ATTACHMENT 3 TO AEP:NRC:00500

ITEM 1 OF ATTACHMENT 3 TO AEP:NRC:00500

SMA has reviewed the report entitled "D. C. Cook Nuclear Power Plant American Electric Power Estimate of Ultimate Pressure Capacity of Containment Structure" dated 26 September 1980, prepared by Harstead Engineering Associates, Inc. which was transmitted to AEP from the NRC by letter from S. A. Varga dtd. 6 November 1980.

While we appreciate the report was a preliminary, limited evaluation which did not necessarily identify all limiting failure modes nor did it rigorously evaluate those modes which were identified, we have identified three areas where SMA believes the Harstead report has underestimated the ultimate pressure retaining capacity of the D. C. Cook containment.

On sheets 5-1-1 (second) through 5-1-3 of the Harstead calculations a shell pullout failure mode where the base slab concrete fails in diagonal tension is identified which limits the containment capacity to 46 psi. We believe this evaluation is overly conservative because no consideration was taken of the capacity of the base mat concrete to carry diagonal tension (shear) in accordance with the existing design code equation even in the presence of membrane tension in the base mat. In the attached analysis (shts. 1-3) Harstead's analysis has been modified to include the effect of concrete carrying diagonal tension. Results of this analysis indicates that this particular failure mode can carry internal pressures in excess of 70 psi.

On sheet 8-1-4 of the Harstead report the moment capacity of the splice has been arbitrarily assumed limited by a lever arm of 4.5 inches or the distance from the centroid of the tension bolt to the center of the 4 inch plate. Since the capacity of the joint to transfer moment is limited by the bending capacity of the 2 inch splice plate loaded in tension, T, the arbitrary selection of the 4.5 inch lever arm increases the T seen by the bolt. In the attached analysis the limiting moment on the splice is determined by tension in the bolt. The resultant capacity of the splice based on Harstead's plate capacity assumption is 43.6 psi rather than the 23.5 psi determined in the report. It should also be noted that detailed finite element analysis of the hatch indicates the maximum moment does not occur in the splice as will be further documented in the containment report currently under preparation.

Finally, Harstead used specified minimum material strengths where the other two ice containment evaluation reports (Sequoyah and McGuire) used actual mill test values (lowest test value) as reported in the attachment to Mr. Dirchs letter to NRC Chairman Ahearne dated 26 November 1980. This results in a bias comparison unfavorable to D. C. Cook since such test values are greater than the specified minimum values used in design.

For the reasons stated above we believe the Harstead report gives limiting internal pressure capacities for the D. C. Cook containment which are understated and have not been determined on a basis which can permit direct comparison with similar containment systems.

①	SUBJECT: EVALUATION OF BASE SLAB TO CARRY AXIAL TENSILE LOAD FROM CONTAINMENT SHELL	SHEET 1 OF 3 BY JDS

HARSTEAD CALCULATION NEGLECTS SHEAR (DIAGONAL TENSION) CAPACITY OF CONCRETE IN BASE SLAB.

1) CALCULATE SHEAR (DIAGONAL TENSION) CAPACITY OF BASE SLAB.

a) DETERMINE MEMBER TENSILE STRESS IN BASE SLAB

$$V_B = \frac{P}{\beta}$$

WHERE

$$\beta^4 = \left[\frac{E_s h_s}{4 a_c^2 D}\right]$$

$$D = \frac{E_c h_c^3}{12(1-\nu)}$$

$E_s = 29 \times 10^6$ PSI

$h_s = \sim 2\#18 @ 18'' + \frac{3}{8}''$ LINER

$h_s = 8''/18'' + \frac{3}{8}'' = 0.819$ IN./IN.

$a_c = 711$ IN.

$h_c = 42$ IN.

$\nu_c = 0.17$, $\nu_s = 0.3$

$E_c = 3 \times 10^6$ PSI

$E_s = 29 \times 10^6$ PSI.

	SUBJECT EVALUATION OF BASE SLAB TO CARRY AXIAL TENSILE LOAD FROM CONTAINMENT SHELL	SHEET 2 OF 3 BY JDS

$$\beta^4 = \frac{29\times10^6 \times 0.819}{4 \times (711)^2 \times D}$$

$$D = \frac{3\times10^6 \times (42)^3}{12(1-0.17)^2} = 26.9\times10^9$$

$$\beta^4 = 4.4\times10^{-10}$$
$$\beta = 0.458\times10^{-2}$$

$$V_B = \frac{P}{\beta} = \frac{70}{0.458\times10^{-2}}$$

$V_B = 15.2$ K/IN. = 182.4 K/Ft. OF WALL

FROM CC 3421.4.1 OF THE ASME-CC CODE (1977) ←

$$V_c = 2.0\sqrt{f'c}\,(1-0.002\,Nu/Ag)$$

WHERE

$Nu = 182.4$ K/Ft.

$Ag = 10\times12\times12 = 1440$ IN^2

$\therefore 0.002 \times 182.40/1440 = 0.253$

$$V_c = 2.0\sqrt{3500}\,(1-0.253)$$
$$= 2.0 \times 59.2 \times 0.747 = 88.4 \text{ PSI}$$

RADIAL SHEAR CAPACITY OF CONCRETE IN BASEMENT

$88.4\cdot12\cdot12\cdot10 = 127.36$ K/Ft.

	SUBJECT EVALUATION OF BASE SLAB TO CARRY AXIAL TENSILE LOAD FROM CONTAINMENT SHELL	SHEET 3 OF 3
		BY ______ DATE ______

CONSERVATIVELY ASSUME 48.2 PSI CARRIED BY SUMMATION OF FORCES AS DETERMINED BY HARSTEAD CALCULATION ON SUMMATION OF FORCES

$$\text{EXCESS} = 70 - 48.2 = \frac{21.8 \cdot 690}{2} = 90.252 \text{ K/FT.}$$

$90.252 < 127.36$ ∴ SHEAR (DIAGONAL TENSION) FAILURE WILL NOT OCCUR UP TO 70 PSI INTERNAL PRESSURE

GIVEN THE LIMITING CASE OF DEAD LOAD CAUSING TENSION IN BASE MAT FROM GENSHEL ANALYSIS (AEP)

(PRESSURE) (DEAD WT.)
$$182,400 + 51,600 = 234.0 \text{ K/FT.}$$

$$0.002 \times 234000/1440 = .325$$

$$v_c = 2.0 \times 59.2 \times .675 = 79.9 \text{ PSI}$$

RADIAL SHEAR CAPACITY OF CONCRETE IN BASE

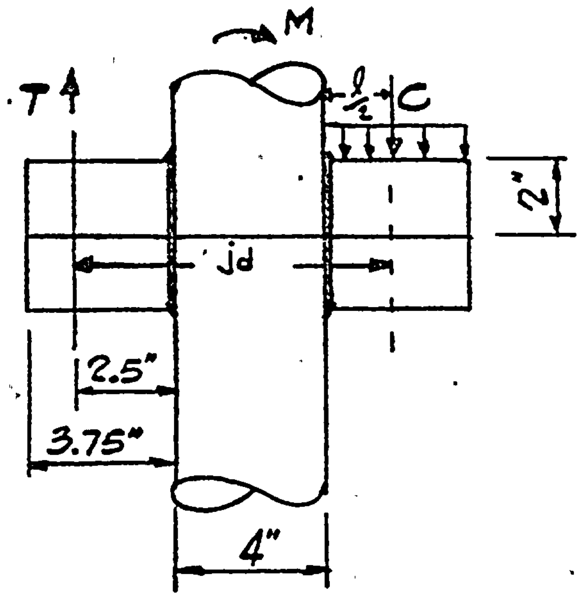
$$79.9 \times 12 \times 12 \times 10 = 116.01 \text{ K/FT}$$

$$90.252 < 116.0 \;\therefore\; \text{OK}$$

NOTE: THIS IS HARSTEAD'S LIMITING CALCUATION IN CONCRETE. DETAILED ANALYSIS MAY SHOW OTHER FAILURE MODES MORE LIMITING.

②	SUBJECT: CAPACITY OF SPLICE PLATE IN EQUIPMENT HATCH FOR D.C. COOK CONT.	SHEET 1 OF 1 BY JDS

GIVEN: SPLICE AS SHOWN
DETERMINE MOMENT CAPACITY OF SPLICE
(a) ASSUME C CONTROLLED BY BEARING BETWEEN PLATES IN COMPRESSION
(b) Assume T controls from bolt



ALLOWABLE – 2" ℄

$M_{c℄} = f_s S = 38 \cdot \frac{1}{6} \times 2.36\text{ IN.} \times 4 = 59.8^{K\cdot IN}/2.36$ IN. OF SPLICE

where the 2.36 IN spacing is the distance between bolts on tension side of splice

$= 25.34^{K\cdot IN./IN.}$ OF SPLICE

(a)

LIMITING BEARING STRESS – COMPRESSION

$(l \cdot l/2) = 3.75 \cdot 1.875 = 7.03$

$f_b = 25.34/7.03 = 3.60$ KSI.

(b) M_c SPLICE $= 3.60 \cdot 3.75 \cdot (2.5 + 4.0 + 1.875) = 113.06$ K·IN/IN. OF
M_t SPLICE $= 25.34/2.5 = 10.136 \cdot (2.5+4.0+1.875) = 84.89$ " SPLICE

(C) COMPARE SPLICE MOMENT CAPACITY TO THAT OF 4" ℄.

$M_{℄} = f_s S \cdot \frac{1}{6} bh^2 = 38 \cdot \frac{1}{6}\ 1 \cdot 16 = 101.33$ K-in

(d) RESULTANT CAPACITY

4" ℄ from HARSTEAD $= 52.0\text{ psi} \cdot \frac{84.89}{101.33} = 43.6$ psi

(e) TENSILE CAPACITY of BOLT

$40 \cdot (.994) \frac{(105)}{70} = 56.6$ psi

ASTM A.193 67 $f_y = 105$ Ksi not 60 Ksi assumed by HARSTEAD

ITEM 2 OF ATTACHMENT 3 TO AEP:NRC:00500

SMA is currently preparing a containment design report on the limiting internal static pressure capacity of the D. C. Cook containment based on the mean as tested material properties which is scheduled for completion by 31 January 1981. Preliminary results of the analysis performed to date indicate the limiting failure mode in the concrete is combined pressure and dead weight shear in the base mat near the attachment to the cylindrical shell. (Note: this is not the same failure mode evaluated by Harstead) The detailed analysis of this failure mode is being performed by AEPSC since the shear loads are based on the GENSHEL computer analysis originally performed by AEPSC during the initial design of the plant. The input and output and design assumptions originally used in the analysis are now being reviewed jointly by AEPSC and SMA.

The other potentially limiting failure modes being evaluated in detail are the limiting pressure capacities of the equipment hatch and personnel hatch. For both the equipment and personnel hatch a two dimensional finite element analysis using the ANSYS computer program is being performed to develop limiting pressure capacities.

It is anticipated that the results of the evaluations currently underway will develop a limiting existing equipment hatch capacity of approximately 40 psi and 48 psi for the concrete based on mean material properties. Lower bound values using specified minimum strength properties would be approximately 30 psi and 40 psi respectively.

ITEM 3 OF ATTACHMENT 3 TO AEP:NRC:00500

At the meeting with the NRC Staff an oral presentation was made by Dr. J. D. Stevenson to the NRC Staff using overhead transparencies as visual aids. Dr. Stevenson's presentation was limited to items 3 and 4 on the attached agenda.

Dr. Stevenson presented Side 1 which was a suggested modification of page 1 of the Table entitled "Design Criteria and Lower Bound Pressure Capacity of Ice Condenser and Mark III Containments" which was attached to a Memorandum to Chairman Ahearne from W. J. Dircks, Executive Director for Operations - NRC, Subject: Ice Condenser and Mark III Containment Internal Pressure Capabilities dtd. November 26, 1980. The suggested changes to the original letter text are shown on Attachment 1.

a. Design pressure reduced from 15 to 12 psi

b. Lower bound Static Pressure Capacity Hatch Cover changed from 49.7 to 69.7 psi

c. Material Strength Assumptions Change "Code Specified" to "Actual Mill Test Values"

These modifications were suggested to make the D. C. Cook containment capacities directly comparable to Sequoyah and McGuire. The actual mill test values used were the mean values taken from random selected samples of the containment materials shown in Slide 2. During the meeting Dr. F. Schauer, NRC Structural Branch Chief, indicated that the "Actual Mill Test Values" indicated for Sequoyah and McGuire were based on the minimum or smallest actual sample test value not the mean value. Such a modification would reduce the pressure capacity values shown in Slide 1 by approximately 15 percent which would still significantly increase the lower bound static pressure capacity indicated for D. C. Cook on Attachment 1.

The bulk of the rest of the meeting was an oral presentation by Dr. Stevenson and a discussion of Harstead's report highlighting the areas of disagreement which are shown on Slide 3 which is summarized in Item 2 of this communication. In addition Dr. Stevenson briefly summarized the results of the hatch finite element analysis performed to date indicating the maximum moment in the hatch plate is occurring adjacent to the personnel hatch and not in the equipment hatch plate splice. A finite element model was shown in Slide 4.

Two other discussions of interest during the meeting was Dr. Schauer's comment that he thought the equipment and personnel hatch should be at least as strong as the concrete containment so that the limiting failure mode in containment pressurization would be the concrete containment structure and not the hatches or penetrations. Dr. Schauer further stated this should be true even if calculated hydrogen explosion pressures were well below the design capacity of the existing hatches or penetrations.

Dr. Schauer's final point concerned the definition of the lower bound containment capacity calculation required by Enclosure 2 to Mr. T. M Novak's letter to J. Dolan (See Attachment 2) dtd. December 11, 1980. He indicated that such a calculation should be based on a statistical 3 standard deviation below the mean parameter. He further indicated the probabilistic methodology used in the analysis should consider the methodology developed by Ames Labratory for the NRC. He further indicated that the report from Ames Labratory describing the probabalistic methodology they used would not be available before February, 1981.

SLIDE 1

(5)

DESIGN CRITERIA AND LOWER BOUND PRESSURE CAPACITY OF ICE CONDENSER AND MARK III CONTAINMENTS

PLANT NAME	CONTAINMENT TYPE	CONTAINMENT DESIGN PRESSURE psig	LOWER BOUND STATIC PRESSURE CAPACITY psig	FAILURE MODE	MATERIAL STRENGTH ASSUMPTIONS	GOVERNING CRITERIA FOR CONTAINMENT DESIGN
D. C. COOK UNIT 1	REINFORCED CONCRETE ICE CONDENSER	12	HATCH COVER: (1) 40.8 SHELL: 69.7	EQUIPMENT HATCH COVER 20' Ø	ACTUAL MILL TEST VALUES	ACI-318/63
D. C. COOK UNIT 2	REINFORCED CONCRETE ICE CONDENSER	12	HATCH COVER: (1) 40.8 SHELL: 69.7	EQUIPMENT HATCH COVER 20' Ø	ACTUAL MILL TEST VALUES	ACI-318/63
SEQUOYAH UNIT 1	STEEL SHELL ICE CONDENSER	12	36 (2)	SHELL TENSION YIELD	ACTUAL MILL TEST VALUES	ASME SEC. III SUB SEC. B AND WINTER 1968 ADDENDA
SEQUOYAH UNIT 2	STEEL SHELL ICE CONDENSER	12	36 (2)	SHELL TENSION YIELD	ACTUAL MILL TEST VALUES	ASME SEC. III SUB SEC. B AND WINTER 1968 ADDENDA
MCGUIRE UNIT 1	STEEL SHELL ICE CONDENSER	15	48 (2)	SHELL TENSION YIELD	ACTUAL MILL TEST VALUES	ASME SEC. III SUB SEC. B AND SUMMER 1970 ADDENDA
MCGUIRE UNIT 2	STEEL SHELL ICE CONDENSER	15	48 (2)	SHELL TENSION YIELD	ACTUAL MILL TEST VALUES	ASME SEC. III SUB SEC. B SUMMER 1970 ADDENDA

SLIDE 2

SUMMARY OF MATERIAL PROPERTIES

		YIELD	ULTIMATE
1. LINER PLATE - SA442 GRADE 60		Ksi	
	SPECIFIED MINIMUM	32.0	60.0
SAMPLE SIZE =6	MEAN VALVES	48.3	64.7
2. EQUIPMENT HATCH - SA516 GRADE 70			
	SPECIFIED MINIMUM	38.0	70.0
SAMPLE SIZE =5	MEAN VALVES	53.2	81.2
3. BOLTING - SA193 GRADE B7			
SAMPLE SIZE -2 ea. 1/2" x 2 1/2"			
	SPECIFIED MINIMUM	105.0	125.0
	MEAN VALVES	119.0	137.0
1" x 5 1/2" (SPLICE)			
	SPECIFIED MINIMUM	105.0	125.0
	MEAN VALVES	121.3	141.0
1 1/4" x 10" (COVER)			
	SPECIFIED MINIMUM	105.0	125.0
	MEAN VALVES	120.1	140.3
4. REINFORCING ROD A15 GRADE 40			
18S	SPECIFIED MINIMUM	40.0	70.0
SAMPLE SIZE 9	MEAN VALVES	49.8	81.8
5. CONCRETE -28 DAY STRENGTH			
	SPECIFIED MINIMUM		3.5
SAMPLE SIZE 8	MEAN VALVE		4.774

SLIDE 3

COMMENTS ON HARSTEAD'S REPORT

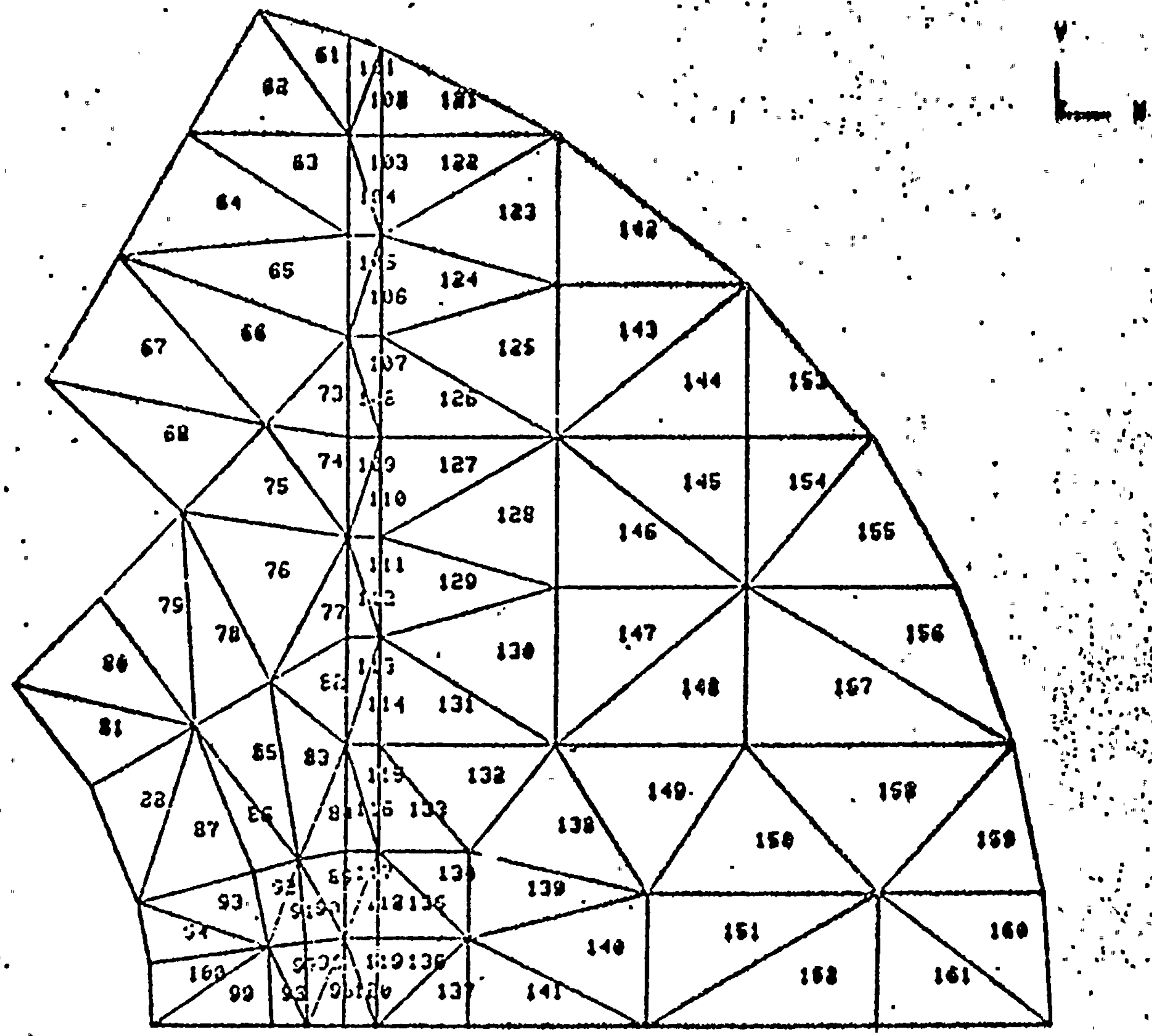
MAJOR AREAS OF DISCUSSION AND DISAGREEMENT ARE:

1) SPLICE PLATE IN EQUIPMENT HATCH LIMITS CAPACITY OF CONTAINMENT TO ~24 psi

2) CAPACITY OF CONCRETE BASE MAT TO TRANSFER SHEAR OR DIAGONAL TENSION STRESS LIMITING CONTAINMENT CAPACITY TO ~ 46 psig

SLIDE 4

34 PREP7-PLOT*



?PREP7

EPLT ANSYS 8