APPENDIX 3I

REPORT ON ANALYSIS OF HIGH ENERGY LINE BREAKS OUTSIDE CONTAINMENT

The information contained in this appendix was not revised, but has been extracted from the original FSAR and is provided for historical information.

APPENDIX 3I

REPORT ON

ANALYSES OF HIGH ENERGY LINE BREAKS

OUTSIDE CONTAINMENT

Prepared for

PUBLIC SERVICE COMPANY OF NEW HAMSPHIRE

SEABROOK STATION

Prepared by

United Engineers & Constructors
A Raytheon Company

Report No. 9763-006-S-N-2

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SUMMARY

The environmental envelopes that the safety related Class 1E equipment will experience following postulated high energy line breaks outside containment have been determined. Systems containing high energy lines for which breaks have been evaluated include the Main Steam, Feedwater, Auxiliary Steam and Condensate, Chemical and Volume Control, Steam Generator Blowdown, and Hot Water Heating.

1.0 INTRODUCTION

It is necessary to demonstrate that equipment used to perform a required safety function for Seabrook Nuclear Station - Units 1 & 2 are capable of functioning properly in the normal, abnormal, or accident environmental conditions to which they could be exposed. As stated in NUREG-0588[1], among these environmental conditions are the elevated temperature, humidity, and/or pressure which could result from the postulated rupture of high energy lines which may be in the vicinity of this equipment. The purpose of this study is to evaluate the consequences of high energy line breaks outside containment and develop the environmental envelopes for Class 1E equipment.

2.0 METHOD OF ANALYSIS

Each of the high energy lines and all of the Class 1E equipment outside containment were identified and located. Based on this information, the various plant buildings were nodalized and the high energy line break (HELB) locations chosen in such a way as to provide an accurate representation of the environmental conditions that would result in the vicinity of the Class 1E equipment following a postulated HELB.

2.1 Mass and Energy Releases

Each high energy line was evaluated on the basis of the methods of Standard Review Plans 3.6.1 and 3.6.2(2) to determine the types, areas, and locations of postulated ruptures that would result in the most severe environmental conditions at each of the Class 1E equipment. The break releases were calculated using the Moody critical flow model(3) and accounting for physical restrictions within the system (e.g. flow and pressure control valves) and the frictional effects of the piping system.

These release rates were taken to be constant, i.e. no decay of the reservoir pressure was assumed, until isolation of the ruptured line was initiated or, as in the case of the closed Hot Water Heating Systems, until the piping inventory was depleted.

The methods and assumptions employed in calculating the mass and energy release rates for each high energy line are outlined in Table 2.1-1. As noted in this table, isolation of many of these lines will be accomplished by the use of redundant temperature detectors in various plant areas that, in the event of elevated temperatures, will send closure signals to redundant isolation valves present in the

high energy lines. The locations of these temperature detectors are provided in Figures 2.1-1, 2.1-2, and 2.1-3.

The mass and energy release rates used in evaluating the pressure, temperature, and humidity responses throughout the various plant areas are calculated and defined in References 6, 7, and 8.

2.2 Pressure/Temperature/Humidity Transients

The environmental conditions that result due to postulated high energy line ruptures were determined for the following areas:

1. Primary Auxiliary Building (PAB)
2. Containment Enclosure Area (CEA)
3. Fuel Storage Building (FSB)
4. Main Steam/Feedwater Pipe Chase
5. Tank Farm Area (TFA)
6. Waste Processing Building/Primary Auxiliary Building (WPB/PAB) Chase

For HELB other than Hot Water heating Line Breaks (HWHLB), the environmental Responses of the PAB, CEA, TFA, WPB/PAB Chase, and MS/FW Pipe Chase were calculated using the COMPRESS[4] computer program. Using the break mass and energy releases and the building nodalizations discussed previously, COMPRESS calculates the transient pressures, temperatures, and humidities that would occur throughout the plant building following these ruptures. The methods and assumptions used in these pressure/ temperature calculations agree with those of NUREG-0588[1].

Table 2.2-1 lists the ambient conditions, building initial conditions, and other pertinent design basis information used in analyzing these environmental transients. The ambient and initial conditions were

chosen so as to maximize the temperature response that would result from these postulated HELB. In addition, the Uchida condensing steam heat transfer correlation is used during the condensing mode while a convective heat transfer coefficient of 2.0 Btu/hr-ft^2-°F is used otherwise.

The environmental response of the PAB, CEA, and FSB to postulated HWHLB was calculated using a reasonable, yet still conservative, hand calculation method which accounted for mass and heat transfer between the hot water and the room air. Since the HWH subsystems are closed systems which will not be isolated and these plant areas are supplied with ventilation air by non-Class 1E systems, the maximum temperatures and humidities that result from HWHLB are calculated by releasing the total HWH subsystem fluid mass into the initial room air mass.

The building initial conditions were determined based on the historical distribution of ambient conditions which occur during the time of the year when the HWH system is in operation (September through May). These conditions are defined in Table 2.2-1.

3.0 HELB ANALYSES AND RESULTS

The environmental response of the plant buildings to postulated high energy line ruptures were calculated using the methods outlined in Section 2.0. The results of these HELB analyses (other than HWHLB) are presented in the following sections.

3.1 Primary Auxiliary Building

From an evaluation of each of the high energy lines in the PAB and their operating conditions, it was concluded that the break locations listed in Table 3.1-1 would provide environmental envelopes for the Class 1E equipment.

Figure 3.1-1 shows the layout of the PAB and the zone designations which were useful in defining the environmental parameters throughout the PAB. Zone 32A, which is not shown, represents the PAB below the the (-)6' elevation and includes the piping tunnels, Zone 32B represents the 2' and (-)6' elevations, and Zones 32 and 33C, 32 and 33D, and 32 and 33E represent the 7', 25', and 53' elevations, respectively. Zones 47 and 48 represent the Chemical and Volume Control System (CVCS) equipment vaults and contain no Class 1E equipment.

Table 3.1-2 summarizes the peak and enveloping temperatures and pressures that would occur in each of these zones for each postulated high energy line rupture. All areas can be taken to experience 100% relative humidity, condensing environments, however, air displacement and thus essentially pure steam environments would be expected to occur only in the general vicinity of the postulated breaks.

For each of the ruptures considered in these tables there follows a series of four figures, lettered A though D. The A series of these figures (e.g. Figure 3.1-2A, 3.1-3A) physically defines the nodal arrangement which was chosen to analyze the rupture's effect on the PAB environment. The B series provides the flow diagrams and physical parameters (volumes, heat sink areas, flow areas) for this nodal arrangement. Figures C and D provide the calculated temperature and pressure transients for each of the nodes defined in the A and B series figures.

3.2 Containment Enclosure Area

The Containment Enclosure Area contains several high energy (CVCS) lines, however, only the letdown line operates at an elevated temperature. Therefore, only a rupture of this line has been considered as stated in Table 3.2-1.

The layout of the Containment Encosure Area, which includes the Mechanical Penetration Area, the Charging Pump Cubicles, and the Residual Heat Removal (RHR), Safety Injection (SI), and Containment Spray (CBS) Vaults, is shown in Figure 3.2-1A, Sheets 1 and 2. These figures also show the nodal arrangement used, while Figure 3.2-1B provides the corresponding flow diagram and physical parameters. Table 3.2-2 summarizes the pressures and temperatures experienced in the various areas of the enclosure volume following a postulated CVCS letdown line break. Figures 3.2-1C and 3.2-1D show the transient temperatures and pressures in the CEA. By a variation of the assumed initial conditions (10% vs. 95% relative humidity), an additional investigation was made which determined the maximum pressure response of the CEA. This result is shown in Figure 3.2-1E. For the HELB

temperature detection system is use, the peak pressures correspond to approximately 95 seconds after the break. These peak pressures are listed in Table 3.2-2. The relative humidity throughout all CEA compartments would reach 100%.

3.3 Main Steam/Feedwater Pipe Chase

The breaks evaluated for the Main Steam/Feedwater Pipe Chase are listed in Table 3.3-1. It was concluded that the MS line breaks will result in more severe environmental conditions than the FW line breaks.

Figures 3.3-1A and 3.3-1B define the MS/FW Pipe Chase arrangement and nodalization. The MS/FW Pipe Chase reaches a maximum of 325°F for a spectrum of MS line break sizes from 0.10 ft^2 to 1.0 ft^2. The temperature transient resulting from a 0.10 ft^2 break is provided in Figure 3.3-1C and the results are summarized in Table 3.3-2.

3.4 Tank Farm Area

The break evaluated for the Tank Farm Area is listed in Table 3.4-1. Since no HELB temperature detectors are located in the Tank Farm Area, the Auxiliary Steam line break releases will continue until the operator detects the break and isolates the line.

Figure 3.4-1A defines the nodal parameters used for the Tank Farm Area HELB analysis. The resulting temperature and pressure transients are provided in Figures 3.4-1B and 3.4-1C, respectively, and the peak values summarized in Table 3.4-2.

3.5 Waste Processing Building/Primary Auxiliary Building Chase

The WPB/PAB Chase, which is located between the WPB and Column Line A of the PAB, contains both Class 1E equipment and several Auxiliary Steam and Condensate lines. The line ruptures which have been evaluated are listed in Table 3.5-1.

Figure 3.5-1A defines the nodal parameters used for evaluation of the WPB/PAB Chase response to postulated HELB. Figures 3.5-1B and 3.5-1C provide the temperature and pressure transients that result for the enveloping HELB. The peak values for pressure and temperature are summarized in Table 3.5-2.

4.0 HWHLB ANALYSES AND RESULTS

The environmental response following postulated HWHLB has been calculated for those plant buildings with Hot Water Heating (HWH) systems which operate in the high energy region, i.e. pressure greater than 275 psig or temperature greater than 200°F. The HWHLB postulated are listed in Table 4.0-1. The results of these HWHLB analyses are presented individually in the following sections and are summarized in Table 4.0-2.

4.1 Primary Auxiliary Building

The peak environmental conditions at the 53' elevation of the PAB due to postulated HWHLB were found to be 110°F with a relative humidity of 100%. These conditions are enveloped by the consequences resulting from other HELB postulated to occur in the PAB.

4.2 Containment Enclosure Area

The HWH system piping which serves the PAB and FSB passes through the CEA. A postulated rupture of one of these lines results in temperatures and relative humidities throughout the CEA of approximately 106°F and 100%, respectively. Due to the location of this piping, very localized conditions may be slightly more severe although the large recirculation air flows will tend to mitigate these effects to a certain extent. With the exception of these localized effects the environmental conditions that result from a CVCS letdown line break will envelope those resulting from a HWHLB.

4.3 Fuel Storage Building

Since the hot water heating piping are the only high energy lines present in the FSB, the environmental conditions that result from a postulated HWHLB will define the enveloping conditions for high

energy line ruptures. The resulting environmental conditions are 100°F with a 100% relative humidity.

4.4 Emergency Feedwater Pumphouse

Since the hot water heating piping are the only high energy lines present in the EFWPH, the environmental conditions that result from a postulated HWHLB will define the enveloping conditions for high energy line ruptures. The resulting environmental conditions are 88°F with a 100% relative humidity.

4.5 Service Water Pumphouse

Since the hot water heating piping are the only high energy lines present in the SWPH, the environmental conditions that result from a postulated HWHLB will define the enveloping conditions for high energy line ruptures. The maximum temperature that would be expected to result in the SWPH is 90°F. Due to the relatively large room volume and small volume of hot water heating piping for the SWPH, the maximum relative humidity that is expected to result following a HWHLB is 90%

5.0 CONCLUSIONS

The analysis of high energy line ruptures outside containment has yielded a realistic evaluation of the elevated temperatures, pressures, and humidities that can result in the various buildings of Units 1 and 2. These results provide the HELB environmental envelopes for evaluation of the Class 1E equipment. These envelopes should be evaluated along with the conditions that result following postulated moderate energy line breaks, loss of ventilation air flow, and any other events which may cause adverse environmental conditions to develop.

6.0 REFERENCES

1. NUREG-0588, "Interim Staff Position on Environmental Qualification of Safety-Related Electrical Equipment", August, 1979.

2. NUREG-0800, U.S. NRC Standard Review Plans 3.6.1 and 3.6.2, July, 1981.

3. Moody, F. J., "Maximum Two-Phase Vessel Blowdown from Pipes", Journal of Heat Transfer, August 1966.

4. UEC-TR-004-1, "COMPRESS - A Code for Calculating Subcompartment Pressure Responses", July, 1976.

5. Appendix E attached to ANSI Standard N176, "Design Basis for Protection of Nuclear Power Plants Against Effects of Postulated Pipe Rupture".

6. Calculation Set No. 4.3.35-F03

7. Calculation Set No. MSVCS-FAG-07

8. Calculation Set No. 4.3.35-F01

TABLE 2.1-1

DETERMINATION OF MASS/ENERGY RELEASE

Line	CVCS Letdown Line	Steam Generator Blowdown	Auxiliary Steam and Condensate Lines	Main Steam Line	Feedwater Line	Hot Water Heating Line
Plant Condition	Heatup Phase	Hot Standby	Full Power	Full Power	Full Power	Full Power
Line Conditions	P = 435 psia T = 380°F	P = 1100 psia T = 550°F	P = 165 psia T = 358°F	P = 1000 psia T = 545°F	P = 1100 psia T = 440°F	P = 137 psia T = 250°F
Break Flow	Limited by CVCS Letdown Line Control Valves	Moody critical flow with piping system frictional effects included (Methodology of App. E attached to ANSI Std. N176[5])	Limited by upstream pressure control valves	Releases calculated using Westinghouse information package methodology	Releases calculated using Westinghouse information package methodology	Moody Critical Flow Model
Isolation Mechanism	Dependent on Location: HELB Temperature Detection System or Operator Action at 30 min.	HELB Temperature Detection System	Dependent on Location: HELB Temperature Detection System or operator action at 30 minutes.	Reactor Protection System and Emergency Feedwater Discontinued at 30 min.	Reactor Protection System	No Isolation Occurs
Isolation Valve Closure Time	10 Seconds	5 Seconds	15 Seconds	Isolation Valve in Faulted Loop Fails.	Isolation Valve in Faulted Loop Fails	No Isolation Occurs

TABLE 2.2-1

Design Basis Information

A. Ambient Conditions

1. HELB, other than HWHLB:	14.7 psia/88°F/100% RH
2. HWHLB:	14.7 psia/70°F/95% RH

B. Building Initial Conditions

1. HELB, other than HWHLB:	14.7 psia/104°F/95% RH
2. HWHLB:	14.7 psia/86°F/56% RH

C. HELB Temperature Detection System

1. Temperature at Isolation Signal Initiation: (Intended to cover setpoint plus instrument error margins of up to 10°F)	130°F
2. System Response Time-time delay: until signal at isolation valves	8.1 Seconds

D. Ventilation System Operation

1. No credits are taken for energy removal or air exchange by non-Class 1E ventilation systems.

2. Credits are taken for Class 1E ventilation systems according to their performance characteristics following postulated HELB.

E. Unit Trip

1. A concurrent loss of offsite power or unit trip has not been assumed.

TABLE 3.1-1

Primary Auxiliary Building
High Energy Line Break Locations

1. Steam Generator Blowdown Line (Lines No. SG-1301-5-3", SG1304-5-3", SG-1307-5-3", or SG-1310-5-3")

   a. At 53' elevation of PAB in vicinity of blowdown flash tank.

2. Auxiliary Steam and Condensate Lines

   a. Line No. 2302-2-8" - At 53' elevation of PAB along Column Line 5 between Columns A & B.

   b. Line No. 2303-1-6" - At 7' elevation of PAB between Column Lines 5 & 6.

   c. Line No. 2404-2-3" - At (-) 6' elevation of PAB along Column Line C.

   d. Line No. 2406-1-4" - At (-) 6' elevation of PAB along Column Line 2.

3. Chemical and Volume Control System Letdown Line (Line No. CS-360-9-3")

   a. At 7' elevation of PAB in the CVCS equipment vault area.

TABLE 3.1-2

Primary Auxiliary Building
Summary of Results

ZONE DESIGNATION	SG-1310-5-3" Break @ Zone 32E		AS-2302-2-8" Break @ Zone 33E		AS-2303-1-6" Break @ Zone 33C		AS-2404-2-3" Break @ Zone 32B		AS-2406-1-4" Break @ Zone 32B		CS-360-9-3" Break @ Zone 47		Enveloping Conditions	
	Temp. °F	Press. psig	Temp. °F	Press. psig	Temp. °F	Press. psig	Temp. °F	Press. psig	Temp. °F	Press. psig	Temp. °F	Press. psig	Temp. °F	Press. psig
32A	108.	0.4	104	.04	104.	0.1	220	0.4	190.	0.3	114	.05	220.	0.4
32B	108.	0.4	104.	.04	104.	0.1	220	0.4	190.	0.3	114.	.05	220.	0.4
32C	108.	0.4	104.	.04	104.	0.1	132	0.1	136.	0.1	112.	.05	136.	0.4
33C	108.	0.4	104.	.04	163.	0.1	105	0.1	104.	0.1	107.	.05	163.	0.4
32D	111.	0.4	105.	.04	113.	0.1	105	0.1	104.	0.1	108.	.05	113.	0.4
33D	111.	0.4	105.	.04	113.	0.1	105	0.1	104.	0.1	108.	.05	113.	0.4
32E	165.	0.5	112.	.04	104.	0.1	105	0.1	104.	0.1	107.	.05	165.	0.5
33E	131.	0.5	158.	.06	104.	0.1	105	0.1	104.	0.1	107.	.05	158.	0.5
47	108.	0.4	104.	.04	134.	0.1	105	0.1	120.	0.1	185.	.15	185.	0.4
48	108.	0.4	104.	.04	134.	0.1	105	0.1	120.	0.1	185.	.15	185.	0.4

TABLE 3.2-1

Containment Enclosure Area
High Energy Line Break Locations

1. Chemical and Volume Control System Letdown Line
(Line No. CS-360-9-3")

   a. In Mechanical Penetration Area (MPA) at (-) 34'-6" elevation near containment wall penetration.

TABLE 3.2-2

Containment Enclosure Area
Summary of Results

Compartment	CVCS Letdown Line Rupture (CS-360-9-3")	
	Peak Temperature (°F)	Peak Pressure (psig)
Mechanical Penetration Area	134	0.35
Remainder of Enclosure Volume (Including Charging Pump Cubicles & Ventilation Equipment Area)	108	0.35

TABLE 3.3-1

Main Steam/Feedwater Pipe Chase
High Energy Line Break Locations

1. Main Steam Line

   a. At 21' elevation of MS/FW Pipe Chase

2. Feedwater Line

   a. At 3' elevation of MS/FW Pipe Chase

TABLE 3.3-2

Main Steam/Feedwater Pipe Chase
Summary of Results

Main Steam Line Rupture	
Peak Temperature (°F)	Peak Pressure (psig)
325	Pressure Varies dependent upon location with respect to break location and has been studied in detail in a separate analysis. Maximum Pressure: 4.8

TABLE 3.4-1

Tank Farm Area
High Energy Line Break Locations

1. Auxiliary Steam and Condensate Lines

   a. Line No. AS-2302-32-8"

TABLE 3.4-2

Tank Farm Area
Summary of Results

Auxiliary Steam Line Rupture	
Peak Temperature (°F)	Peak Pressure (psig)
290	1.1

TABLE 3.5-1

Waste Processing Building/Primary Auxiliary Building Chase
High Energy Line Break Locations

1. Auxiliary Steam and Condensate Lines

   a. Line No. 2339-1-1 1/2" - At 53' elevation of WPB/PAB Chase

   B. Line No. 2341-1-1 1/2" - At 25' elevation of WPB/PAB Chase

TABLE 3.5-2

Waste Processing Building/Primary Auxiliary Building Chase Summary of Results

Compartment	AS-2339-1-1 1/2" Break @ 53' elevation		AS-2341-1-1 1/2" Break @ 25' elevation	
	Temp. (°F)	Pressure (psig)	Temp. (°F)	Pressure (psig)
WPB/PAB Chase 53' elevation	175	0.05	168	0.05
WPB/PAB Chase 25' elevation and 15' 5" elevation	168	0.05	175	0.05

NOTE: Due to the general arrangement of the WPB/PAB Chase area, the results obtained for a break of Line No. AS-2339-1-1 1/2" have been extrapolated to be representative of the environmental conditions that would result from a break of Line No. AS-2341-1-1 1/2".

TABLE 4.0-1

Hot Water Heating Line Break Locations

1. Primary Auxiliary Building

   a. At 53' elevation of PAB

2. Containment Enclosure Area

   a. At 21'-6" elevation of CEA

3. Fuel Storage Building

   a. At 21'-6" elevation of FSB

4. Emergency Feedwater Pumphouse

   a. At 27' elevation of EFWPH

5. Service Water Pumphouse

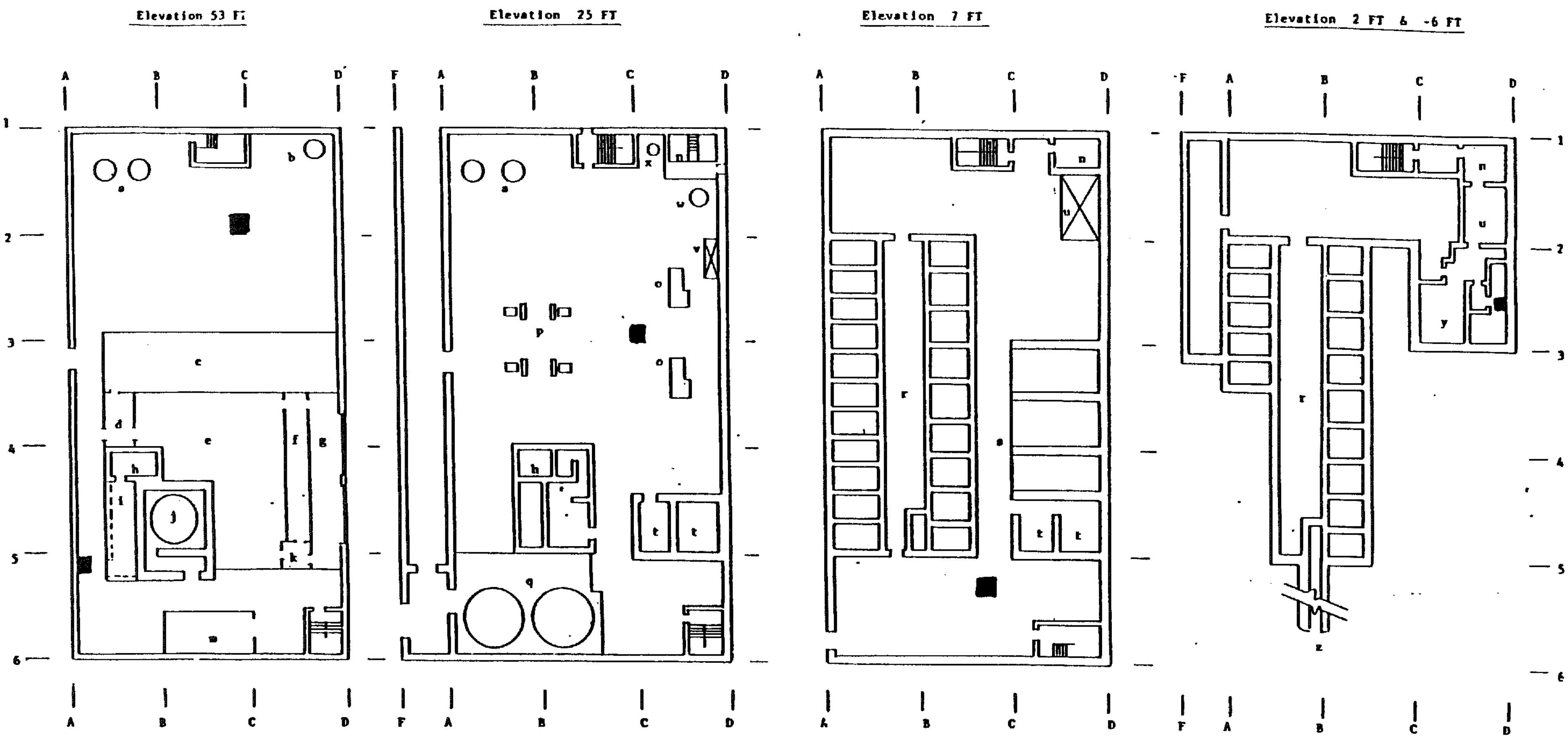
   a. At 21' elevation of SWPH

TABLE 4.0-2

Hot Water Heating Line Breaks
Summary of Results

1.	Primary Auxiliary Building: (53' elevation)	110°F/100% RH
2.	Containment Enclosure Area:	106°F/100% RH
3.	Fuel Storage Building:	100°F/100% RH
4.	Emergency Feedwater Pumphouse:	88°F/100% RH
5.	Service Water Pumphouse:	90°F/90% RH

PSNH SEABROOK STATION PRIMARY AUXILIARY BUILDING



a. PCCW Hx's
b. Blowdown Flash Tank
c. PAB Exhaust Fan Room
d. Air Lock
e. PAB Inlet & Containment
f. Inlet Heaters
g. Inlet Filters
h. RAACT Pipe Chase
i. Valve Aisle
j. CVCS Tank
k. Air Lock
m. Storage Area
n. Electrical Chase
o. 480 V. Load Centers
p. PCCW Pumps
q. Boric Acid Tanks
r. CVCS Vaults
s. Charging Pump Vaults
t. Letdown Degasifier
u. Non-RAACT Pipe Chase
v. HVAC Opening
w. Boron Injection Tank
x. Chiller Surge Tank
y. Aux. Steam Condensate Tank
z. Pipe Trench

■ Denotes Thermocouple Location

Figure 2.1-1: Primary Auxiliary Building Showing Locations of HELB Temperature Detection Thermocouples

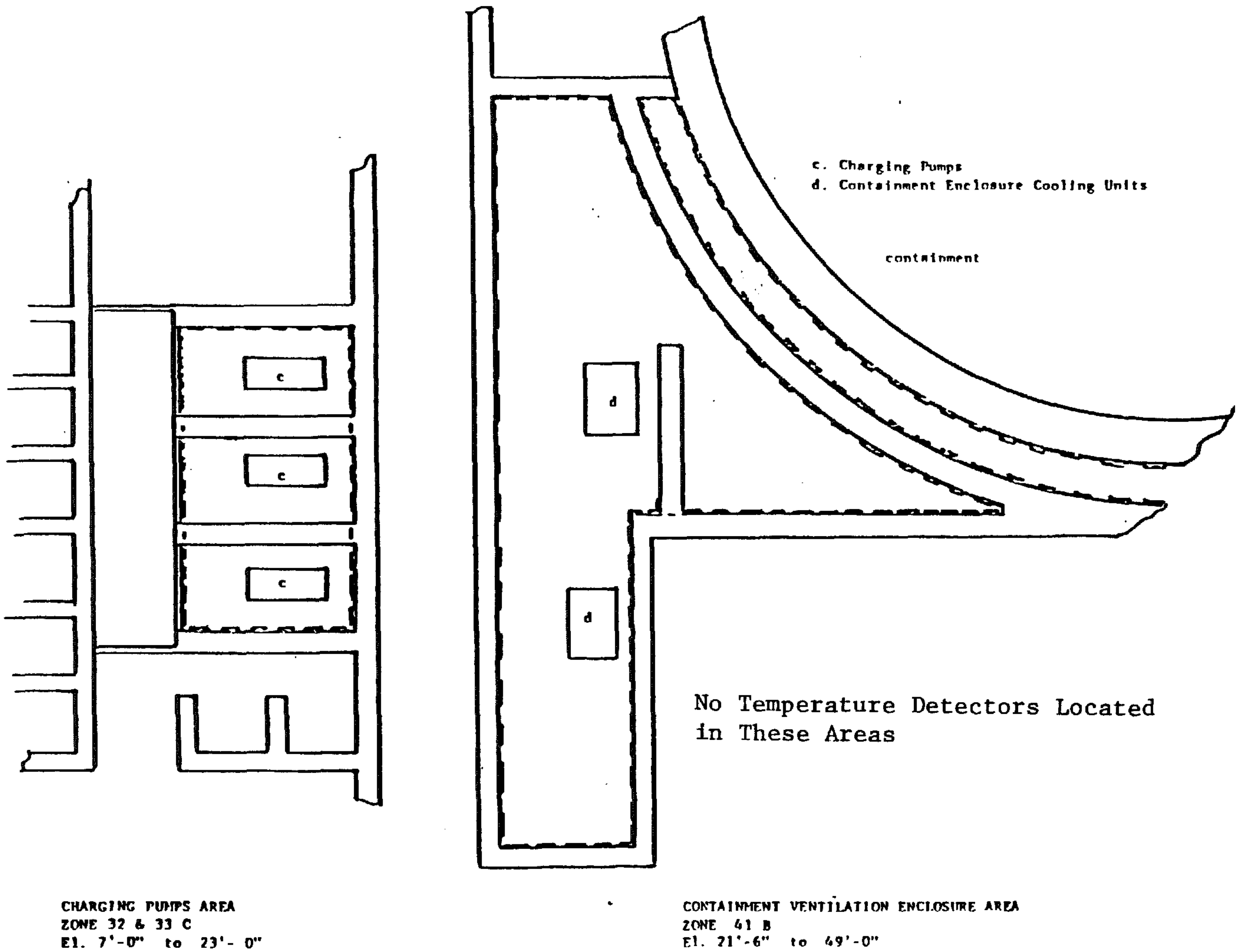


Figure 2.1-2: Containment Enclosure Area Showing Locations of HELB Temperature Detection Thermocouples

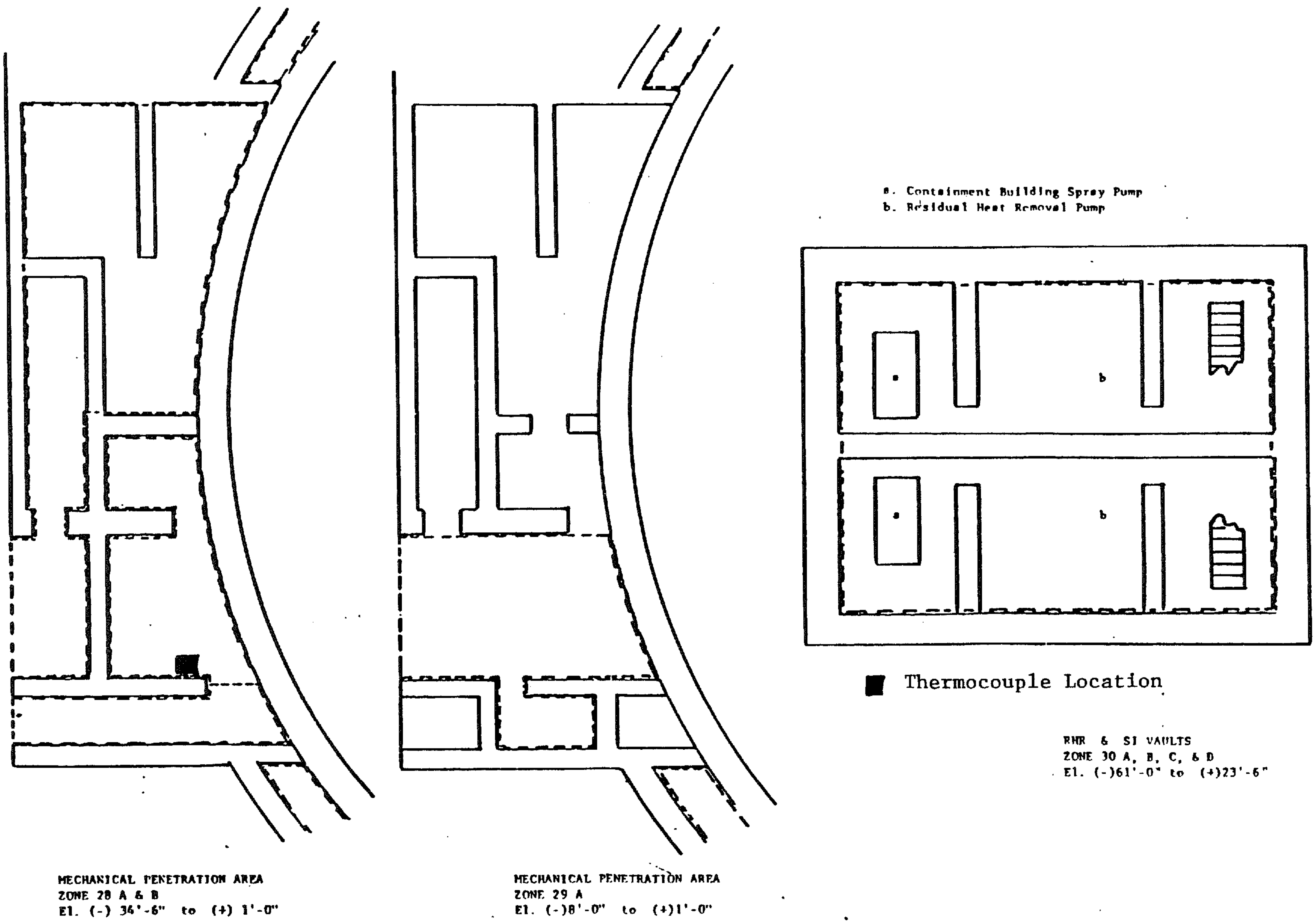
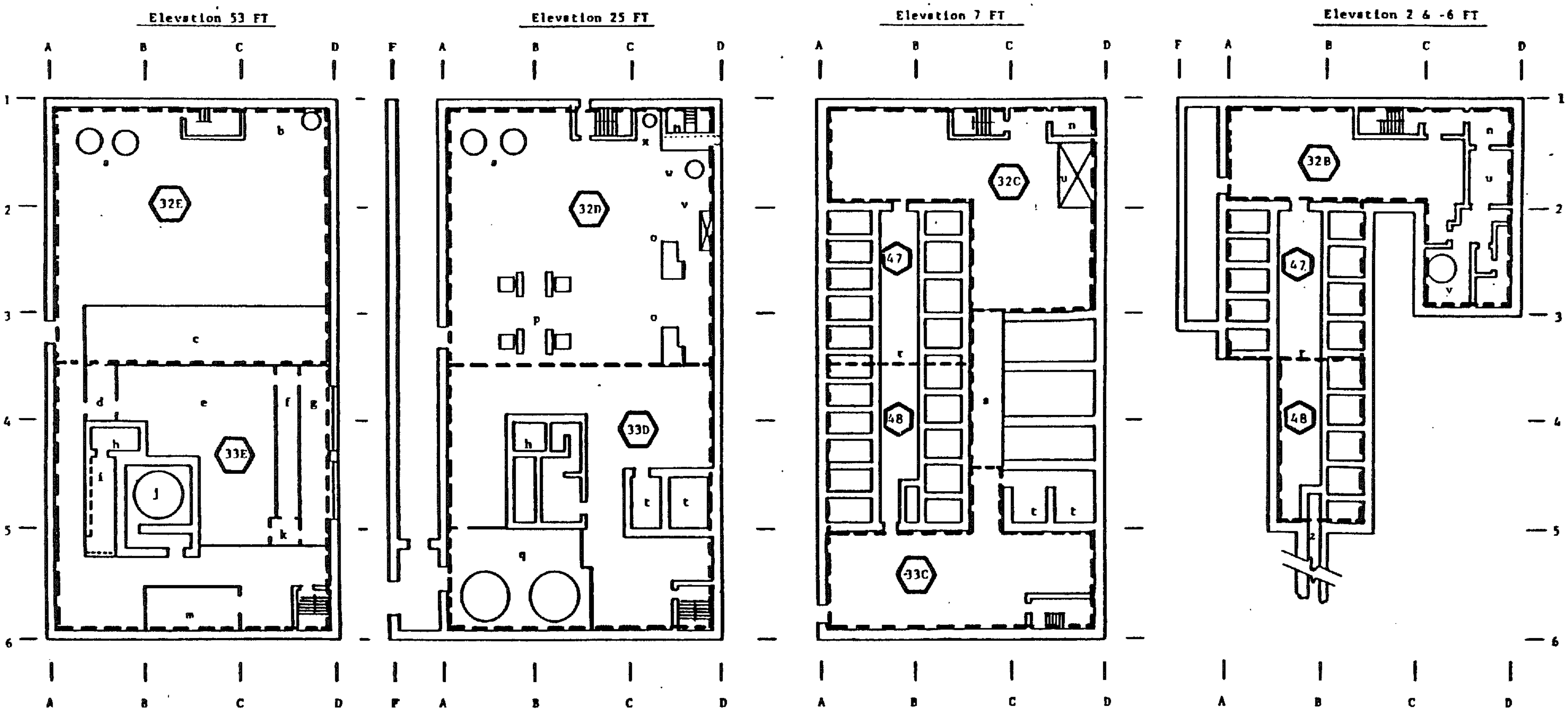
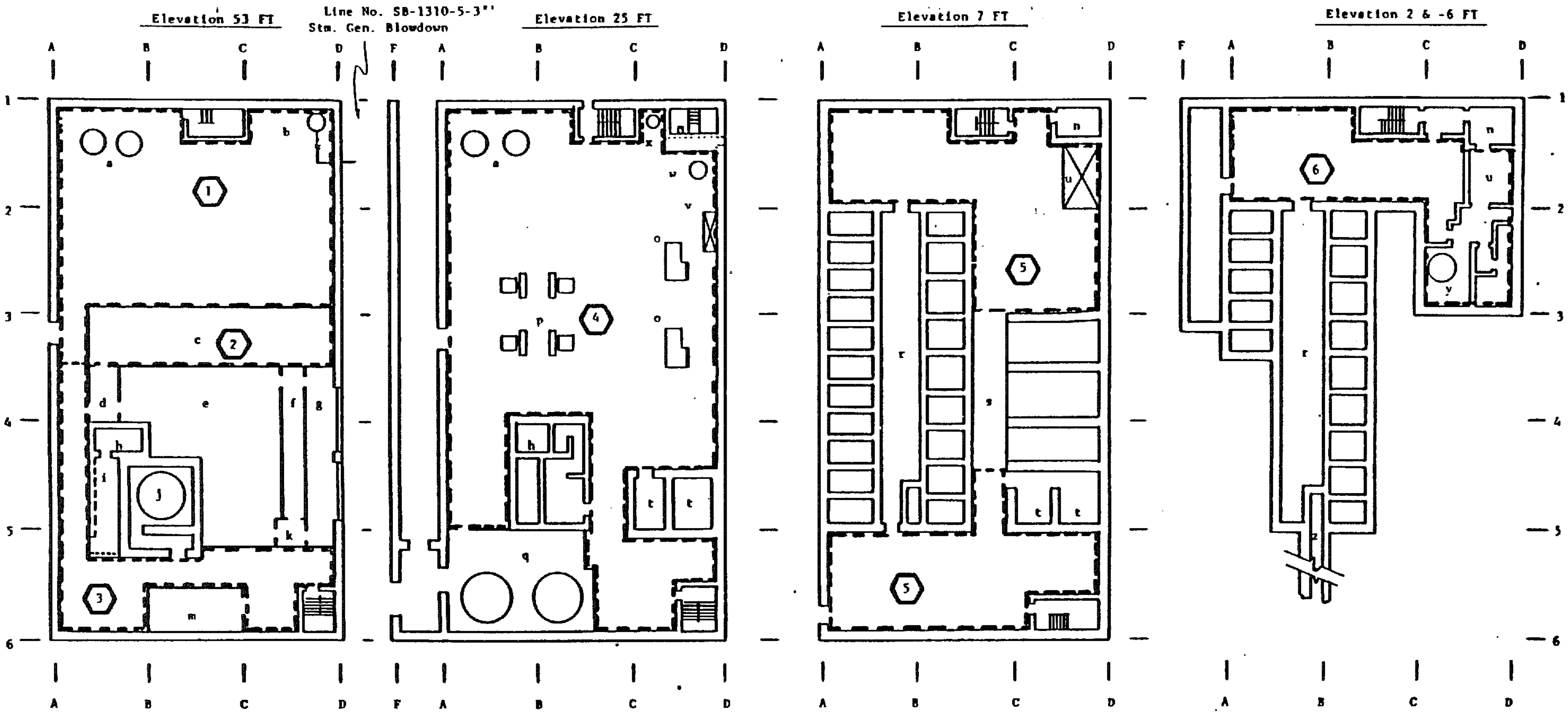


Figure 2.1-3: Containment Enclosure Area Showing Locations of HELB Temperature Detection Thermocouples



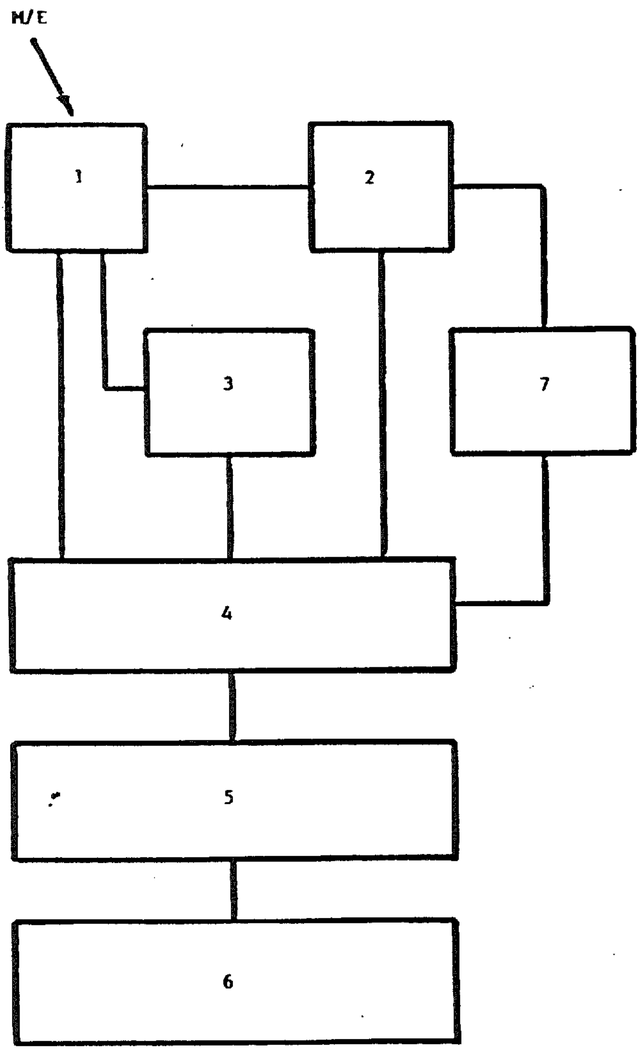
a. PCCW Heat Exchangers
b. Blowdown Flash Tank
c. PAB Exhaust Fan Room
d. Air Lock
e. PAB Inlet & Containment Purge Fans
f. Inlet Heaters
g. Inlet Filters
h. RAACT Pipe Chase
i. Valve Aisle
j. CVCS Tank
k. Air Lock
m. Storage Area
n. Electrical Chase
o. 480 v. Load Centers
p. PCCW Pumps
q. Boric Acid Tanks
r. CVCS Vaults
s. Charging Pump Vaults
t. Letdown Degassifier
u. Non-RAACT Pipe Chase
v. HVAC Opening
w. Boron Injection Tank
x. Chiller Surge Tank
y. Aux. Steam Condensate Tank
z. Pipe Trench

Figure 3.1-1: Zone Designations of Primary Auxiliary Building at Various Elevations



- a. PCCW Heat Exchangers
- b. Blowdown Flash Tank
- c. PAB Exhaust Fan Room
- d. Air Lock
- e. PAB Inlet & Containment Purge Fans
- f. Inlet Heaters
- g. Inlet Filters
- h. RAACT Pipe Chase
- i. Valve Aisle
- j. CVCS Tank
- k. Air Lock
- m. Storage Area
- n. Electrical Chase
- o. 480 v. Load Centers
- p. PCCW Pumps
- q. Boric Acid Tanks
- r. CVCS Vaults
- s. Charging Pump Vaults
- t. Letdown Degassifier
- u. Non-RAACT Pipe Chase
- v. HVAC Opening
- w. Boron Injection Tank
- x. Chiller Surge Tank
- y. Aux. Steam Condensate Tank
- z. Pipe Trench

Figure 3.1-2A: Nodal Arrangement of Primary Auxiliary Building at Various Elevations for Steam Generator Blowdown Line Break Analysis



NODE	VOLUME (ft^3)	HEAT SINK AREA(ft^2)
1	95,490	18,000
2	23,520	560
3	53,930	8,000
4	243,400	42,670
5	108,070	18,500
6	38,235	15,900
7	ATMOSPHERE	

FLOW PATHS' CHARACTERISTICS

				LOSS FACTOR			
FROM NODE	TO NODE	AREA(ft^2)	INERTIA(ft^{-1})	K_c	K_{exp}	K_{fric}	K_{total}
1	2	15.0	.05	.78	1.0	.01	1.79
1	3	128.7	.45	.42	.85	.17	1.44
1	4	9.40	.88	.78	1.0	.20	1.98
2	4	31.5	.09	.78	1.0	.01	1.79
2	7	20.0	5.00	.78	1.0	3.50	5.28
3	4	10.6	5.40	.78	1.0	2.22	4.00
4	5	44.8	.80	.78	1.0	.30	2.08
4	7	20.0	.50	.78	1.0	1.60	3.38
5	6	5.9	8.50	.78	1.0	3.2	4.98

Figure 3.1-2B: Nodal Parameters of Primary Auxiliary Building for Steam Generator Blowdown Line Break Analysis

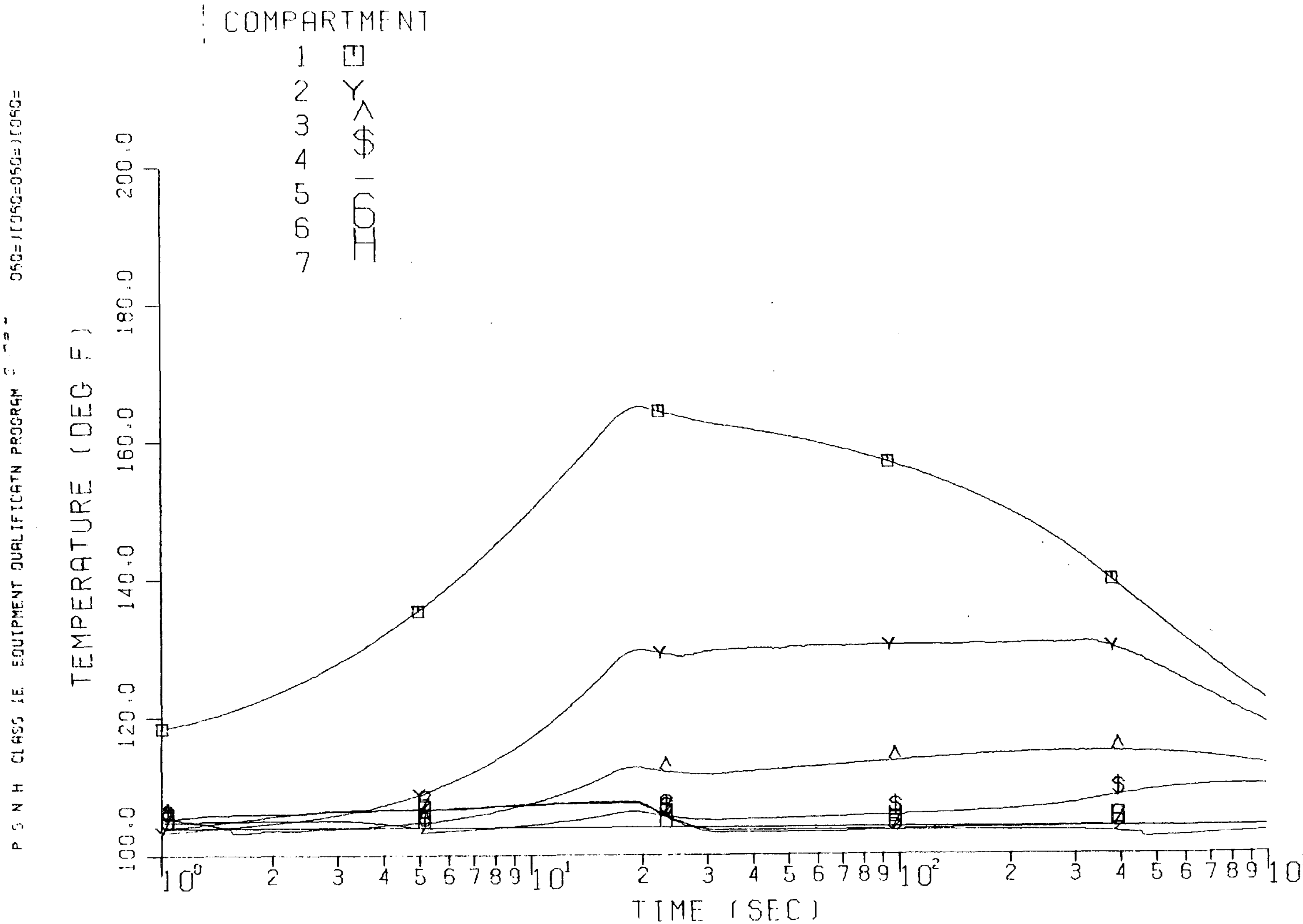


Figure 3.1-2C: Temperature Responses in Primary Auxiliary Building Following A Rupture of 3" Steam Generator Blowdown Line

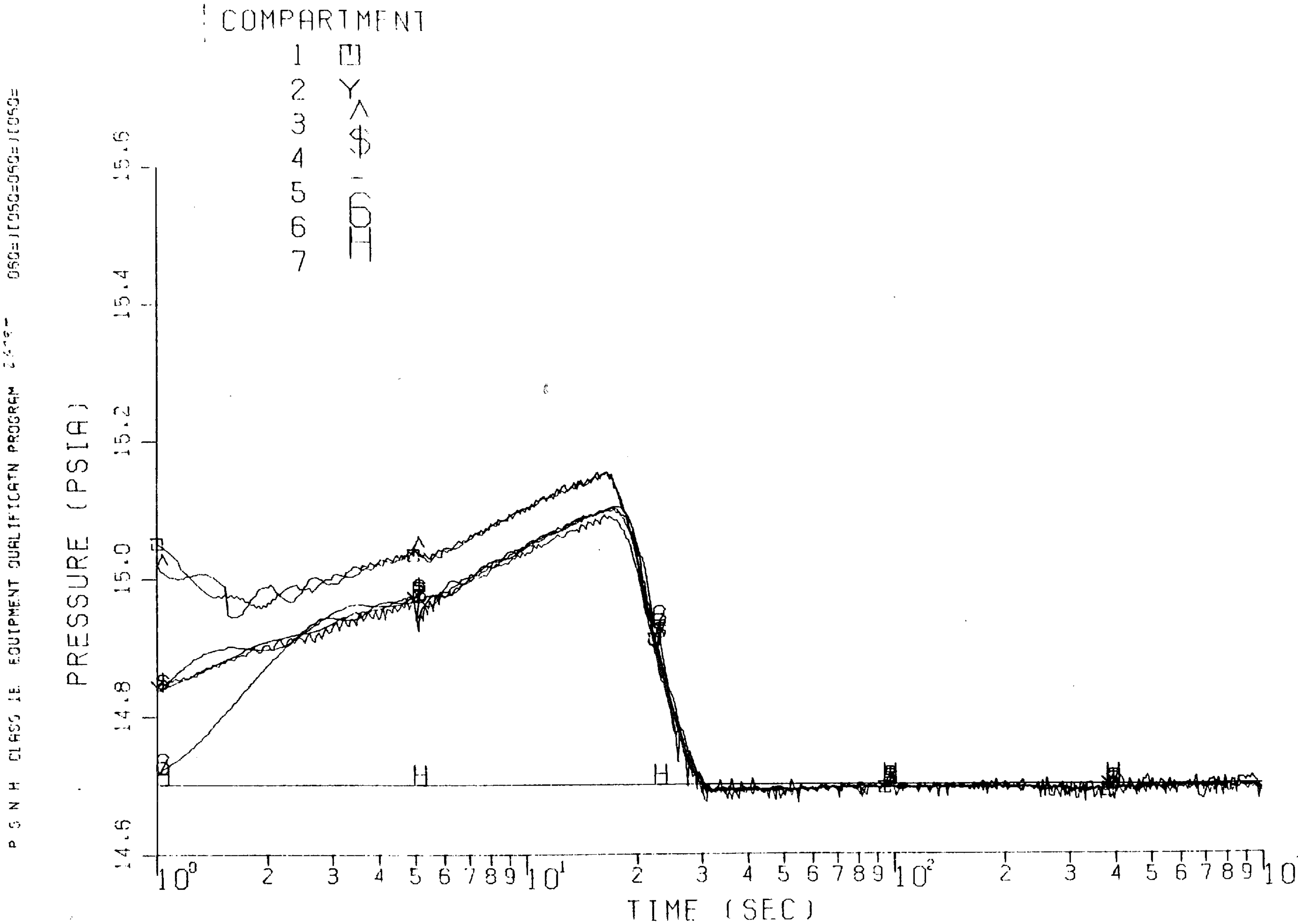
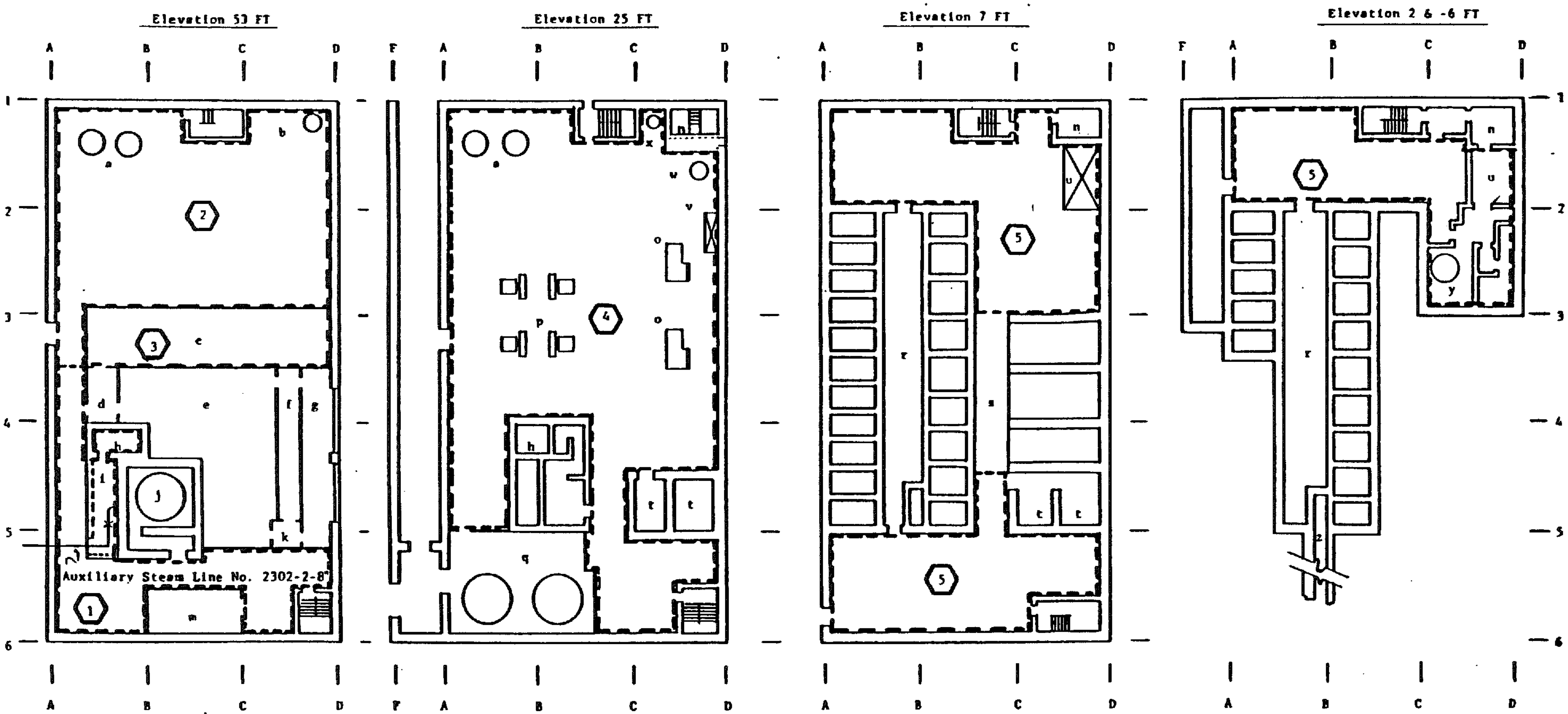
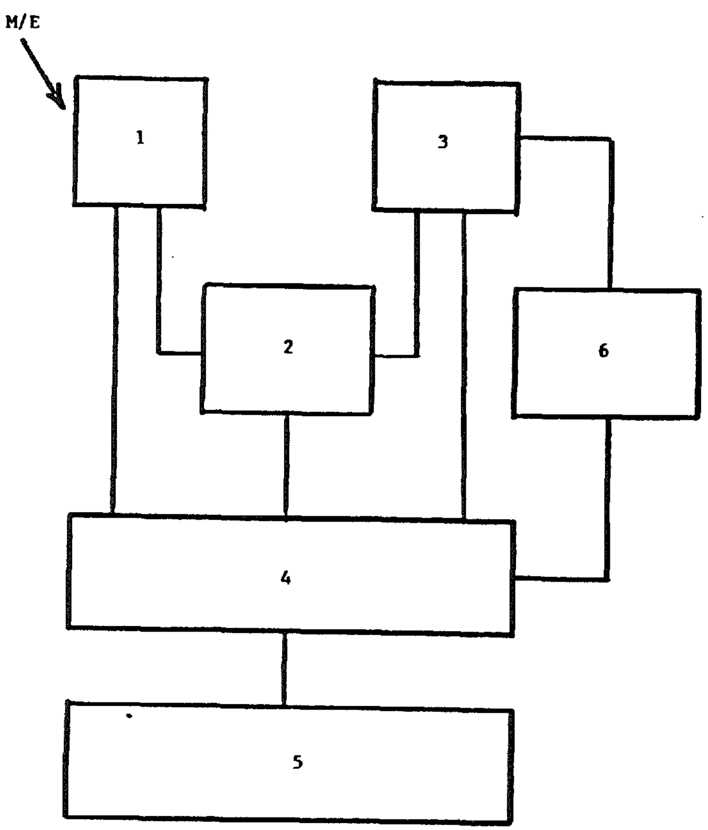


Figure 3.1-2D: Pressure Responses in Primary Auxiliary Building Following a Rupture of 3" Steam Generator Blowdown Line



a. PCCW Heat Exchangers
b. Blowdown Flash Tank
c. PAB Exhaust Fan Room
d. Air Lock
e. PAB Inlet & Containment Purge Fans
f. Inlet Heaters
g. Inlet Filters
h. RAACT Pipe Chase
i. Valve Aisle
j. CVCS Tank
k. Air Lock
m. Storage Area
n. Electrical Chase
o. 480 v. Load Centers
p. PCCW Pumps
q. Boric Acid Tanks
r. CVCS Vaults
s. Charging Pump Vaults
t. Letdown Degassifier
u. Non-RAACT Pipe Chase
v. HVAC Opening
w. Boron Injection Tank
x. Chiller Surge Tank
y. Aux. Steam Condensate Tank
z. Pipe Trench

Figure 3.1-3A: Nodal Arrangement of Primary Auxiliary Building at Various Elevations for Auxiliary Steam Line AS-2302-2-8" Break Analysis



NODE	VOLUME (ft^3)	HEAT SINK AREA(ft^2)
1	53,930	8,000
2	95,490	18,000
3	23,520	560
4	243,400	42,670
5	146,300	34,400
6	ATMOSPHERE	

FLOW PATHS CHARACTERISTICS

FROM NODE	TO NODE	AREA(ft^2)	INERTIA (ft^{-1})	LOSS FACTOR K_c	K_{exp}	K_{fric}	K_{total}
1	2	128.7	.45	.42	.85	.17	1.44
1	4	10.6	5.40	.78	1.0	2.22	4.00
2	3	15.0	.05	.78	1.0	.01	1.79
2	4	9.4	.88	.78	1.0	.20	1.98
3	4	31.5	.09	.78	1.0	.01	1.79
3	6	20.0	5.00	.78	1.0	3.50	5.28
4	5	44.8	.80	.78	1.0	.30	2.08
4	6	20.0	.50	.78	1.0	1.60	3.38

Figure 3.1-3B: Nodal Parameters of Primary Auxiliary Building for Auxiliary Steam Line AS-2302-2-8" Break Analysis

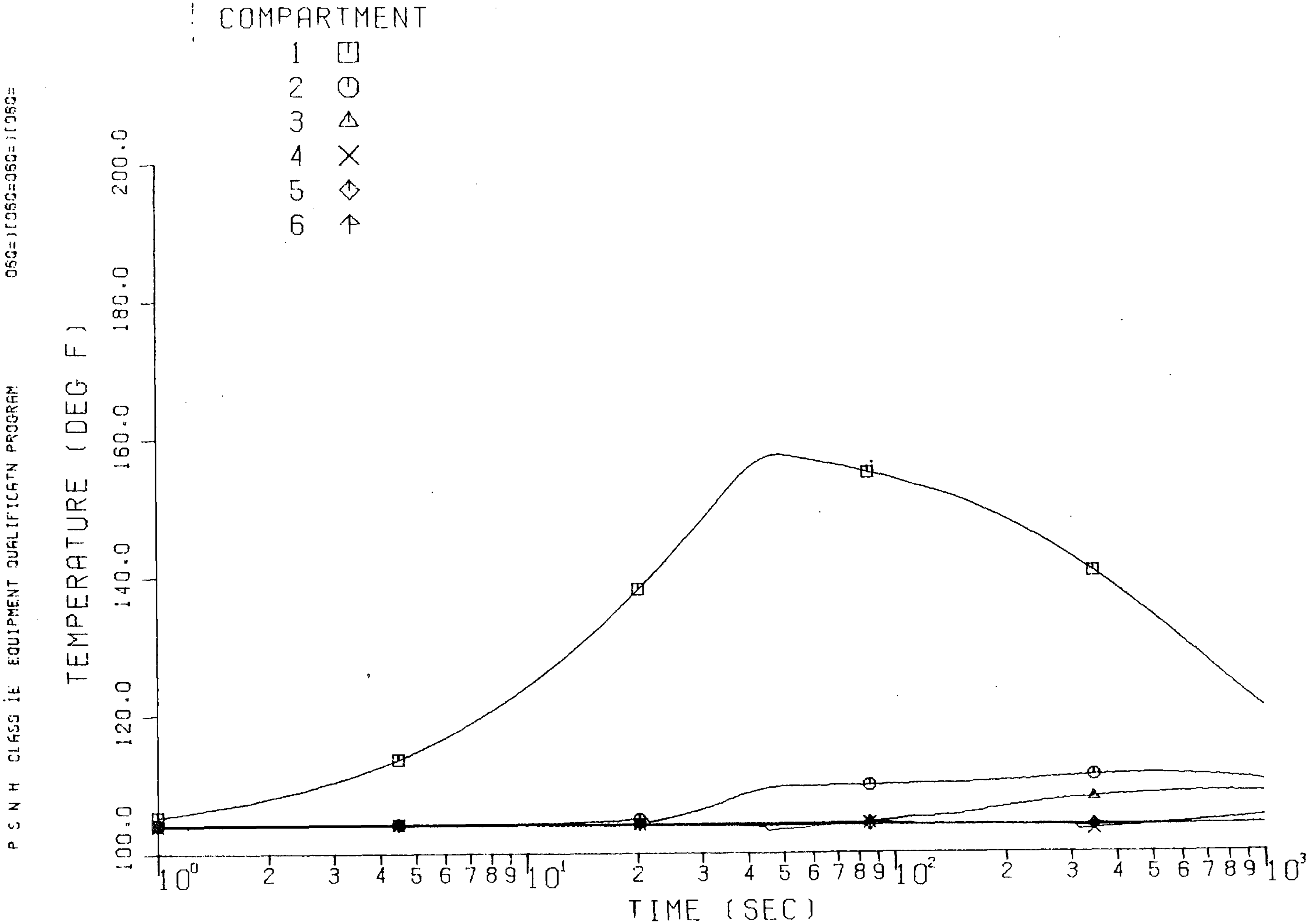


Figure 3.1-3C: Temperature Responses in Primary Auxiliary Building Following a Rupture of 8" Auxiliary Steam Line

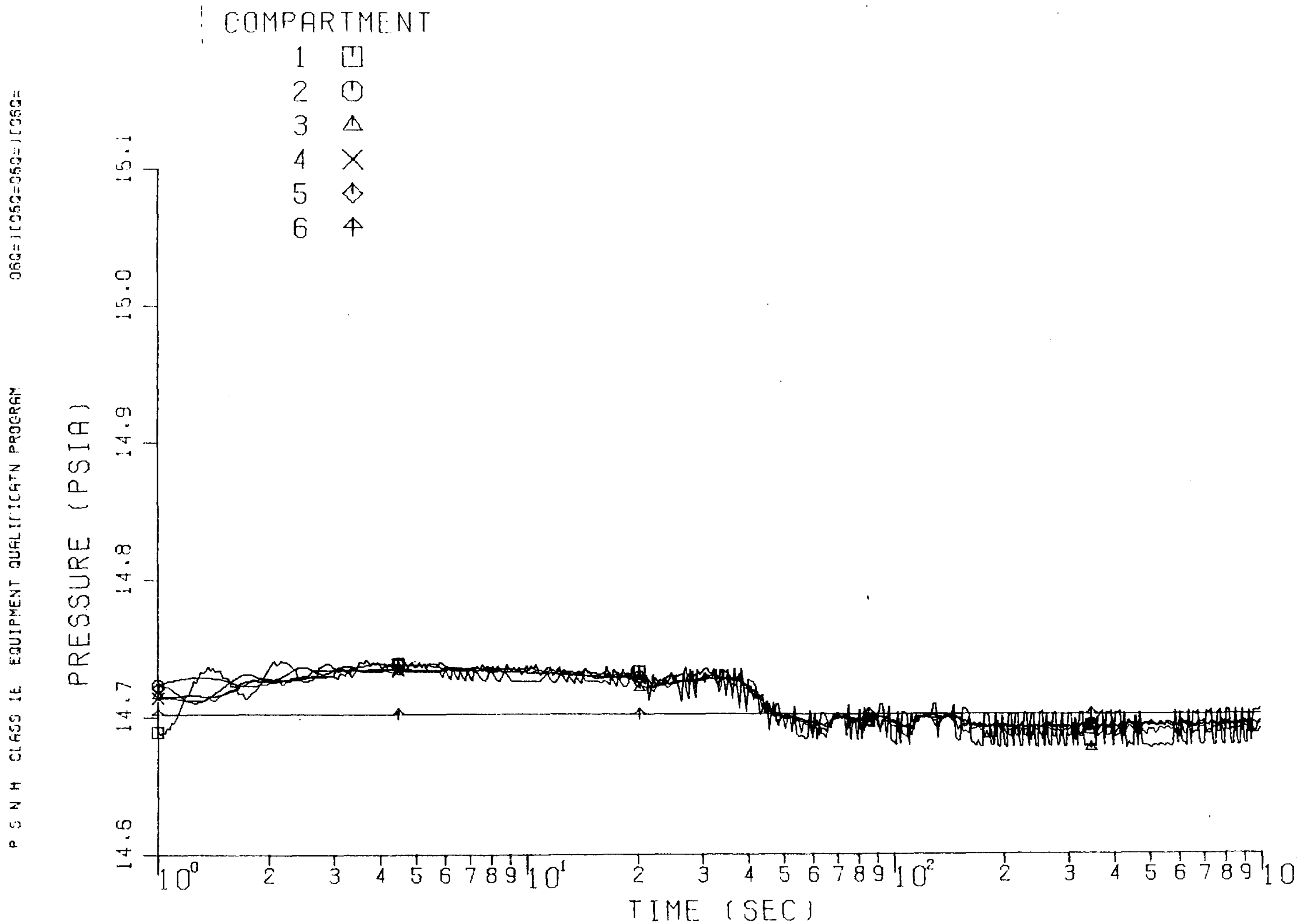
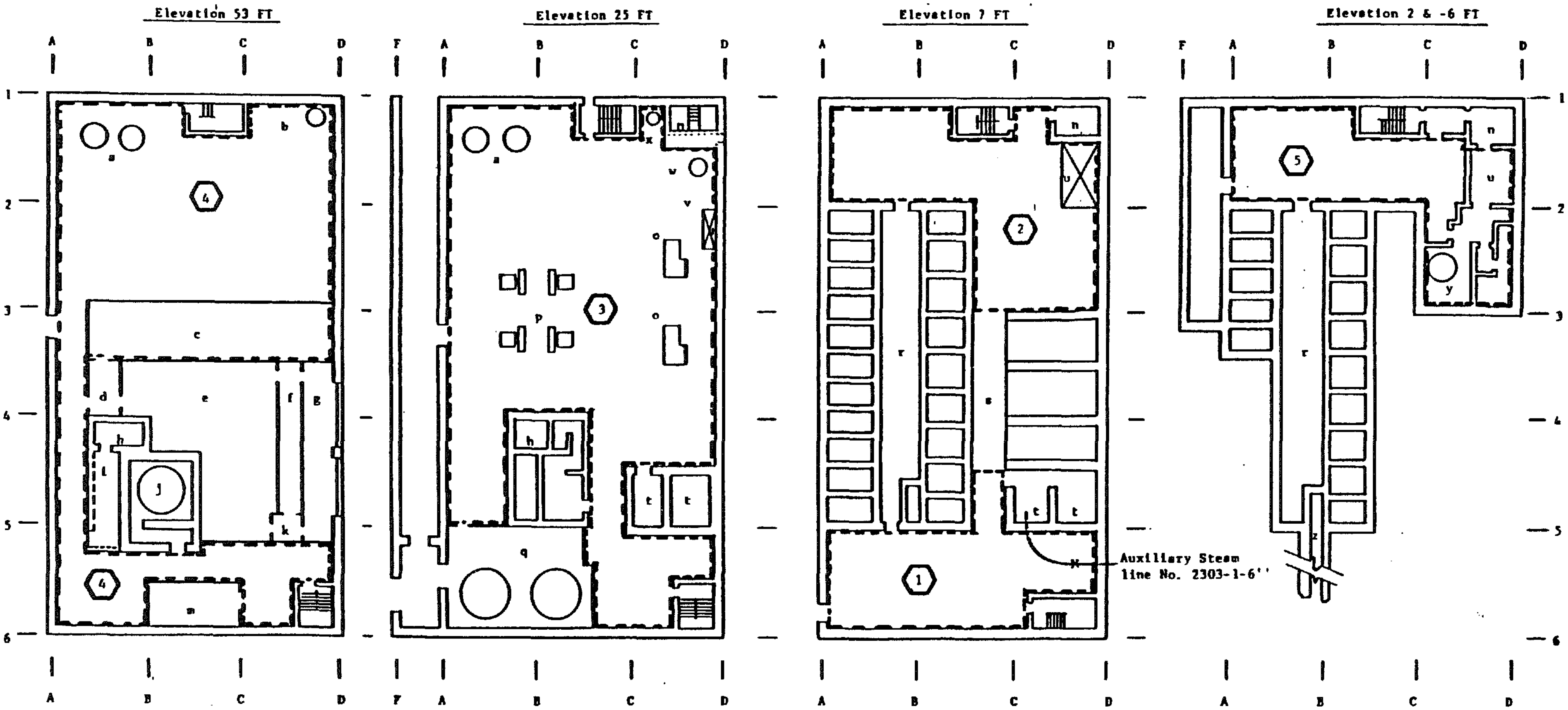
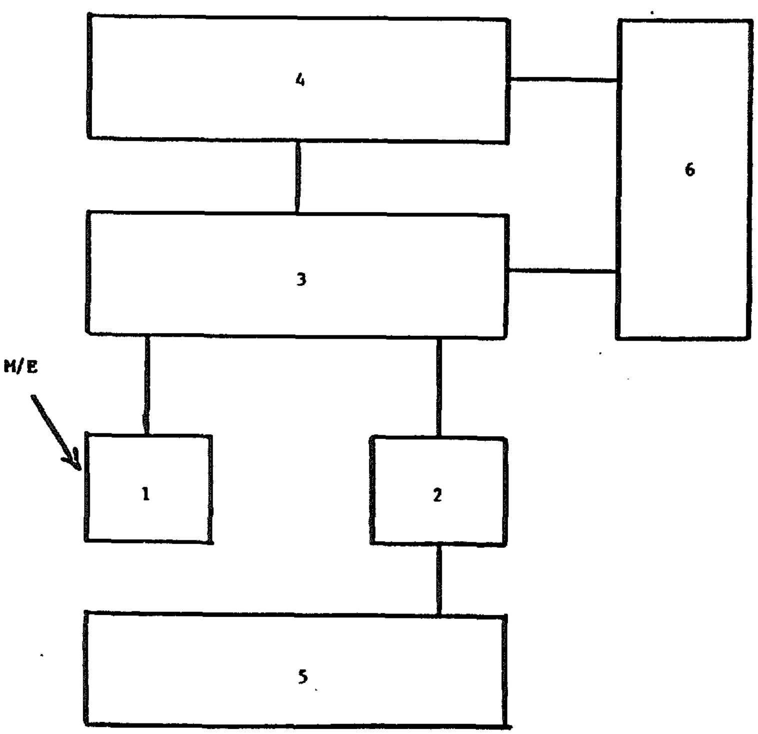


Figure 3.1-3D: Pressure Responses in Primary Auxiliary Building Following a Rupture of 8" Auxiliary Steam Line



a. PCCW Heat Exchangers
b. Blowdown Flash Tank
c. PAB Exhaust Fan Room
d. Air Lock
e. PAB Inlet & Containment Purge Fans
f. Inlet Heaters
g. Inlet Filters
h. RAACT Pipe Chase
i. Valve Aisle
j. CVCS Tank
k. Air Lock
l. Storage Area
m. Electrical Chase
o. 480 v. Load Centers
p. PCCW Pumps
q. Boric Acid Tanks
r. CVCS Vaults
s. Charging Pump Vaults
t. Letdown Degassifier
u. Non-RAACT Pipe Chase
v. HVAC Opening
w. Boron Injection Tank
x. Chiller Surge Tank
y. Aux. Steam Condensate Tank
z. Pipe Trench

Figure 3.1-4A: Nodal Arrangement of Primary Auxiliary Building at Various Elevations for Auxiliary Steam Line AS-2303-1-6" Break Analysis



NODE	VOLUME (ft^3)	HEAT SINK AREA(ft^2)
1	38,200	8,500
2	49,700	10,000
3	243,400	42,670
4	172,940	26,560
5	38,235	15,900
6	ATMOSPHERE	

FLOW PATHS CHARACTERISTICS

FROM NODE	TO NODE	AREA(ft^2)	INERTIA (ft^{-1})	LOSS FACTOR K_c	K_{exp}	K_{fric}	K_{total}
1	3	60.0	.04	.78	1.0	.02	1.80
2	3	44.8	.80	.78	1.0	.30	2.08
2	5	5.9	8.50	.78	1.0	3.20	4.98
3	4	51.5	1.33	.78	1.0	.33	2.11
3	6	20.0	.50	.78	1.0	1.60	3.38
4	6	20.0	5.00	.78	1.0	3.50	5.28

Figure 3.1-4B: Nodal Parameters of Primary Auxiliary Building for Auxiliary Steam Line AS-2303-1-6" Break Analysis

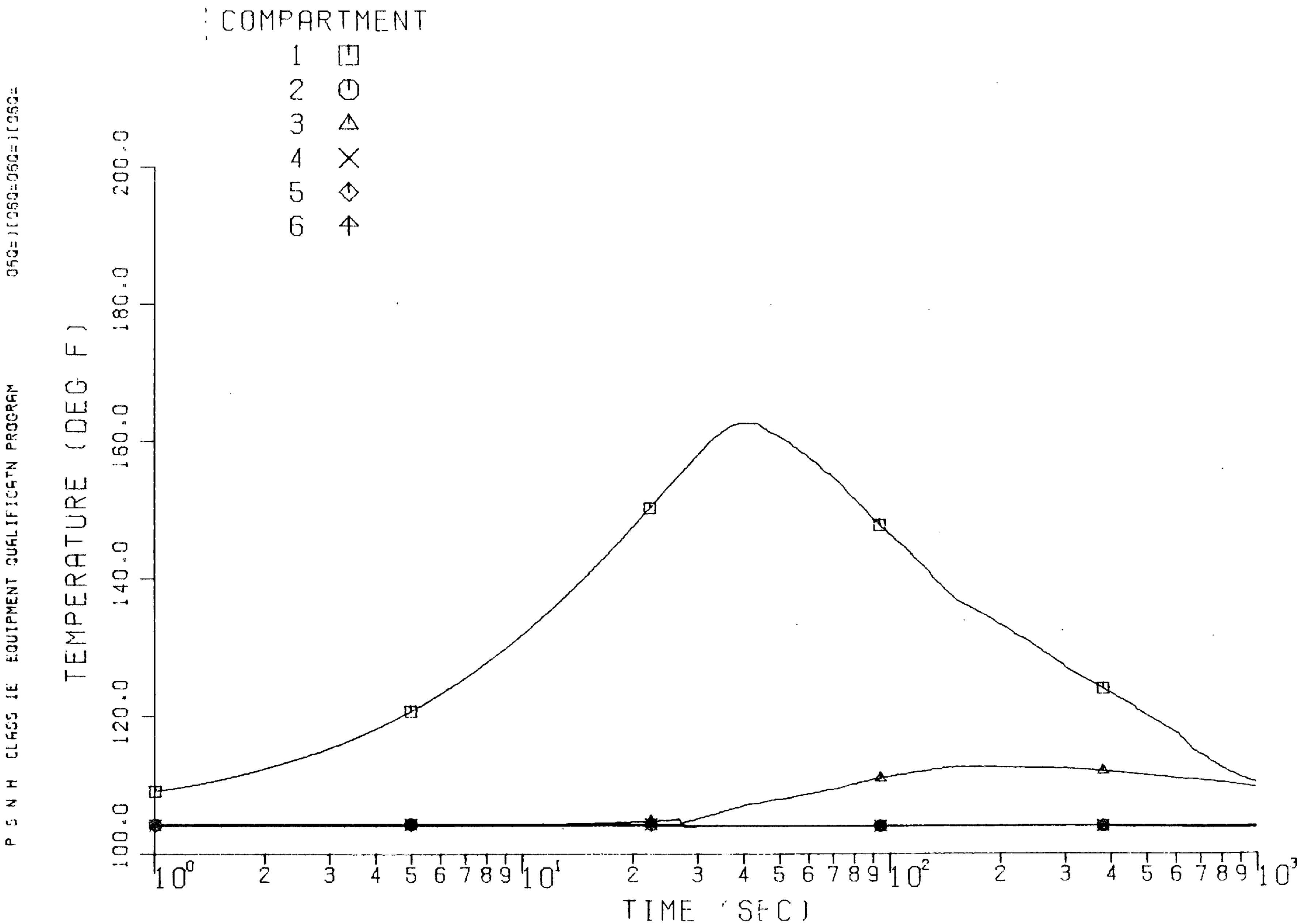


Figure 3.1-4C: Temperature Responses in Primary Auxiliary Building Following a Rupture of 6" Auxiliary Steam Line

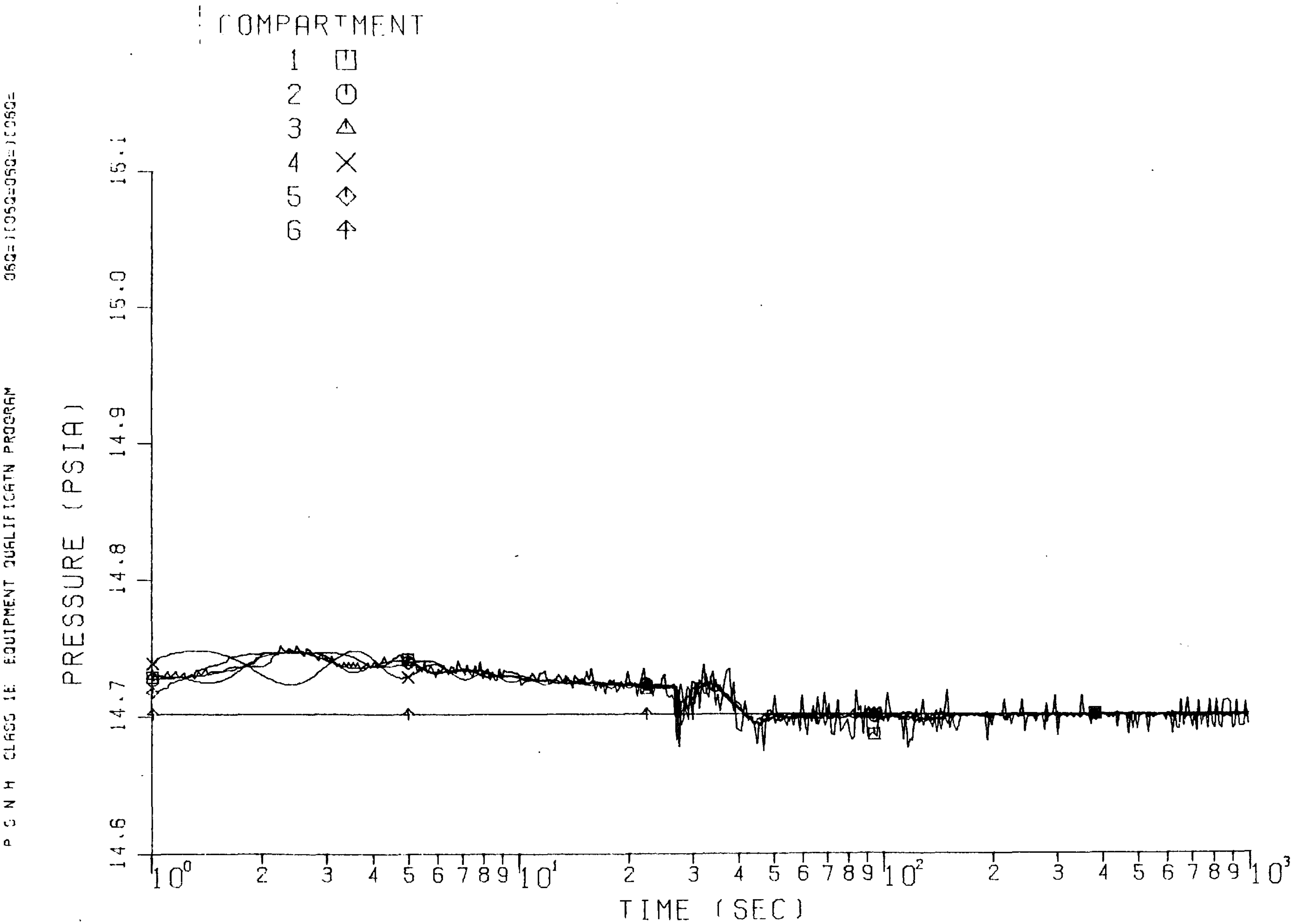
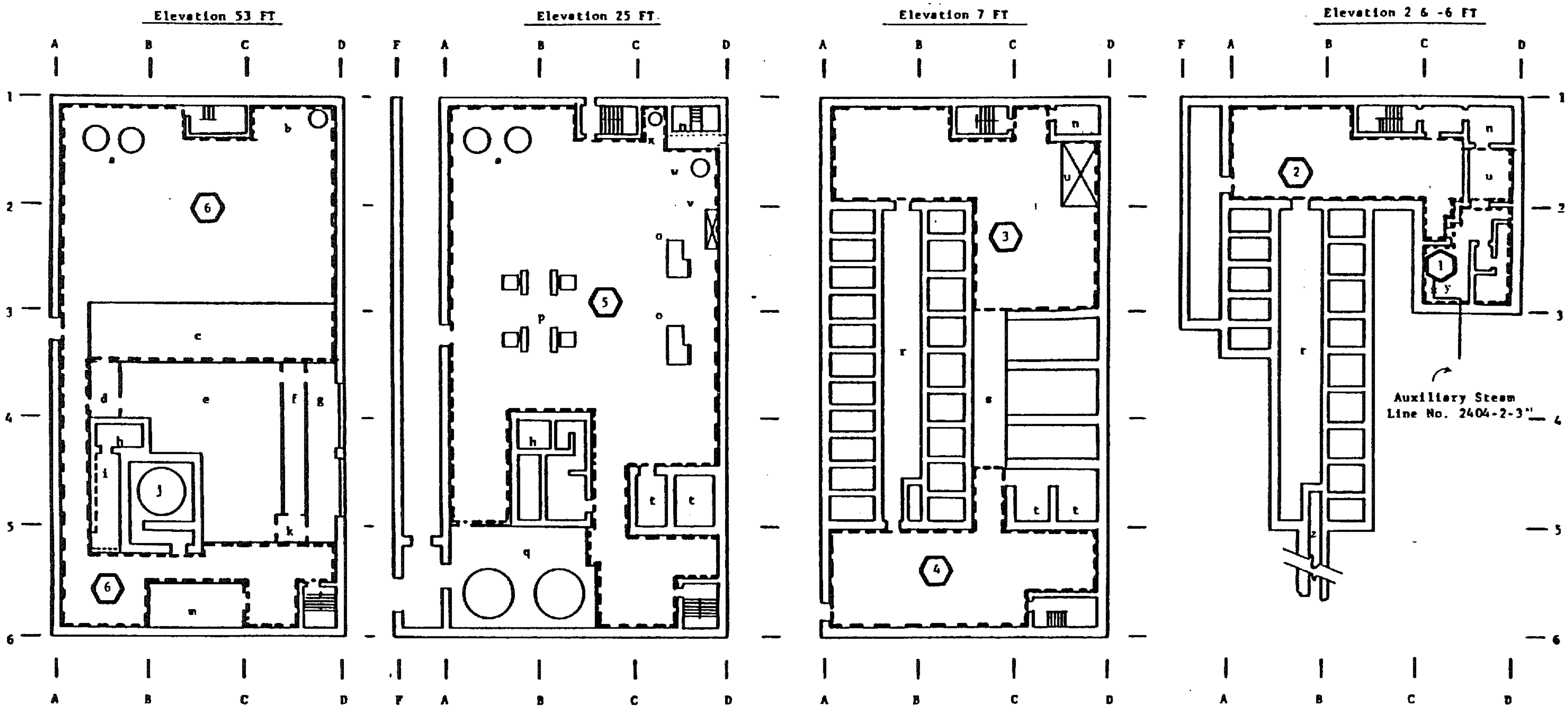
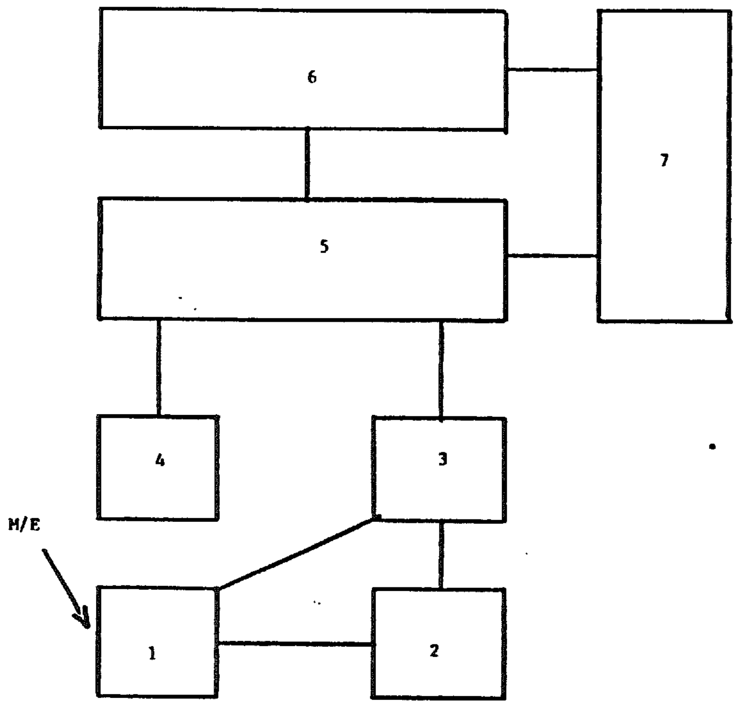


Figure 3.1-4D: Pressure Responses in Primary Auxiliary Building Following a Rupture of 6" Auxiliary Steam Line



a. PCCW Heat Exchangers
b. Blowdown Flash Tank
c. PAB Exhaust Fan Room
d. Air Lock
e. PAB Inlet & Containment Purge Fans
f. Inlet Heaters
g. Inlet Filters
h. RAACT Pipe Chase
i. Valve Aisle
j. CVCS Tank
k. Air Lock
m. Storage Area
n. Electrical Chase
o. 480 v. Load Centers
p. PCCW Pumps
q. Boric Acid Tanks
r. CVCS Vaults
s. Charging Pump Vaults
t. Letdown Degassifier
u. Non-RAACT Pipe Chase
v. HVAC Opening
w. Boron Injection Tank
x. Chiller Surge Tank
y. Aux. Steam Condensate Tank
z. Pipe Trench

Figure 3.1-5A: Nodal Arragement of Primary Auxiliary Building at Various Elevations for Auxiliary Steam Condensate Line ASC-2404-2-3" Break Analysis



NODE	VOLUME (ft^3)	HEAT SINK AREA(ft^2)
1	8,645	4,180
2	29,700	11,700
3	49,700	10,000
4	38,200	8,500
5	243,400	42,670
6	172,940	26,560
7	ATMOSPHERE	

FLOW PATHS CHARACTERISTICS

				LOSS FACTOR			
FROM NODE	TO NODE	AREA(ft^2)	INERTIA (ft^{-1})	K_c	K_{exp}	K_{fric}	K_{total}
1	2	2.1	15.0	.78	1.0	1.5	3.28
1	3	3.0	10.3	.78	1.0	1.4	3.18
2	3	5.9	8.5	.78	1.0	3.20	4.98
3	5	44.8	.80	.78	1.0	.30	2.08
4	5	6.3	.32	.78	1.0	.10	1.88
5	6	51.5	1.33	.78	1.0	.33	2.11
5	7	20.0	.50	.78	1.0	1.60	3.38
6	7	20.0	5.00	.78	1.0	3.50	5.28

Figure 3.1-5B: Nodal Parameters of Primary Auxiliary Building for Auxiliary Steam Condensate Line ASC-2404-2-3" Break Analysis

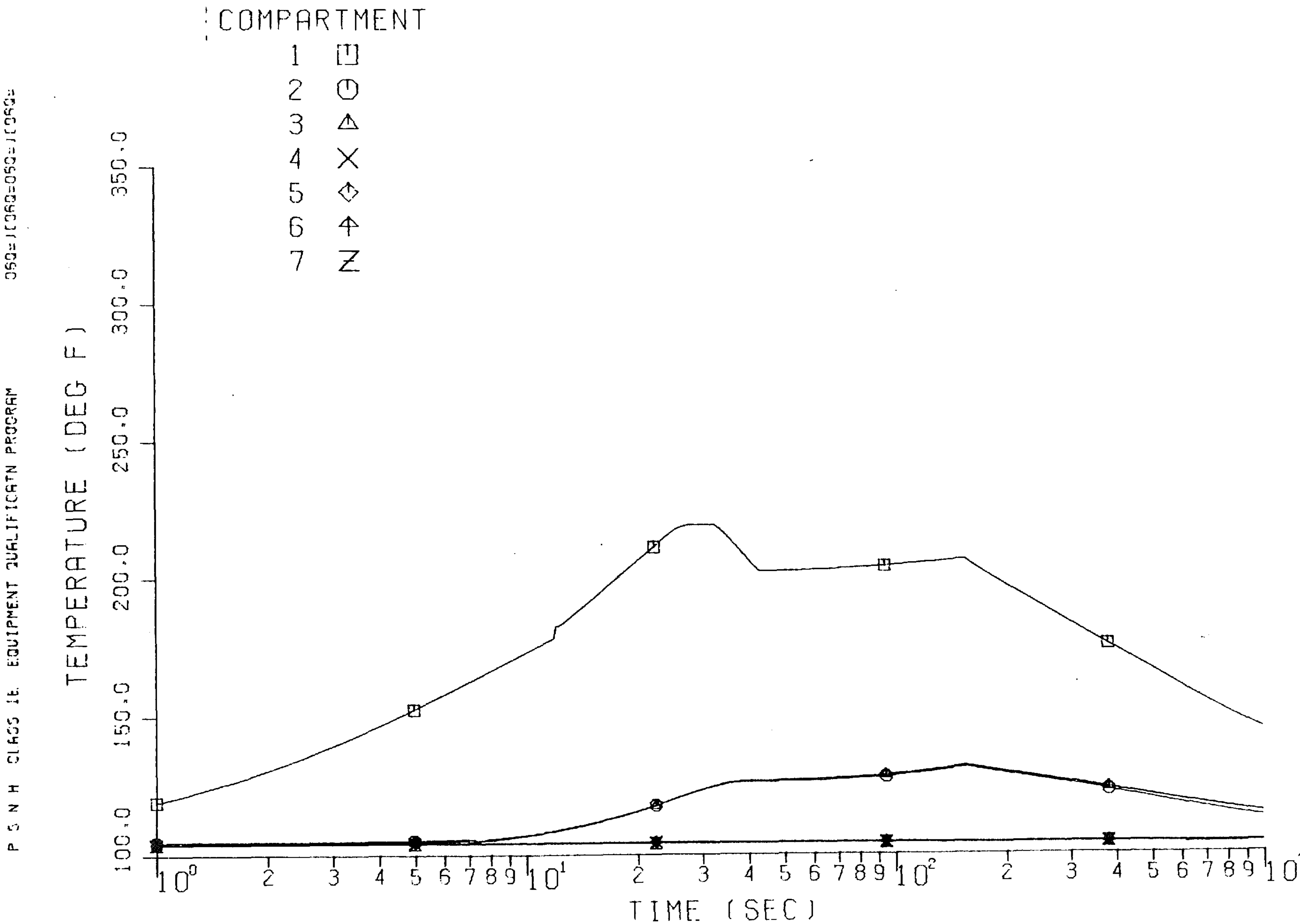


Figure 3.1-5C: Temperature Responses in Primary Auxiliary Building
Following a Rupture of 3" Auxiliary Steam Condensate Line

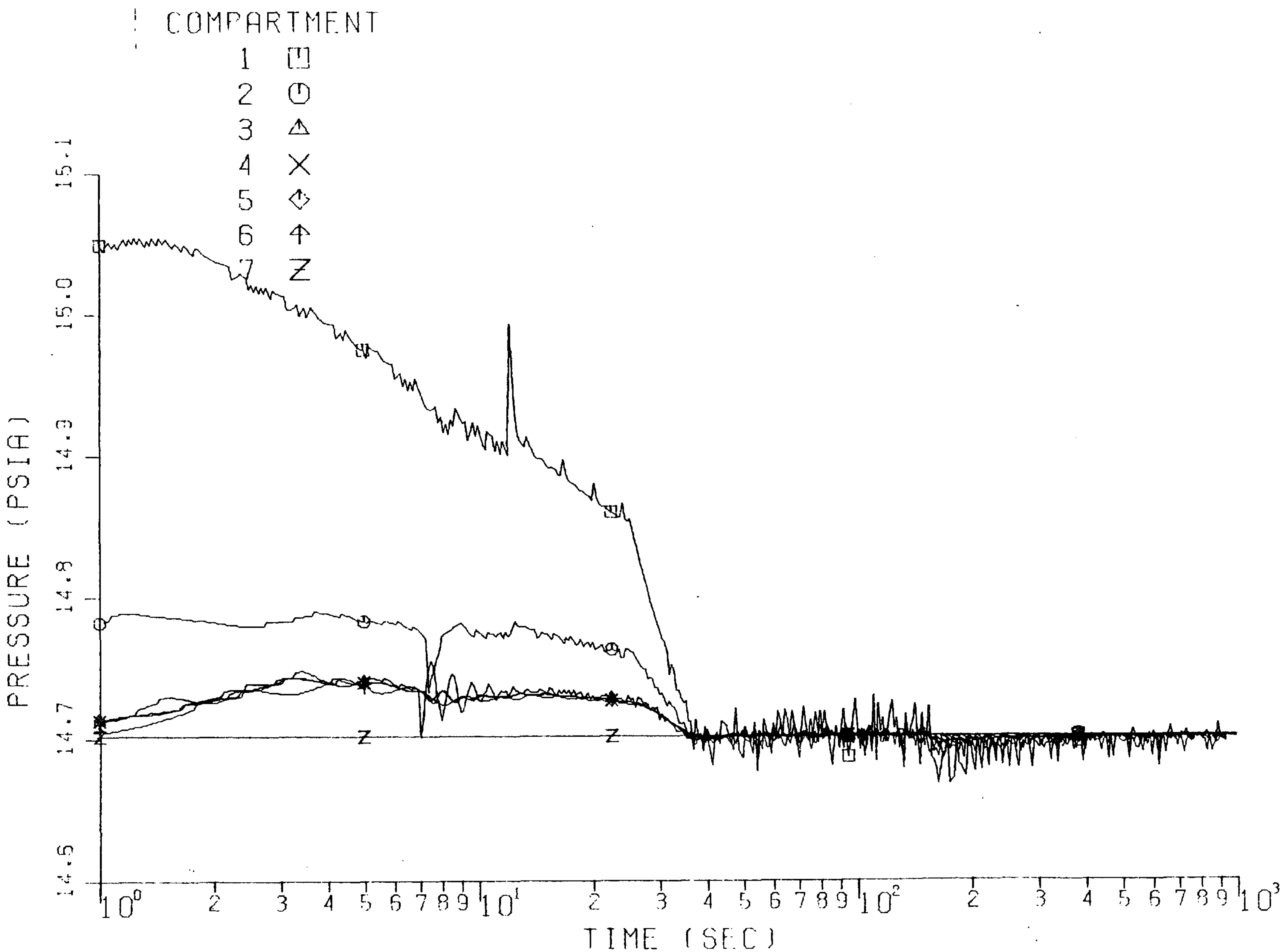
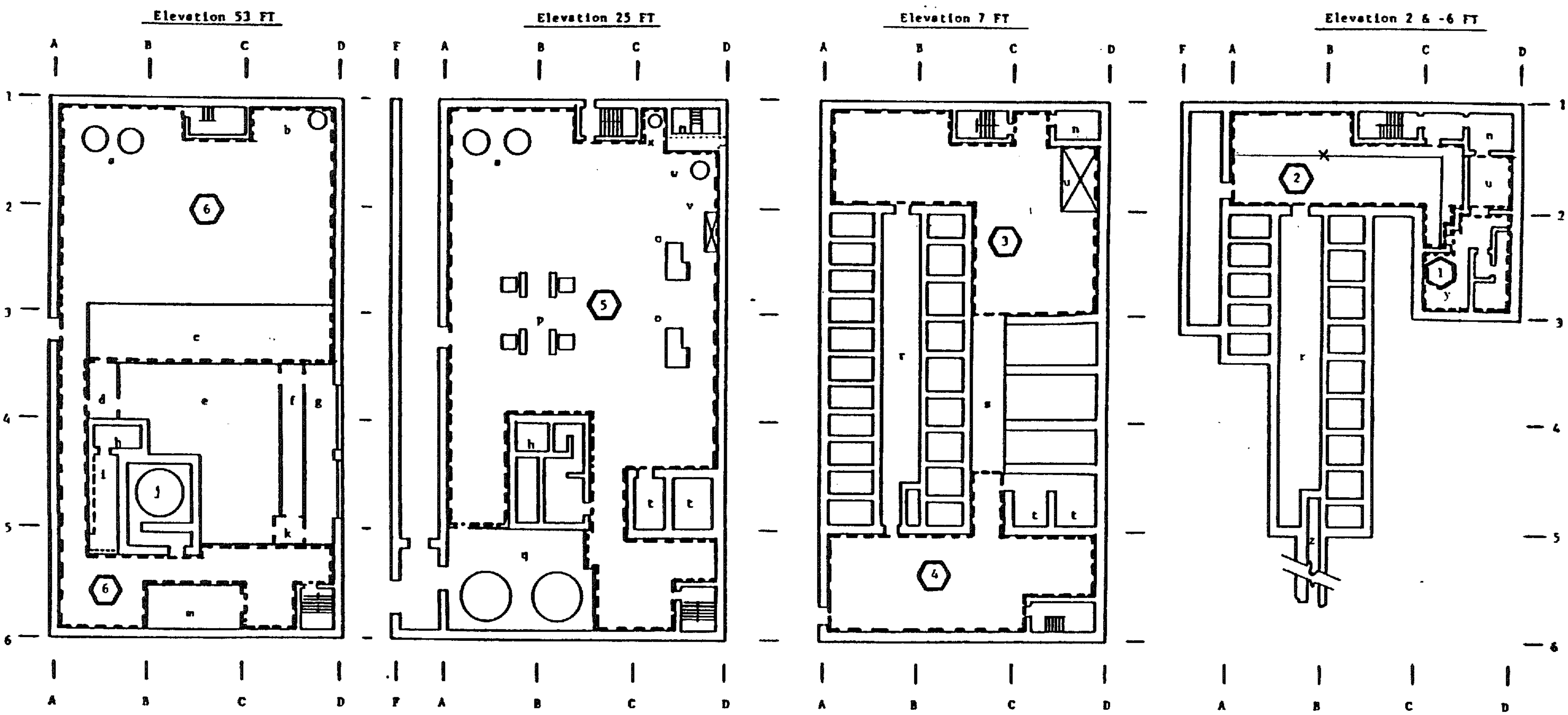
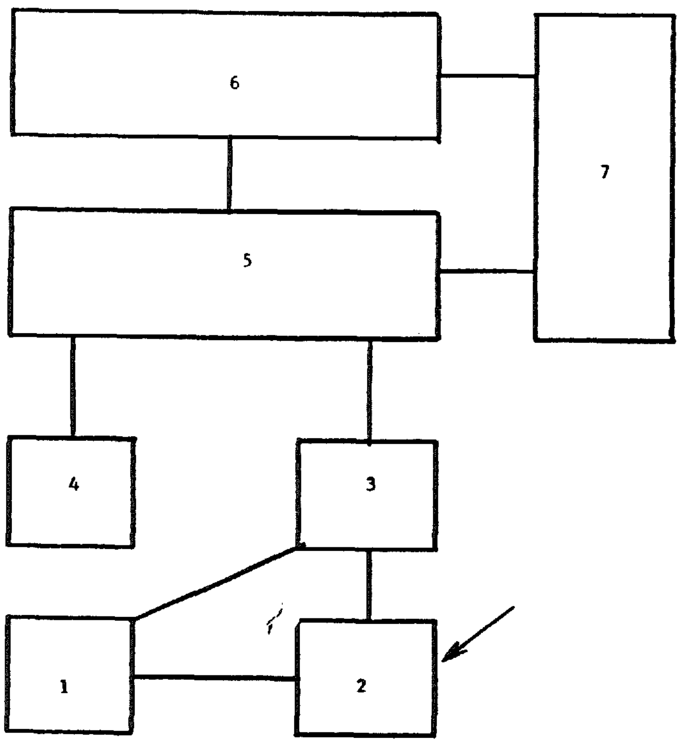


Figure 3.1-5D: Pressure Responses in Primary Auxiliary Building Following a Rupture of 3" Auxiliary Steam Condensate Line



a. PCCW Heat Exchangers
b. Blowdown Flash Tank
c. PAB Exhaust Fan Room
d. Air Lock
e. PAB Inlet & Containment Purge Fans
f. Inlet Heaters
g. Inlet Filters
h. RAACT Pipe Chase
i. Valve Aisle
j. CVCS Tank
k. Air Lock
l. Storage Area
m. Electrical Chase
o. 480 v. Load Centers
p. PCCW Pumps
q. Boric Acid Tanks
r. CVCS Vaults
s. Charging Pump Vaults
t. Letdown Degassifier
u. Non-RAACT Pipe Chase
v. HVAC Opening
w. Boron Injection Tank
x. Chiller Surge Tank
y. Aux. Steam Condensate Tank
z. Pipe Trench

Figure 3.1-6A: Nodal Arrangement of Primary Auxiliary Building at Various Elevations for Auxiliary Steam Condensate Line ASC-2406-1-4" Break Analysis



NODE	VOLUME (ft^3)	HEAT SINK AREA(ft^2)
1	8,645	4,180
2	29,700	11,700
3	49,700	10,000
4	38,200	8,500
5	243,400	42,670
6	172,940	26,560
7	ATMOSPHERE	

FLOW PATHS CHARACTERISTICS

FROM NODE	TO NODE	AREA(ft^2)	INERTIA (ft^{-1})	LOSS FACTOR K_c	K_{exp}	K_{fric}	K_{total}
1	2	2.1	15.0	.78	1.0	1.5	3.28
1	3	3.0	10.3	.78	1.0	1.4	3.18
2	3	5.9	8.5	.78	1.0	3.20	4.98
3	5	44.8	.80	.78	1.0	.30	2.08
4	5	6.3	.32	.78	1.0	.10	1.88
5	6	51.5	1.33	.78	1.0	.33	2.11
5	7	20.0	.50	.78	1.0	1.60	3.38
6	7	20.0	5.00	.78	1.0	3.50	5.28

Figure 3.1-6B: Nodal Parameters of Primary Auxiliary Building for Auxiliary Steam Condensate Line ASC-2406-1-4" Break Analysis

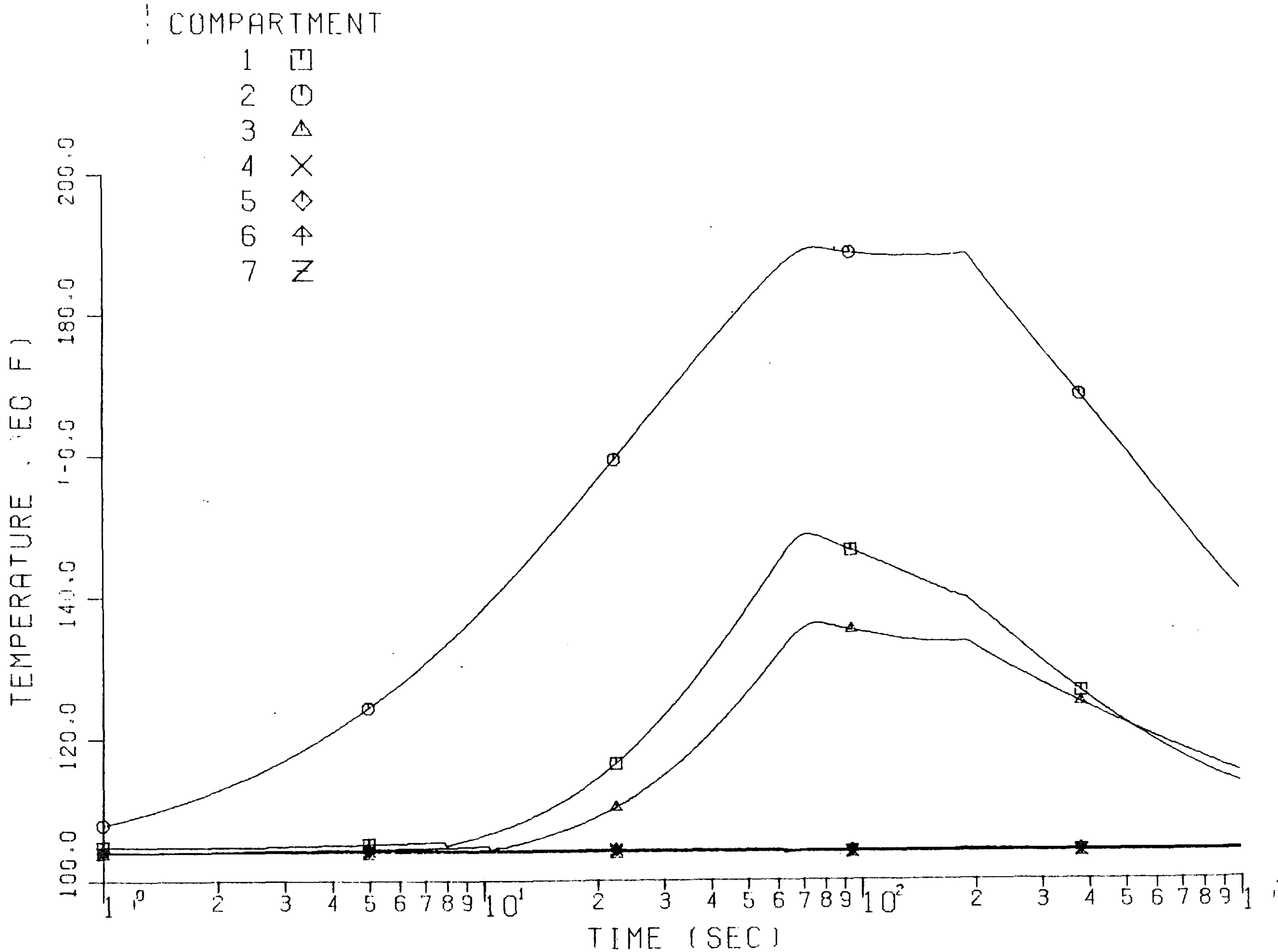


Figure 3.1-6C: Temperature Responses in Primary Auxiliary Building Following a Rupture of 4" Auxiliary Steam Condensate Line

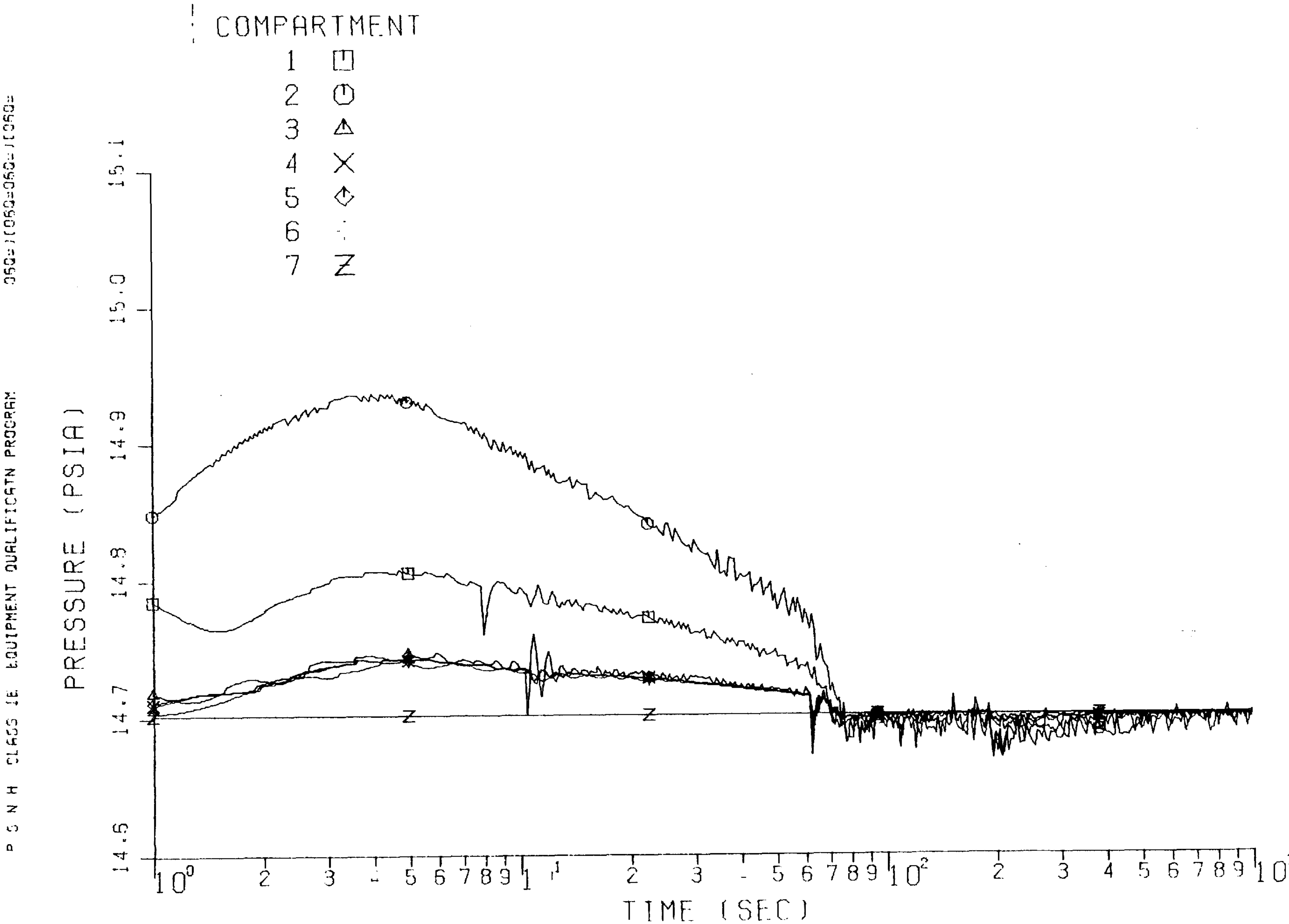
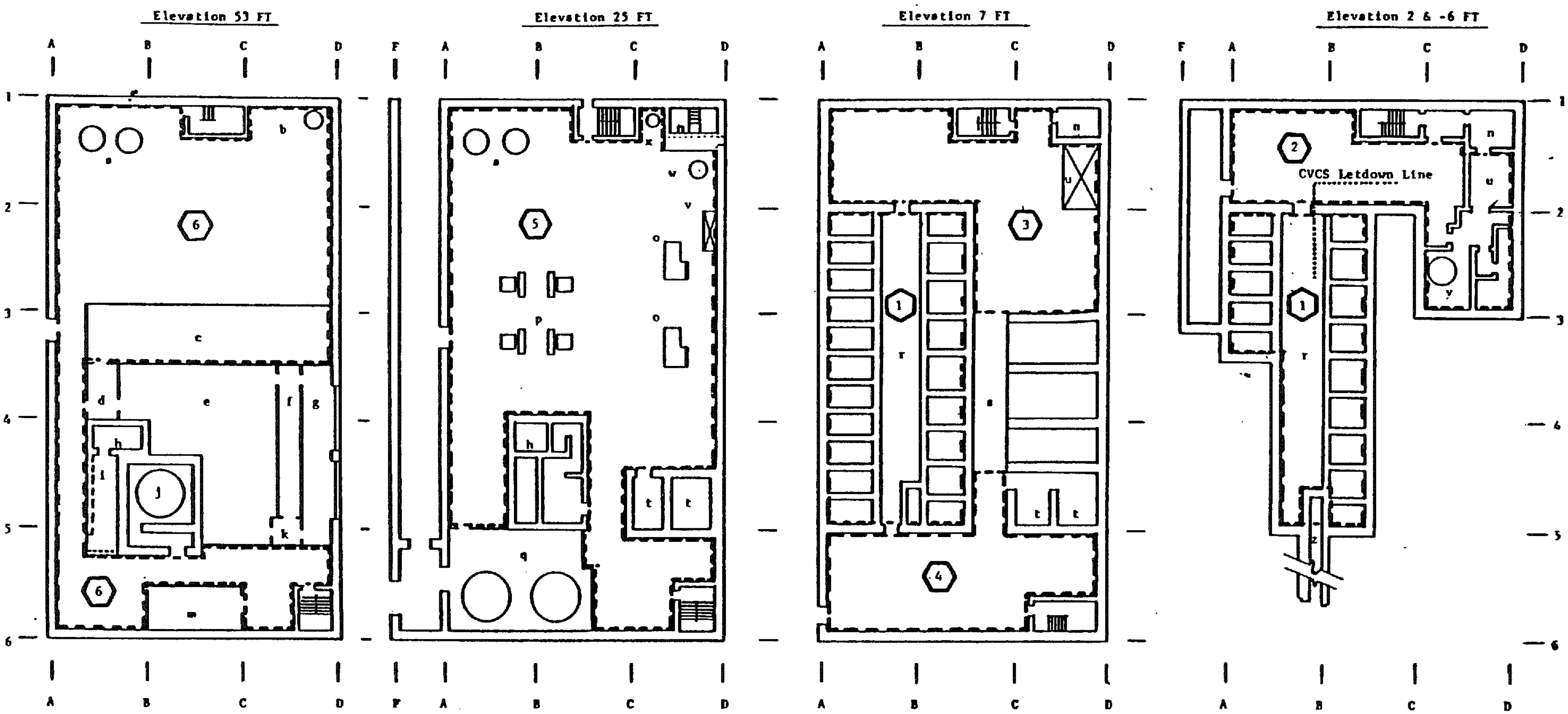
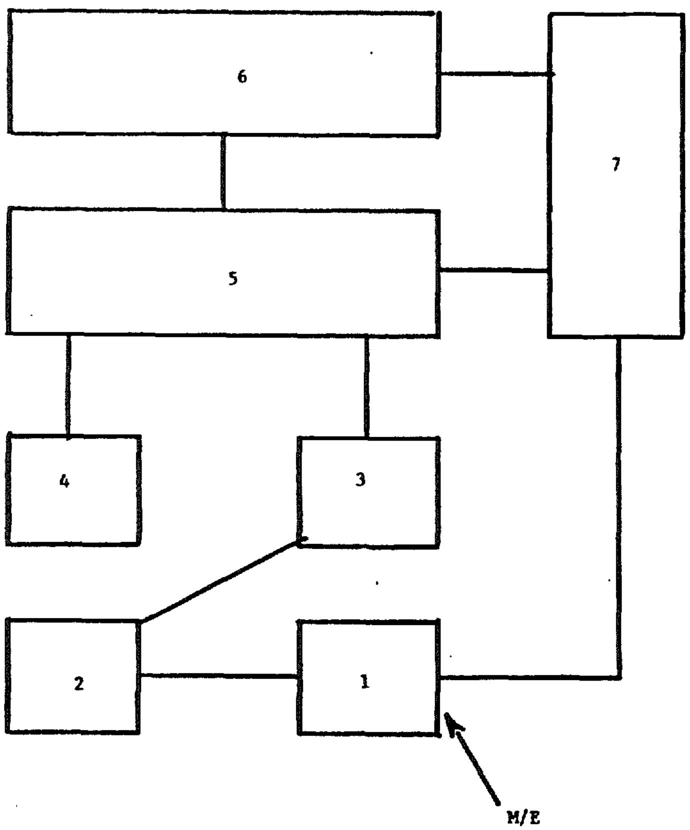


Figure 3.1-6D: Pressure Responses in Primary Auxiliary Building
Following a Rupture of 4" Auxiliary Steam Condensate Line



a. PCCW Heat Exchangers
b. Blowdown Flash Tank
c. PAB Exhaust Fan Room
d. Air Lock
e. PAB Inlet & Containment Purge Fans
f. Inlet Heaters
g. Inlet Filters
h. RAACT Pipe Chase
i. Valve Aisle
j. CVCS Tank
k. Air Lock
l. Storage Area
m. Electrical Chase
o. 480 v. Load Centers
p. PCCW Pumps
q. Boric Acid Tanks
r. CVCS Vaults
s. Charging Pump Vaults
t. Letdown Degassifier
u. Non-RAACT Pipe Chase
v. HVAC Opening
w. Boron Injection Tank
x. Chiller Surge Tank
y. Aux. Steam Condensate Tank
z. Pipe Trench

Figure 3.1-7A: Nodal Arrangement of Primary Auxiliary Building at Various Elevations for CVCS Letdown Line Break Analysis



NODE	VOLUME (ft^3)	HEAT SINK AREA (ft^2)
1	47,100	23,000
2	38,235	15,900
3	49,700	10,000
4	38,200	8,500
5	243,400	42,670
6	172,940	26,560
7	ATMOSPHERE	

FLOW PATHS CHARACTERISTICS

FROM NODE	TO NODE	AREA (ft^2)	INERTIA (ft^{-1})	LOSS FACTOR K_c	K_{exp}	K_{fric}	K_{total}
1	2	.80	45.0	.11	.11	.22	.44
1	7	1.4	37.5	.34	.20	.67	1.21
2	3	2.3	47.0	.78	1.0	1.80	3.58
3	5	44.8	.80	.78	1.0	.30	2.08
4	5	6.3	.32	.78	1.0	.10	1.88
5	6	51.5	1.33	.78	1.0	.33	2.11
5	7	20.0	.50	.78	1.0	1.6	3.38
6	7	20.0	5.00	.78	1.0	3.5	5.28

Figure 3.1-7B: Nodal Parameters of Primary Auxiliary Building for CVCS Letdown Line Break Analysis

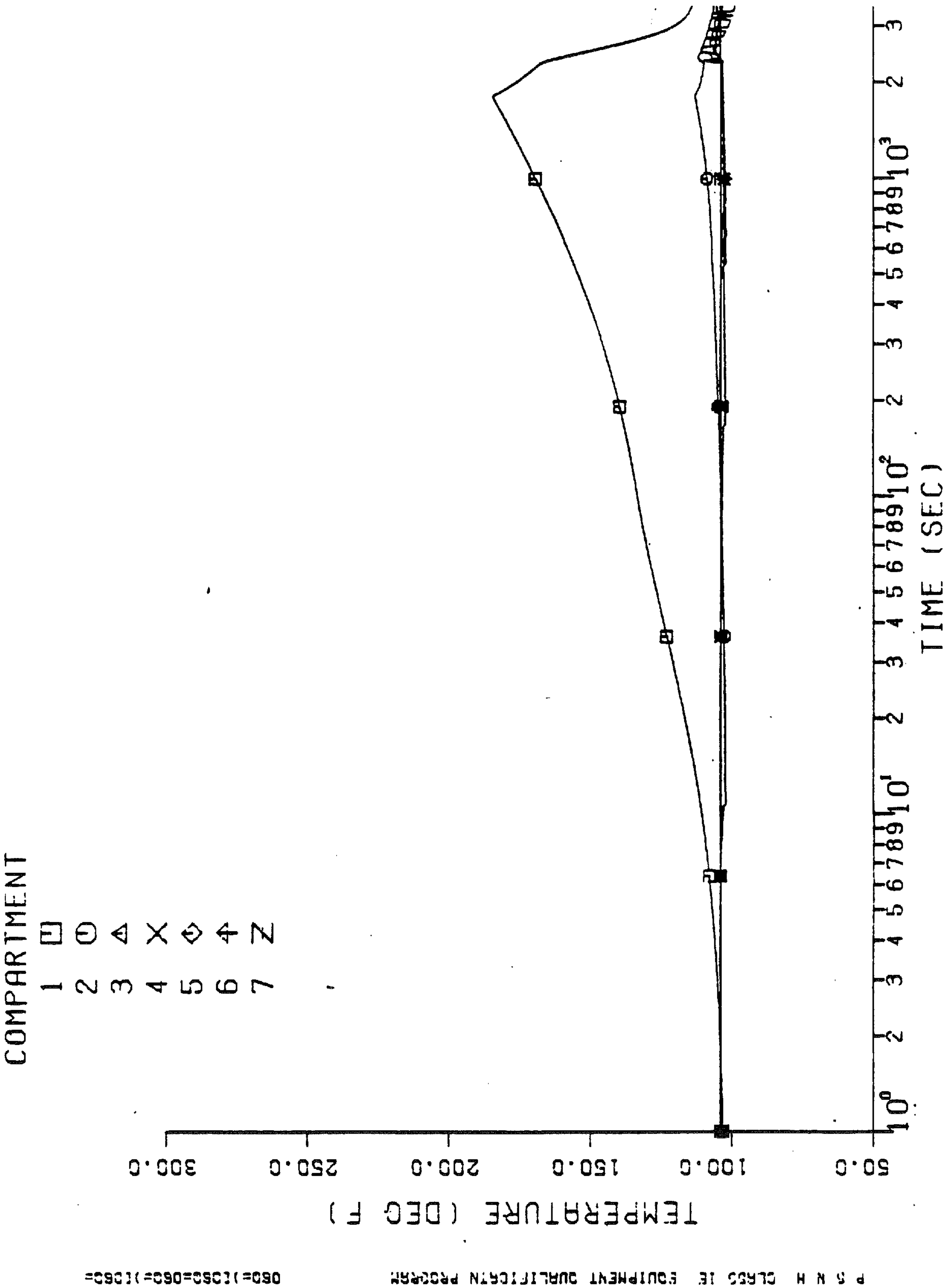


Figure 3.1-7C: Temperature Responses in Primary Auxiliary Building
Following a Rupture of CVCS Letdown Line

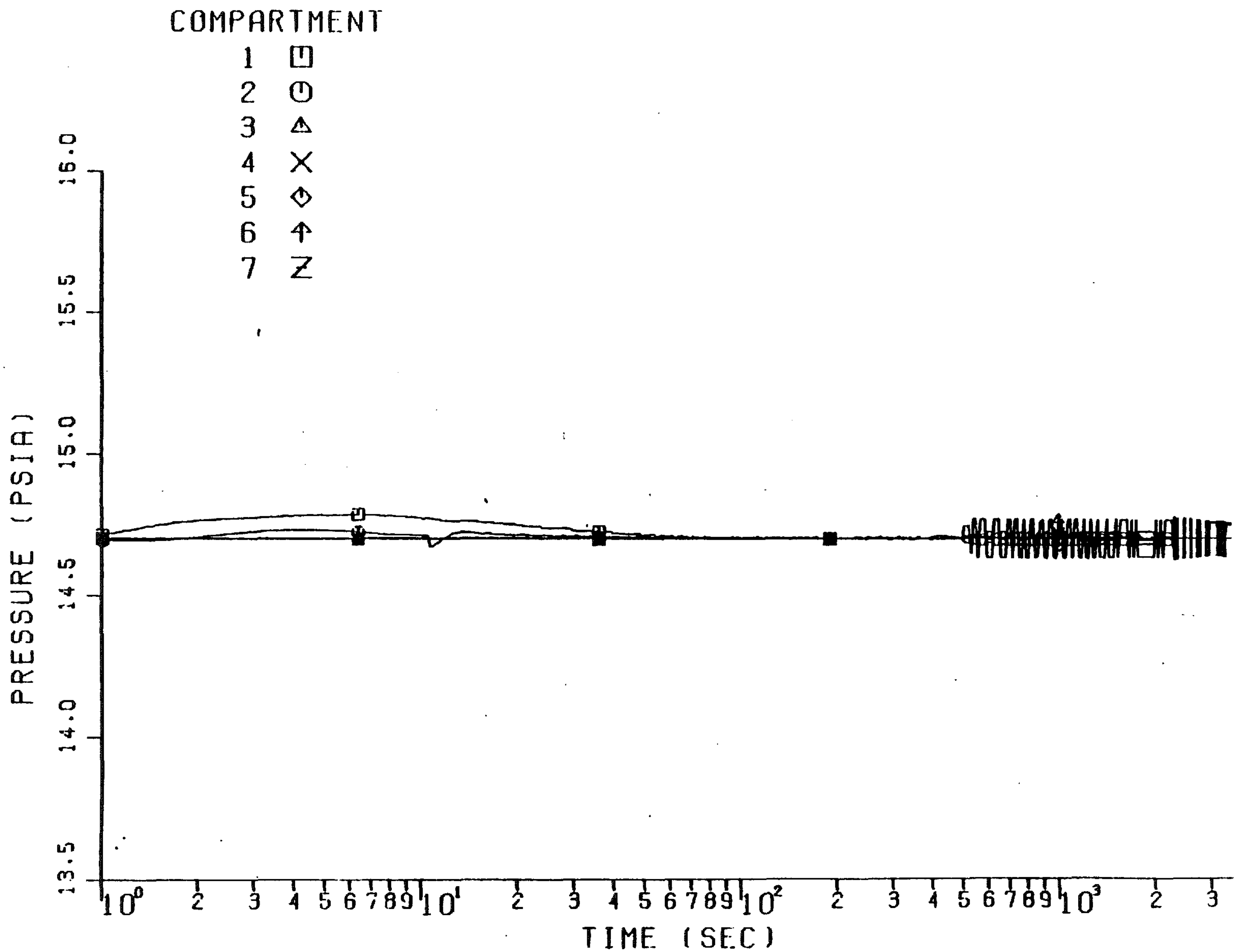


Figure 3.1-7D: Pressure Responses in Primary Auxiliary Building
Following a Rupture of CVCS Letdown Line

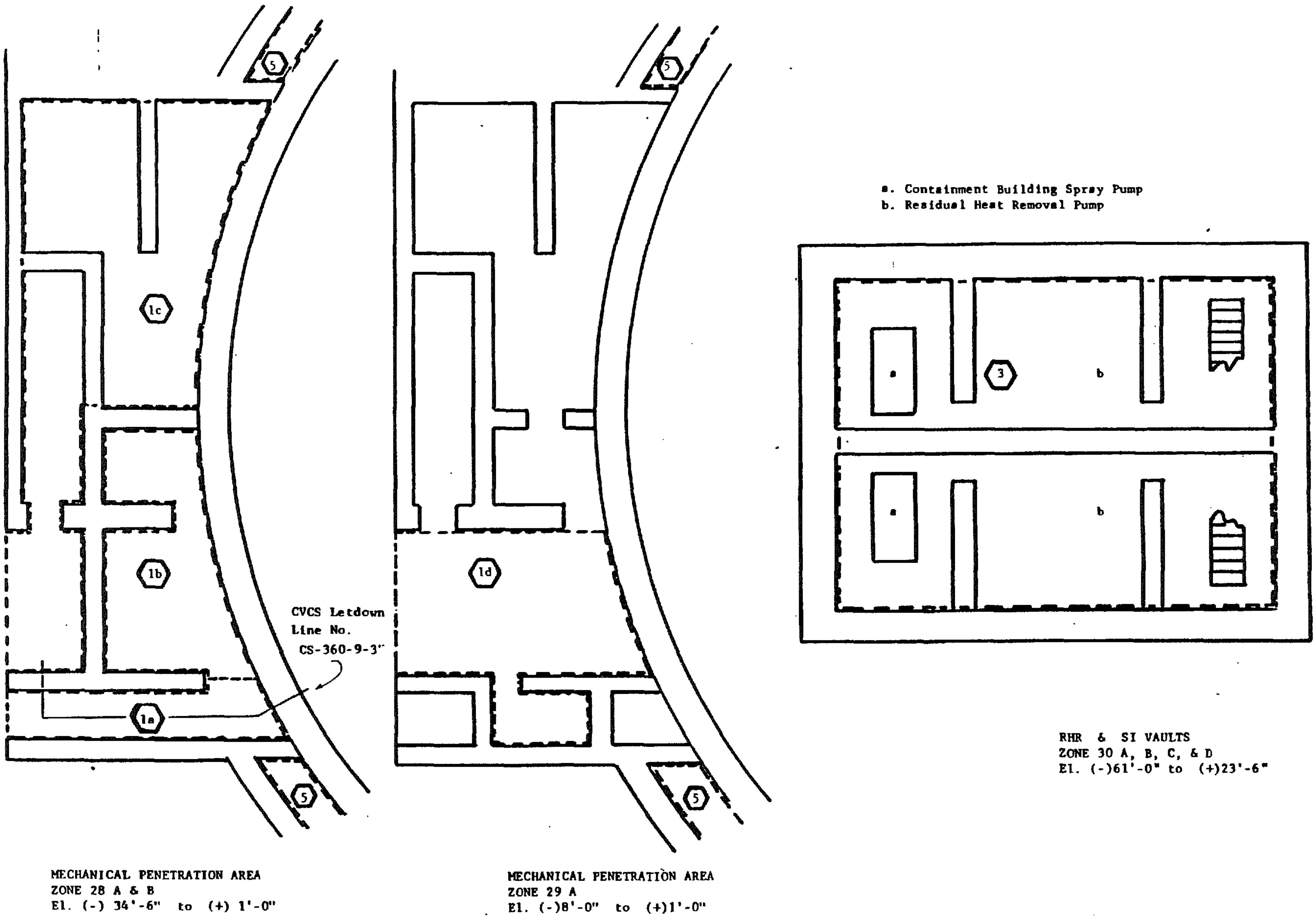


Figure 3.2-1A: Containment Enclosure Area Showing Nodal Arrangement
(Sheet 1 of 2) for CVCS Letdown Line Break Analysis

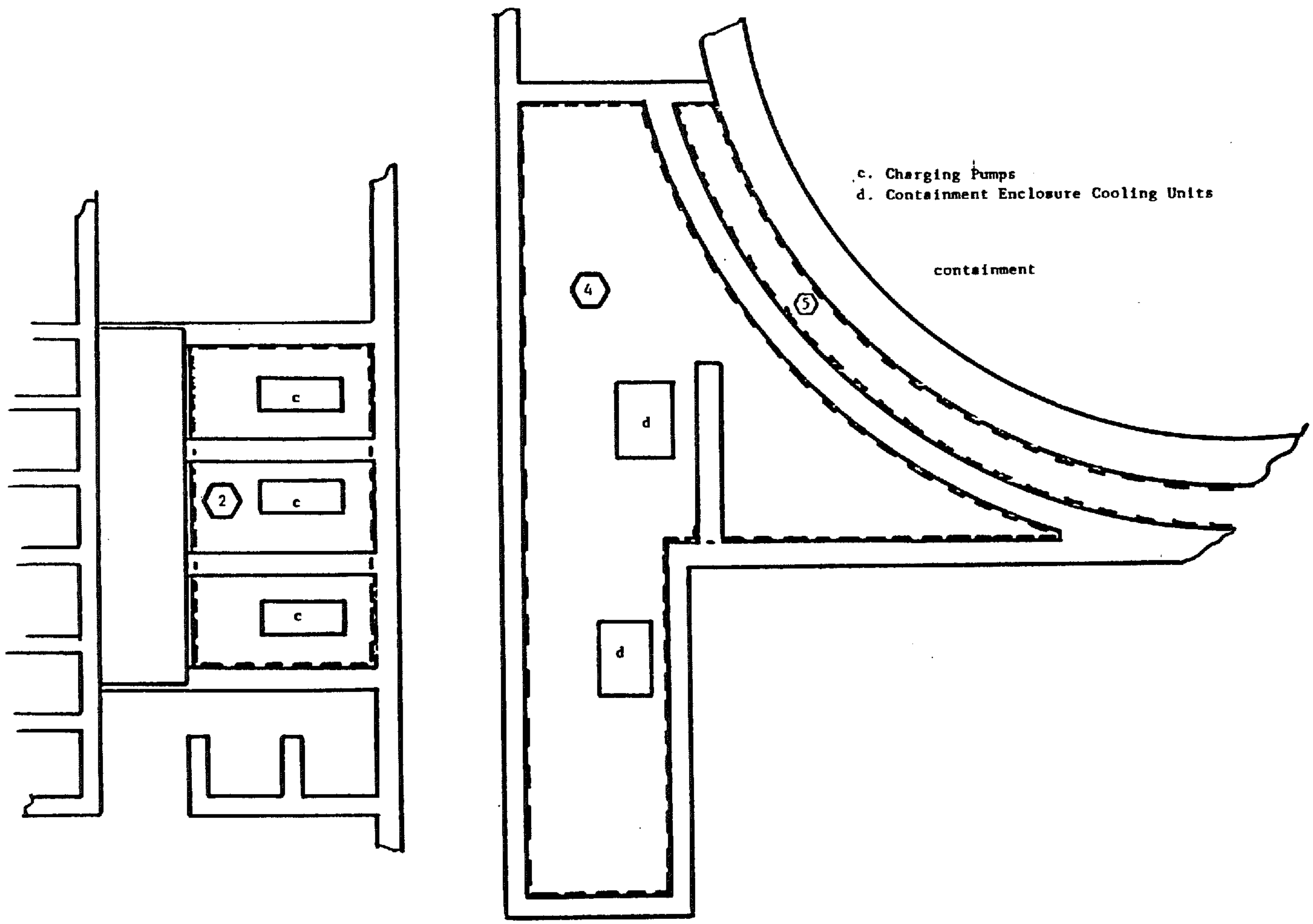
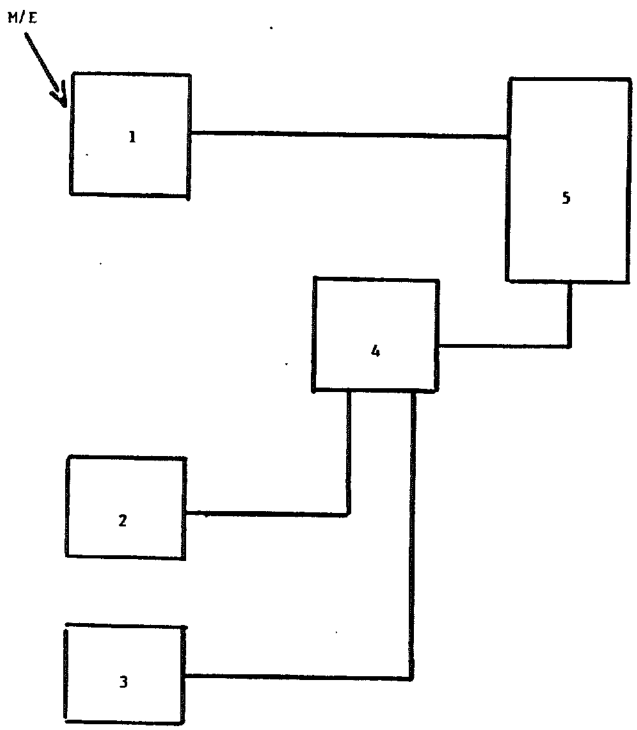


Figure 3.2-1A : Containment Enclosure Area Showing Nodal
(Sheet 2 of 2) Arrangement for CVCS Letdown Line Break Analysis



NODE	VOLUME (ft^3)	HEAT SINK AREA(ft^2)
1	66,355	21,400
2	12,000	4,050
3	144,000	61,170
4	92,570	15,000
5	524,350	145,000

FLOW PATHS CHARACTERISTICS

FROM NODE	TO NODE	AREA (ft^2)	INERTIA (ft^{-1})	LOSS FACTORS K_c	K_{exp}	K_{fric}	K_{total}
1	5	20.0	.20	.78	1.0	.02	1.80
2	4	8.0	5.50	.78	1.0	.74	2.52
3	4	18.9	4.07	.78	1.0	7.1	8.88
4	5	28.0	.18	.78	1.0	.10	1.88

Figure 3.2-1B: Nodal Parameters of Containment Enclosure Area for CVCS Letdown Line Break Analysis

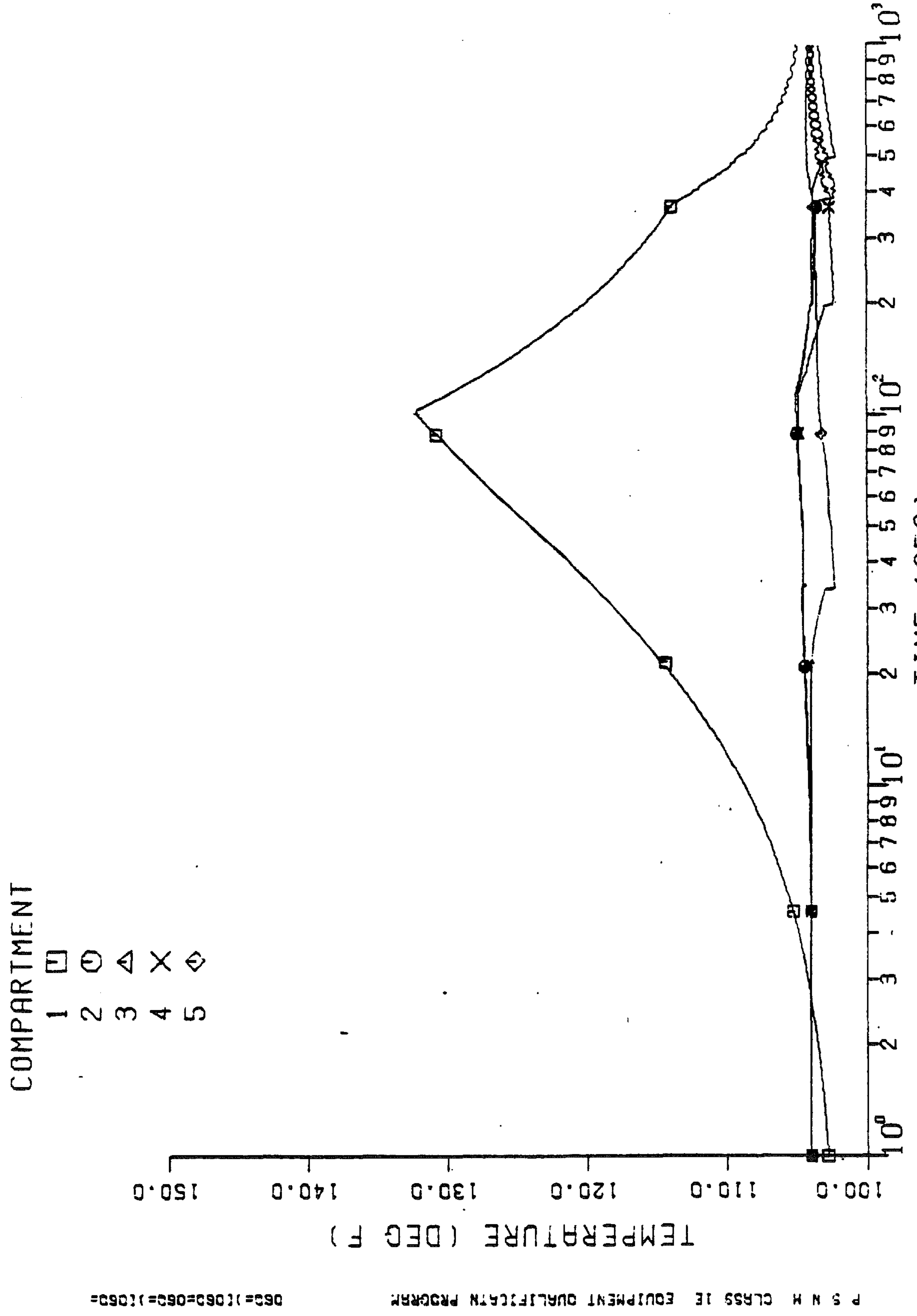


Figure 3.2-1C: Temperature Responses in Containment Enclosure Area Following a Rupture of 3" CVCS Letdown Line

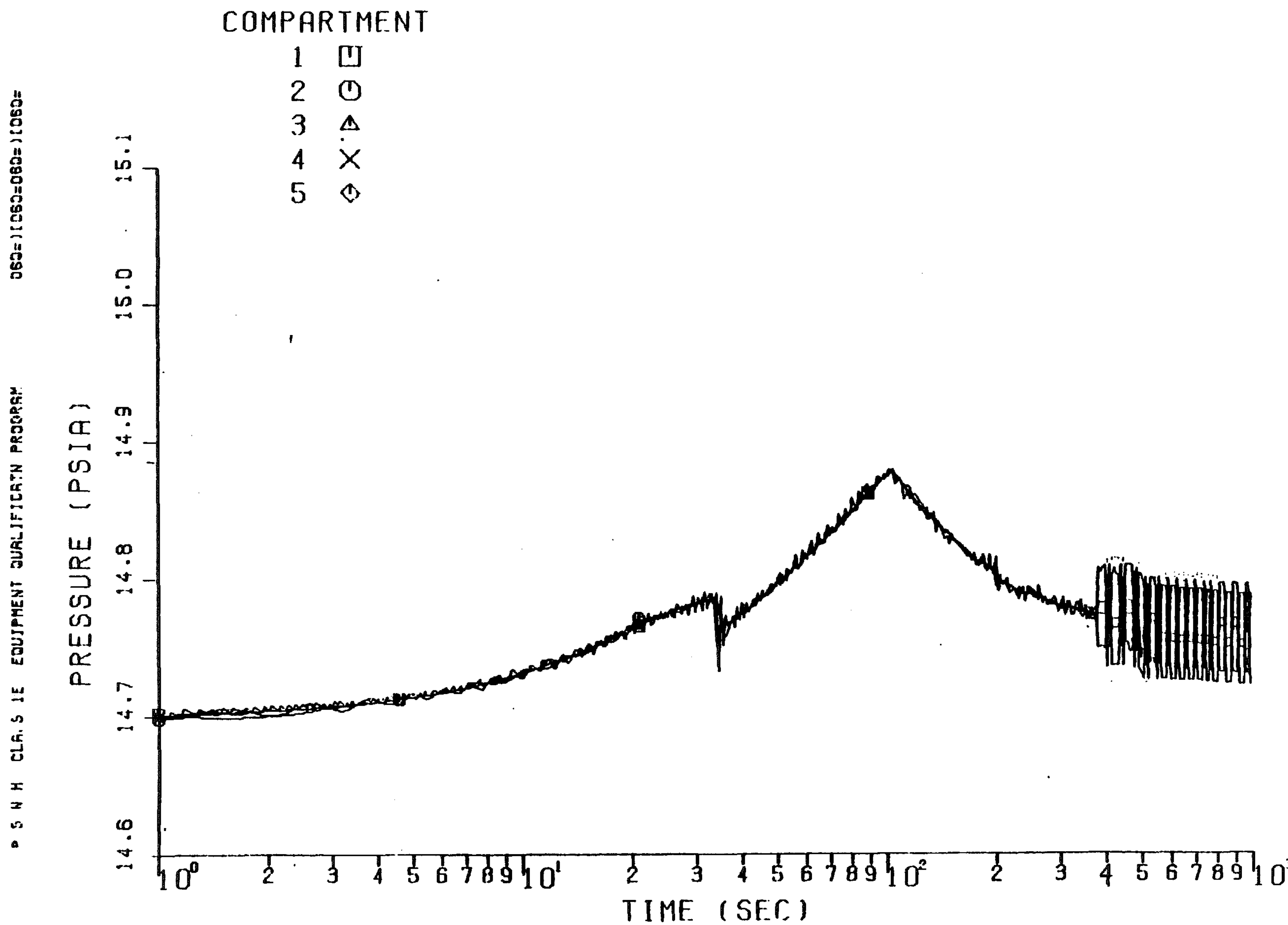


Figure 3.2-1D: Pressure Responses in Containment Enclosure Area
Following a Rupture of 3" CVCS Letdown Line

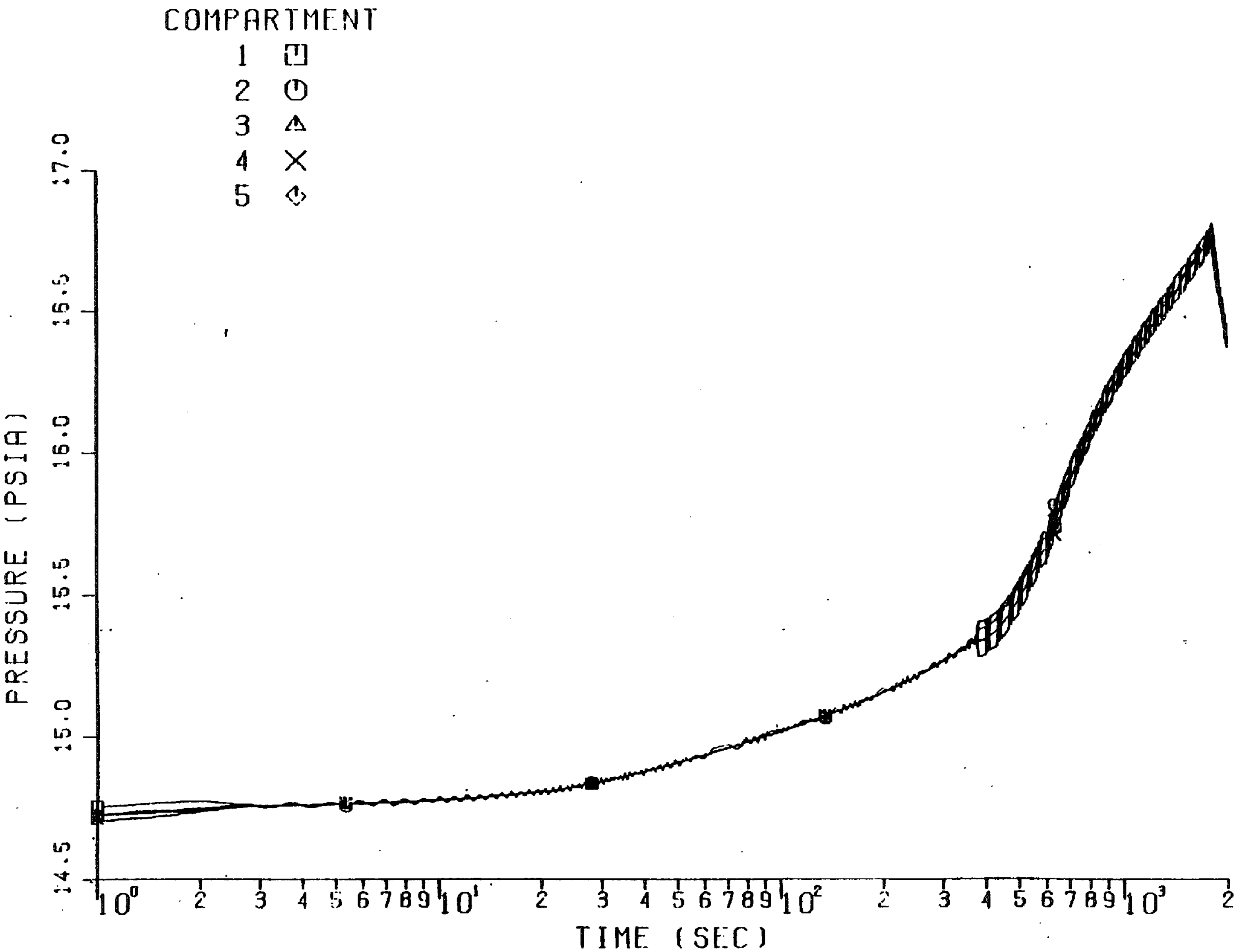


Figure 3.2-1E: Maximized Pressure Responses in Containment Enclosure
Area Following a Rupture of 3" CVCS Letdown Line

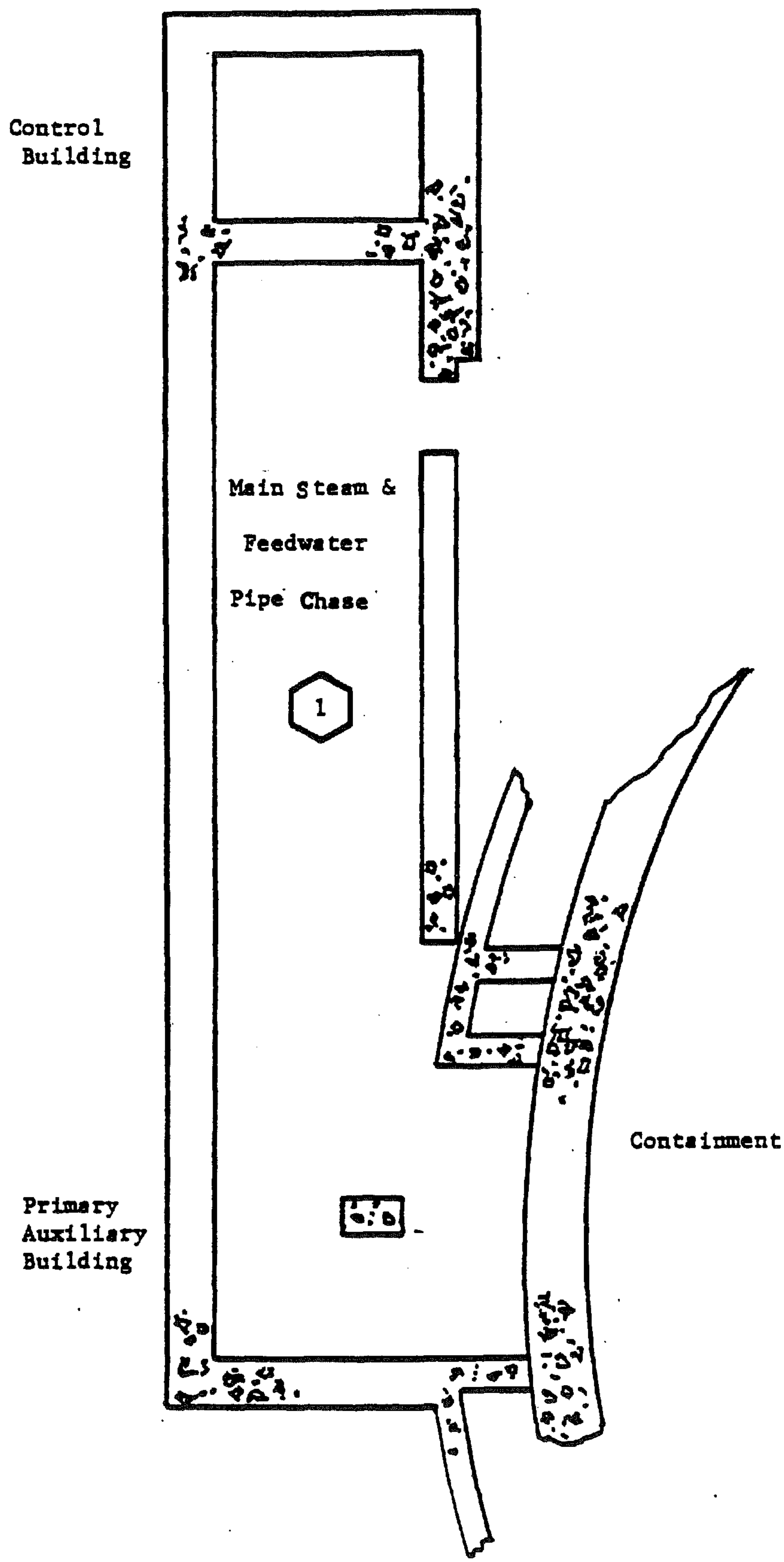
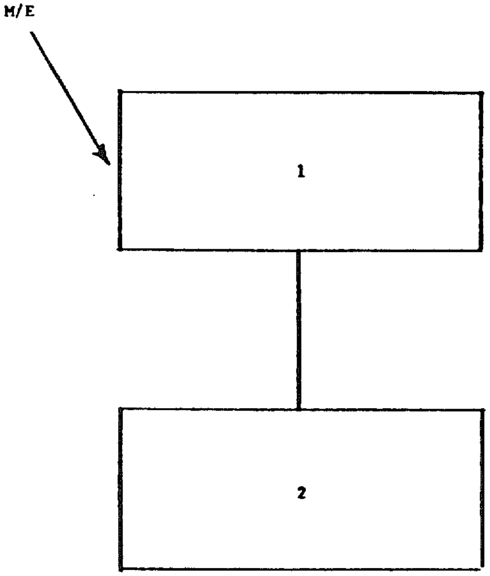


Figure 3.3-1A: Nodal Arrangement of Main Steam/
Feedwater Pipe Chase

NODE NODE	VOLUME (ft^3)	HEAT SINK Area (ft^2)
1	69,270	16,930
2	Atmosphere	



FLOW PATH CHARACTERISTICS

FROM NODE	TO NODE	AREA (ft^2)	INERTIA (ft^{-1})	LOSS FACTORS K_c	K_{exp}	K_{fric}	K_{total}
1	2	856	.01	.78	1.0	.10	1.88

Figure 3.3-1B: Nodal Parameters of Main Steam/Feedwater Pipe Chase for Main Steam Line Break Analysis

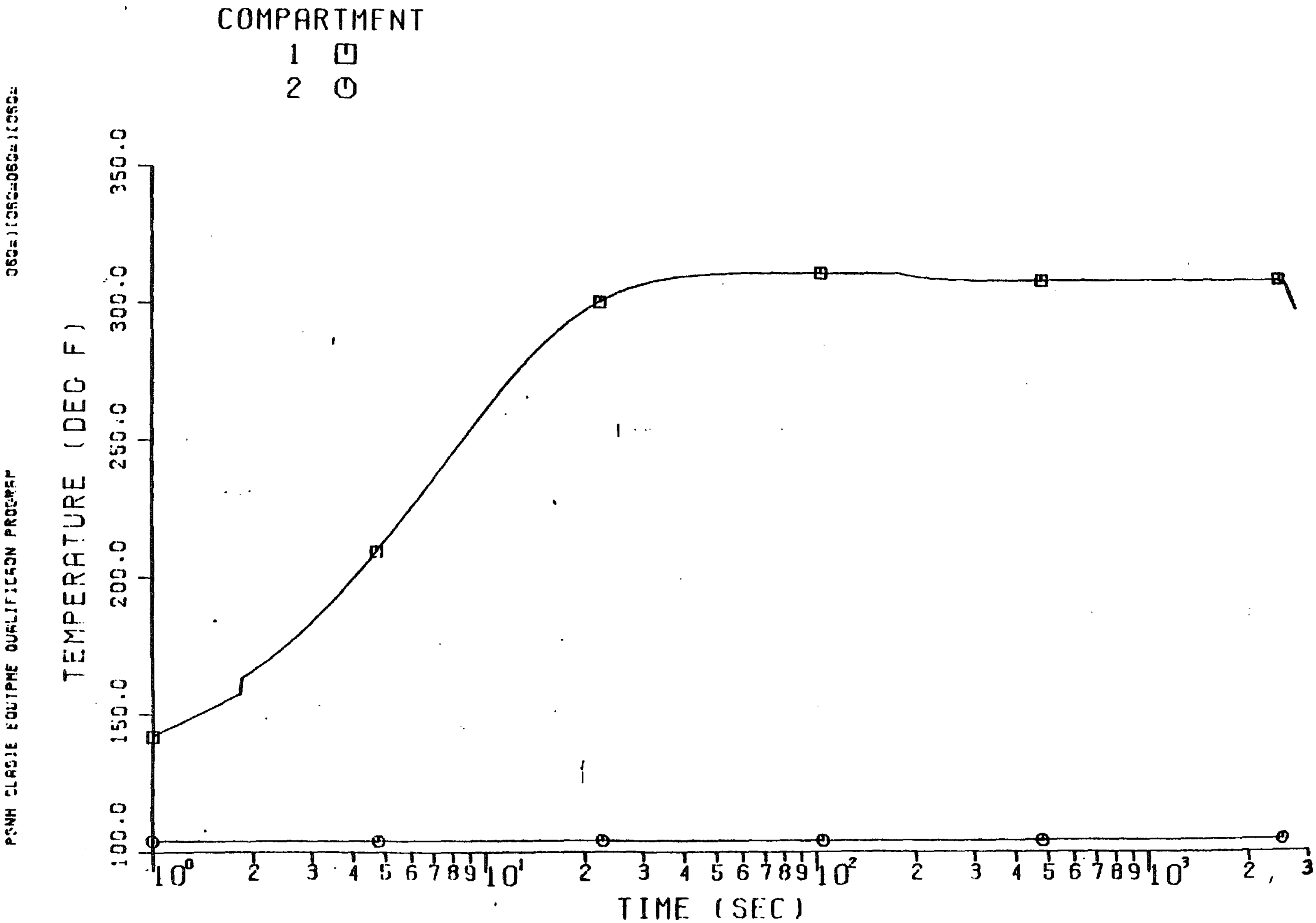
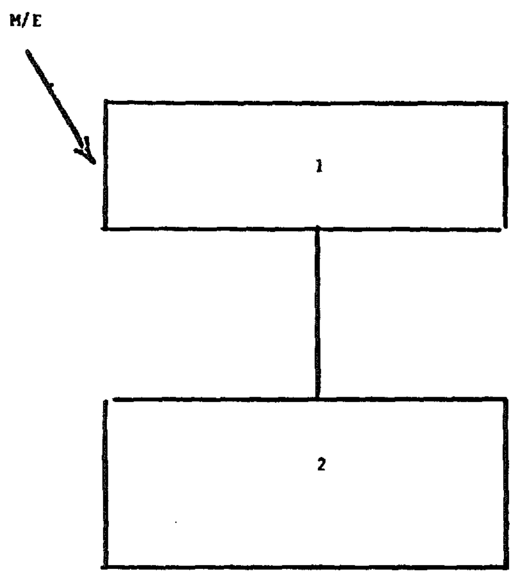


Figure 3.3-1C: Temperature Response of Main Steam/Feedwater Pipe Chase
Following a Small (0.10 Square Feet) Rupture of Main Steam Line



NODE	VOLUME (ft^3)	HEAT SINK AREA(ft^2)
1	240,000	11,000
2	Atmosphere	

FLOW PATH CHARACTERISTICS

FROM NODE	TO NODE	AREA (ft^2)	INERTIA (ft^{-1})	LOSS FACTORS K_c	K_{exp}	K_{fric}	K_{total}
1	2	10.00	.006	.78	1.0	0.01	1.79

Figure 3.4-1A: Nodal Parameters of Tank Farm Area for Auxiliary Steam Line AS-2302-32-8" Break Analysis

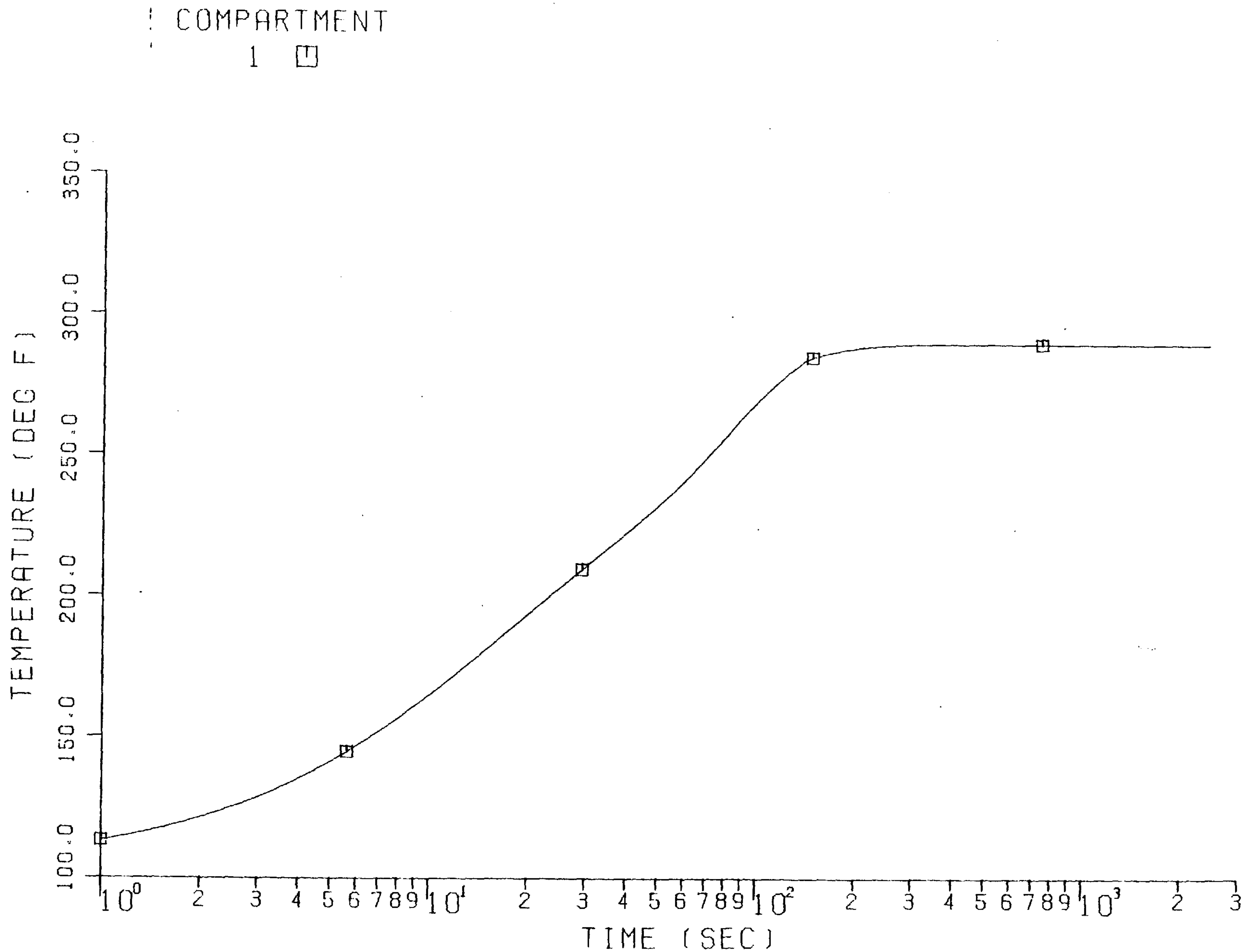


Figure 3.4-1B: Temperature Response of Tank Farm Area
Following a Rupture of 8" Auxiliary Steam Line

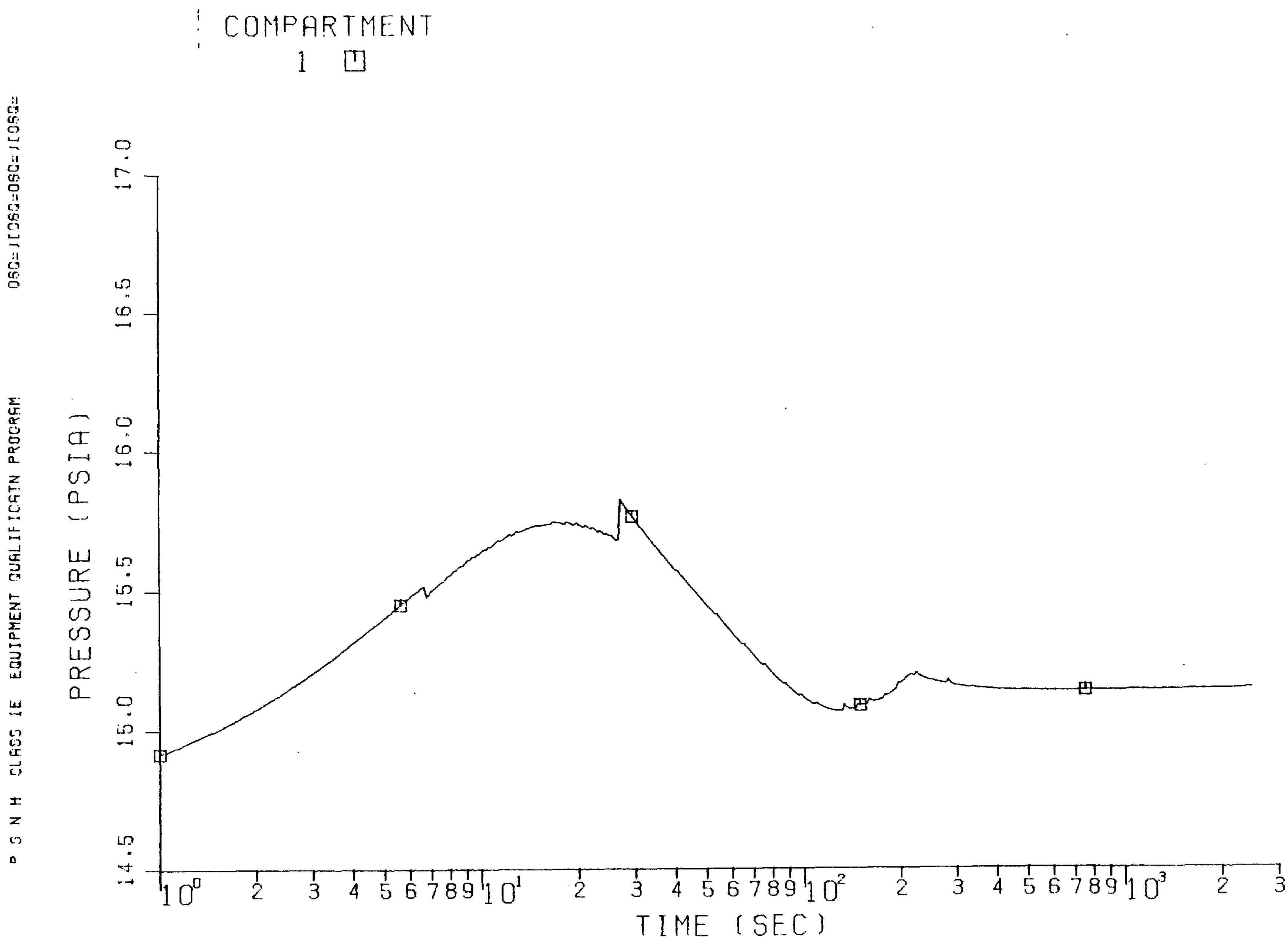
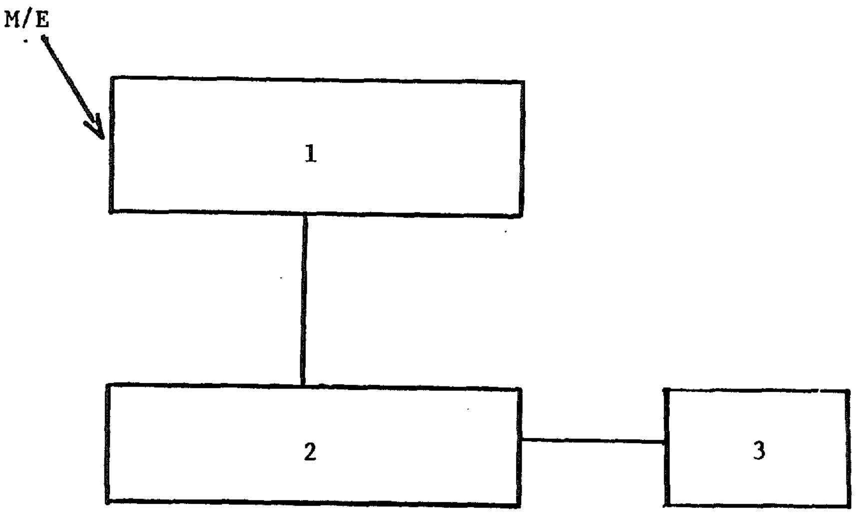


Figure 3.4-1C: Pressure Response of Tank Farm Area Following a Rupture of 8" Auxiliary Steam Line



NODE	VOLUME (ft^3)	HEAT SINK AREA(ft^2)
1	19,030	3,890
2	17,500	4,760
3	Atmosphere	

FLOW PATHS CHARACTERISTICS

				LOSS FACTORS			
FROM NODE	TO NODE	AREA (ft^2)	INERTIA (ft^{-1})	K_c	K_{exp}	K_{fric}	K_{total}
1	2	8.40	0.24	.78	1.0	0.01	1.79
2	3	1.75	1.14	.78	1.0	0.06	1.84

Figure 3.5-1A: Nodal Parameters of Waste Processing Building/Primary Auxiliary Building Chase for Auxiliary Steam Line AS-2339-1-1 1/2" Break Analysis

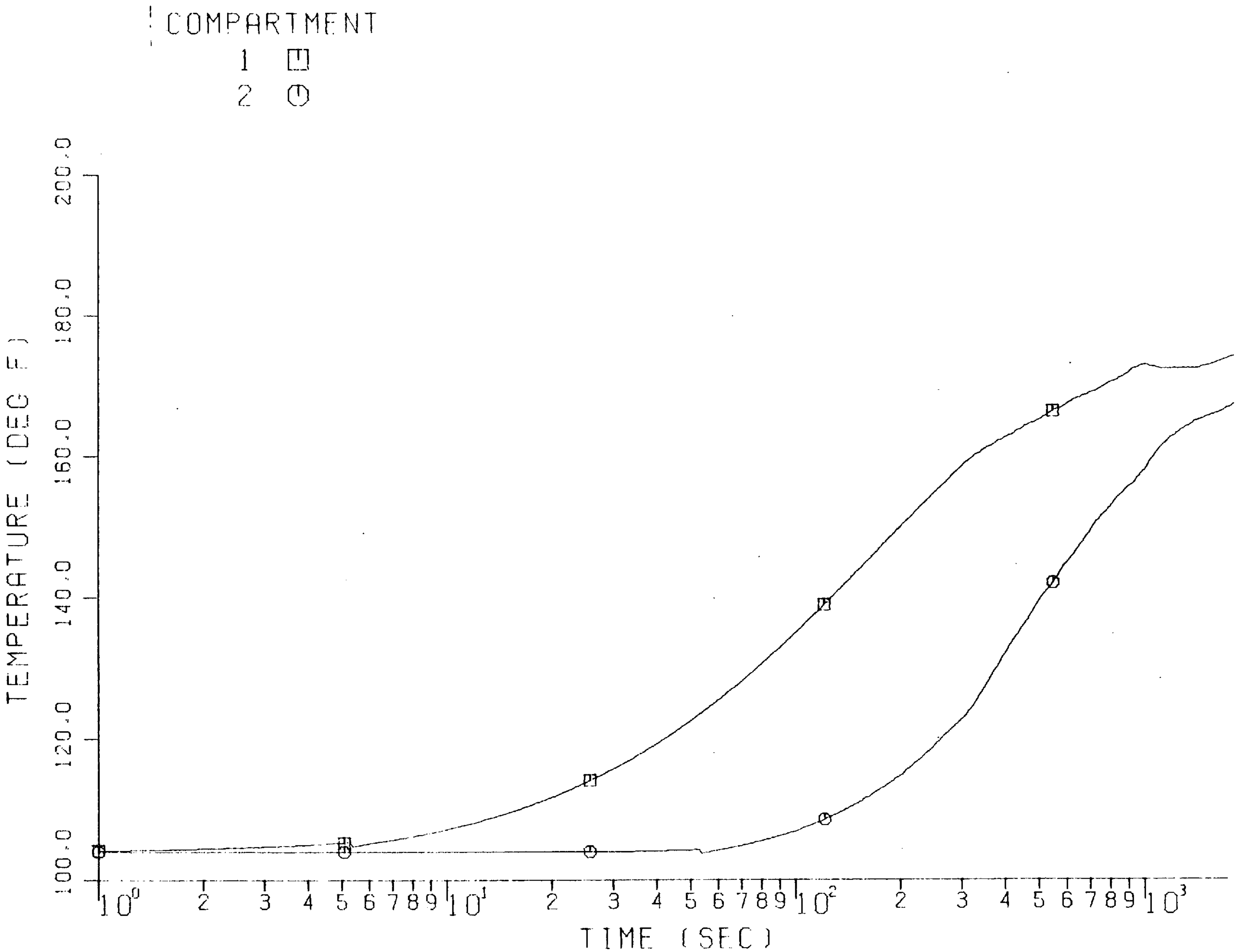


Figure 3.5-1B: Temperature Response of WPB/PAB Chase
Following a Rupture of 1 1/2" Auxiliary Steam Line

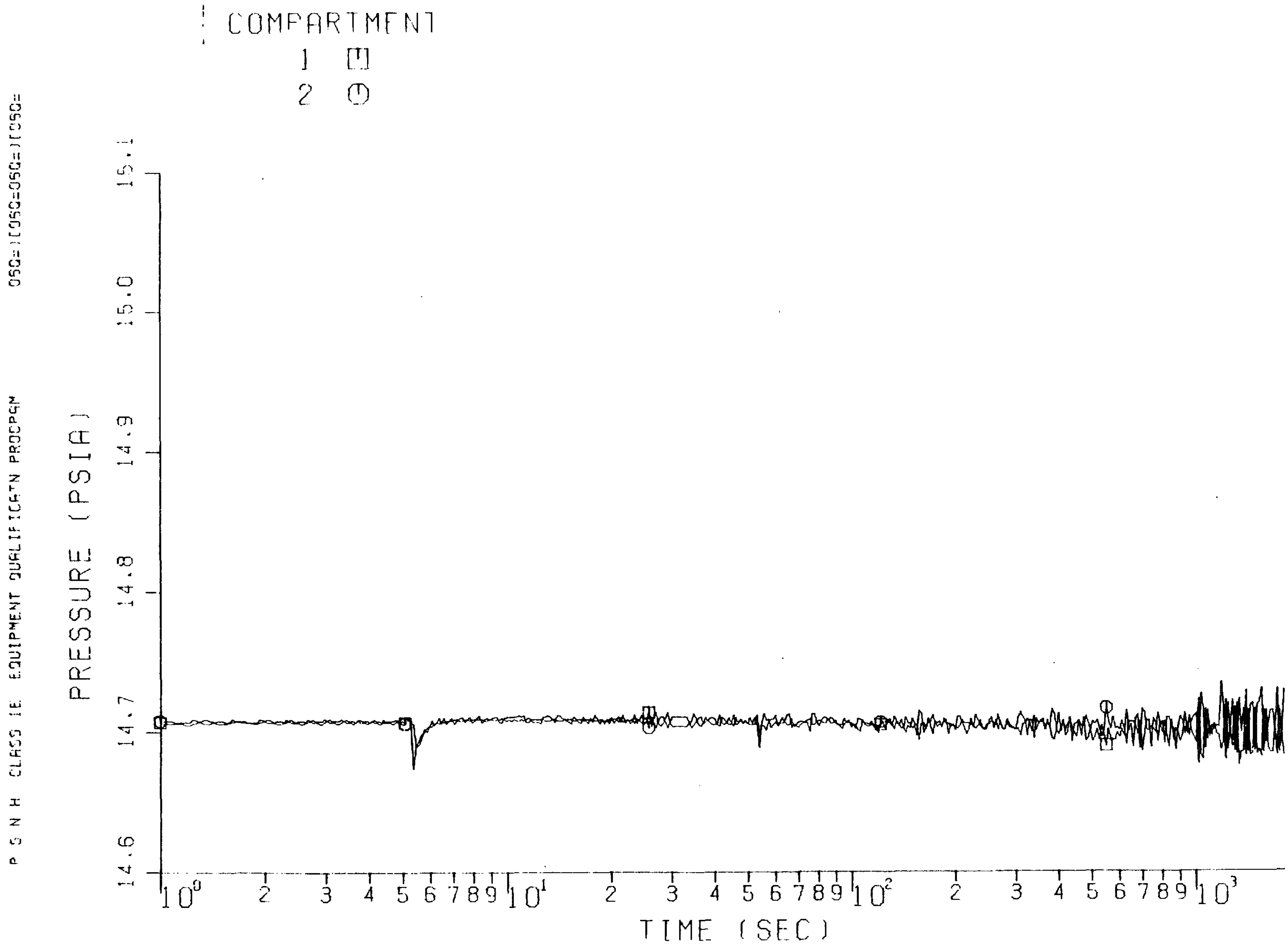


Figure 3.5-1C: Pressure Response of WPB/PAB Chase
Following a Rupture of 1 1/2" Auxiliary Steam Line