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CLASS I
OCTOBER 1981
REVISION 1

MARK 1 CONTAINMENT PROGRAM PLANT UNIQUE LOAD DEFINITION BRUNSWICK STEAM ELECTRIC PLANT: UNITS 1, 2

GENERAL ELECTRIC

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ABSTRACT

This document provides unique definition of specific containment loading conditions that would result from a postulated loss-of-coolant accident in Brunswick Steam Electric Plant: Units 1 and 2. Transient information is provided for containment pressures and temperatures, vent system thrust, torus vertical loads, vent system pool swell impact loads and vent header deflector loads. The document has been prepared under the Mark I Containment Program to aid Carolina Power & Light Company in the performance of a containment structural evaluation.

INTRODUCTION

This report provides specific transient loading information resulting from a postulated loss-of-coolant accident (LOCA) in the Brunswick Steam Electric Plant: Units 1 and 2. This report, in conjunction with the Mark I Containment Load Definition Report, was prepared for the Carolina Power & Light Company to use in the structural evaluation of the Mark I Containment system.

The following specific LOCA-related transient information is included:

- Pressure and temperature time histories for the drywell and wetwell
- Vent system thrust loads
- Net vertical pool swell loads and average submerged pressures on the wetwell
- Pool swell impact and drag loads on the vent system
- Vent header deflector loads

Transient information is presented via a series of figures for each of the above areas. An alpha-numeric identification scheme was developed for the figures such that the alpha designation denotes the plant of interest, while the first three digits of the numeric designation denote the applicable discussion section in the Mark I Containment Program Load Definition Report (NEDO-21888).

Transient conditions presented in this report are results of plant unique testing and/or analysis for specific plant conditions that have been provided or requested by the aforementioned utility. Changes to those specific plant conditions could result in changes to the transient information reported herein. If, after further review of this document, the responsible utility considers that such changes would be appropriate, the document can be modified accordingly.

LOCA Pressure and Temperature Transients

LOCA Pressure and Temperature Transients

This section provides the LOCA-induced pressure and temperature transients for the drywell and wetwell. The initial conditions for which the pressure and temperature responses were evaluated are also presented. Transient conditions are included for the design basis accident (DBA), intermediate break accident (IBA) and small break accident (SBA). The list of applicable figures and tables for this section is given on the following page.

The peak drywell pressure and temperature and the wetwell pressure and temperature at 30 seconds are identified on the DBA containment pressure and temperature plots (Figures 4.1.1-1 and 4.1.1-2).

The peak containment pressures, the containment temperatures at the end of RPV blowdown, and the containment pressures and temperatures at the time of ADS initiation are identified on the IBA and SBA containment pressure and temperature plots (Figures 4.1.2-1, 4.1.2-2, 4.1.3-1, and 4.1.3-2).

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PLANT UNIQUE PRESSURE/TEMPERATURE RESPONSE FIGURES AND TABLES

Figure/Table No.	Title	Applicable Revision No.
Table B 4.1.1-1	Plant Conditions at Instant of DBA Pipe Break	Revision 1
Figure B 4.1.1-1	DBA Containment Pressure Response	↓
Figure B 4.1.1-2	DBA Containment Temperature Response	
Table B 4.1.2-1	Plant Conditions at Instant of IBA Pipe Break	
Figure B 4.1.2-1	IBA Containment Pressure Response	
Figure B 4.1.2-2	IBA Containment Temperature Response	
Table B 4.1.3-1	Plant Conditions at Instant of SBA Pipe Break	
Figure B 4.1.3-1	SBA Containment Pressure Response	
Figure B 4.1.3-2	SBA Containment Temperature Response	

Table B 4.1.1-1

PLANT CONDITIONS AT INSTANT OF DBA PIPE BREAK

102% Licensed Power (MWt)	2485
Initial Suppression Pool Temperature (°F)	84.0
Downcomer Submergence (ft)	4.33
Airspace Volume (ft^3)	
Drywell	164,100
Wetwell	122,000
Airspace Pressure (psig)	
Drywell	0.75
Wetwell	0.75

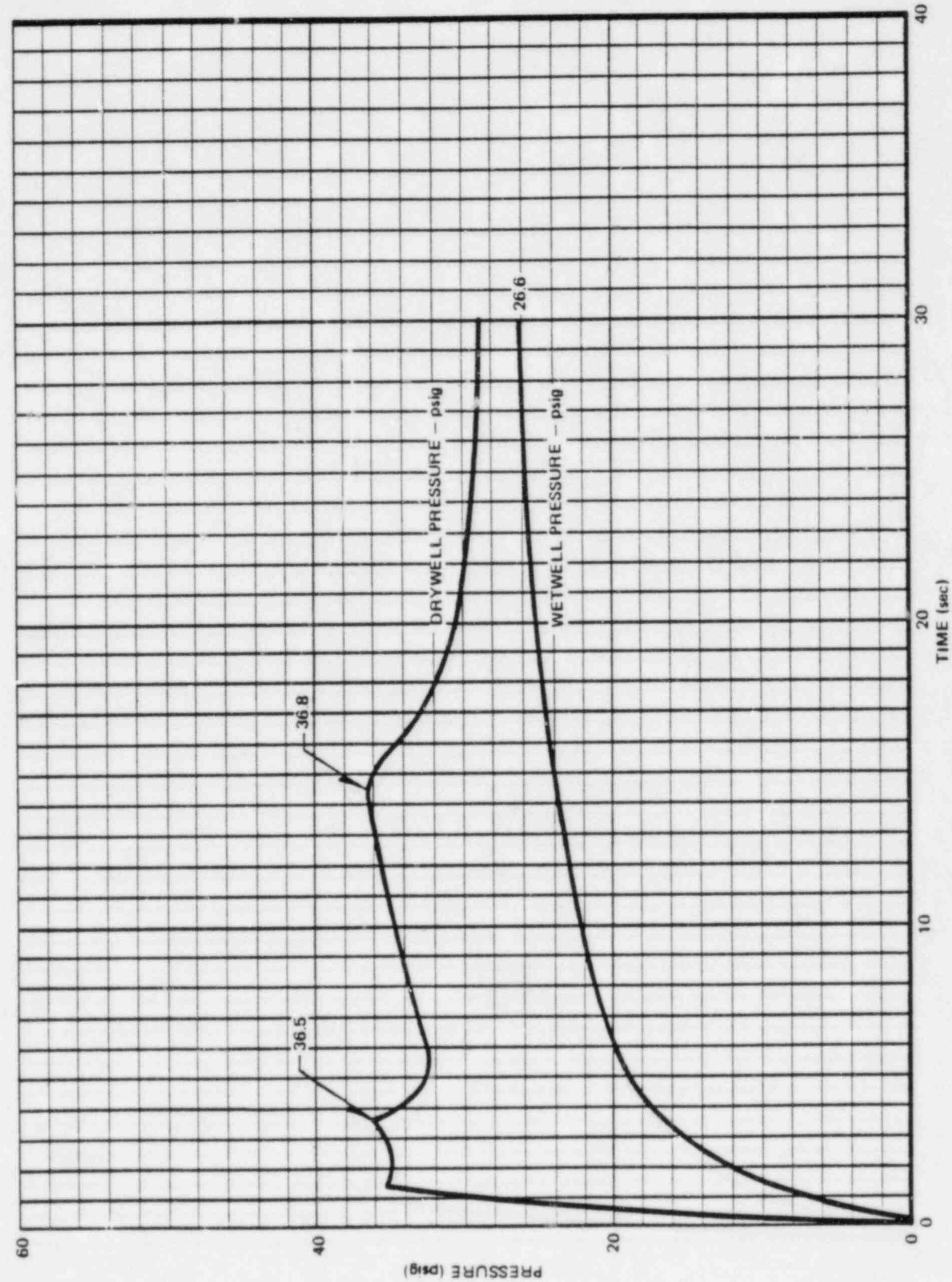

Figure B 4.1.1-1. DBA Containment Pressure Response

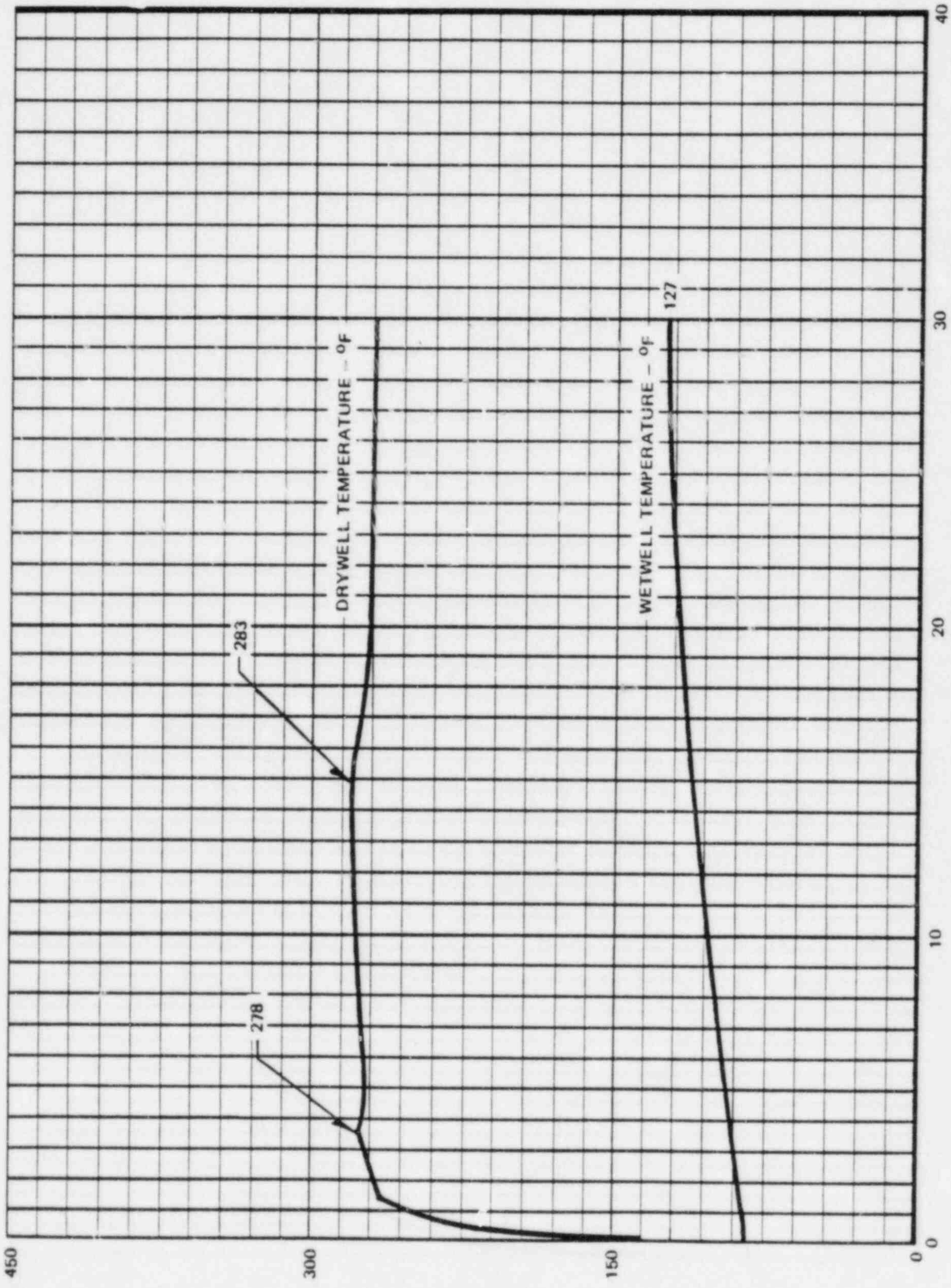

Figure B 4.1.1-2. DBA Containment Temperature Response

Table B 4.1.2-1

PLANT CONDITIONS AT INSTANT OF IBA PIPE BREAK

102% Licensed Power (MWt)	2485
Initial Suppression Pool Temperature (°F)	95.0
Downcomer Submergence (ft)	4.33
Airspace Volume (ft^3)	
Drywell	164,100
Wetwell	122,000
Airspace Pressure (psig)	
Drywell	0.75
Wetwell	0.75

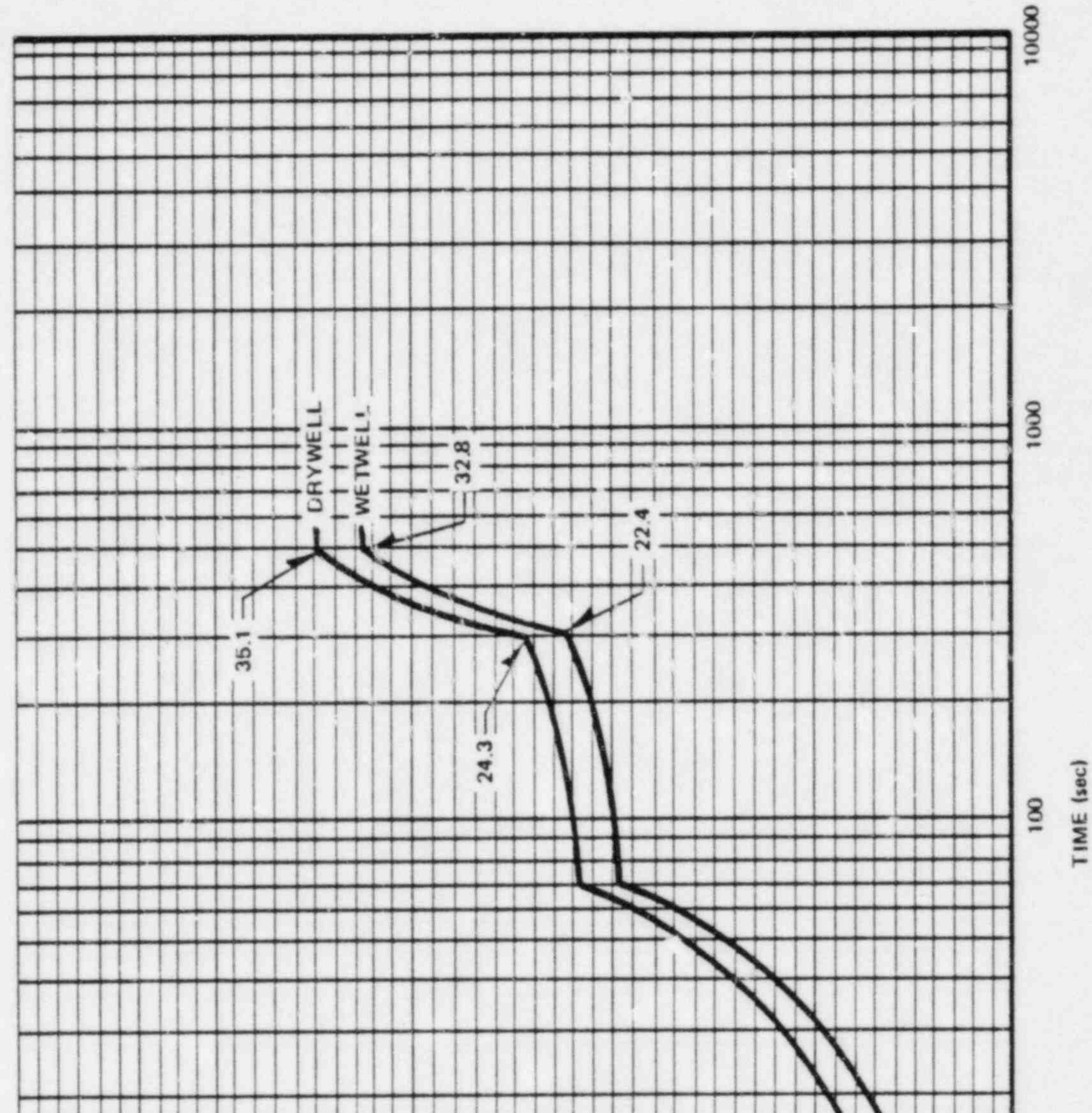

Figure B 4.1.2-1. IBA Containment Pressure Response

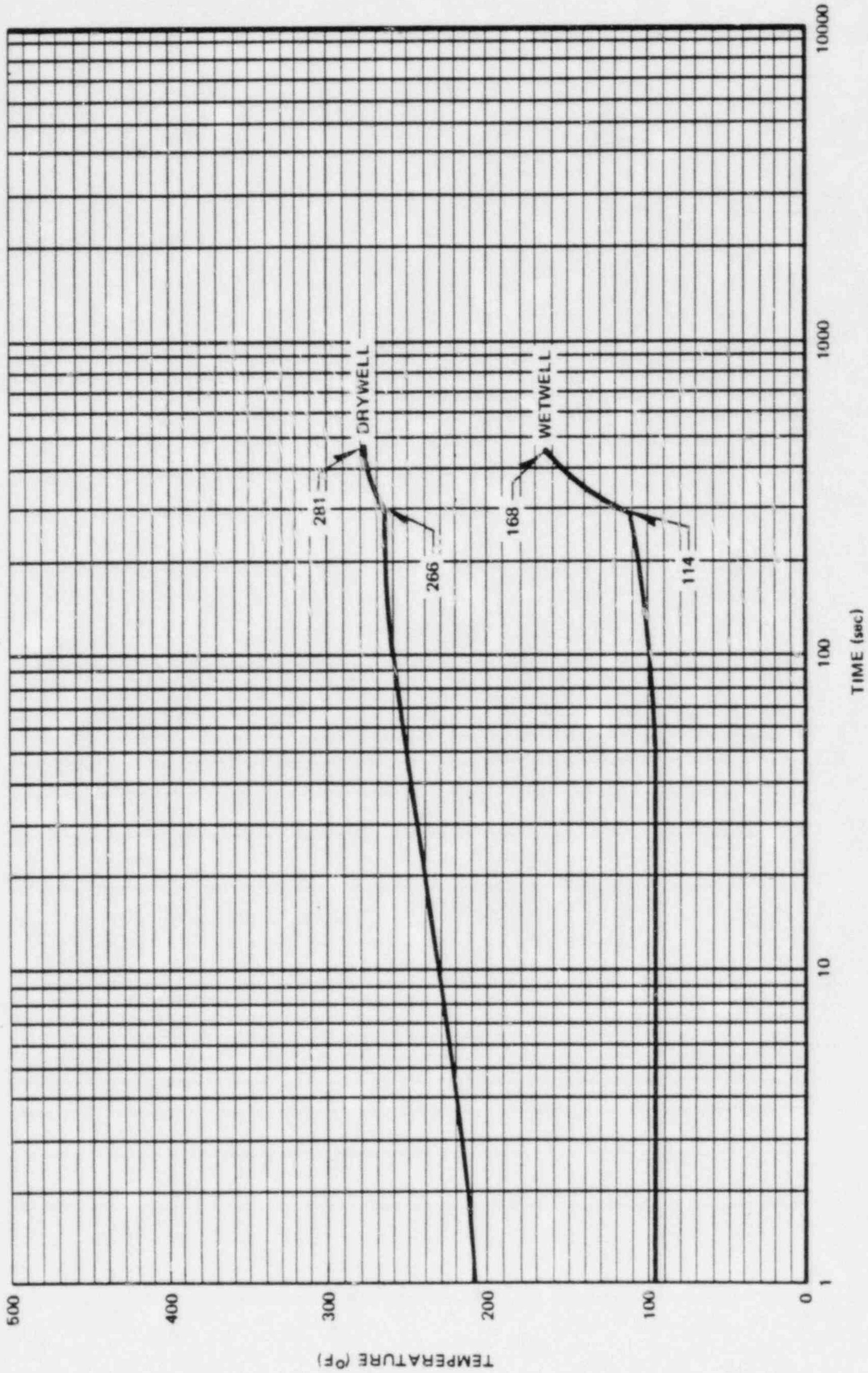

Figure B 4.1.2-2. IBA Containment Temperature Response

Table B 4.1.3-1

PLANT CONDITIONS AT INSTANT OF SBA PIPE BREAK

102% Licensed Power (MWt)	2485
Initial Suppression Pool Temperature (°F)	95.0
Downcomer Submergence (ft)	4.33
Airspace Volume (ft^3)	
Drywell	164,100
Wetwell	122,000
Airspace Pressure (psig)	
Drywell	0.75
Wetwell	0.75

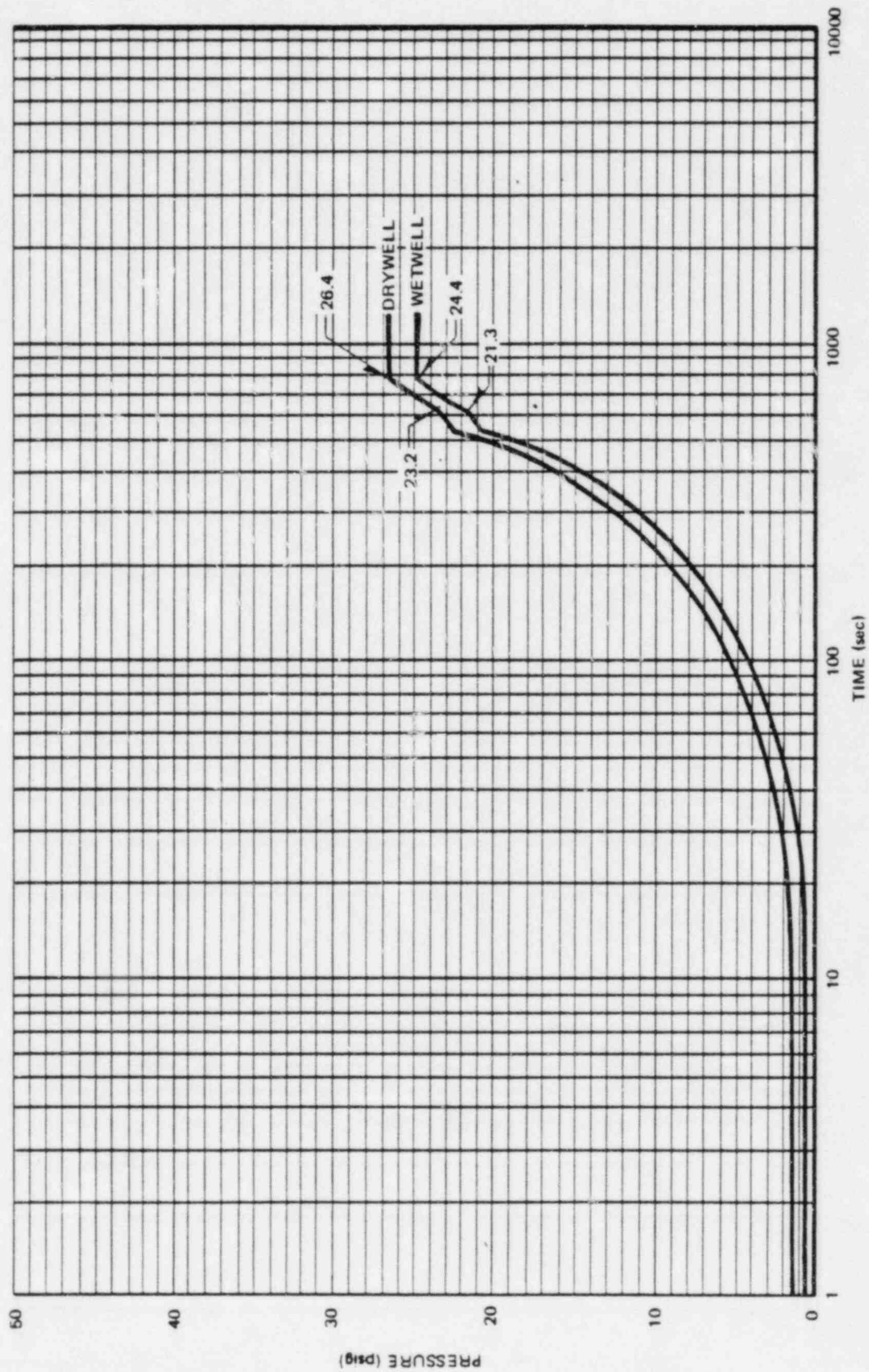

Figure B 4.1.3-1. SBA Containment Pressure Response

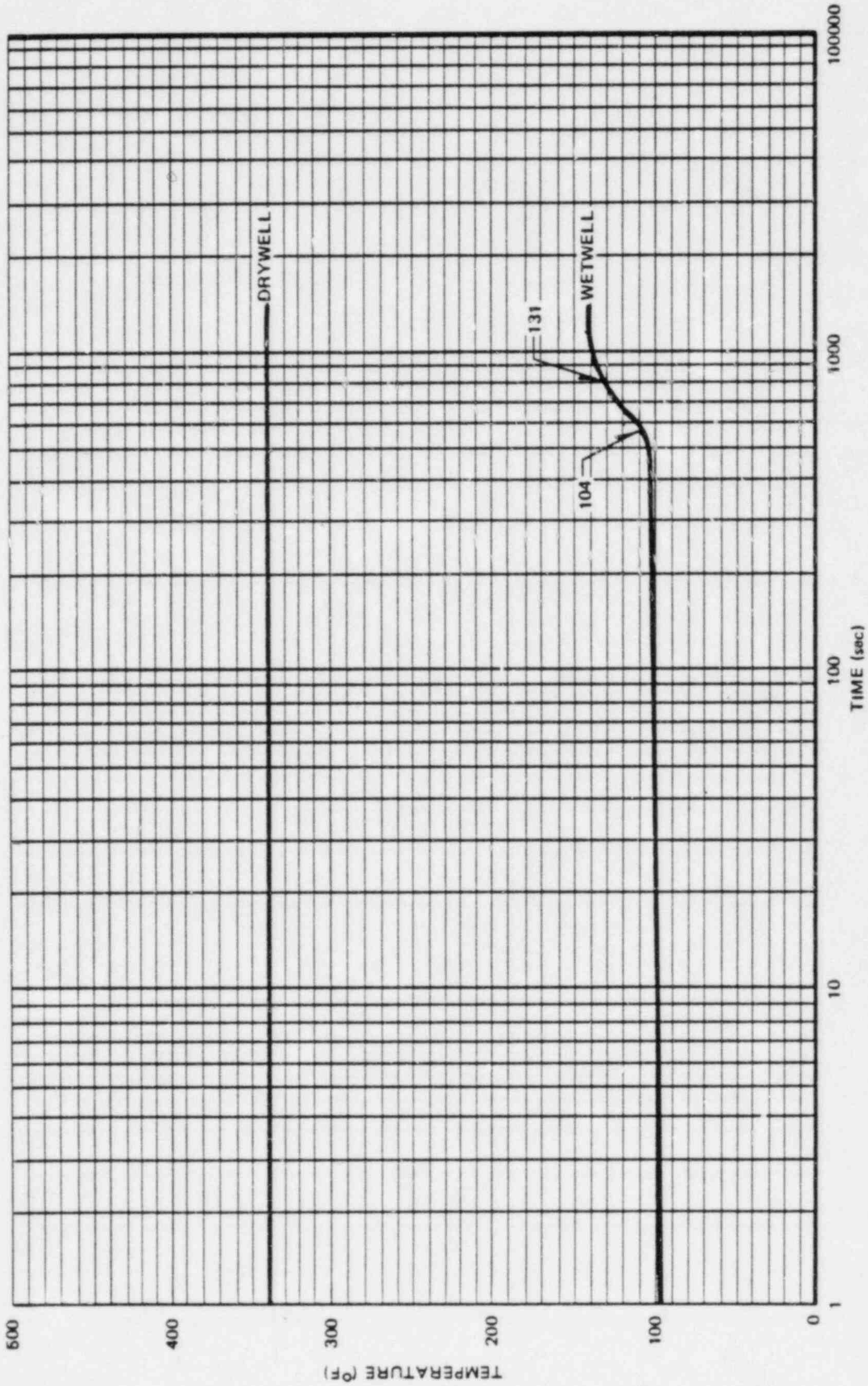

Figure B 4.1.3-2. SBA Containment Temperature Response

DBA Vent System Thrust Loads - Zero ΔP

DBA Vent System Thrust Loads - Zero ΔP

This section provides thrust loads for the main vents, vent header and downcomers resulting from the postulated DBA for plant operation at zero drywell-wetwell pressure differential. The list of applicable figures and tables for this section is given on the following page.

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PLANT UNIQUE DBA VENT SYSTEM THRUST LOAD FIGURES

Figure/Table No.	Title	Applicable Revision No.
Table B 4.2-1	Nomenclature DBA Vent System Thrust Load Sections	Revision 1
Table B 4.2-2	Plant Conditions at Instant of DBA Pipe Break for Thrust Load Calculations	
Figure B 4.2-1	Definition of Positive Thrust Loads	
Figure B 4.2-2	Single Main Vent Forces (0-5 secs)	
Figure B 4.2-3	Vent Header Forces pre Mitre Bend (0-5 secs)	
Figure B 4.2-4	Single Downcomer Forces (0-5 secs)	
Figure B 4.2-5	Total Vertical Forces, Net Vertical Force (0-5 secs)	
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Figure B 4.2-7	Vent Header Forces per Mitre Bend (0-30 secs)	
Figure B 4.2-8	Single Downcomer Forces (0-30 secs)	
Figure B 4.2-9	Total Vertical Forces, Net Vertical Force (0-30 secs)	
Figure B 4.2-10	Pressure Time Histories (0-5 secs)	
Figure B 4.2-11	Pressure Time Histories (0-30 secs)	↓

Table B 4.2-1

NOMENCLATURE FOR DBA VENT SYSTEM THRUST LOAD SECTION

PDW	Drywell pressure
PWW	Wetwell airspace pressure
P1	Main vent pressure
P2	Vent header pressure
P3	Downcomer pressure
F1V1	Vertical force on a single main vent end cap
F1H1	Horizontal force on a single main vent end cap
F1V2	Vertical force on a single main vent mitre bend (applicable to Browns Ferry and Oyster Creek only)
F1H2	Horizontal force on a single main vent mitre bend (applicable to Browns Ferry and Oyster Creek only)
F2V	Vertical force on vent header (per mitre bend)
F2H	Horizontal force on vent header (per mitre bend)
F3V	Vertical force on a single downcomer mitre bend
F3H	Horizontal force on a single downcomer mitre bend
F4V	Vertical force on second mitre bend of a single downcomer (if applicable)
F4H	Horizontal force on second mitre bend of a single downcomer (if applicable)
F1V1T	Total main vent end cap vertical force = F1V1 x number of main vents
F1V2T	Total main vent mitre bend vertical force = F1V2 x number of main vents
F2VT	Total vent header vertical force = F2V x number of vent header mitre bends
F3VT	Total vertical force (first downcomer mitre bend) = F3V x number of downcomers
F4VT	Total vertical force (second downcomer mitre bend) = F4V x number of downcomers
FNETV	FNETV = F1V1T + F1V2T + F2VT + F3VT + F4VT
A_{VH}	Vent header flow area
A_{VP}	Total main vent flow area

Table B 4.2-1 (Continued)

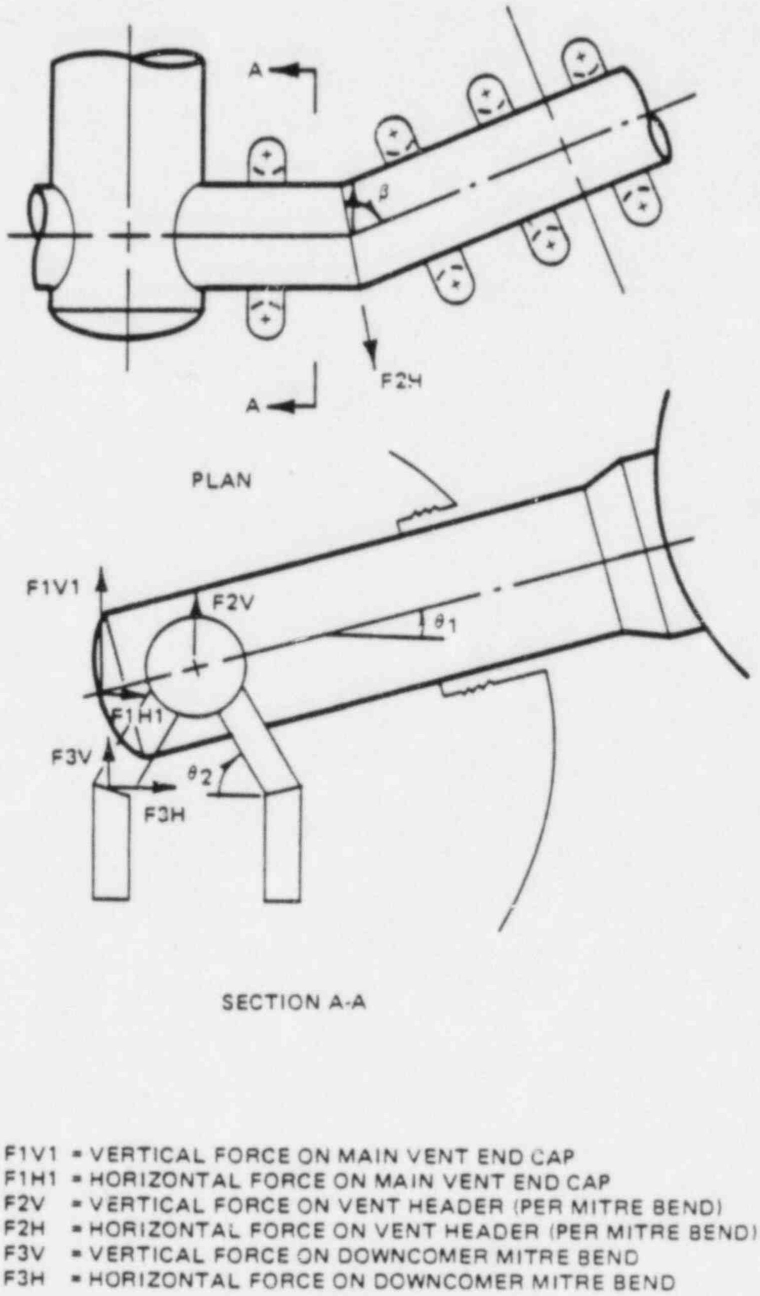
NOMENCLATURE FOR DBA VENT SYSTEM THRUST LOAD SECTION

A_{DC}	Total downcomer flow area
n_1	Number of main vents
n_2	Number of downcomers
n_3	Number of vent header mitre bends
$\dot{m}_T$	Total mass flow rate
V_1	Fluid velocity in main vent
V_2	Fluid velocity in vent header
V_3	Fluid velocity in downcomer
Θ_1	Angle of main vent with horizontal
Θ_2	Angle of first downcomer mitre bend with horizontal
Θ_3	Angle of second downcomer mitre bend with horizontal
α	Angle of main vent mitre bend with horizontal
β	90^o - (vent header mitre bend angle)

Table B 4.2-2

PLANT CONDITIONS AT INSTANT OF DBA PIPE BREAK FOR THRUST LOAD CALCULATIONS (ZERO ΔP)

Thermal Power (102% of licensed)(MWt)	2485
Initial Suppression Pool Temperature (°F)	84
Downcomer Submergence (ft)	4.33
Airspace Volume (ft^3)	
Drywell	164,100
Wetwell	122,000
Airspace Pressure (psig)	
Drywell	0.75
Wetwell	0.75



F1V1 = VERTICAL FORCE ON MAIN VENT END CAP
F1H1 = HORIZONTAL FORCE ON MAIN VENT END CAP
F2V = VERTICAL FORCE ON VENT HEADER (PER MITRE BEND)
F2H = HORIZONTAL FORCE ON VENT HEADER (PER MITRE BEND)
F3V = VERTICAL FORCE ON DOWNCOMER MITRE BEND
F3H = HORIZONTAL FORCE ON DOWNCOMER MITRE BEND

FORCES ARE SHOWN IN THEIR ASSUMED POSITIVE DIRECTION

Figure B 4.2-1. Definition of Positive Thrust Loads

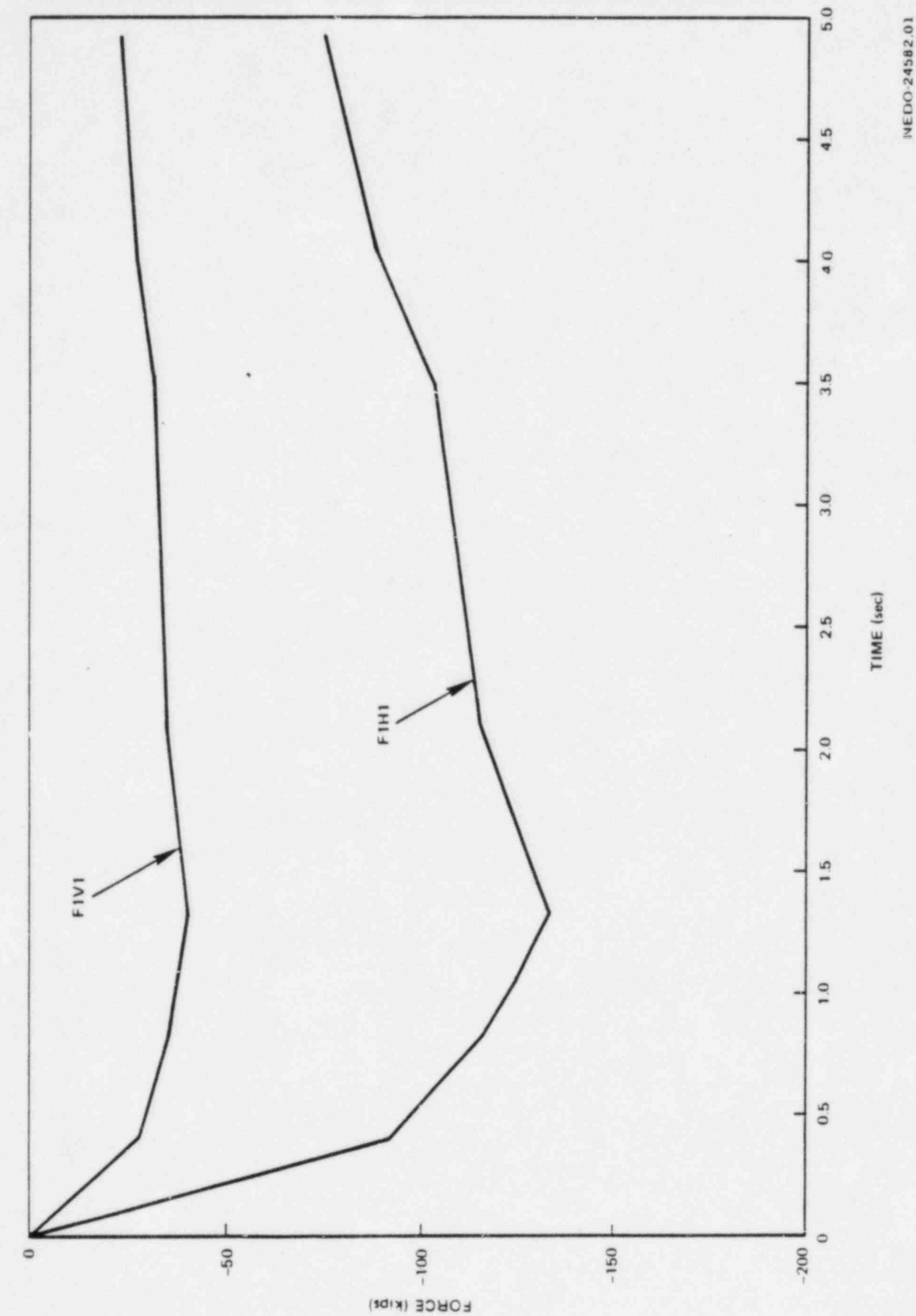


Figure B4.2-2. Single Main Vent Forces (0-5 sec) (Zero ΔP)

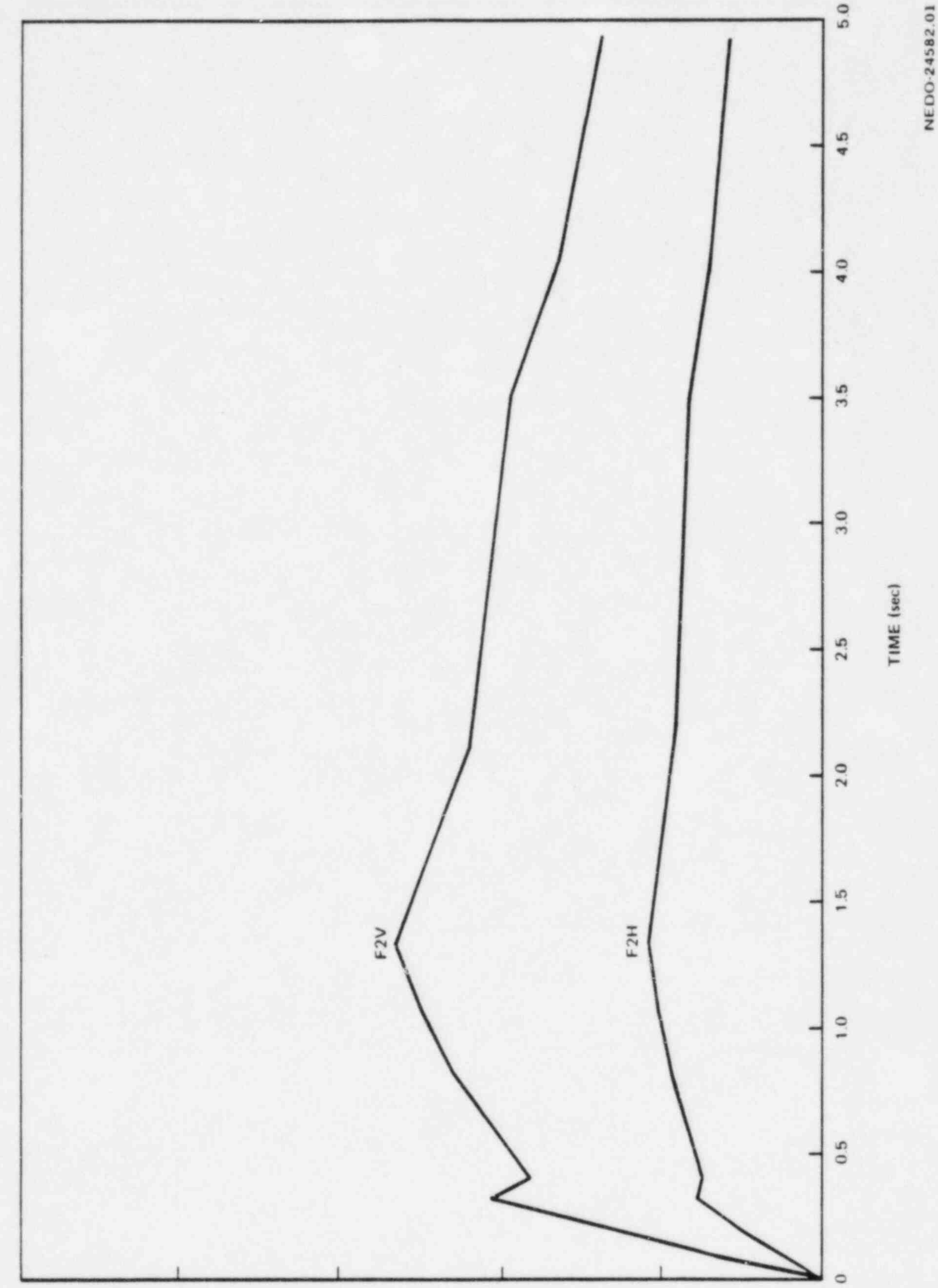


Figure B4.2-3. Vent Header Forces Per Mitre Bend (0-5 sec) (Zero ΔP)

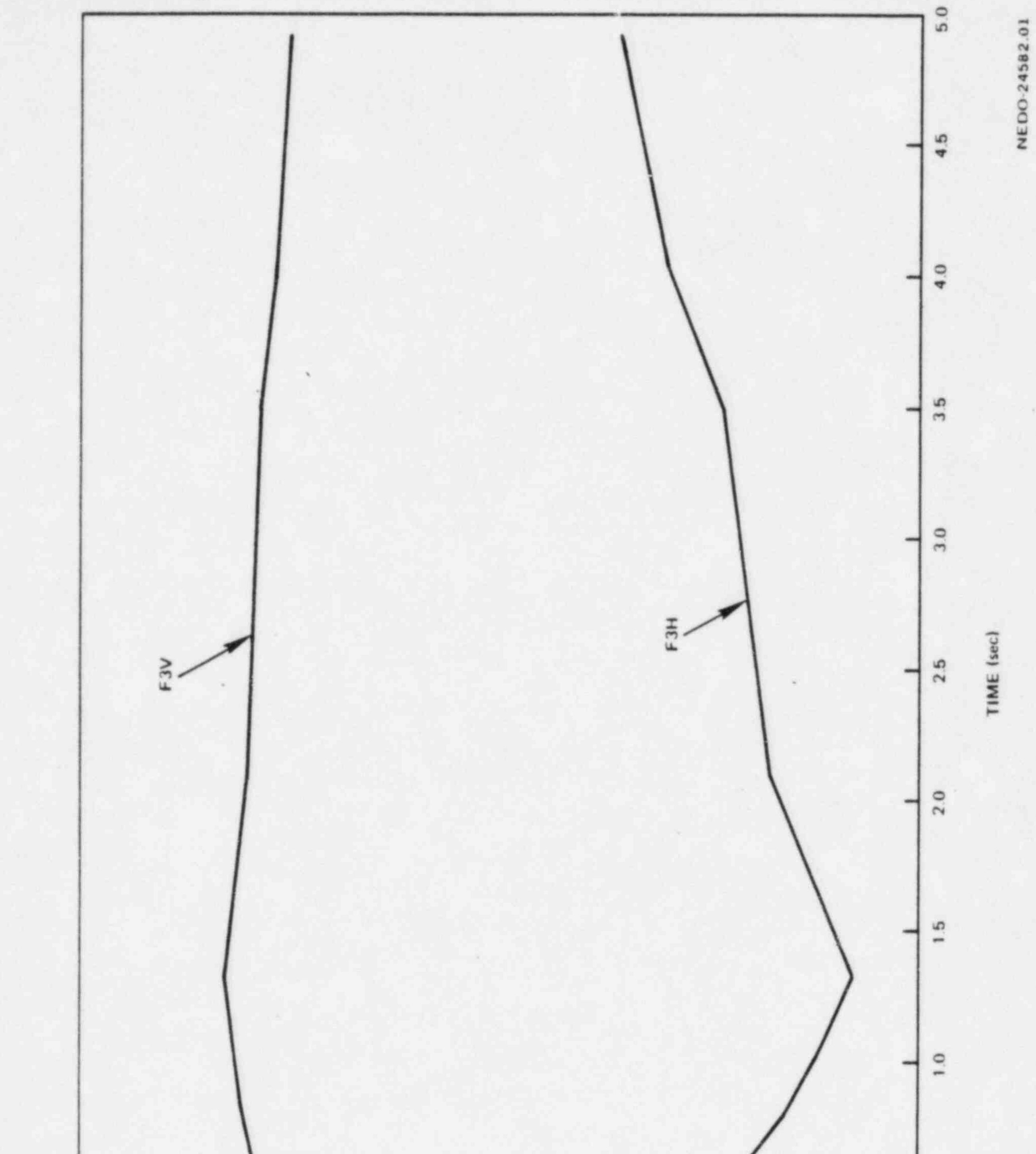


Figure B4.2-4. Single Downcommer Forces (0-5 sec) (Zero ΔP)

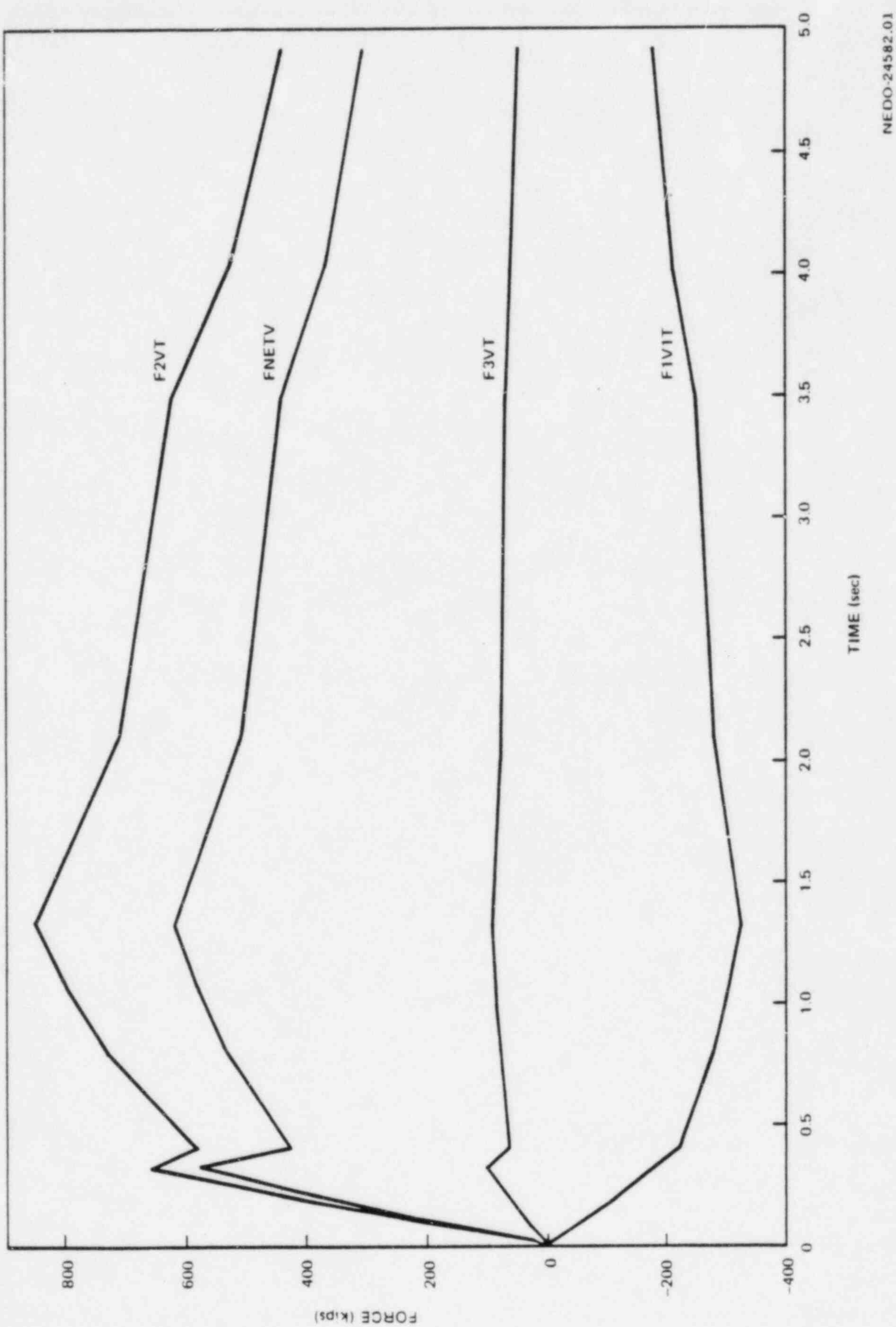


Figure 4.2-5. Total and Net Vertical Forces (0-5 sec) (Zero ΔP)

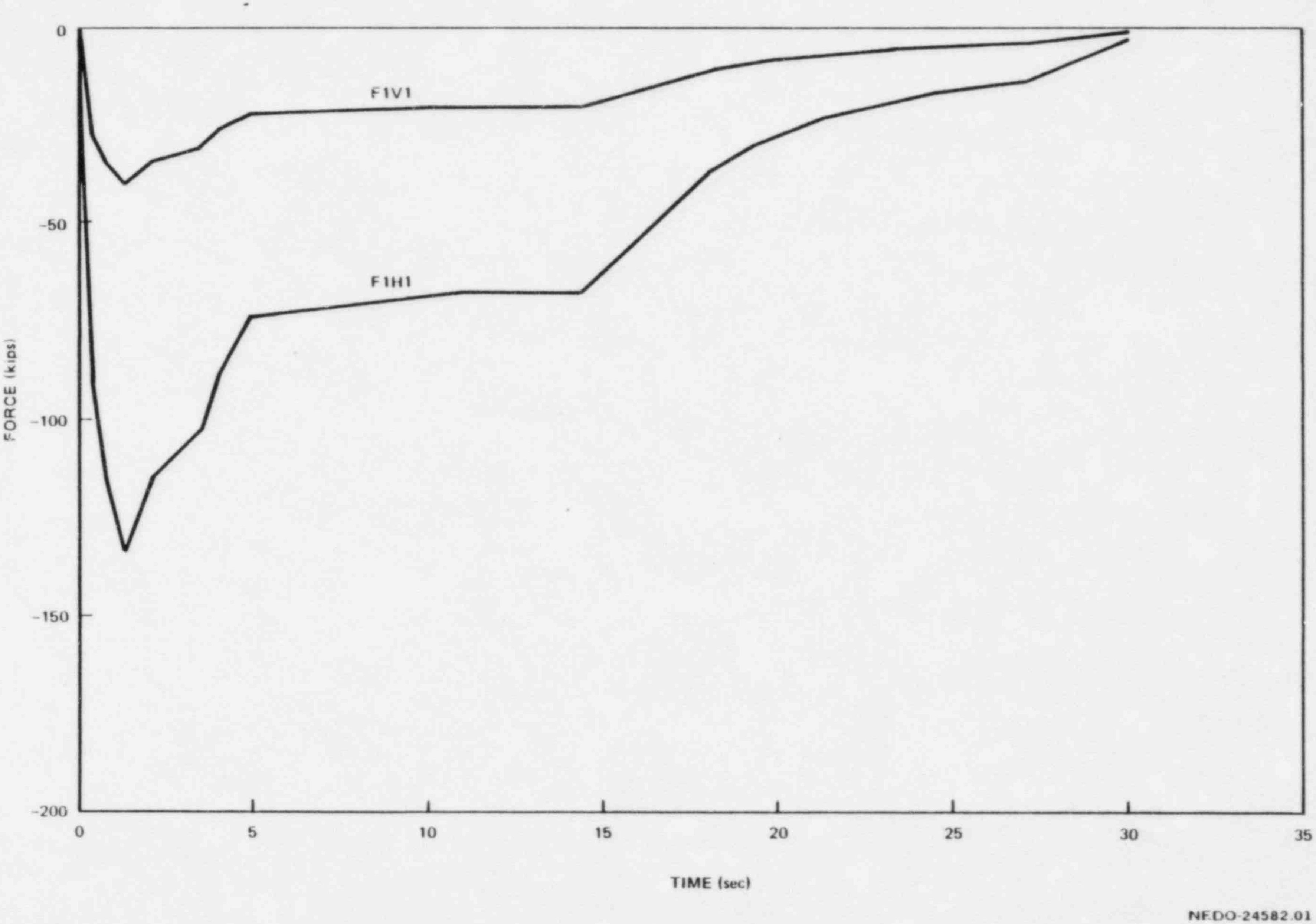


Figure B4.2-6. Single Main Vent Forces (0-30 sec) (Zero ΔP)

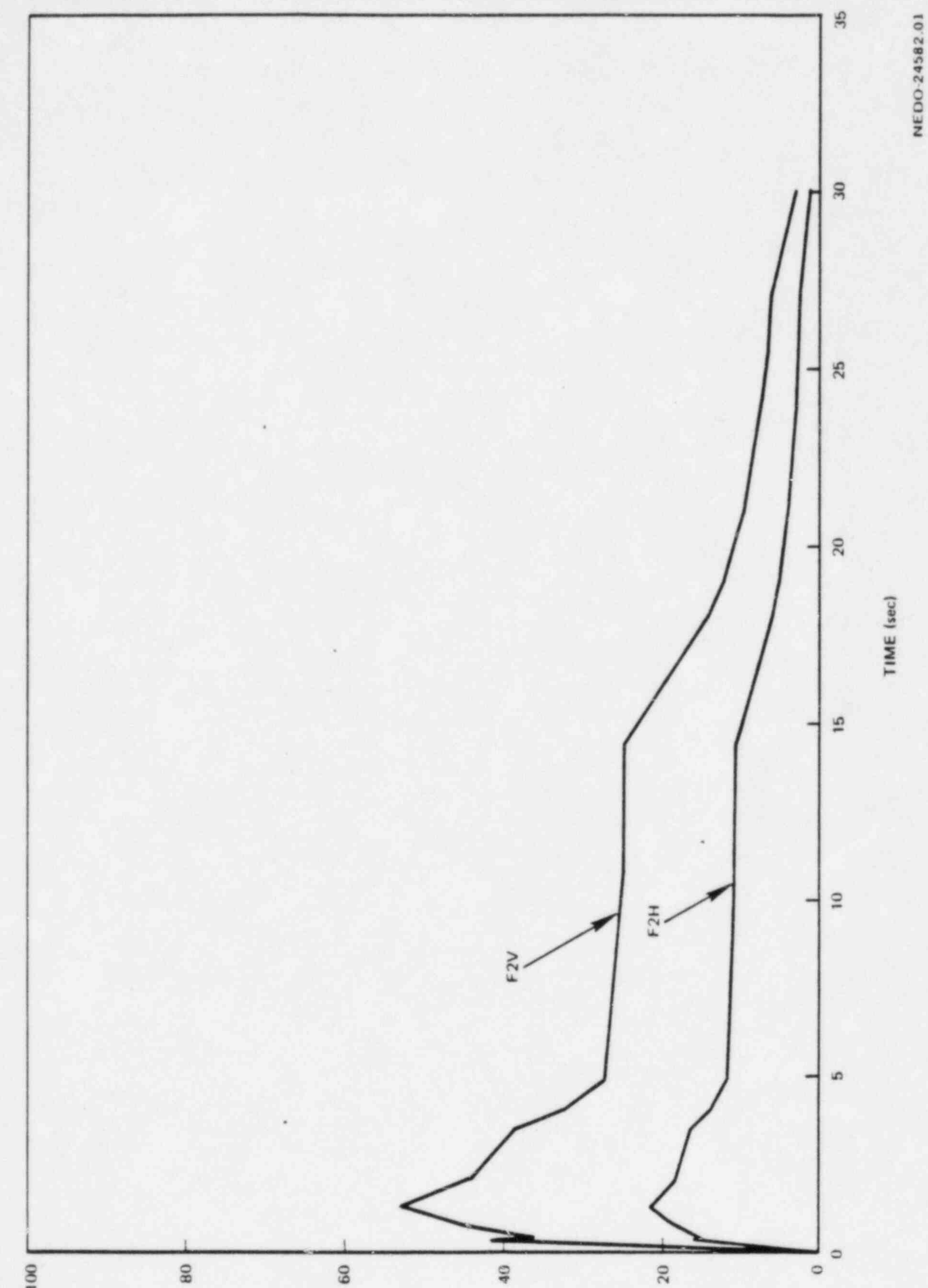


Figure B4.2-7. Vent Header Forces per Mitre Bend (0-30 sec) (Zero ΔP)

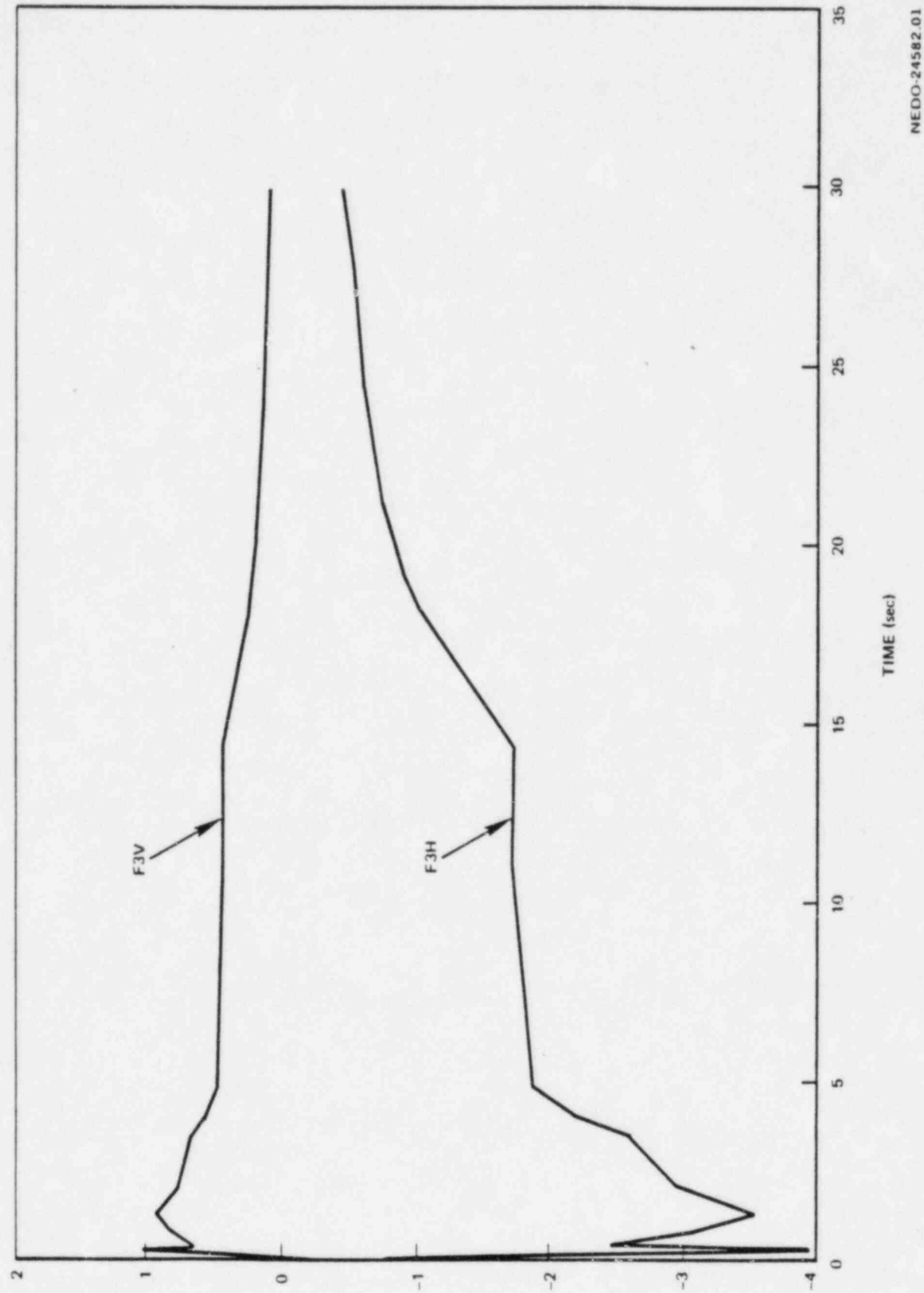


Figure B4.2-8. Single Downcomer Forces (0-30 sec) (Zero ΔP)

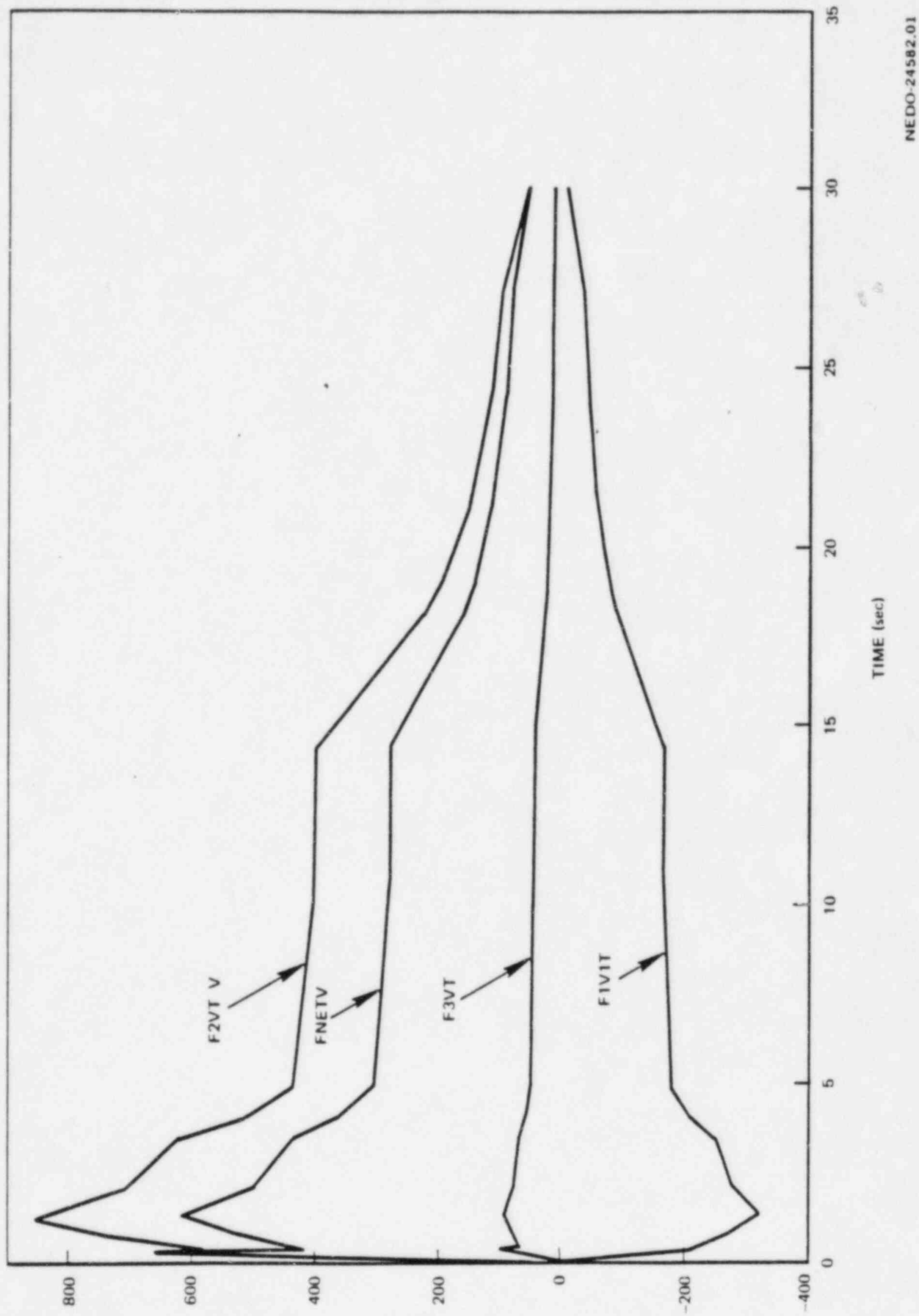


Figure B4.2-9. Total and Net Vertical Forces (0-30 sec) (Zero ΔP)

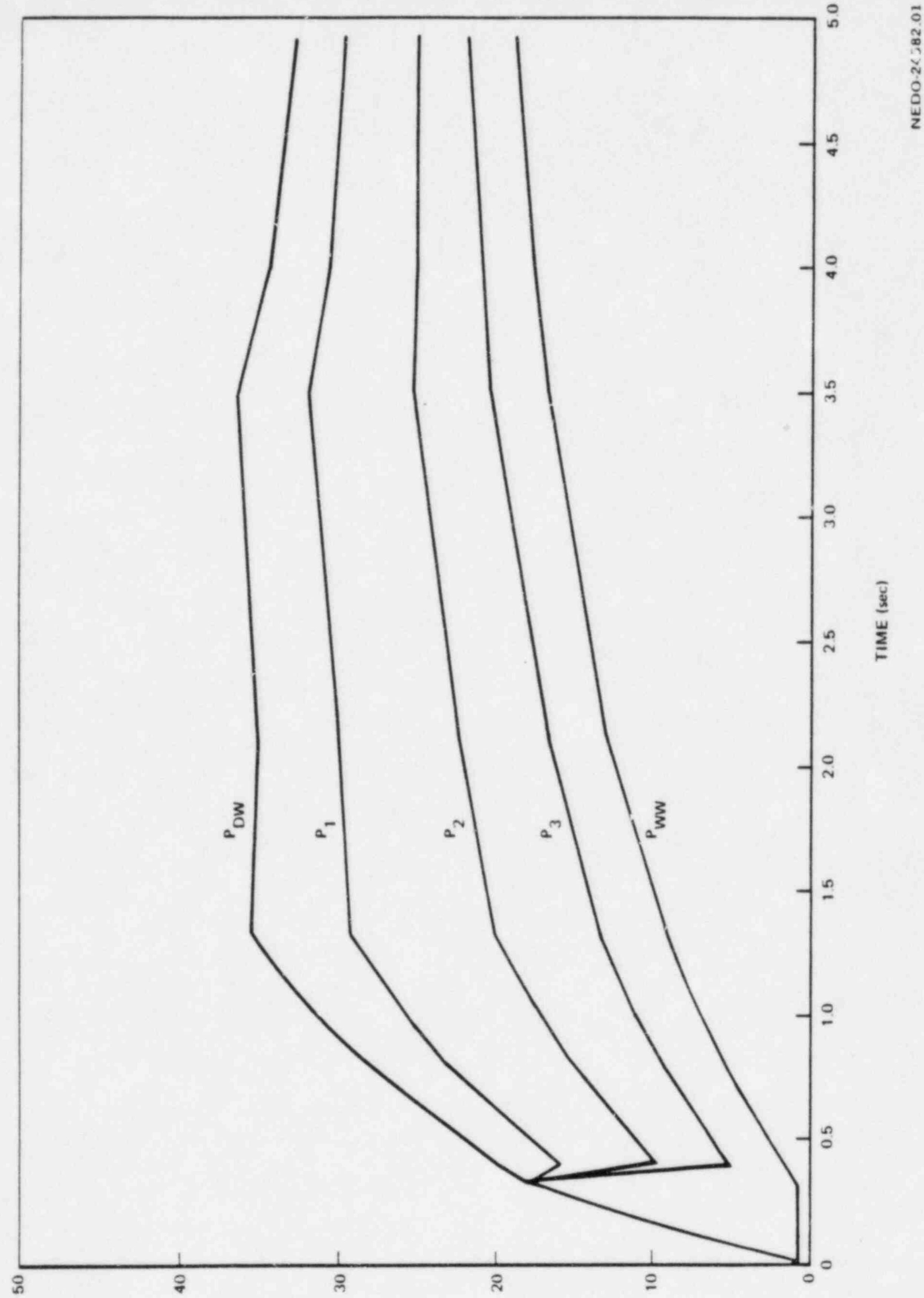


Figure B4.2-10. Pressure Time Histories (0-5 sec) (Zero ΔP)

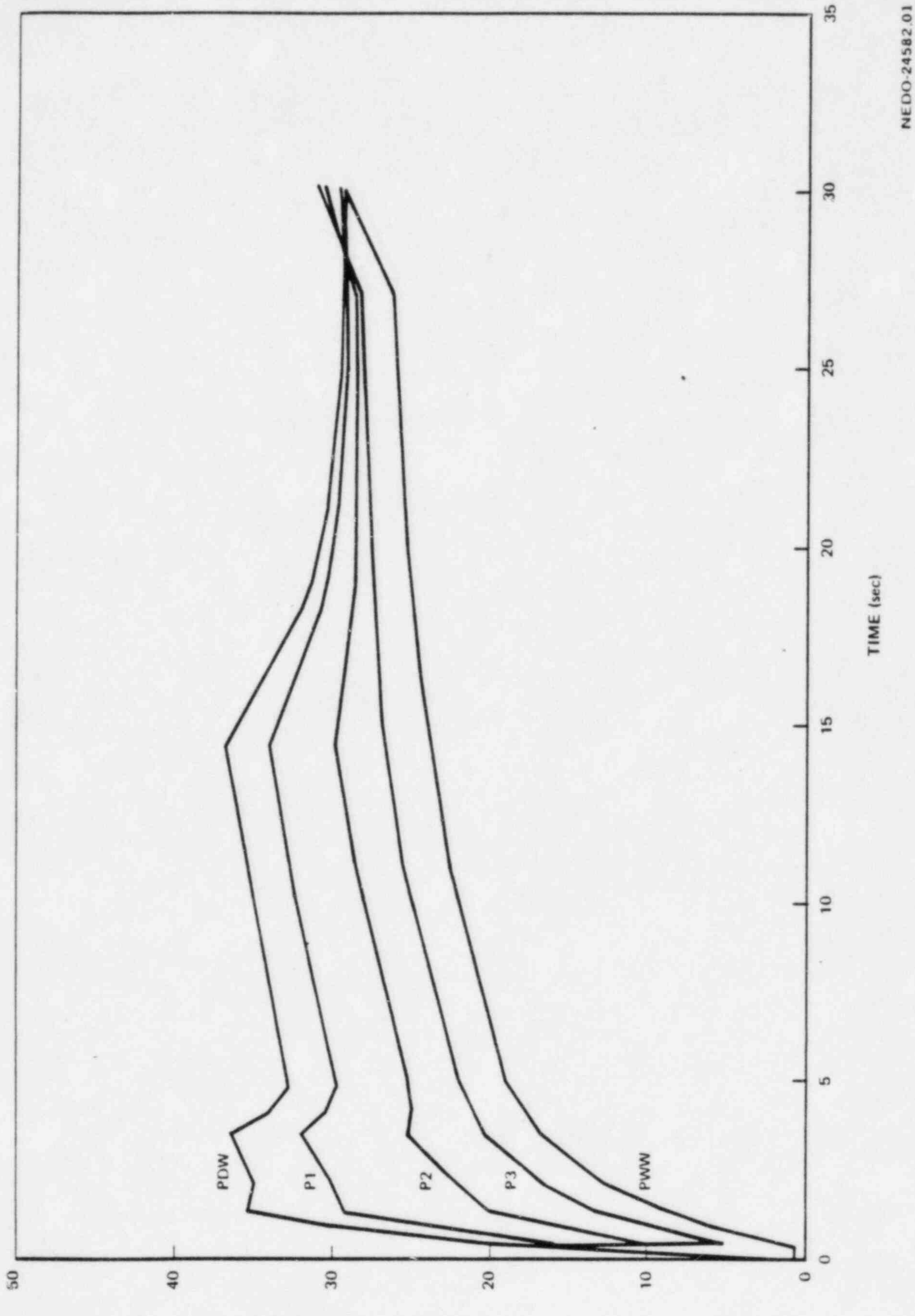


Figure B4.2-11. Pressure Time Histories (0-30 sec) (Zero ΔP)

Pool Swell Torus Vertical Loads

Pool Swell Torus Vertical Loads

This section provides the net torus vertical load and average shell pressure histories resulting from the drywell air purge to the wetwell during the postulated DBA. The list of applicable figures for this section is given on the following page.

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POOL SWELL TORUS VERTICAL LOADS

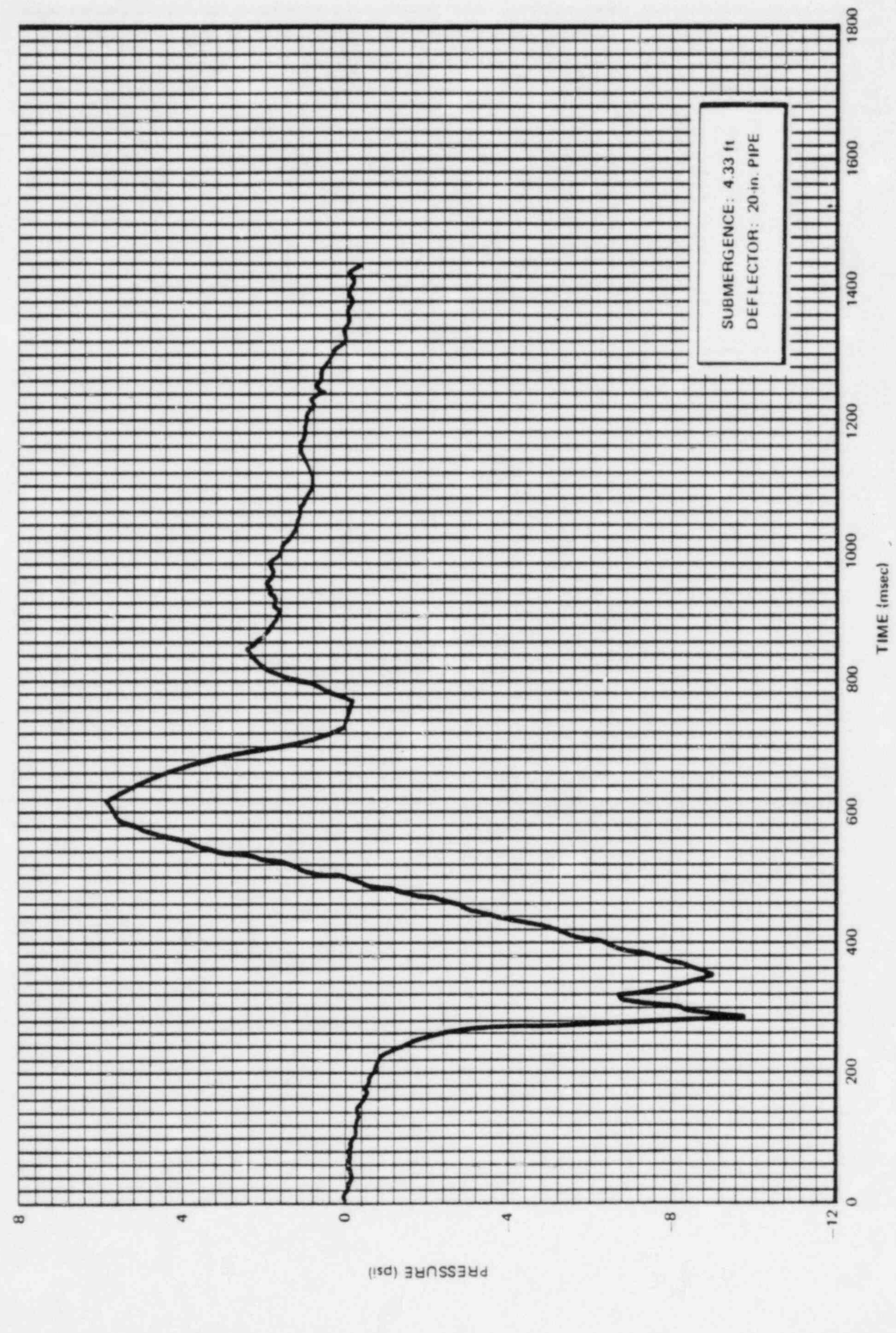

Figure B 4.3.1-1. Net Torus Vertical Load (Zero ΔP)

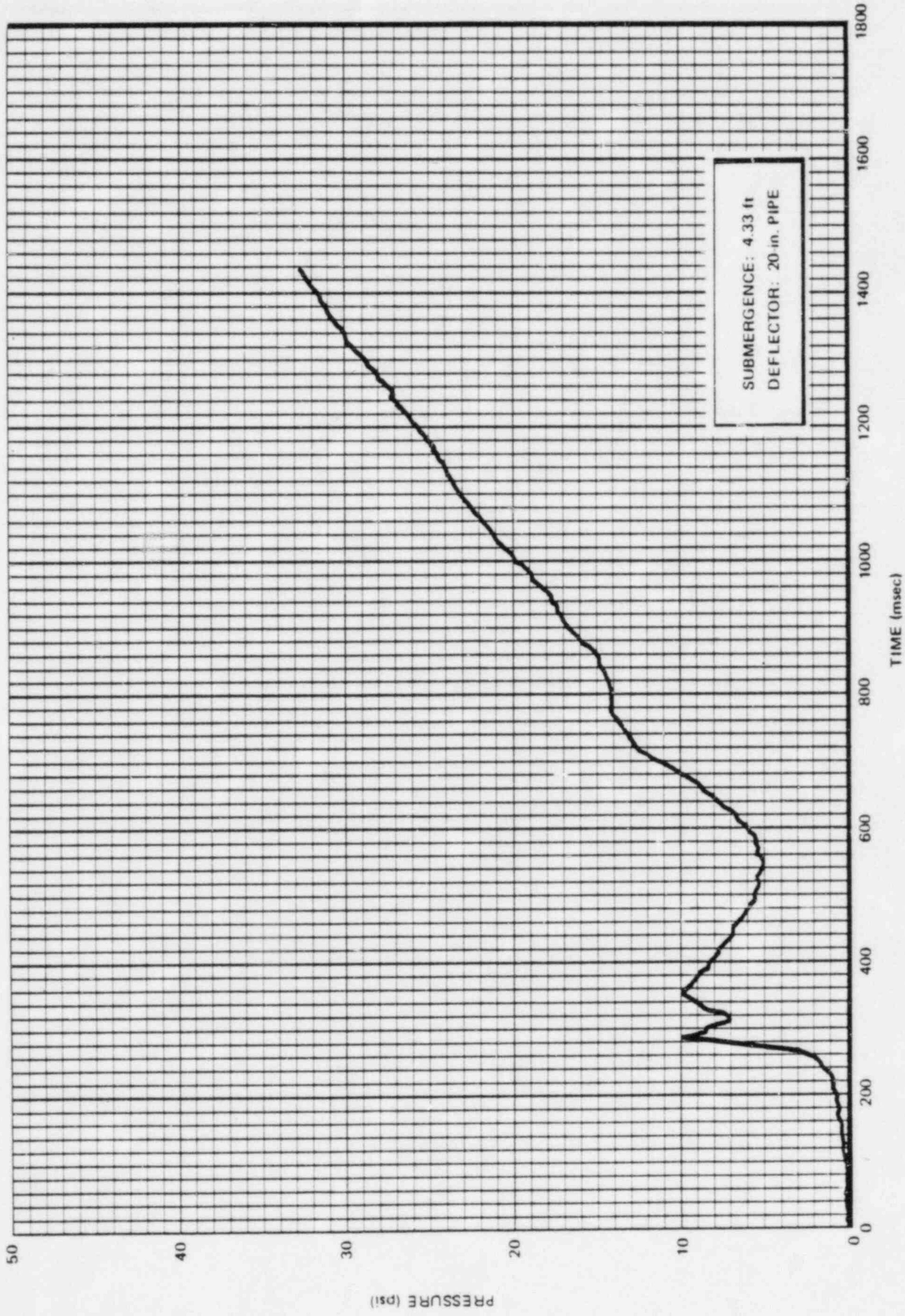

Figure B 4.3.2-1. Average Submerged Pressure (Zero ΔP)

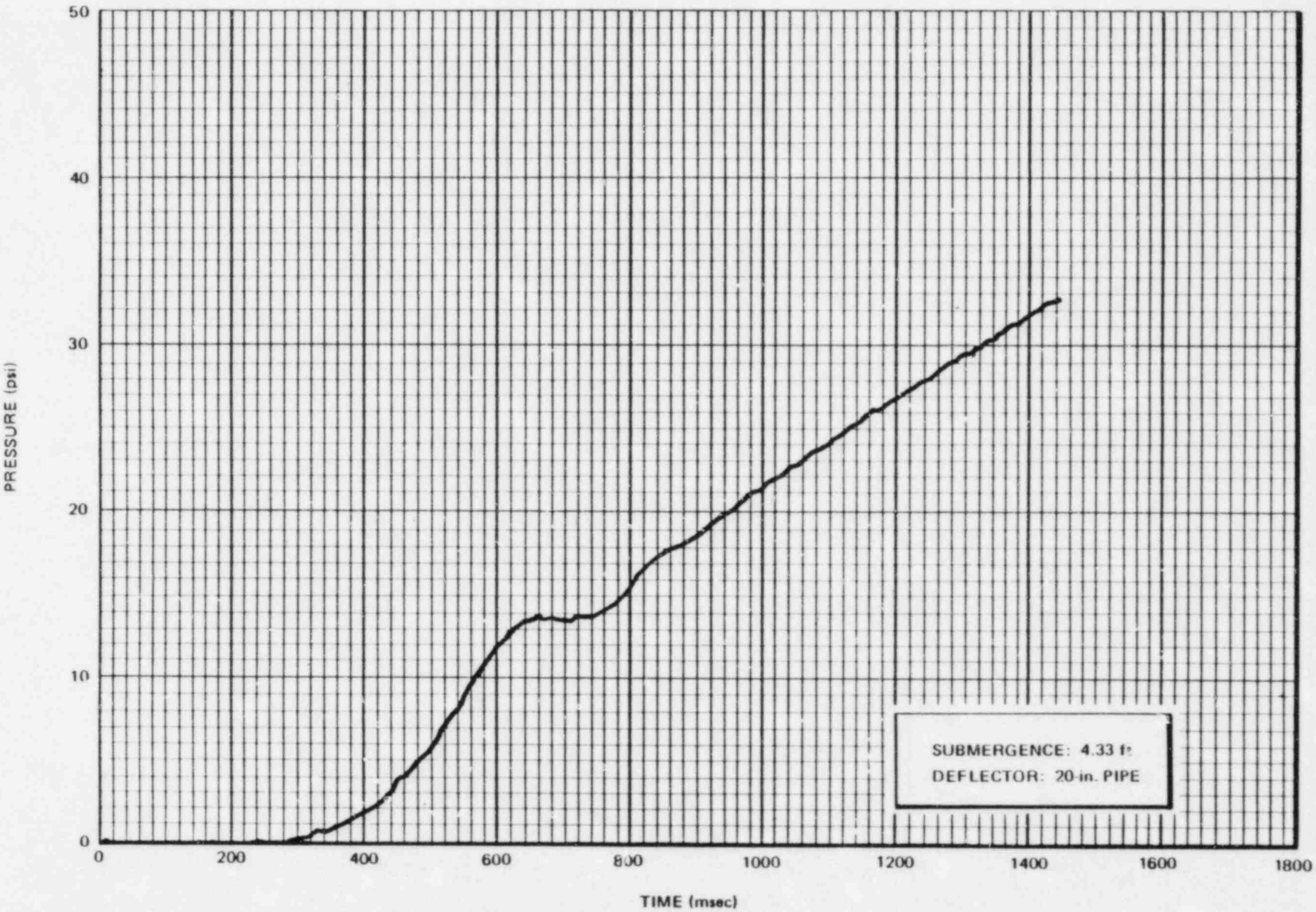

Figure B 4.3.2-2. Torus Air Pressure (Zero ΔP)

Vent System Impact and Drag

Pool Swell Impact and Drag Loads

This section provides the pool swell impact and drag pressures on the vent header as a function of position and time. Also included are the pool swell displacement and velocity distributions for evaluation of impact and drag loads on other structures located above the pool. The list of applicable figures and tables for this section is given on the following page.

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PLANT UNIQUE POOL SWELL IMPACT AND DRAG LOAD FIGURES

Figure/Table No.	Title	Applicable Revision No.
Figure B 4.3.3-1	Location of Impact/Drag Pressure Transients on Header	Revision 1
Table B 4.3.3-1	Vent Header Local Impact/Drag Pressure Transients (Zero ΔP)	↓
Figure B 4.3.3-2	Longitudinal Vent Header Impact Velocity Distribution (Zero ΔP)	↓
Figure B 4.3.3-3	Longitudinal Time Delay Distribution (Zero ΔP)	↓
Figure B 4.3.3-4	Circumferential Time Delay Distribution (Zero ΔP)	↓
Figure B 4.3.4-1	Pool Swell Displacement Distribution (Zero ΔP)	↓
Figure B 4.3.4-2	Pool Swell Velocity Distribution (Zero ΔP)	↓

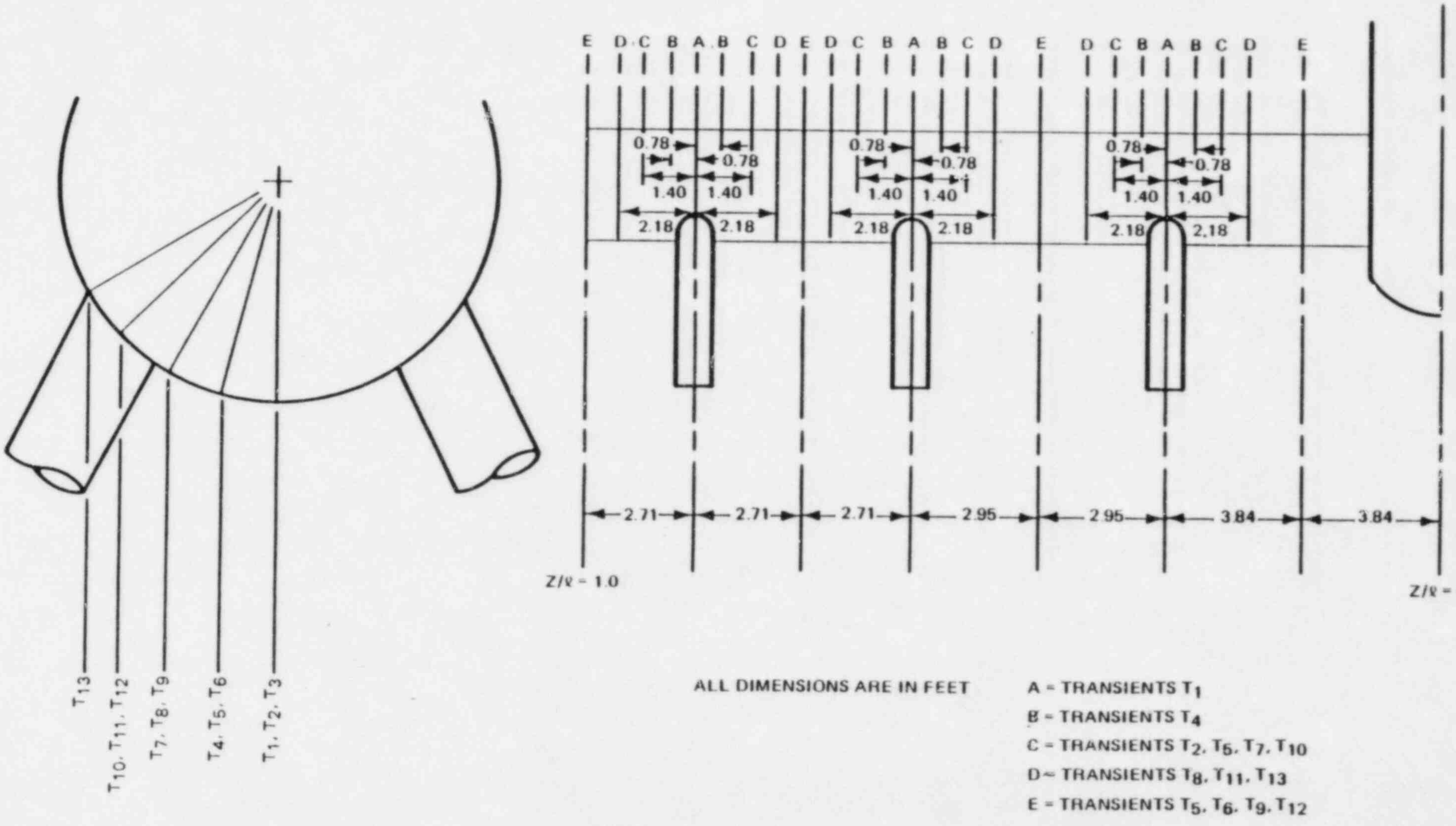

Figure B 4.3.3-1. Location of Impact/Drag Pressure Transients on Header

Table B 4.3.3-1

VENT HEADER LOCAL IMPACT/DRAG PRESSURE TRANSIENTS (ZERO ΔP)

Submergence: 4.33 ft - Deflector: 20-in. pipe

LOCATION T1

T (MSEC)	P (PSI)
.0000	.0000
7.6551	26.6420
17.4790	7.2652
30.4693	12.2874
101.7244	.0000

LOCATION T2

T (MSEC)	P (PSI)
.0000	.0000
7.5532	22.1199
12.1279	3.5783
27.5675	14.4790
101.5886	.0000

LOCATION T3

T (MSEC)	P (PSI)
.0000	.0000
17.7821	13.1938
26.9150	6.2535
45.9458	4.7462
75.3009	.0000

LOCATION T4

T (MSEC)	P (PSI)
.0000	.0000
12.7044	16.0077
22.5254	5.3106
48.8476	7.6822
102.1906	.0000

LOCATION T5

T (MSEC)	P (PSI)
.0000	.0000
5.5291	24.4229
11.0889	3.3722
21.5220	11.8954
109.0136	.0000

LOCATION T6

T (MSEC)	P (PSI)
.0000	.0000
11.6977	8.4996
26.6812	9.1253
63.8404	2.6376
98.7721	.0000

LOCATION T7

T (MSEC)	P (PSI)
.0000	.0000
8.3349	17.2411
14.4759	5.8130
53.6840	4.8540
95.5029	.0000

LOCATION T8

T (MSEC)	P (PSI)
.0000	.0000
1.5290	86.5953
3.7021	7.0831
28.5347	6.9505
82.1405	.0000

LOCATION T9

T (MSEC)	P (PSI)
.0000	.0000
1.7628	53.0395
4.4650	7.3537
36.7566	7.1283
80.5805	.0000

LOCATION T10

T (MSEC)	P (PSI)
.0000	.0000
6.1174	2.7908
32.3102	2.4136
48.8476	.6983
87.7118	.0000

LOCATION T11

T (MSEC)	P (PSI)
.0000	.0000
4.8267	9.2183
11.2156	2.9311
34.8220	2.9540
80.5171	.0000

LOCATION T12

T (MSEC)	P (PSI)
.0000	.0000
1.8660	7.1735
14.1844	4.1324
43.0439	3.5501
87.6291	.0000

LOCATION T13

T (MSEC)	P (PSI)
.0000	.0000
19.3456	.3969
38.6912	.7076
58.0367	.8883
103.2034	.0000

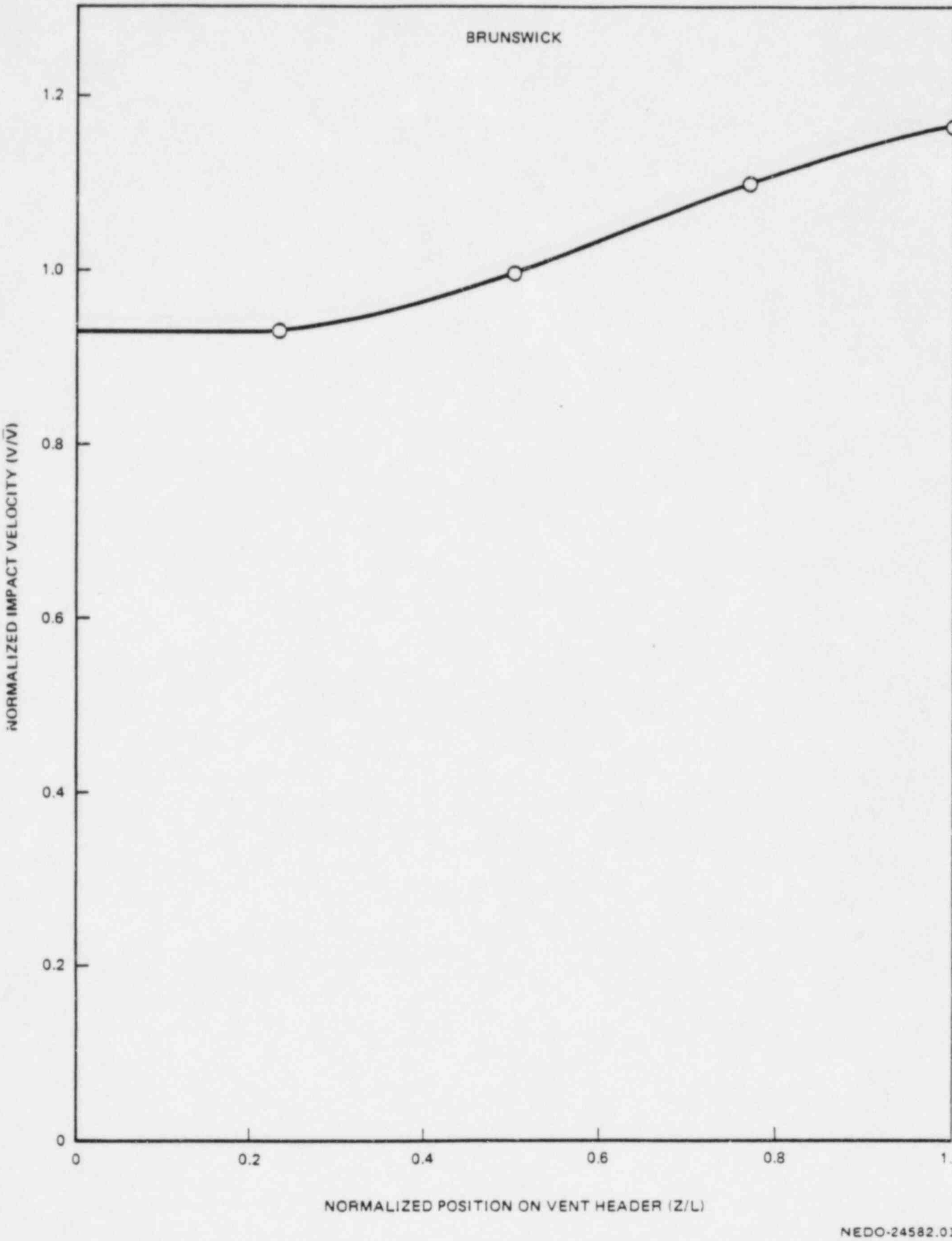

Figure B4.3.2-2. Longitudinal Vent Header Impact Velocity Distribution Based on EPRI Main Vent Orifice Test

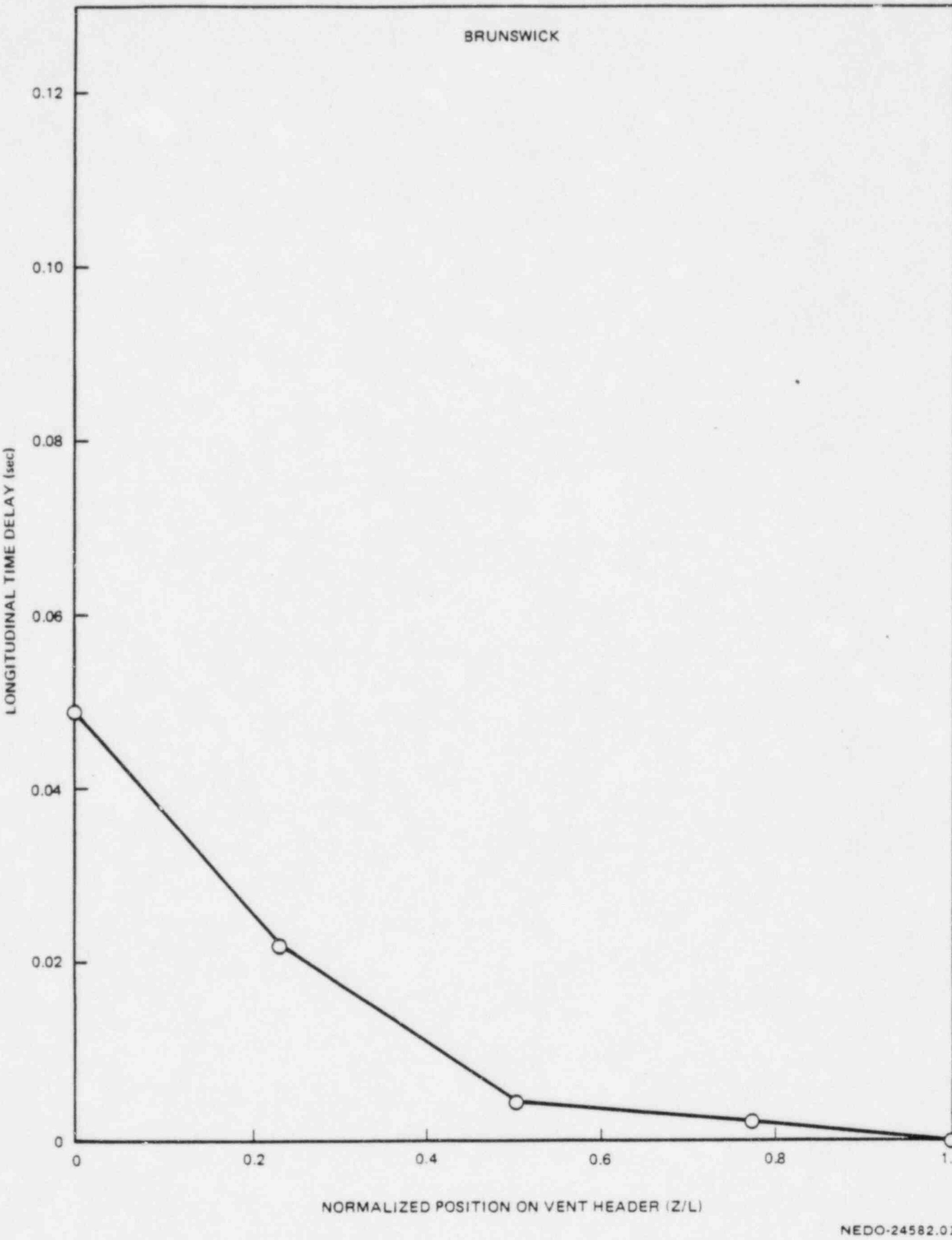

Figure B4.3.3-3. Longitudinal Time Delay Distribution Based on EPRI Main Vent Orifice Test

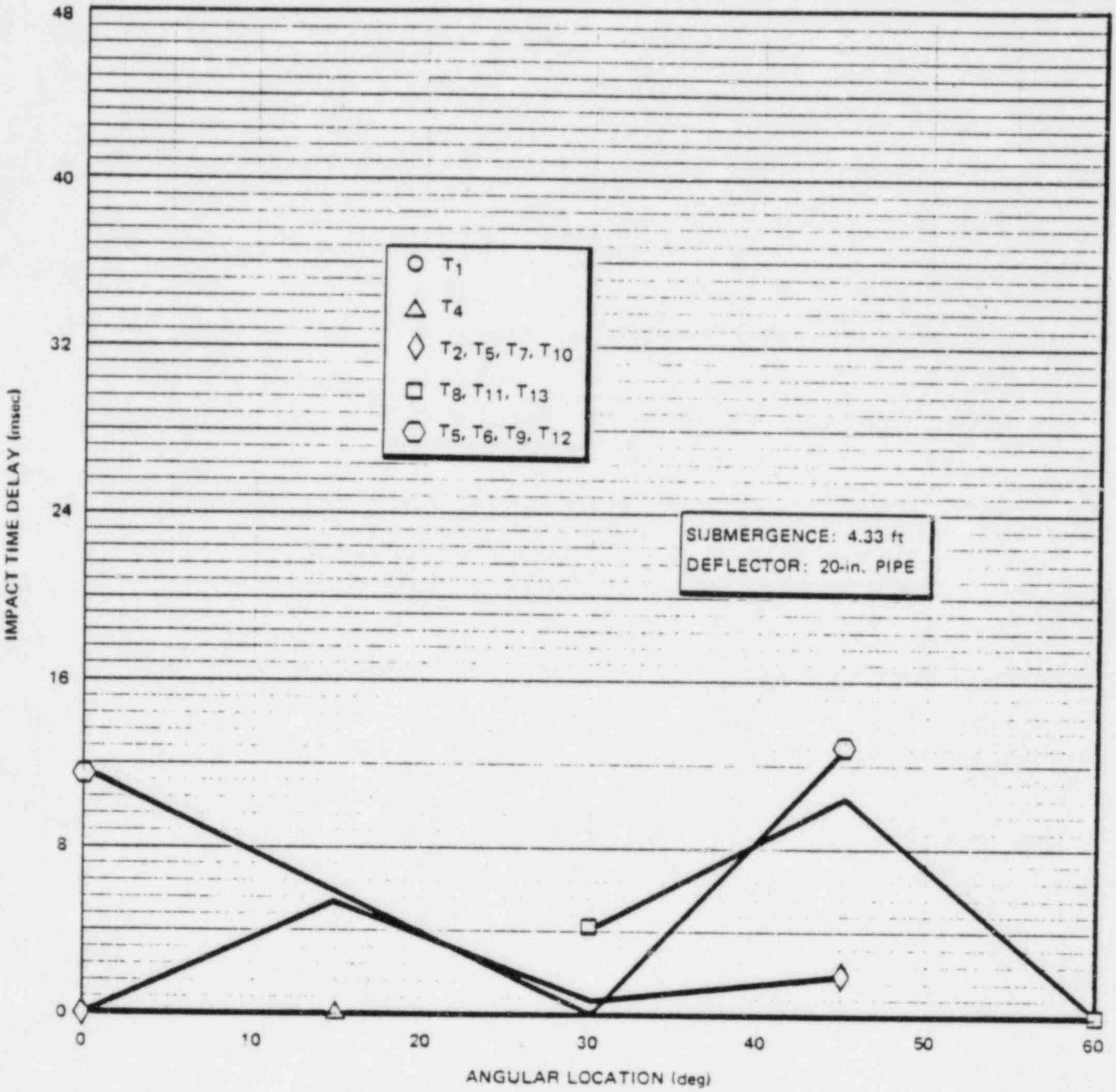

Figure B 4.3.3-4. Circumferential Time Delay Distribution (Zero ΔP)

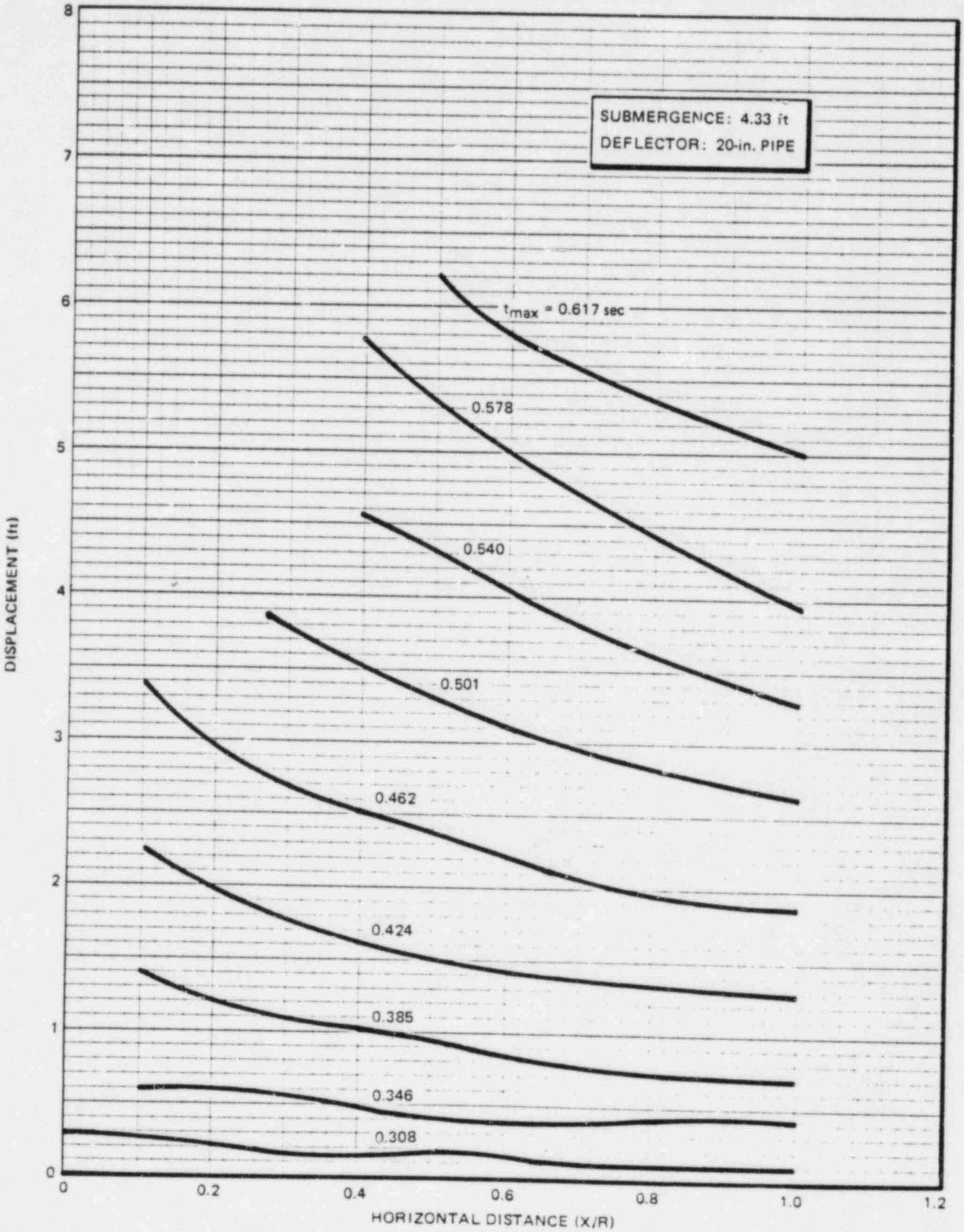

Figure B 4.3.4-1. Pool Swell Displacement Distribution (Zero ΔP)

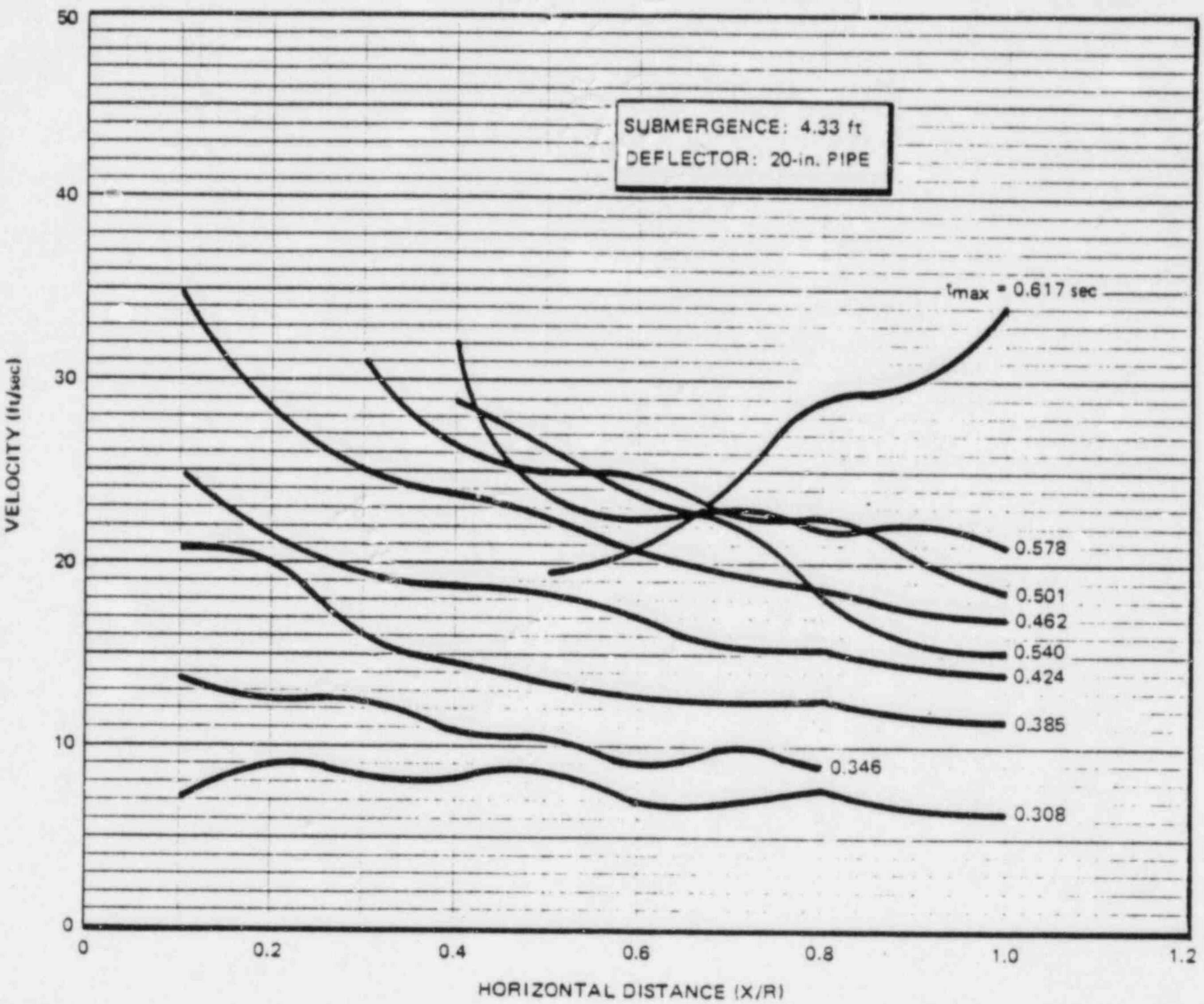

Figure B 4.3.4-2. Pool Swell Velocity Distribution (Zero ΔP)

Pool Swell Vent Header Deflector Loads

Pool Swell Vent Header Deflector Loads

This section provides the vent header deflector loads from the pool swell resulting from the drywell air purge to the wetwell during the postulated DBA.

The loads presented are full scale running load as a function of time from LOCA break, for three values of Z/L (distance along the deflector). Z/L = 0 corresponds to the middle of the vent bay and Z/L = 1.0 corresponds to the middle of the non-vent bay.

These loads were derived from the method discussed in the Mark I Containment Program Vent Header Deflector Load Definition (NEDO-24612).

BRUNSWICK

PLANT UNIQUE POOL SWELL VENT HEADER DEFLECTOR LOADS

Figure/Table Number	Title	Applicable Revision No.
Figure B 4.3.9-1	Vent Header Deflector Load	Revision 1

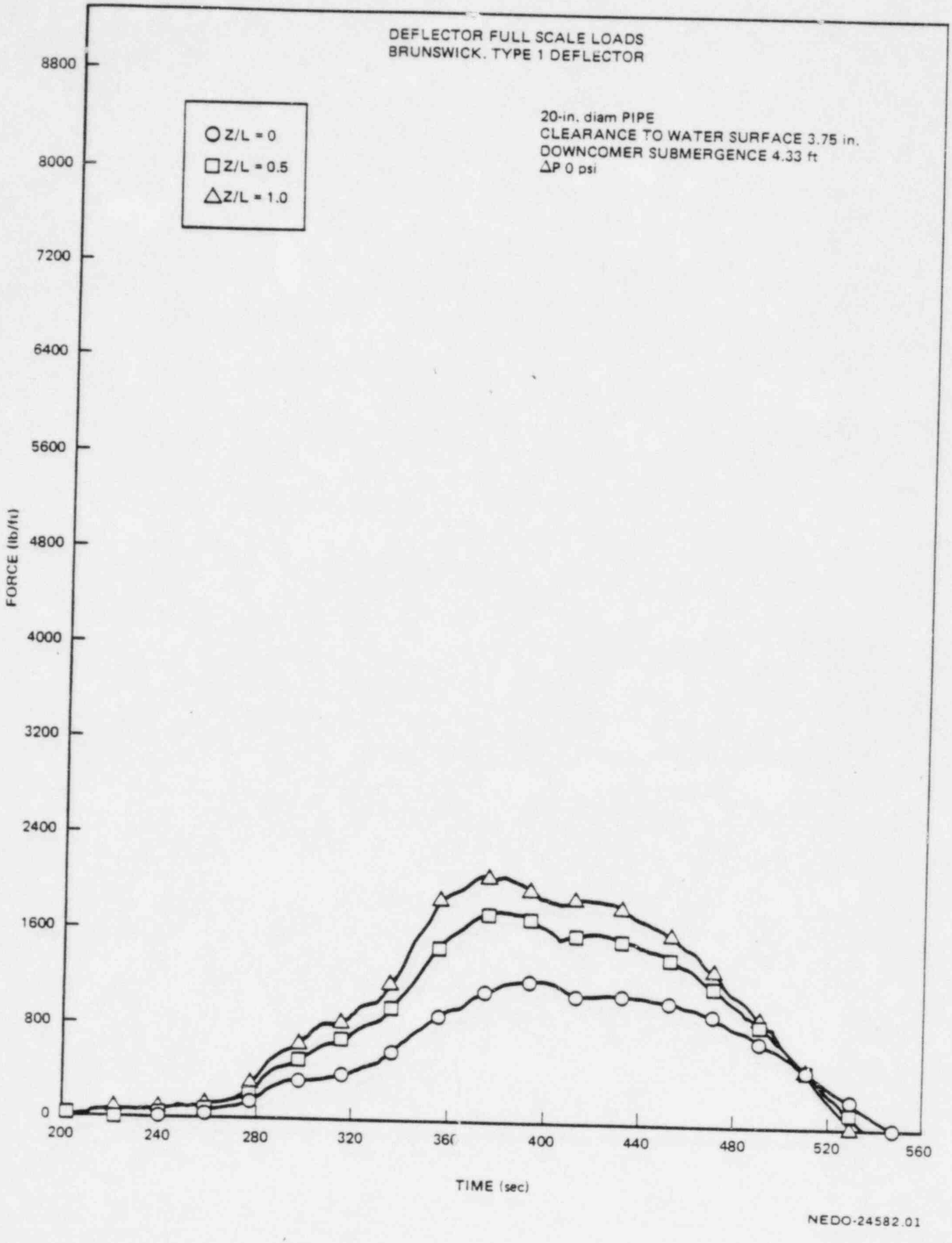

Figure B4.3.9-1. Vent Header Deflector Load

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TECHNICAL INFORMATION EXCHANGE

TITLE PAGE

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		DATE October 1981
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		GOVERNMENT CLASS –
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SUMMARY

This document provides unique definition of specific containment loading conditions that would result from a postulated loss-of-coolant accident in Brunswick Steam Electric Plant: Units 1 and 2. Transient information is provided for containment pressures and temperatures, vent system thrust, torus vertical loads, vent system pool swell impact loads, and vent header deflector loads. The document has been prepared under the Mark I Containment Program to aid Carolina Power & Light Company in the performance of a containment structural evaluation.

By cutting out this rectangle and folding in half, the above information can be fitted into a standard card file.

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GENERAL ELECTRIC

April 11, 1979
MI-G-66

To: MARK I UTILITIES

Subject: MARK I CONTAINMENT PROGRAM - PLANT UNIQUE LOAD DEFINITION REPORTS

As an addendum to the Mark I Containment Program Load Definition Report (LDR), specific plant unique information has been generated for each Mark I Utility. This information includes LOCA pressure and temperature transients, vent system thrust loads at both operating and zero ΔP, torus pool swell vertical loads, vent header impact and drag loads and vent header deflector loads. The information has been collected in a Plant Unique Load Definition (PULD) Report.

Please find enclosed the PULD for your Mark I plant for use in structural design and evaluation. It should be noted that vent header impact and drag loads and vent header deflector loads will be submitted as an addendum to the PULD in the late April/early May time period. Mark I Program looseleaf binders for the PULDs will also be transmitted at a later date.

Also find enclosed as an attachment to this letter, a recommendation for an increase in wetwell pressure for DBA structural evaluations. This attachment should be attached to the enclosed PULD.

R.H. Kohrs

R.H. Kohrs, Manager
Mark I Program

RHK:kad
Attachment/Enclosure

CONTAINMENT PRESSURE/TEMPERATURE RESPONSE CALCULATIONS

Note: This memorandum applies to all Mark I Plants except Oyster Creek and Nine Mile Point.

The containment pressure and temperature histories for the DBA presented in the Mark I LDR section 4.1.1 and the PULD's (Figures 4.1.1-1 and 4.1.1-2) are based on initial conditions which maximize the initial drywell pressurization rate and the vent system thrust loads, thus the resulting wetwell pressure response is not maximized. For example, the initial wetwell pool temperature was chosen to be at its nominal value which resulted in a lower wetwell pressure response whereas a higher initial wetwell pool temperature would have resulted in a higher wetwell pressure and temperature response. A low wetwell pressure response implies that the pressure differential between the drywell and the wetwell at any point in time following the DBA is maximized which results in conservative vent system thrust loads.

Furthermore, the presented drywell and wetwell pressure histories are terminated at 30 seconds. Therefore, to utilize a bounding wetwell pressure history for the DBA when performing structural evaluations, it is recommended that 1.0 psi be added to the wetwell pressure response presented in Figure 4.1.1-1 of the PULD document for the time period less than 30 seconds and 2.0 psi be added to the wetwell pressure calculated at 30 seconds for the time period passed 30 seconds. The sketch shown in Figure 1 of this memorandum further illustrates the above recommended procedure.

The containment pressure histories presented for the IBA and SBA bound the expected response for both the drywell and wetwell and therefore no margin need be added.

Attachment #1
MI-G-66

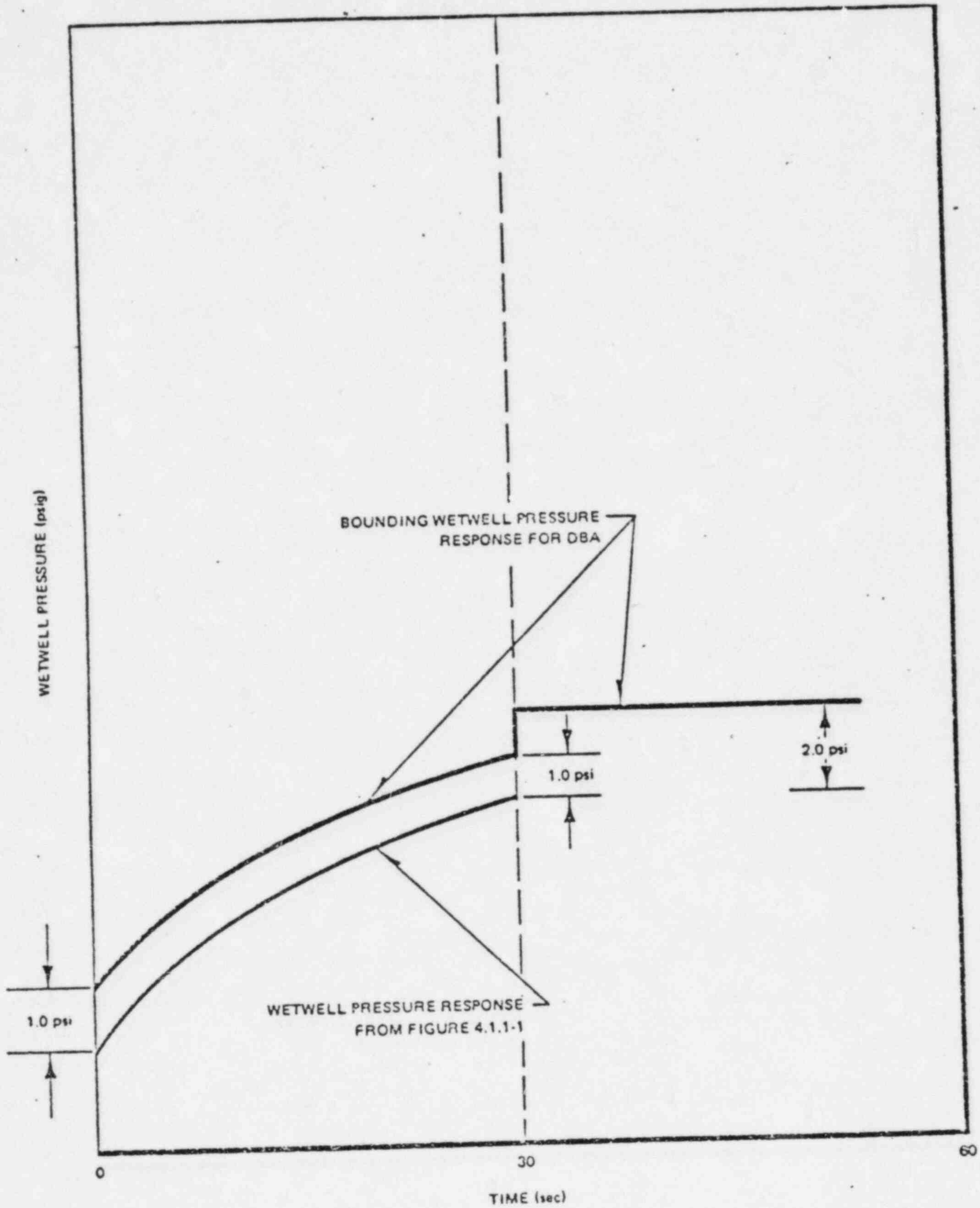

Figure 1