WM. H. ZIMMER POWER STATION

INSTRUCTIONS FOR UPDATING YOUR DAR

Changes to the MARK II DAR are identified by a vertical line in the right margin of the page. To update your copy of the ZPS-1 DAR, remove and destroy the following pages and figures and insert pages and figures as indicated.

REMOVE	INSERT
Page v	Pages v and v (Cont'd)
After page vii	Page vii (Cont'd)
Page xii	Pages xii, xiii, and xiv
Figure 3.2-18	Figure 3.2-18
Figure 3.3-8	Figure 3.3-8
After page E.2-8	Appendix F Title Page; pages F.0-1 through F.0-iii; pages F.1-1 and F.2-1; Figures F.2-1 through F.2-4; page F.3-1; Figure F.3-1; page F.4-1; pages F.5-1 through F.5-7; and Figures F.5-1 through F.5-12.

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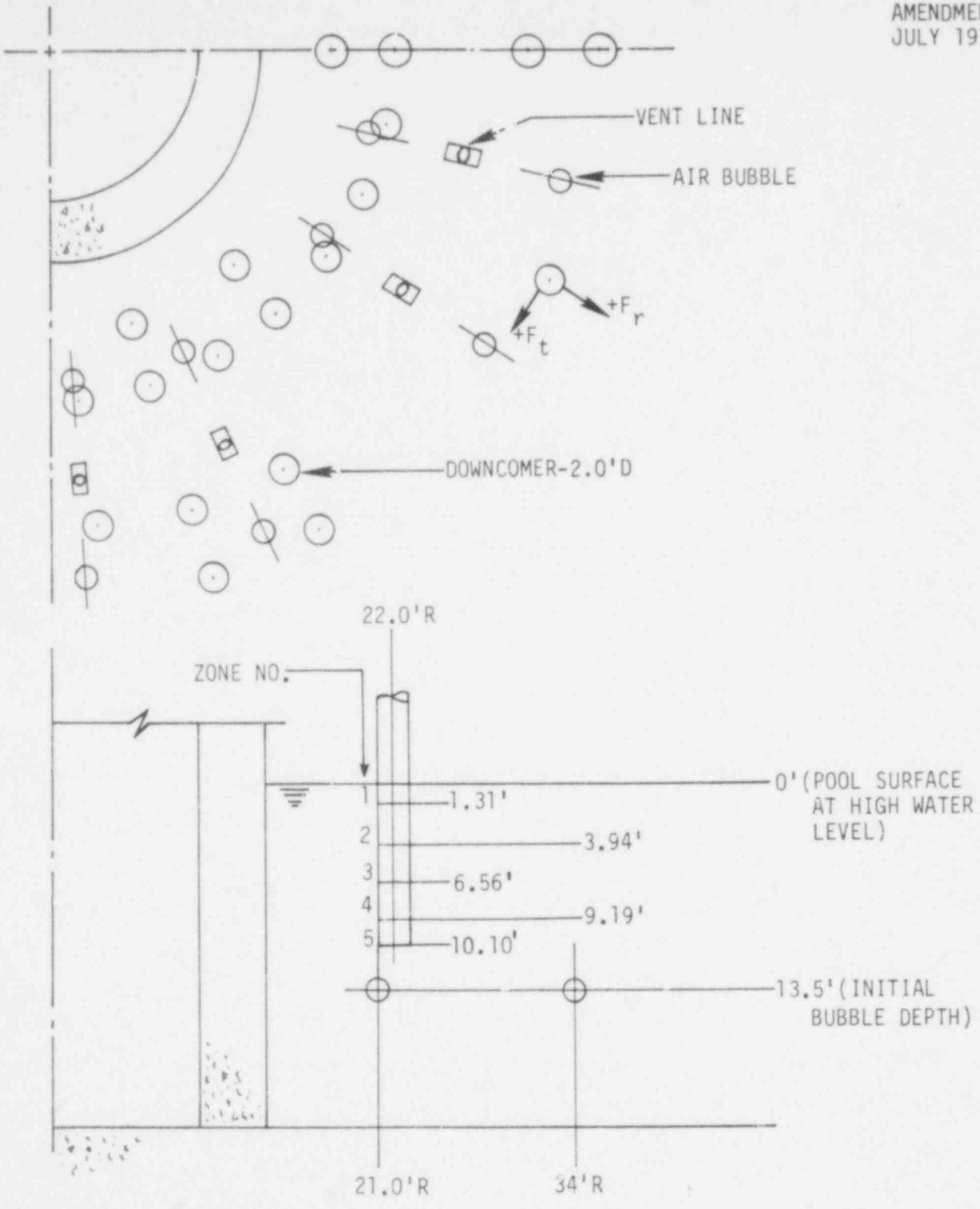

DOWNCOMER ELEVATION

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NOTE:

1. F_t AND F_r ARE ORTHAGONAL COMPONENTS, ie., TANGENTIAL AND RADIAL. VECTORS INDICATE POSITIVE COORDINATE DIRECTIONS.

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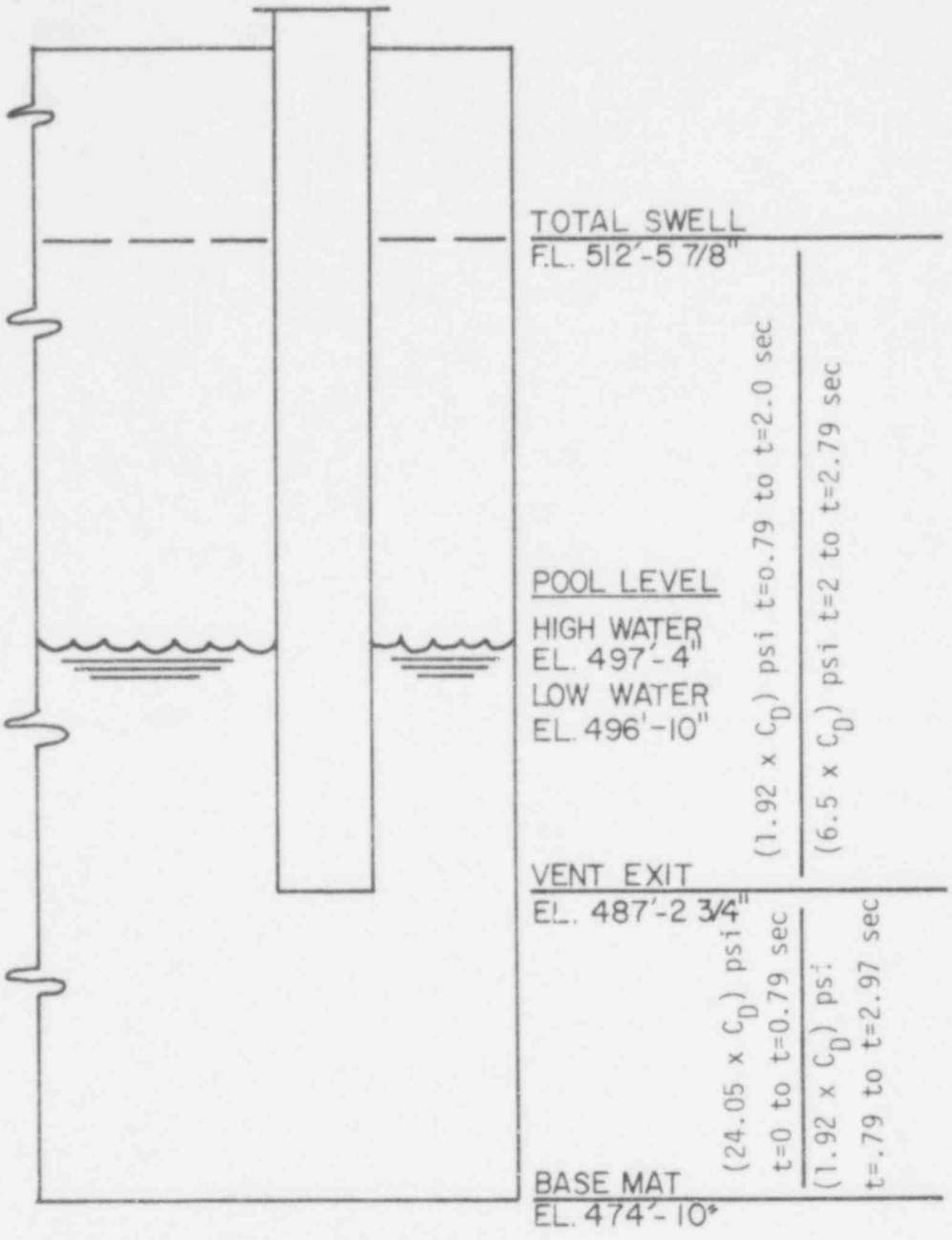
FIGURE 3.2-18

DOWNCOMER VENT GEOMETRY



NOTE:

1. THE DRAG LOAD APPLIES IN EITHER HORIZONTAL OR VERTICAL DIRECTION.

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FIGURE 3.3-8

DRAG LOAD DUE TO POOL SWELL AND FALLBACK PHENOMENA

APPENDIX F

CONTAINMENT STRUCTURE ASSESSMENT FOR LOCA JET IMPINGEMENT AND POOL SWELL LOADS

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F.1.0 INTRODUCTION

This report presents an assessment of the containment structure for the LOCA jet and pool swell loads on the pool boundary defined in the "Lead Plant Program Load Evaluation Report," NUREG-0487 dated October 1978. 12

The adequacy of the containment structure at key design sections is demonstrated with the aid of interaction diagrams.

F.2.0 LOADS

A conservative definition of the LOCA jet load and pool swell load is given in NUREG-0487 dated October 1978.

F.2.1 LOCA Jet Load

Figure F.2-1 shows the spatial distribution of the LOCA jet load on the wetted surface of the suppression pool. The magnitude of the load is 33 psig below vent exit and attenuates linearly to zero at the pool surface.

F.2.2 Pool Swell Load

The containment structure is analyzed for two load cases for the LOCA pool swell phenomenon; the symmetric and the asymmetric loads.

F.2.2.1 Symmetric Pool Swell Load

For the symmetric load, the loading is applied over the entire 360° of the containment wall. The pressure history of the drywell and wetwell air space is given in Figure F.2-2. Curve A of this figure applies to the drywell and curve B applies to that portion of the wetwell wall which is above the pool water surface. The LOCA-pool swell portion of these curves ends at time 2.97 seconds. 12

The peak wetwell air space pressure during this event is 23 psig, while the peak drywell pressure is 21 psig.

For the portion of the wetwell walls which are below the water surface, the load definition is given in Figure F.2-3. This load is 22 psig at the basemat level which decreases linearly to 16 psig at the elevation of the vent exit, and then increases linearly to 23 psig at the maximum pool swell elevation.

F.2.2.2 Asymmetric Pool Swell Load

The peak drywell pressure during this event is applied uniformly over the entire drywell.

Figure F.2-4 shows the pressure distribution of the pool swell asymmetric load for the wetwell.

The asymmetric pool swell load of 23 psig is applied over a sector of 180°, in addition to the hydrostatic load.

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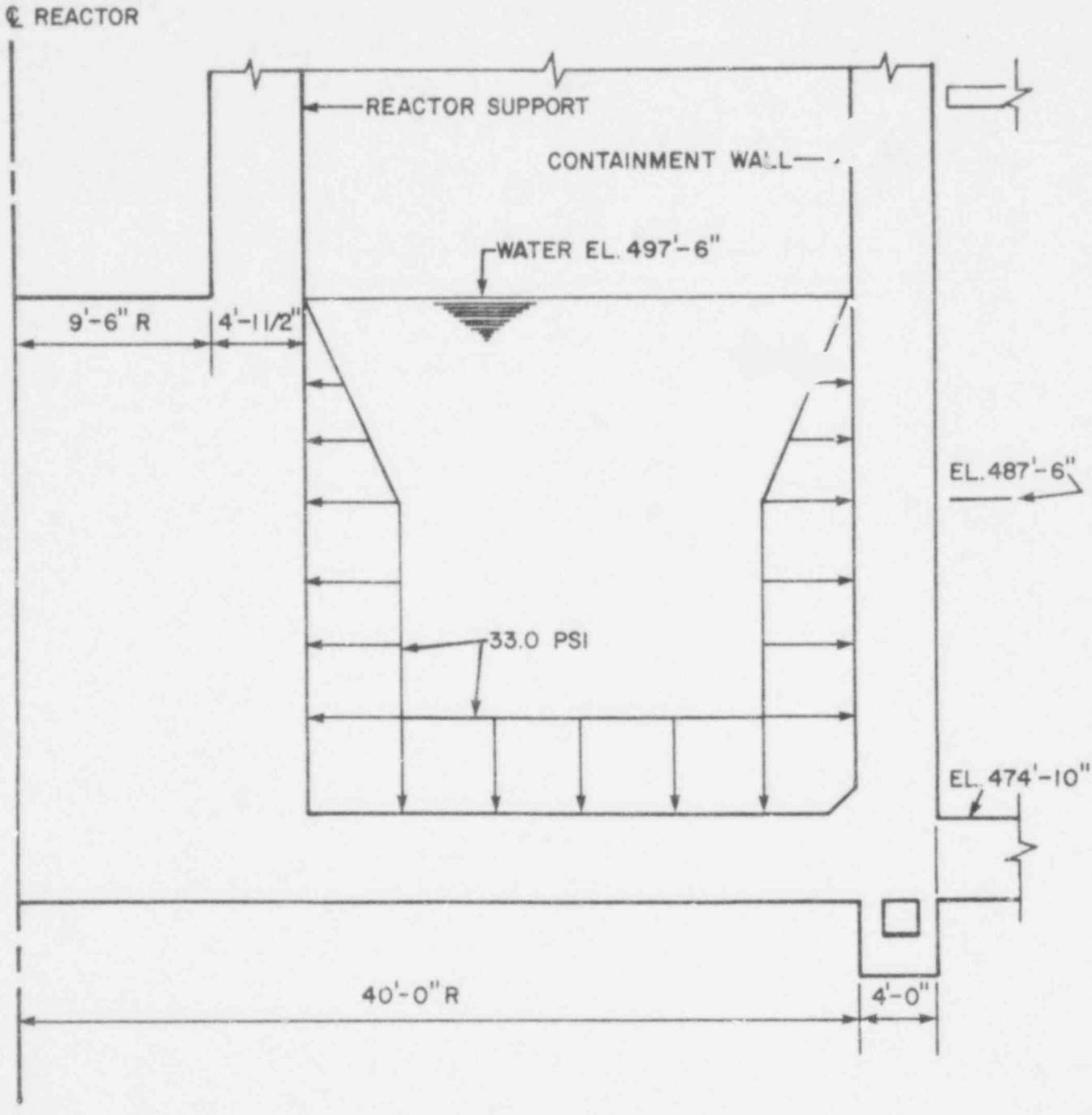

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FIGURE F.2-1

LOCA JET IMPINGEMENT PRESSURE DISTRIBUTION

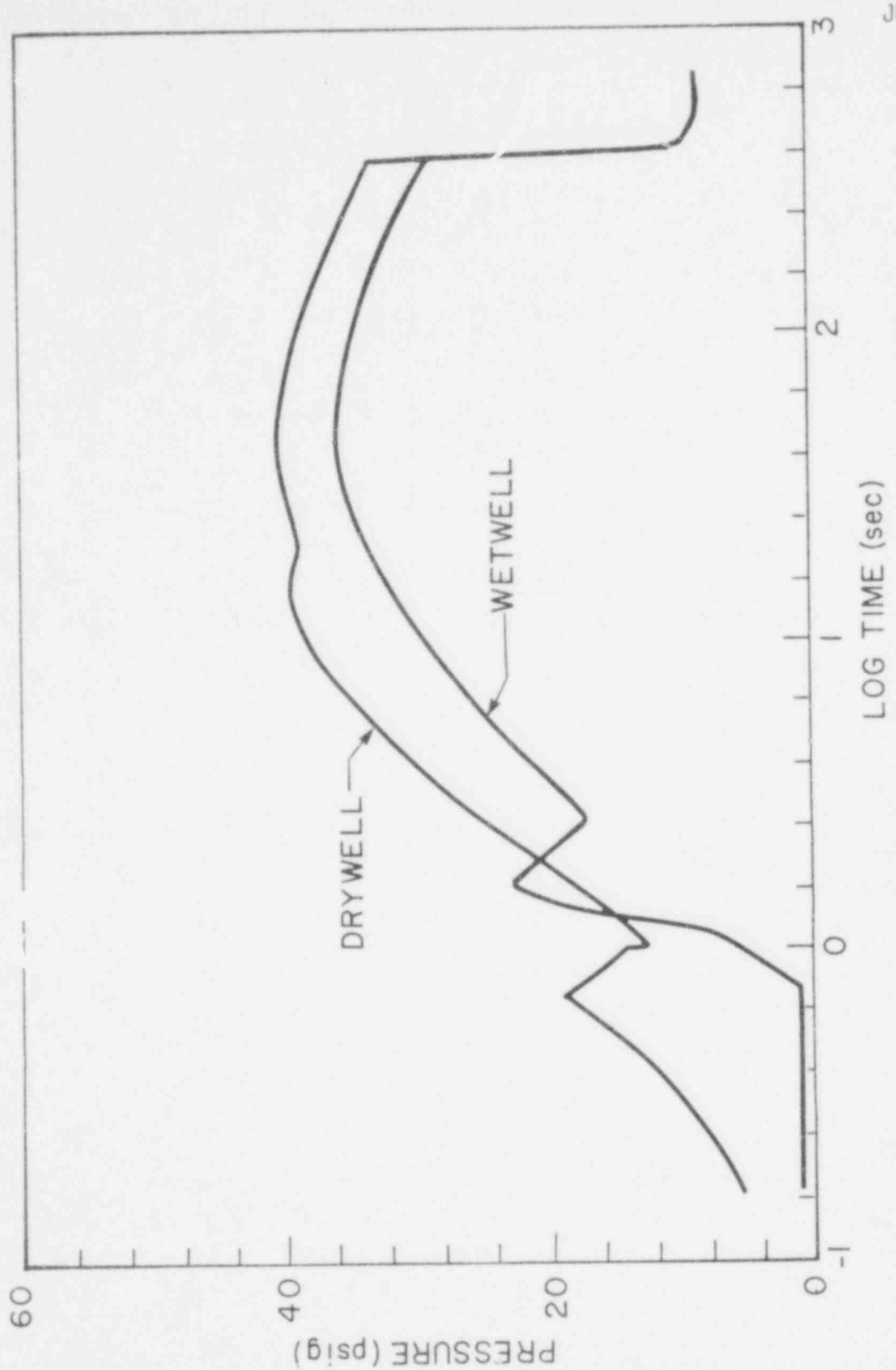

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FIGURE F.2-2

DRYWELL/WETWELL PRESSURE HISTORY FOR MAIN STEAMLINE BREAK

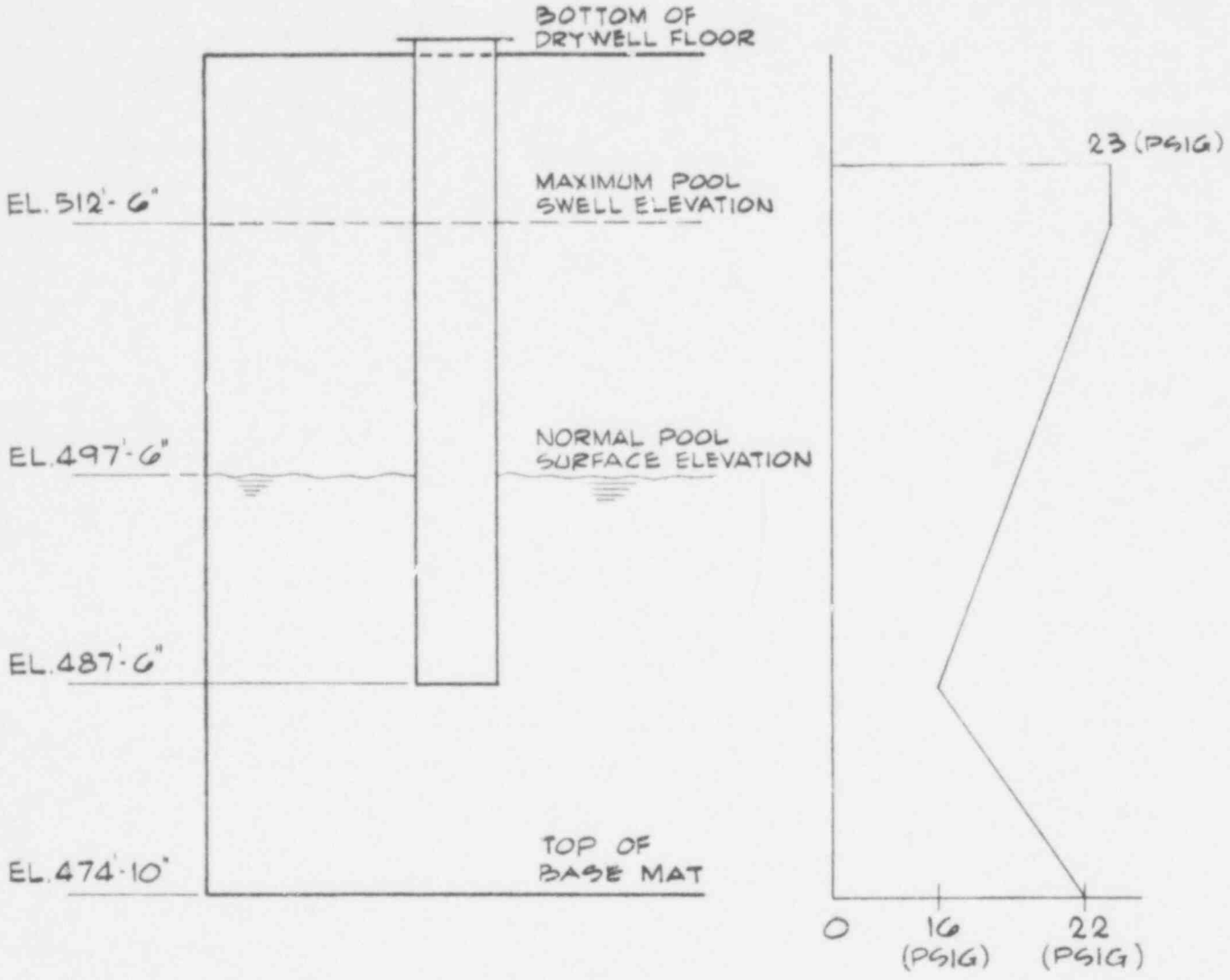

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FIGURE F.2-3

POOL SWELL SYMMETRIC LOAD

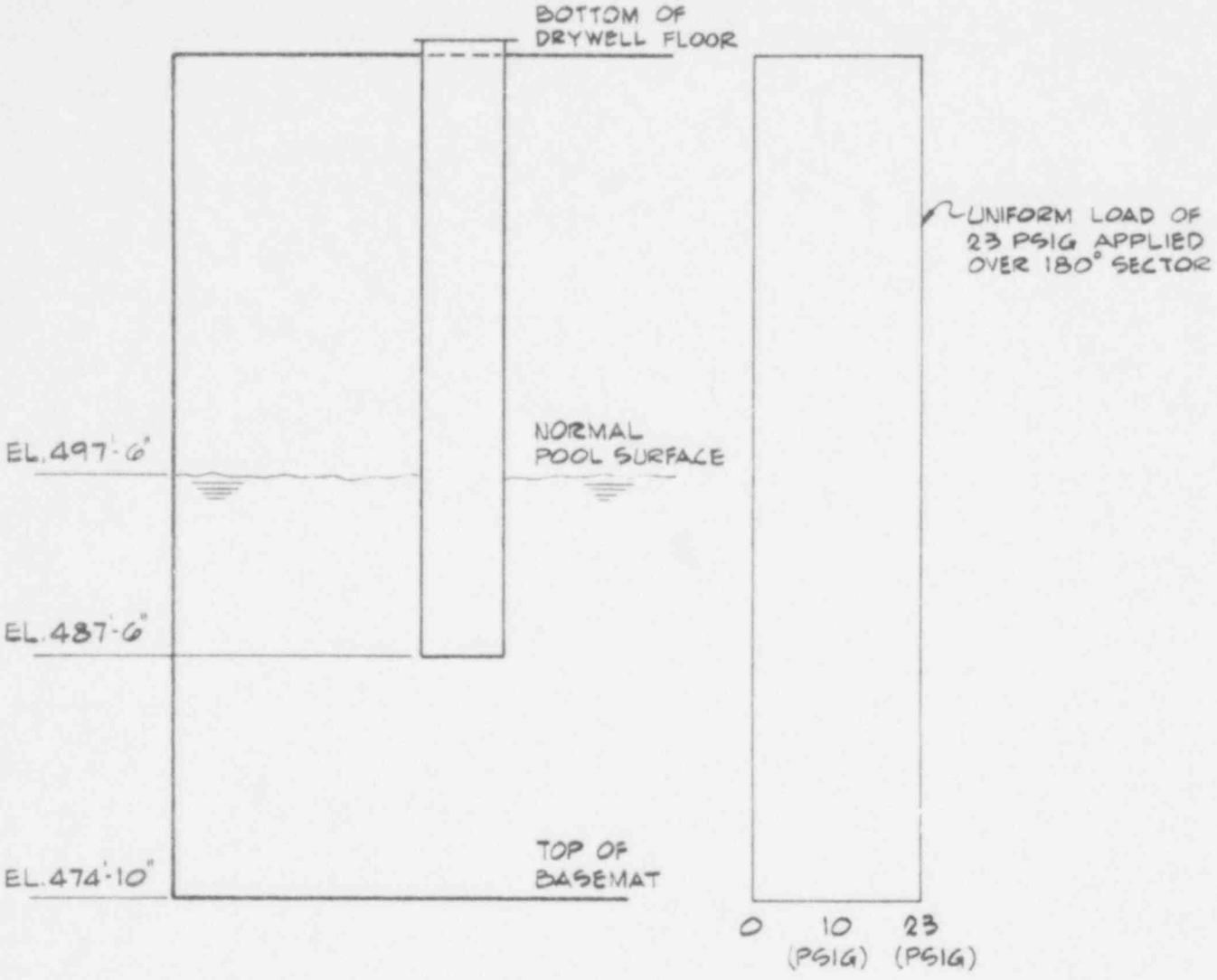

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FIGURE F.2-4
POOL SWELL ASYMMETRIC LOAD

F.3.0 STRUCTURAL ANALYSIS MODEL

The containment is modeled as an axisymmetric structure by finite shell elements as shown in Figure F.3-1. The structural model includes the basemat, primary containment, reactor pedestal, drywell floor, and reactor pressure vessel (RPV). The soil is modeled by axisymmetric solid finite elements in nine horizontal layers down to the bedrock level. 12

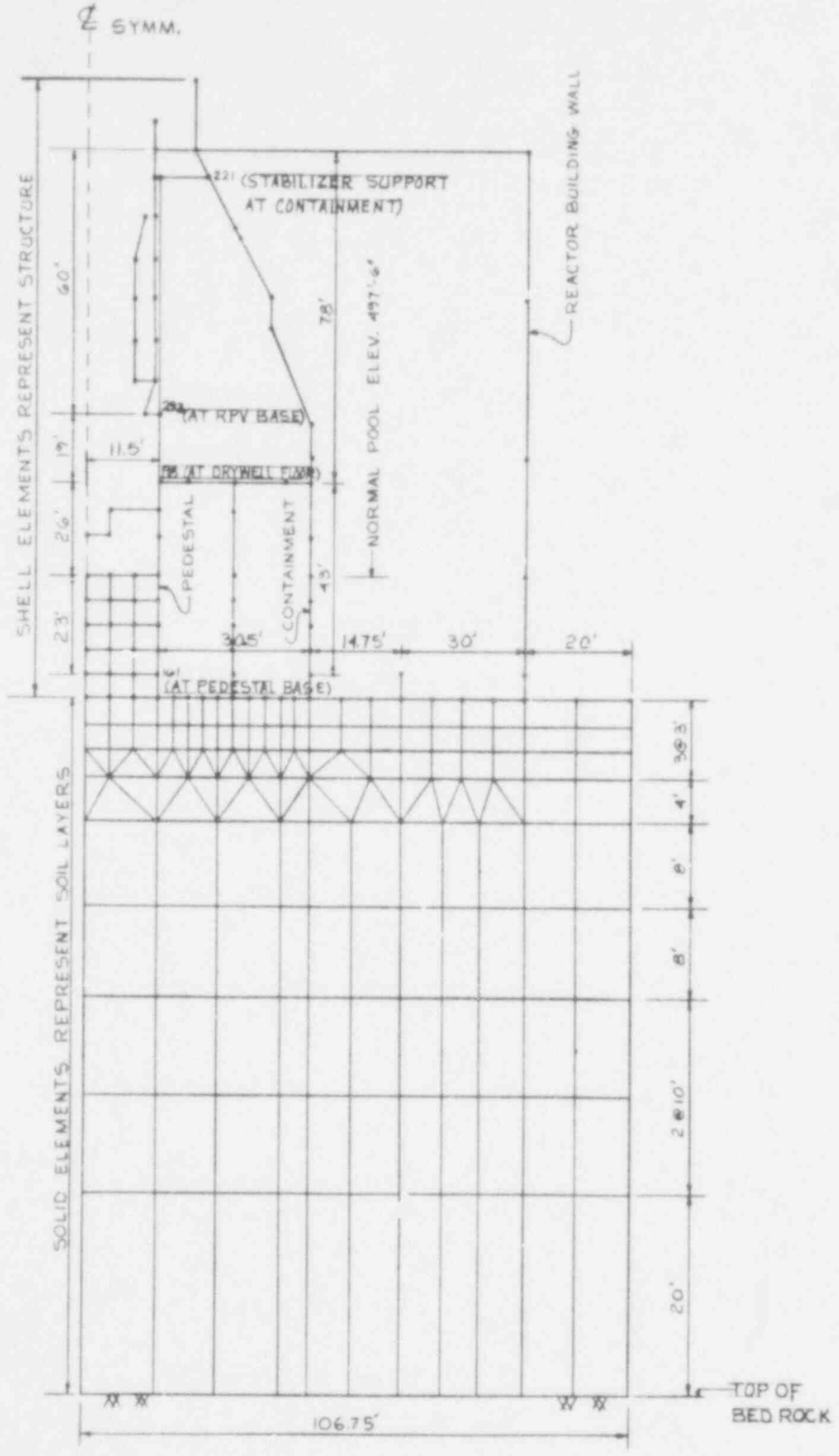

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FIGURE F.3-1

STRUCTURAL MODEL INCLUDING SOIL

F.4.0 METHOD OF ANALYSIS AND RESULTS

The containment structure, described in Section F.3.0, is analyzed by the Sargent & Lundy version of the finite element program DYNAX which is capable of analyzing axisymmetric structures subjected to symmetric and asymmetric static or dynamic loads. The LOCA jet impingement and pool-swell loads are applied as Fourier sine and/or cosine harmonics for each case in this analysis. 12

F.5.0 DESIGN ASSESSMENT

The following key design sections in the containment structure, shown in Figure F.5-1, are selected for this assessment:

a. basemat Section 2 near the junction between the basemat and reactor support,

b. basemat Section 3 near the junction between the basemat and the containment wall,

c. containment Section 1 in the wetwell near the junction between the basemat and the cylindrical wall,

d. containment Section 4 in the drywell wall near the junction between the drywell floor slab and the cylindrical wall, and 12

e. containment Section 11 in the conical drywell wall.

A breakdown of the effects of the LOCA jet impingement and pool swell and other individual loads on these critical design sections is given in Tables F.5-1 through F.5-5.

The design forces and moments on the key sections are obtained by combining the various individual loads in accordance with the load combinations specified in Table F.5-6.

The adequacy of the containment structure is verified by plotting the design force-moment combinations on the interaction diagrams for the various design sections. As can be seen from Figures F.5-3 through F.5-12, all points plot within the boundary of the respective interaction diagrams. This demonstrates that the containment structure can safely accommodate the effects of the conservative LOCA jet impingement and pool-swell loads defined in NUREG-0487 dated October 1978.

TABLE F.5-1

FORCES ON CONTAINMENT SECTION 1 FOR INDIVIDUAL LOADS

LOAD DESCRIPTION	M_ϕ (kip-ft/ft)	M_θ (kip-ft/ft)	N_ϕ (kip/ft)	N_θ (kip/ft)	$Q_{R\phi}$ (kip/ft)	$Q_{R\theta}$ (kip/ft)	Q_T (kip/ft)
PERMANENT LOADS	-226.95	-45.20	-430.74	-113.00	66.65	0	0
OPERATING TEMPERATURE	-73.99	-32.83	6.91	3.64	3.34	0	0
OPERATING BASIS EARTHQUAKE	0	0	118.28	0	0	0	60.95
SAFE SHUTDOWN EARTHQUAKE	0	0	162.40	0	0	0	88.46
+SRV ALL	121.34	3.14	16.17	4.69	13.96	2.82	19.44
-SRV ALL	-47.74	-1.10	-14.96	-4.63	-26.24	-2.82	-19.44
+SRV ASYMMETRICAL	66.52	4.42	11.06	4.64	5.44	1.77	6.00
-SRV ASYMMETRICAL	-19.58	-1.35	-8.19	-2.95	-17.85	-1.77	-6.01
+SRV ADS	95.98	2.38	11.34	2.80	9.44	3.68	12.54
-SRV ADS	-36.46	-0.66	-7.70	-2.73	-21.27	-3.29	-13.33
ASYMMETRICAL CHUGGING	152.59	4.49	9.60	5.21	27.13	0	0
+SRV SINGLE	64.56	1.45	7.03	2.07	4.76	0.65	3.23
-SRV SINGLE	-16.59	-0.38	-2.43	-0.79	-14.82	-1.31	-3.15
SBA & IBA PRESSURE LOADS	169.50	28.80	98.95	8.97	-30.95	0	0
DBA PRESSURE LOADS	199.42	33.90	116.20	10.57	-36.43	0	0
SYMMETRIC POOL SWELL	144.55	4.54	47.07	5.00	-26.22	0	0
ASYMMETRIC POOL SWELL	306.69	10.72	47.43	-5.74	-52.07	±17.81	±62.87
JET IMPINGEMENT	307.3	9.21	18.30	-1.97	-57.19	0	0

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TABLE F.5-2

FORCES ON CONTAINMENT SECTION 4 FOR INDIVIDUAL LOADS

LOAD DESCRIPTION	M_ϕ (kip-ft/ft)	M_θ (kip-ft/ft)	N_ϕ (kip/ft)	N_θ (kip/ft)	$Q_{R\phi}$ (kip/ft)	$Q_{R\theta}$ (kip/ft)	Q_T (kip/ft)
PERMANENT LOSS	42.74	7.34	-401.05	-514.53	-6.21	0	0
OPERATING TEMPERATURE	-198.71	-53.95	9.45	289.91	-49.29	0	0
OPERATING BASIS EARTHQUAKE	0	0	76.56	0	0	0	58.06
SAFE SHUTDOWN EARTHQUAKE	0	0	98.20	0	0	0	83.62
+SRV ALL	10.43	1.92	13.83	5.11	1.14	0	7.46
-SRV ALL	-6.17	-1.16	10.73	-5.75	-2.03	0	-7.46
+SRV ASYMMETRICAL	5.56	0.74	7.41	2.3	1.45	0.07	3.58
-SRV ASYMMETRICAL	-2.64	-0.67	-9.08	-3.69	-1.46	-0.07	-3.48
+SRV ADS	6.28	1.43	10.50	4.07	1.91	0	5.20
-SRV ADS	-4.00	-1.17	-7.71	-4.07	-1.60	0	-5.69
ASYMMETRICAL CHUGGING	11.37	5.12	10.85	10.12	4.03	0	0
+SRV SINGLE	3.48	0.43	4.89	1.53	1.0	0	2.40
-SRV SINGLE	-1.68	0	-2.66	-2.58	0	0	-1.19
SBA & IBA PRESSURE LOADS	58.04	9.87	78.63	66.84	19.76	0	0
DBA PRESSURE LOADS	68.28	11.61	92.51	78.63	23.25	0	0
SYMMETRIC POOL SWELL	47.90	8.14	47.67	60.05	-2.45	0	0
ASYMMETRIC POOL SWELL	62.03	10.52	63.83	54.36	-9.87	0	±7.93
JET IMPINGEMENT	21.02	3.36	21.16	2.39	-1.15	0	0

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TABLE F.5-3

FORCES ON CONTAINMENT SECTION 11 FOR INDIVIDUAL LOADS

LOAD DESCRIPTION	M_ϕ (kip-ft/ft)	M_θ (kip-ft/ft)	N_ϕ (kip/ft)	N_θ (kip/ft)	$Q_{R\phi}$ (kip/ft)	$Q_{R\theta}$ (kip/ft)	Q_T (kip/ft)
PERMANENT LOADS	152.81	23.93	-295.76	-280.19	-7.22	0	0
OPERATING TEMPERATURE	-484.37	-206.28	41.12	-26.00	-20.43	0	0
OPERATING BASIS EARTHQUAKE	0	0	182.08	0	0	0	59.93
SAFE SHUTDOWN EARTHQUAKE	0	0	255.85	0	0	0	87.23
+SRV ALL	12.69	2.13	10.93	5.87	1.92	0	9.20
-SRV ALL	-11.59	-2.23	-6.06	-5.63	-2.08	0	-9.20
+SRV ASYMMETRICAL	0.89	0.77	10.80	1.57	0.20	0.06	7.38
-SRV ASYMMETRICAL	-1.28	-0.78	-10.06	-1.76	-0.24	-0.06	-7.36
+SRV ADS	1.15	1.20	10.26	2.18	0	0	7.85
-SRV ADS	-1.63	-1.25	-9.10	-1.91	0	0	-8.00
ASYMMETRICAL CHUGGING	1.97	7.44	10.26	2.60	0.48	0	0
+SRV SINGLE	0.48	0.74	4.03	0.72	0	0	1.77
-SRV SINGLE	-0.77	-0.62	-3.99	-1.14	0	0	-1.46
SBA & IBA PRESSURE LOADS	3.09	2.65	42.45	71.90	9.86	0	0
DBA PRESSURE LOADS	3.62	3.11	49.89	84.35	11.59	0	0
SYMMETRIC POOL SWELL	6.79	4.03	7.38	43.93	2.66	0	0
ASYMMETRIC POOL SWELL	-3.16	1.49	17.64	48.99	0.32	0	±6.44
JET IMPINGEMENT	-24.51	-4.63	26.13	15.83	-5.45	0	0

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TABLE F.5-4

FORCES ON BASEMAT SECTION 2 FOR INDIVIDUAL LOADS

Load Description	M_ϕ (kip-ft/ft)	M_θ (kip-ft/ft)	N_ϕ (kip/ft)	N_θ (kip/ft)	$Q_{R\phi}$ (kip/ft)	$Q_{R\theta}$ (kip/ft)	Q_T (kip/ft)
PERMANENT LOADS	105.24	3.60	0	0	26.67	0	0
OPERATING TEMPERATURE	-426.00	-460.00	0	0	-10.40	0	0
OPERATING BASIS EARTHQUAKE	-134.00	-116.00	0	0	32.00	32.00	0
SAFE SHUTDOWN EARTHQUAKE	-195.00	-167.00	0	0	45.00	45.00	0
+SRV ALL	125.20	45.40	31.90	8.90	22.00	7.00	9.50
-SRV ALL	-148.10	-56.80	-16.40	-2.30	-27.00	-7.00	-9.50
+SRV ASYMMETRICAL	59.38	27.15	22.43	4.32	11.75	2.13	3.60
-SRV ASYMMETRICAL	-42.93	-22.13	-9.74	-2.73	-27.58	-2.17	-3.72
+SRV ADS	112.50	39.30	22.40	5.90	12.90	5.60	5.90
-SRV ADS	-79.50	-31.80	-9.90	-3.10	-25.00	-4.80	-5.10
ASYMMETRICAL CHUGGING	117.90	30.80	23.90	9.20	22.00	0	0
+SRV SINGLE	72.80	24.70	14.70	1.80	5.50	1.00	1.10
-SRV SINGLE	-29.60	-11.50	-4.50	-1.40	-16.90	-2.00	-2.90
SBA AND IBA PRESSURE LOADS	-222.00	-257.00	0	0	-11.65	0	0
DBA PRESSURE LOADS	-261.12	-301.90	0	0	-13.70	0	0
SYMMETRIC POOL SWELL	-66.75	-26.75	26.86	14.77	-3.25	0	0
ASYMMETRIC POOL SWELL	-212.40	-92.82	122.60 -69.19	44.78	7.60 -1.77	0	±67.09
JET IMPINGEMENT	-192.46	-90.84	51.5	45.8	2.50	0	0

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TABLE F.5-5

FORCES ON BASEMAT SECTION 3 FOR INDIVIDUAL LOADS

Load Description	M_ϕ (kip-ft/ft)	M_θ (kip-ft/ft)	N_ϕ (kip/ft)	N_θ (kip/ft)	$Q_{R\phi}$ (kip/ft)	$Q_{R\theta}$ (kip/ft)	Q_T (kip/ft)
PERMANENT LOADS	-575.84	-150.65	0	0	-75.92	0	0
OPERATING TEMPERATURE	-318.80	-385.50	0	0	5.00	0	0
OPERATING BASIS EARTHQUAKE	-327.00	-113.00	0	0	-29.00	-29.00	0
SAFE SHUTDOWN EARTHQUAKE	-470.00	-164.00	0	0	-42.00	-42.00	0
+SRV ALL	119.10	14.10	18.30	13.90	14.60	1.60	1.80
-SRV AIL	-73.70	-15.00	-6.90	-7.20	-10.10	-1.60	-1.80
+SRV ASYMMETRICAL	45.04	5.24	15.25	6.52	16.70	0.72	2.19
-SRV ASYMMETRICAL	-19.66	-6.06	-4.20	-2.87	-5.21	-0.64	-2.03
+SRV ADS	29.30	7.00	13.30	10.30	10.70	1.40	3.50
-SRV ADS	-33.40	-8.50	-6.50	-4.20	-4.40	-1.20	-3.80
ASYMMETRICAL CHUGGING	89.30	10.90	20.70	7.00	0	0	0
+SRV SINGLE	55.00	6.90	8.30	4.40	7.80	0	0
-SRV SINGLE	-17.80	-2.70	-2.80	-2.60	-2.60	-1.00	-1.00
SBA AND IBA PRESSURE LOADS	-438.00	-15.16	0	0	-60.00	0	0
DBA PRESSURE LOADS	-515.44	-17.82	0	0	-70.58	0	0
SYMMETRIC POOL SWELL	222.30	18.41	22.84	20.82	25.05	0	0
ASYMMETRIC POOL SWELL	297.50	13.15 -6.46	86.32 -24.84	44.36	34.59	0	±26.89
JET IMPINGEMENT	236.9	-11.7	50.9	48.3	29.5	0	0

TABLE F.5-6

DESIGN LOAD COMBINATIONS

EQN	LOAD COND	D	L	F	P_O	T_O	R_O	E_O	E_{SS}	P_B	P_A	T_A	R_A	R_R	SRV	ADS	ALL	ASSYMMETRICAL	SIMPLE
1	Normal w/o Temp	1.4	1.7	1.0	1.0	-	-	-	-	-	-	-	-	-	1.5	0	X	X	0
2	Normal w/Temp	1.0	1.3	1.0	1.0	1.0	1.0	-	-	-	-	-	-	-	1.3	0	X	X	0
3	Normal Sev. Env.	1.0	1.0	1.0	1.0	1.0	1.0	1.25	-	-	-	-	-	-	1.25	0	X	X	0
4	Abnormal	1.0	1.0	1.0	-	-	-	-	-	1.25	-	1.0	1.0	-	1.25	X	0	X	0
4a		1.0	1.0	1.0	-	-	-	-	-	-	1.25	1.0	1.0	-	1.0	0	0	0	X
5	Abnormal Sev. Env.	1.0	1.0	1.0	-	-	-	1.1	-	1.1	-	1.0	1.0	-	1.1	X	0	X	0
5a		1.0	1.0	1.0	-	-	-	1.1	-	-	1.1	1.0	1.0	-	1.0	0	0	0	X
6	Normal Ext. Env.	1.0	1.0	1.0	1.0	1.0	1.0	-	1.0	-	-	-	-	-	1.0	0	X	X	0
7	Abnormal Ext. Env.	1.0	1.0	1.0	-	-	-	-	1.0	1.0	-	1.0	1.0	1.0	1.0	X	0	X	0
7a		1.0	1.0	1.0	-	-	-	-	1.0	-	1.0	1.0	1.0	1.0	1.0	0	0	0	X

LOAD DESCRIPTION

D = Dead Loads

L = Live Loads

F = Prestressing Loads

T_O = Operating Temperature Loads

R_O = Operating Pipe Reactions

P_O = Operating Pressure Loads

SRV = Safety/Relief Valve Loads

E_O = Operating Basis Earthquake

SB_O = Small Break Accident

E_{SS} = Safe Shutdown Earthquake

P_B = SBA and IBA Pressure Load

T_A = Pipe Break Temperature Load

R_A = Pipe Break Temperature Reactions Load

P_A = DBA Pressure Loads (including all pool hydrodynamic loadings)

R_R = Reactions [illegible]orces Due to Pipe Break

IBA = Intermediate Break Accident

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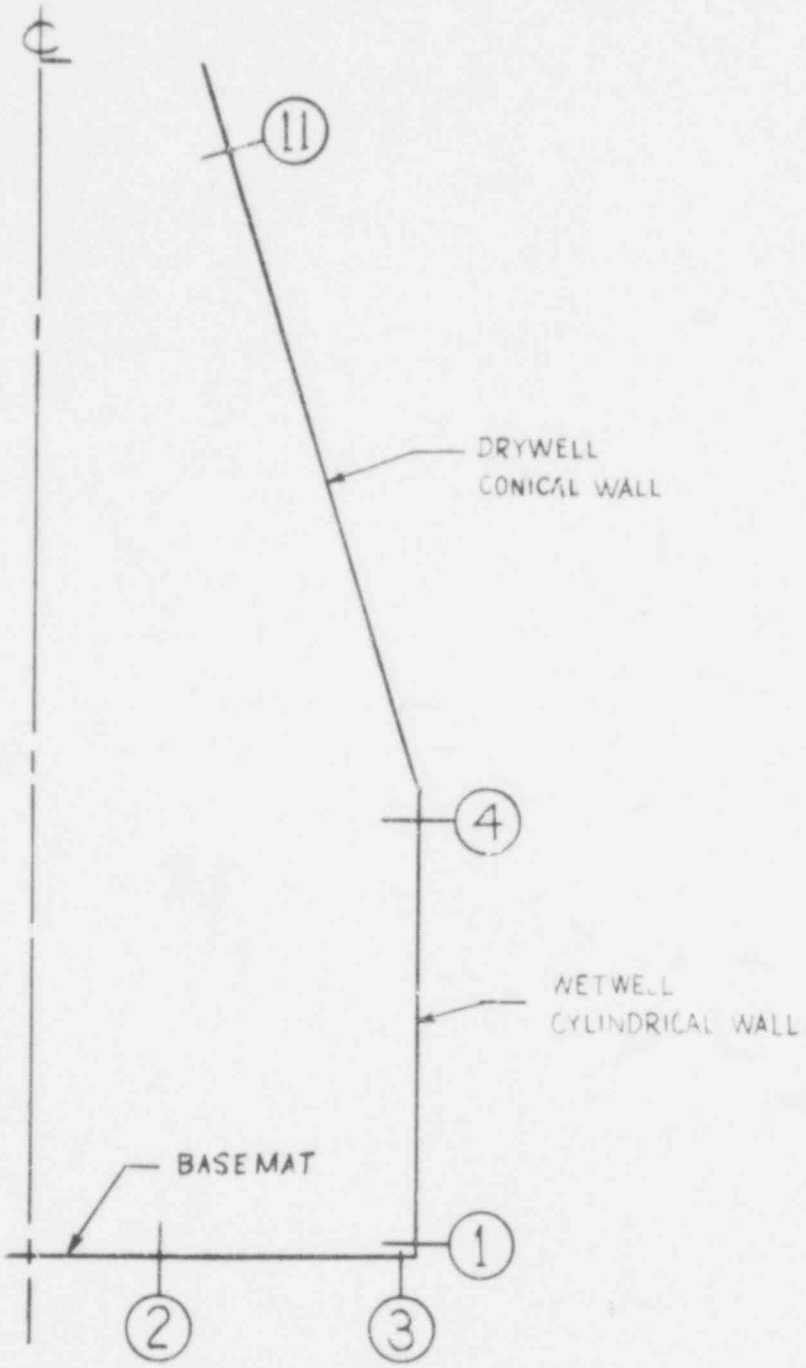

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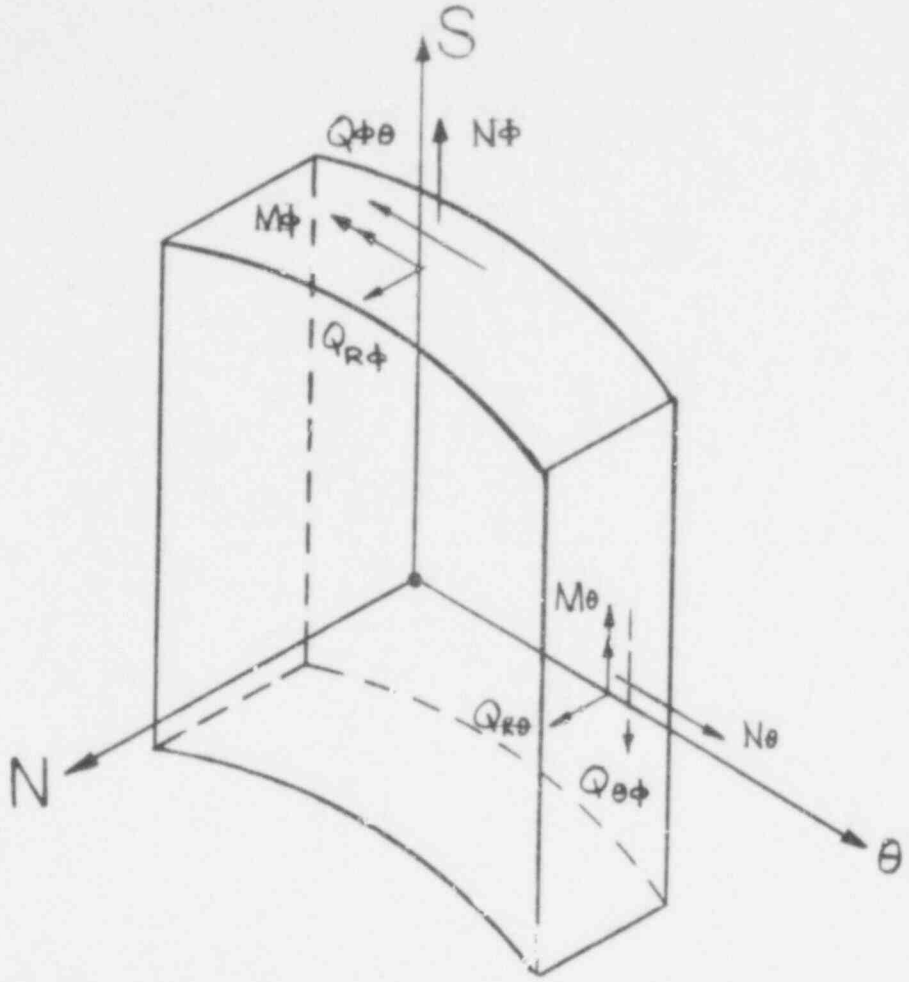
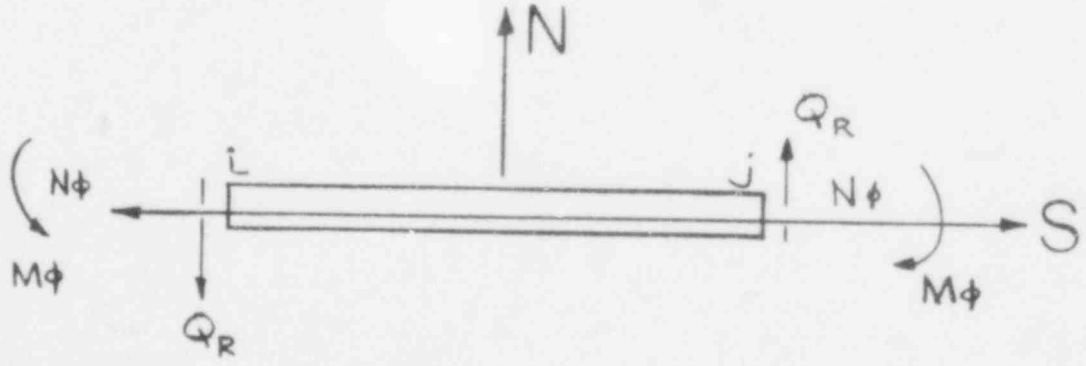
FIGURE F.5-1

KEY CONTAINMENT DESIGN SECTIONS



CONTAINMENT AND PEDESTAL WALL



BASEMAT

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FIGURE F.5-2

NOTATIONS AND SIGN CONVENTIONS FOR FORCES AND MOMENTS

NOTATION

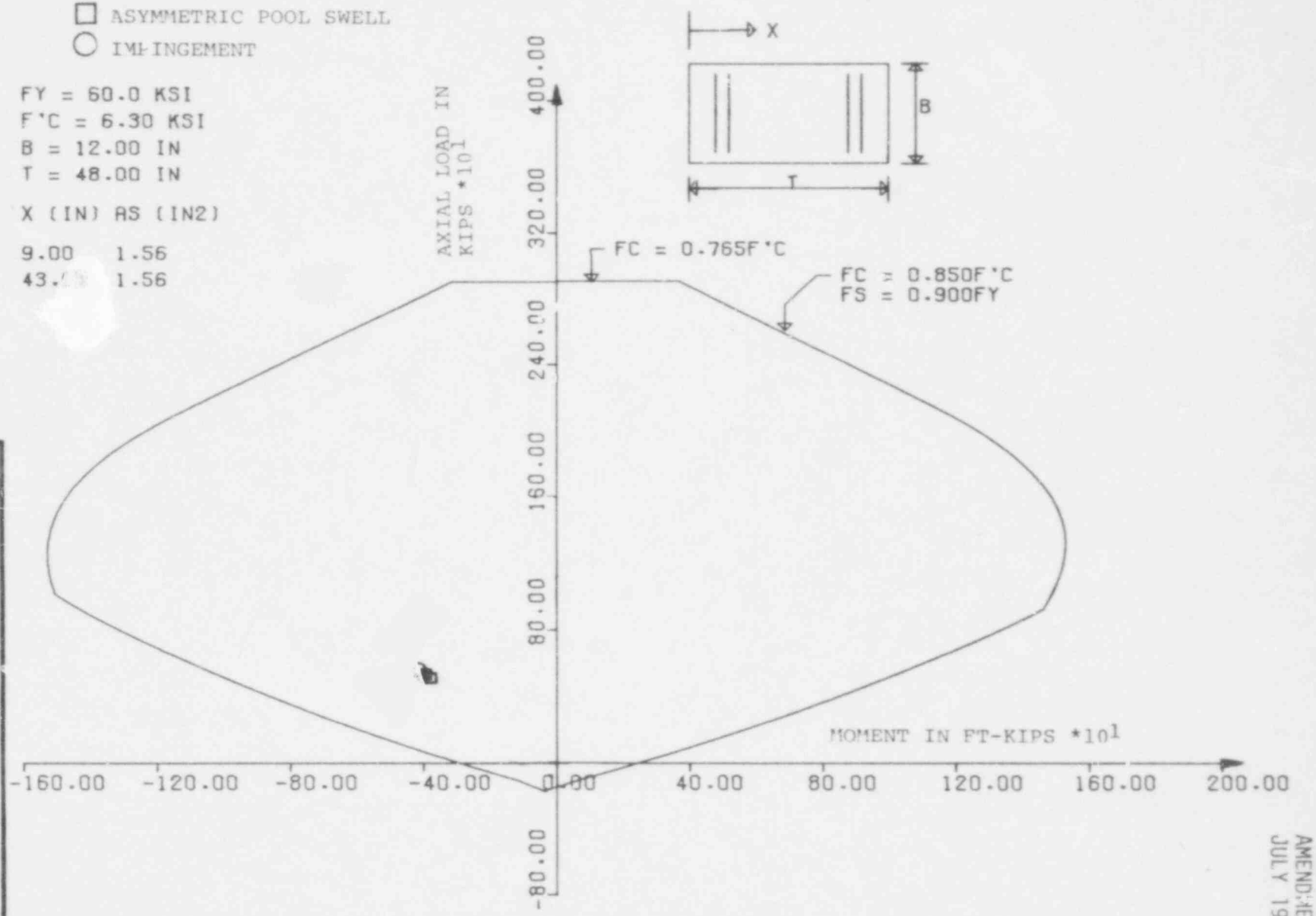
■ SYMMETRIC POOL SWELL

□ ASYMMETRIC POOL SWELL

○ IMPINGEMENT

FY = 60.0 KSI
F'C = 6.30 KSI
B = 12.00 IN
T = 48.00 IN

X (IN)	AS (IN2)
9.00	1.56
43.[illegible]	1.56



488 224

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FIGURE F.5-3

INTERACTION DIAGRAM FOR CONTAINMENT SECTION 1 - MERIDIONAL FORCES

AMENDMENT 12
JULY 1979

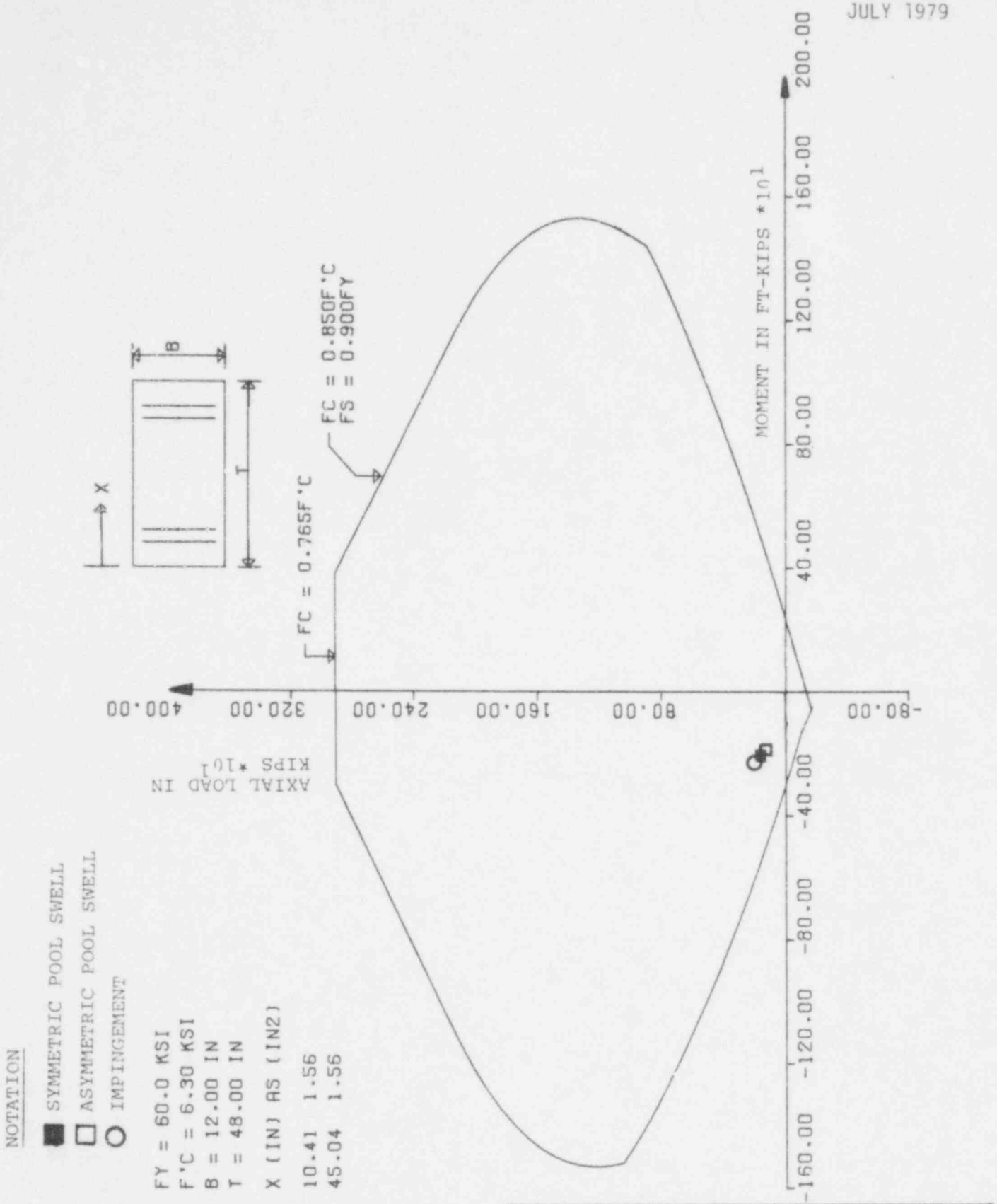

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FIGURE F.5-4

INTERACTION DIAGRAM FOR CONTAINMENT
SECTION 1 - HOOP FORCES

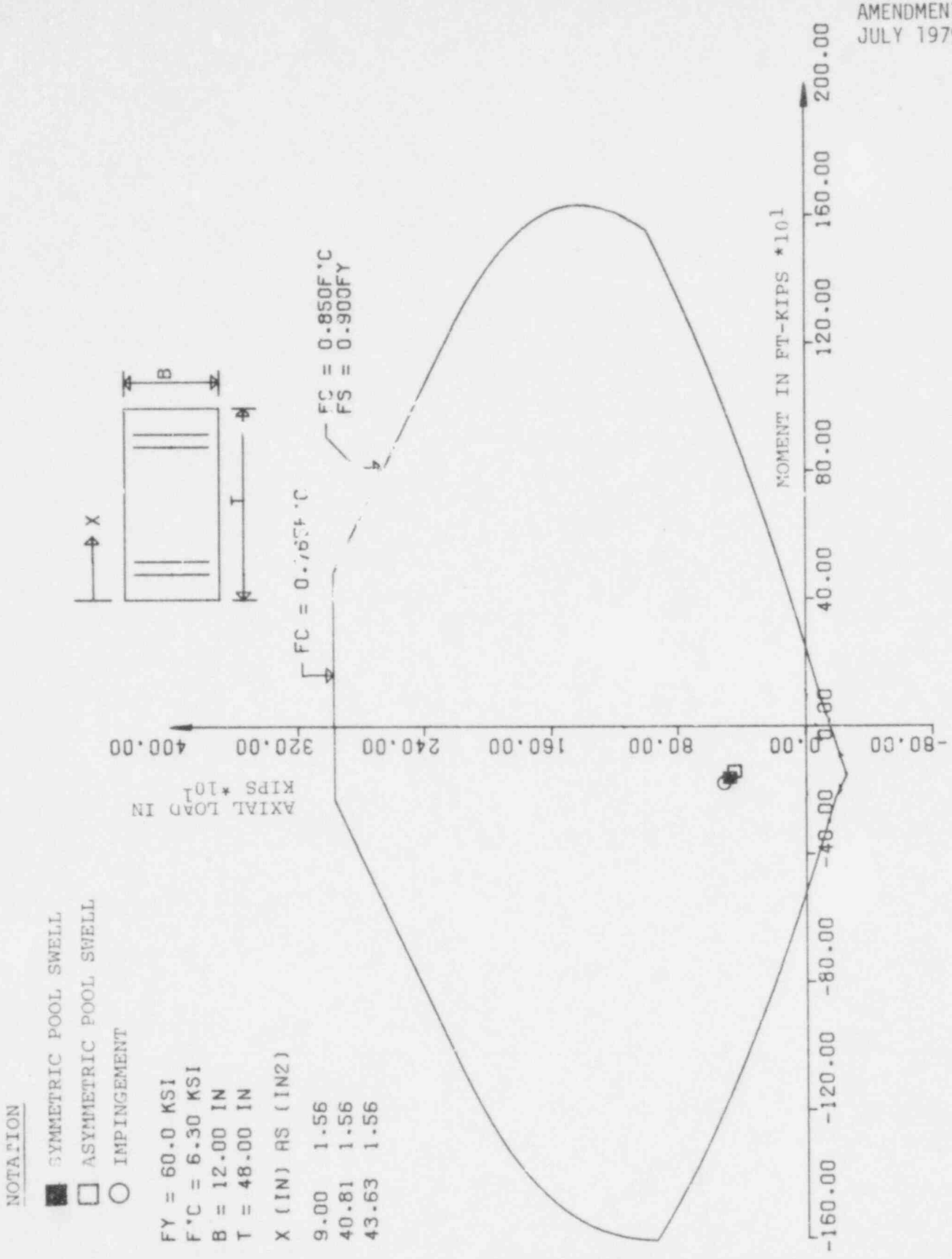

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FIGURE F.5-5 INTERACTION DIAGRAM FOR CONTAINMENT SECTION 4 - MERIDIONAL FORCES

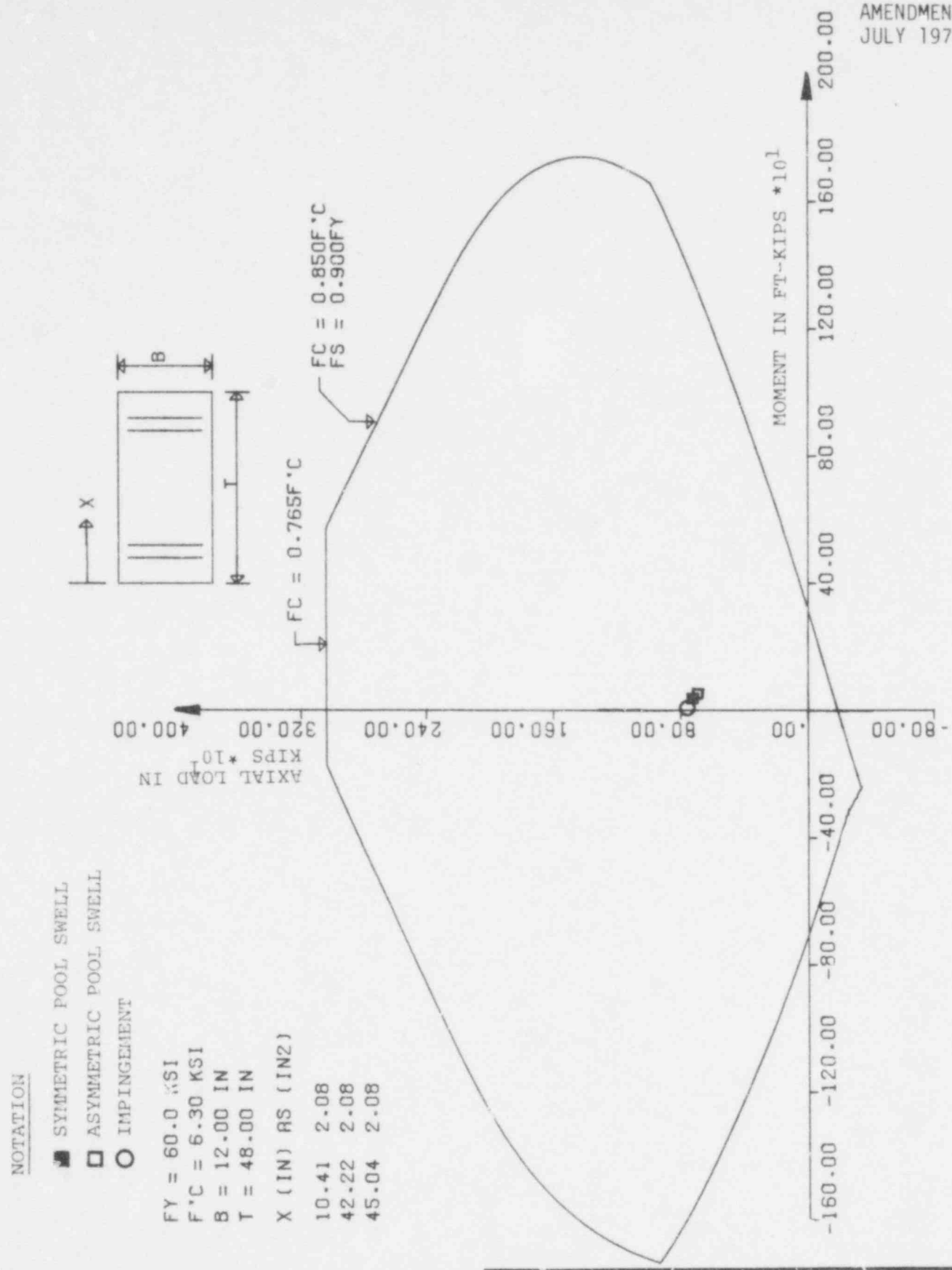

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FIGURE F.5-6

INTERACTION DIAGRAM FOR CONTAINMENT
SECTION 4 - HOOP FORCES

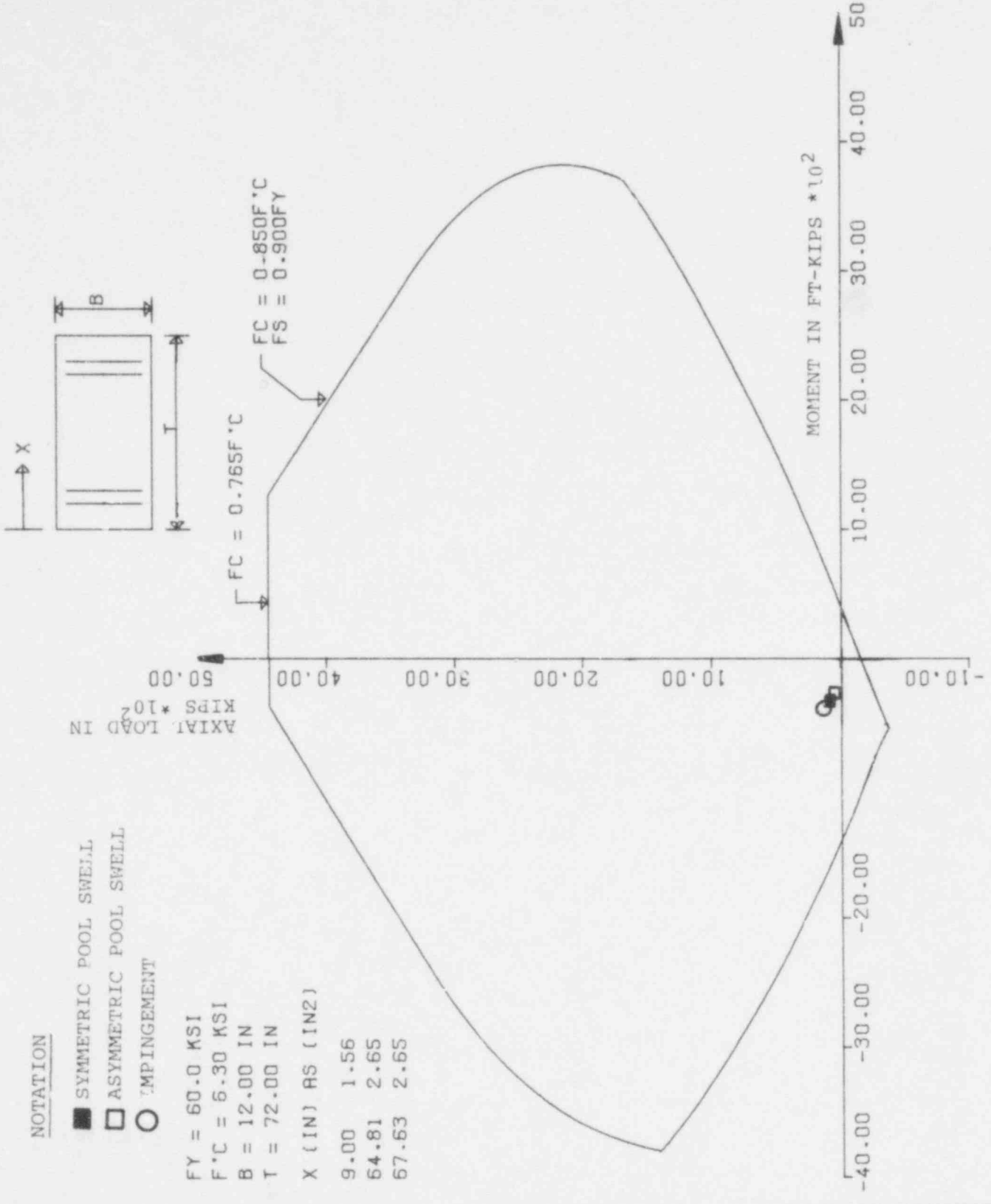

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FIGURE F.5-7

INTERACTION DIAGRAM FOR CONTAINMENT
SECTION 11 - MERIDIONAL FORCES

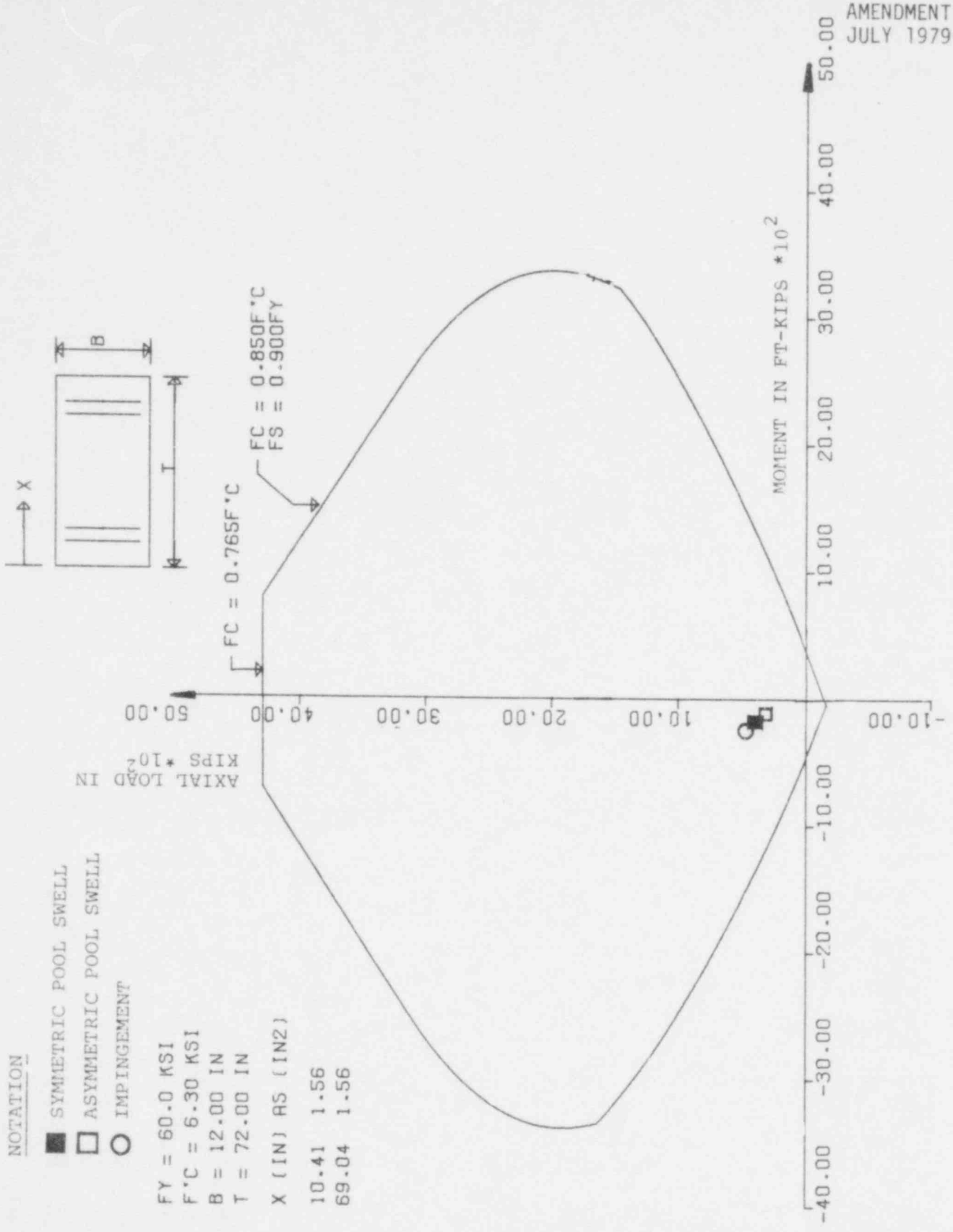

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FIGURE F.5-8 INTERACTION DIAGRAM FOR CONTAINMENT SECTION 11 - HOOP FORCES

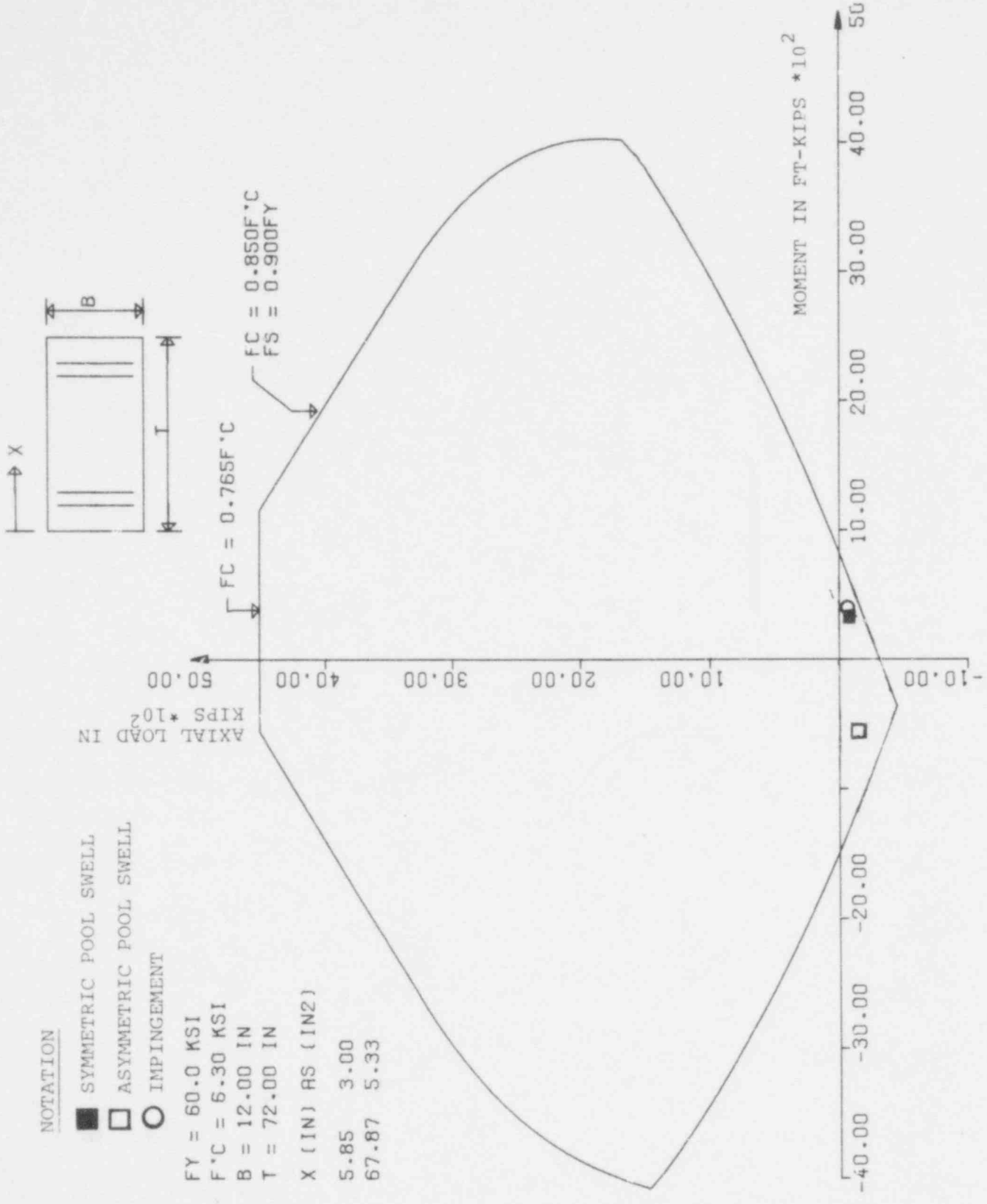

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FIGURE F.5-9
INTERACTION DIAGRAM FOR BASE MAT SECTION 2 - MERIDIONAL FORCES

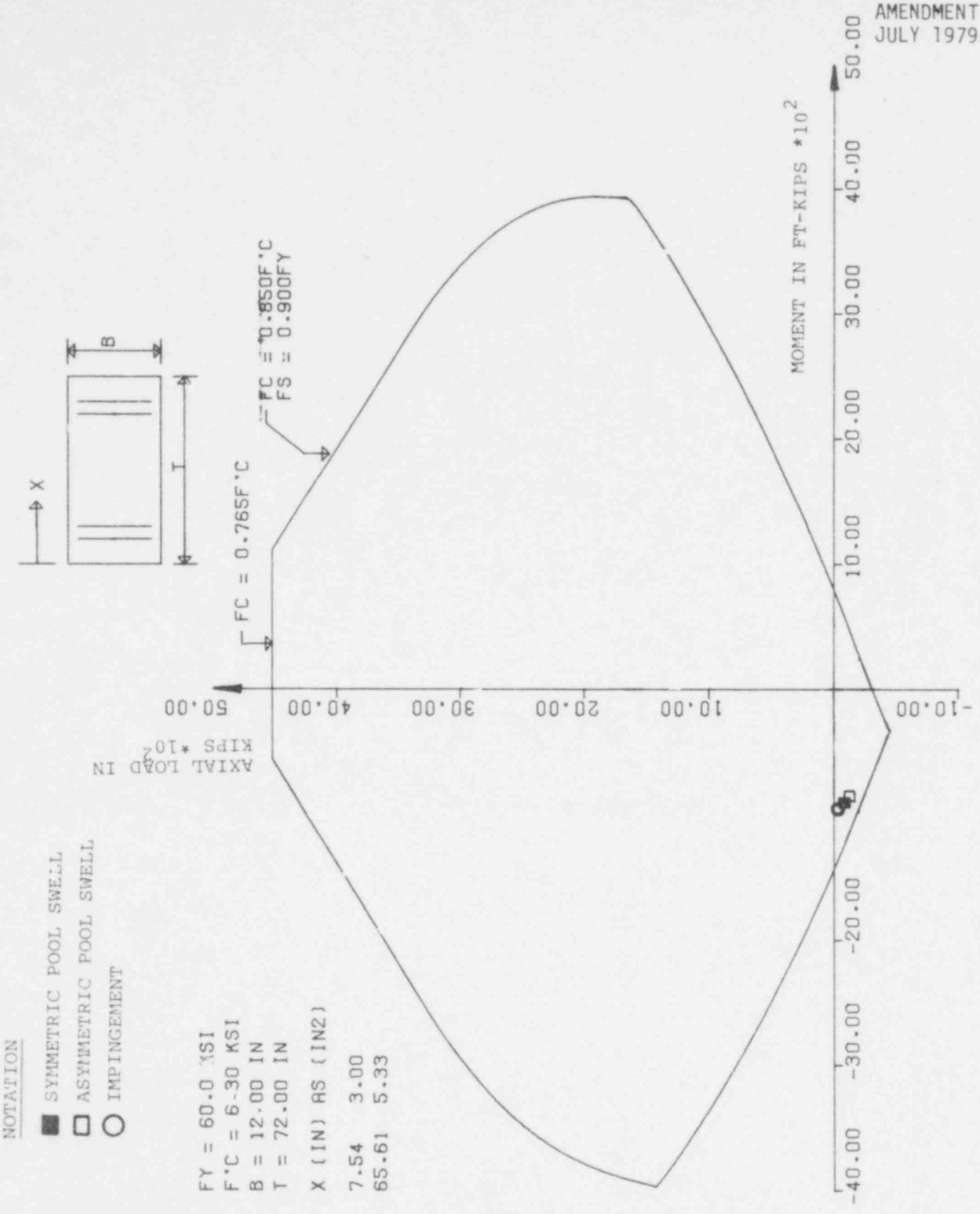

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FIGURE F.5-10

INTERACTION DIAGRAM FOR BASE MAT
SECTION 2 - HOOP FORCES

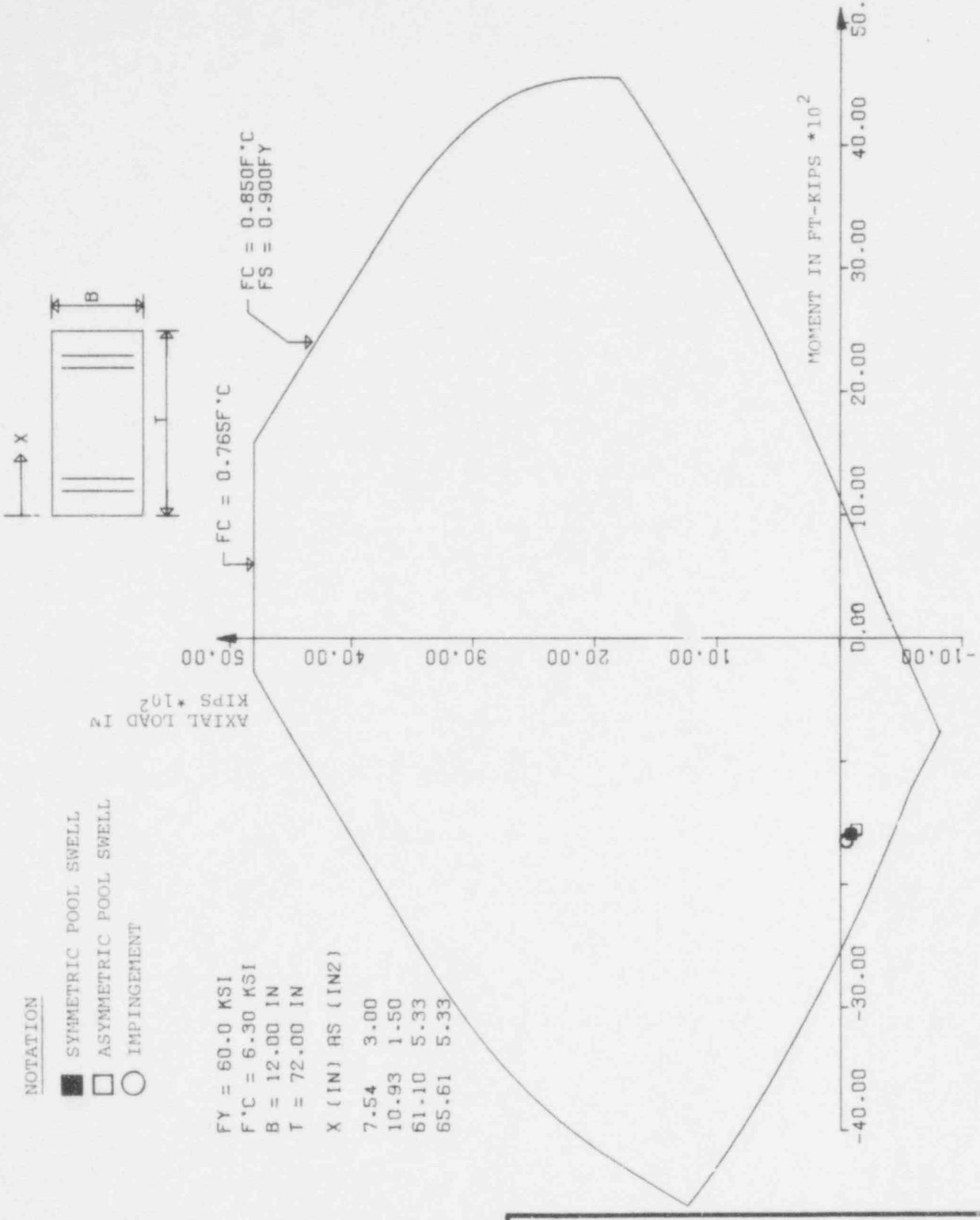

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FIGURE F.5-11

INTERACTION DIAGRAM FOR BASE MAT
SECTION 3 - MERIDIONAL FORCES

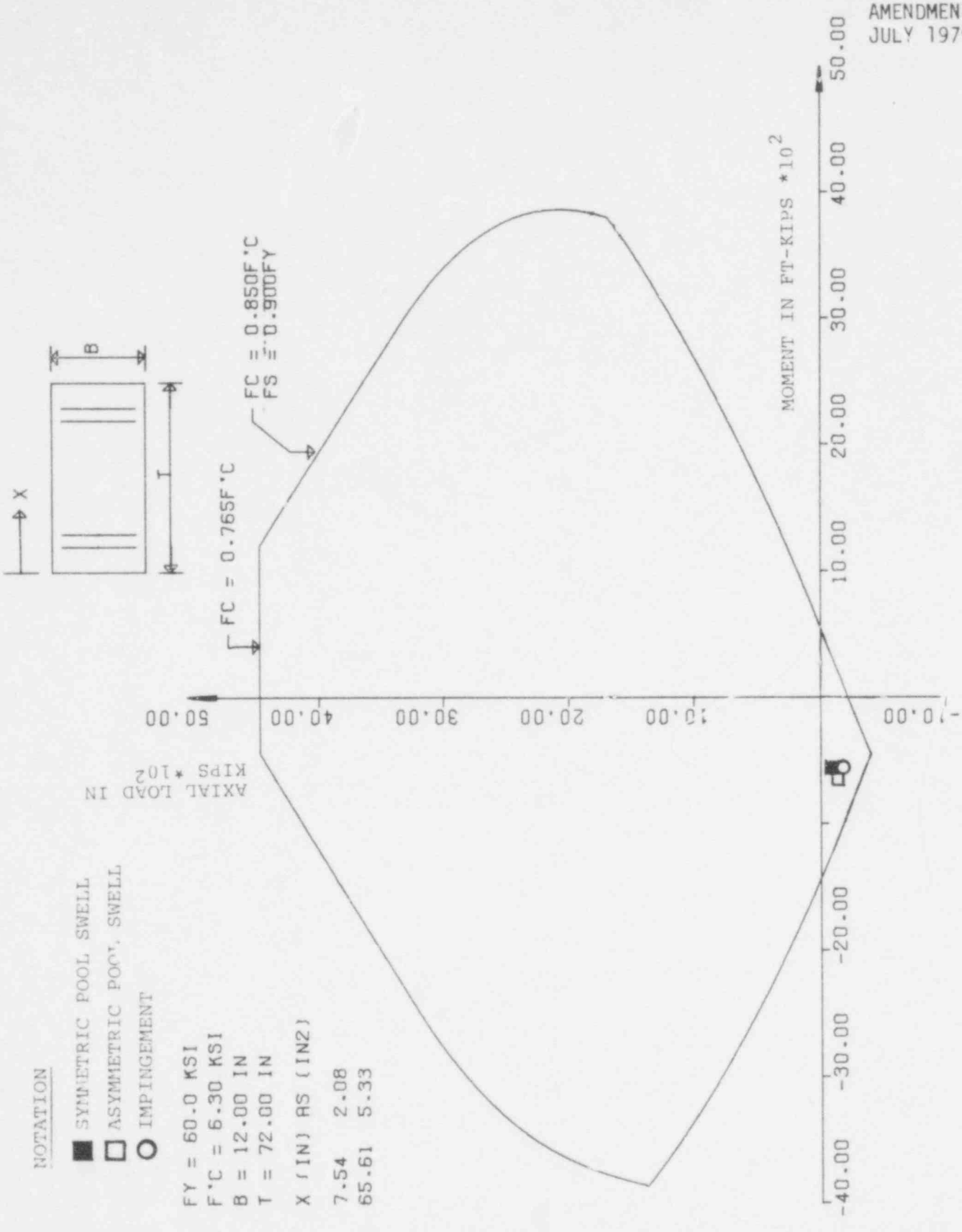

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FIGURE F.5-12 INTERACTION DIAGRAM FOR BASE MAT SECTION 3 - HOOP FORCES