

WM. H. ZIMMER POWER STATIONINSTRUCTIONS 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

Page v  
After page vii  
Page xii  
Figure 3.2-18  
Figure 3.3-8  
After page E.2-8

INSERT

Pages v and v (Cont'd)  
Page vii (Cont'd)  
Pages xii, xiii, and xiv  
Figure 3.2-18  
Figure 3.3-8  
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.

488 193

7907310431 A

TABLE OF CONTENTS (t'd)

	<u>PAGE</u>	
A.4 <u>COMPUTER PROGRAMS</u>	A.4-1	
A.4.1 DYNAX	A.4-1	
A.4.2 FAST	A.4-1	
A.4.3 KALSHEL	A.4-2	
A.4.4 TEMCO	A.4-2	
A.4.5 PIPSYS	A.4-3	
A.4.6 RSG	A.4-4	
A.4.7 SHAKE	A.4-4	
A.4.8 LUSH	A.4-5	
B.0 <u>RESPONSES TO NRC QUESTIONS</u>	B.0-1	1
B.1 <u>NRC LETTER DATED JULY 12, 1976</u>	B.1-1	
B.2 <u>KEYWORD INDEX TO NRC QUESTIONS</u>	B.2-1	
B.3 <u>NRC QUESTIONS WITH RESPONSES</u>	B.3-1	
Series 020 Questions	B020-1	2
Series 041 Questions	B041-1	
Series 130 Questions	B130-1	
C.0 <u>SOIL-STRUCTURE INTERACTION MODEL</u>	C.0-1	
C.1 <u>INTRODUCTION</u>	C.1-1	
C.2 <u>PROCEDURE</u>	C.2-1	1
C.3 <u>DESCRIPTION OF ANALYTICAL MODEL</u>	C.3-1	
C.4 <u>RESULTS</u>	C.4-1	
D.0 <u>CONTAINMENT STRUCTURE ANALYSIS FOR CHUGGING LOADS</u>	D.0-1	8
E.0 <u>RESPONSE TO NRC'S MARCH 15, 1973, REQUEST FOR ADDITIONAL INFORMATION</u>	E.0-1	11
F.0 <u>CONTAINMENT STRUCTURE ASSESSMENT FOR LOCA JET IMPINGEMENT AND POOL SWELL LOADS</u>	F.0-1	
F.1.0 <u>INTRODUCTION</u>	F.1-1	
F.2.0 <u>LOADS</u>	F.2-1	12
F.2.1 LOCA Jet Load	F.2-1	
F.2.2 Pool Swell Load	F.2-1	

TABLE OF CONTENTS (Cont'd)

	<u>PAGE</u>	
F.2.2.1 Symmetric Pool Swell Load	F.2-1	
F.2.2.2 Asymmetric Pool Swell Load	F.2-1	
F.3.0 <u>STRUCTURAL ANALYSIS MODEL</u>	F.3-1	12
F.4.0 <u>METHOD OF ANALYSIS AND RESULTS</u>	F.4-1	
F.5.0 <u>DESIGN ASSESSMENT</u>	F.5-1	

LIST OF TABLES (Cont'd)

<u>NUMBER</u>	<u>TITLE</u>	<u>PAGE</u>
D.1-1	Design Load Combinations	D.1-2
D.5-1	Forces on Containment Section 1 for Individual Loads	D.5-3
D.5-2	Forces on Containment Section 4 for Individual Loads	D.5-4
D.5-3	Forces on Containment Section 11 for Individual Loads	D.5-5
D.5-4	Forces on Base Mat Section 2 for Individual Loads	D.5-6
D.5-5	Forces on Base Mat Section 3 for Individual Loads	D.5-7
D.5-6	Total Design Force - Containment Section 1	D.5-8
D.5-7	Total Design Force - Containment Section 4	D.5-9
D.5-8	Total Design Force - Containment Section 11	D.5-10
D.5-9	Total Design Force - Base Mat Section 2	D.5-11
D.5-10	Total Design Force - Base Mat Section 3	D.5-12
F.5-1	Forces on Containment Section 1 for Individual Loads	F.5-2
F.5-2	Forces on Containment Section 4 for Individual Loads	F.5-3
F.5-3	Forces on Containment Section 11 for Individual Loads	F.5-4
F.5-4	Forces on Base Mat Section 2 for Individual Loads	F.5-5
F.5-5	Forces on Base Mat Section 3 for Individual Loads	F.5-6
F.5-6	Design Load - Combinations	F.5-7

8

12

488 196

LIST OF FIGURES (Cont'd)

<u>NUMBER</u>	<u>TITLE</u>	
B020.58-2	Comparison of Computer Code with EPRI Test Data, Water Velocity vs. Time	
B020.58-3	Comparison of Computer Code with EPRI Test Data, Water Level vs. Time	6
B020.58-4	Pool Surface Position vs. Time	
B020.58-5	Pool Surface Velocity vs. Time	
B020.58-6	Pool Surface Velocity vs. Position	
B020.58-7	Wetwell Air Space and Air Bubble Pressure vs. Time	
B020.62-1	Temperature Instrumentation in the Suppression Pool	
Q020.71-1	Pool Surface Elevation - Run 36	
Q020.71-2	Pool Surface Elevation - Run 37	
Q020.71-3	Pool Surface Velocity - Run 36	12
Q020.71-4	Pool Surface Velocity - Run 37	
Q020.71-5	Bubble Pressure - Run 36	
Q020.71-6	Bubble Pressure - Run 37	
C.3-1	Representative Profile	
C.3-2	Finite Element Model	
C.4-1	Free Field Response Spectra	
C.4-2	Design Response Spectra	1
C.4-3	OBE Horizontal Response Spectra, N-S Component	
C.4-4	OBE Horizontal Response Spectra, E-W Component	
C.4-5	DBE Horizontal Response Spectra, N-S Component	
C.4-6	DBE Horizontal Response Spectra, E-W Component	
C.4-7	OBE Vertical Response Spectra	
C.4-8	DBE Vertical Response Spectra	
D-1	Chugging Load - Magnitude and Spatial Distribution	
D-2	Chugging Load - Time History	
D-2a	Chugging Load - As Used For The Analysis	
D-3	Structural Model Including Soil	
D-4	Frequency Response for Meridional Membrane Force at Containment Wall Elevation 477 Feet 8 Inches	
D-5	Frequency Response for Circumferential Membrane Force at Containment Wall Elevation 477 Feet 8 Inches	
D-6	Frequency Response for Meridional Moment at Containment Wall Elevation 477 Feet 8 Inches	
D-7	Frequency Response for Circumferential Moment at Containment Wall Elevation 477 Feet 8 Inches	
D-8	Frequency Response for Meridional Shear at Containment Wall Elevation 477 Feet 8 Inches	12
D-9	Frequency Response for Meridional Membrane Force at Containment Wall Elevation 514 Feet 0 Inch	
D-10	Frequency Response for Circumferential Membrane Force at Containment Wall Elevation 514 Feet 0 Inch	
D-11	Frequency Response for Meridional Moment at Containment Wall Elevation 514 Feet 0 Inch	
D-12	Frequency Response for Circumferential Moment at Containment Wall Elevation 514 Feet 0 Inch	

LIST OF FIGURES (Cont'd)

<u>NUMBER</u>	<u>TITLE</u>
D-13	Frequency Response for Meridional Shear at Containment Wall Elevation 514 Feet 0 Inch
D-14	Frequency Response for Meridional Membrane Force at Base Mat R=40 Feet 5-1/2 Inches
D-15	Frequency Response for Circumferential Membrane Force at Base Mat R=40 Feet 5-1/2 Inches
D-16	Frequency Response for Meridional Moment at Base Mat R=40 Feet 5-1/2 Inches
D-17	Frequency Response for Circumferential Moment at Base Mat R=40 Feet 5-1/2 Inches
D-18	Frequency Response for Meridional Shear at Base Mat R=40 Feet 5-1/2 Inches
D-19	Key Containment Design Sections
D-20	Interaction Diagram for Containment Section 1 - Meridional Forces
D-21	Interaction Diagram for Containment Section 1 - Hoop Forces
D-22	Interaction Diagram for Containment Section 4 - Meridional Forces
D-23	Interaction Diagram for Containment Section 4 - Hoop Forces
D-24	Interaction Diagram for Containment Section 11 - Meridional Forces
D-25	Interaction Diagram for Containment Section 11 - Hoop Forces
D-26	Interaction Diagram for Base Mat Section 2 - Meridional Forces
D-27	Interaction Diagram for Base Mat Section 2 - Hoop Forces
D-28	Interaction Diagram for Base Mat Section 3 - Meridional Forces
D-29	Interaction Diagram for Base Mat Section 3 - Hoop Forces
F.2-1	LOCA Jet Impingement Pressure Distribution
F.2-2	Drywell/Wetwell Pressure History for Main Steamline Break
F.2-3	Pool Swell Symmetric Load
F.2-4	Pool Swell Asymmetric Load
F.3-1	Structural Model Including Soil
F.5-1	Key Containment Design Sections
F.5-2	Notations and Sign Conventions for Forces and Moments
F.5-3	Interaction Diagram for Containment Section 1 - Meridional Forces
F.5-4	Interaction Diagram for Containment Section 1 - Hoop Forces
F.5-5	Interaction Diagram for Containment Section 4 - Meridional Forces

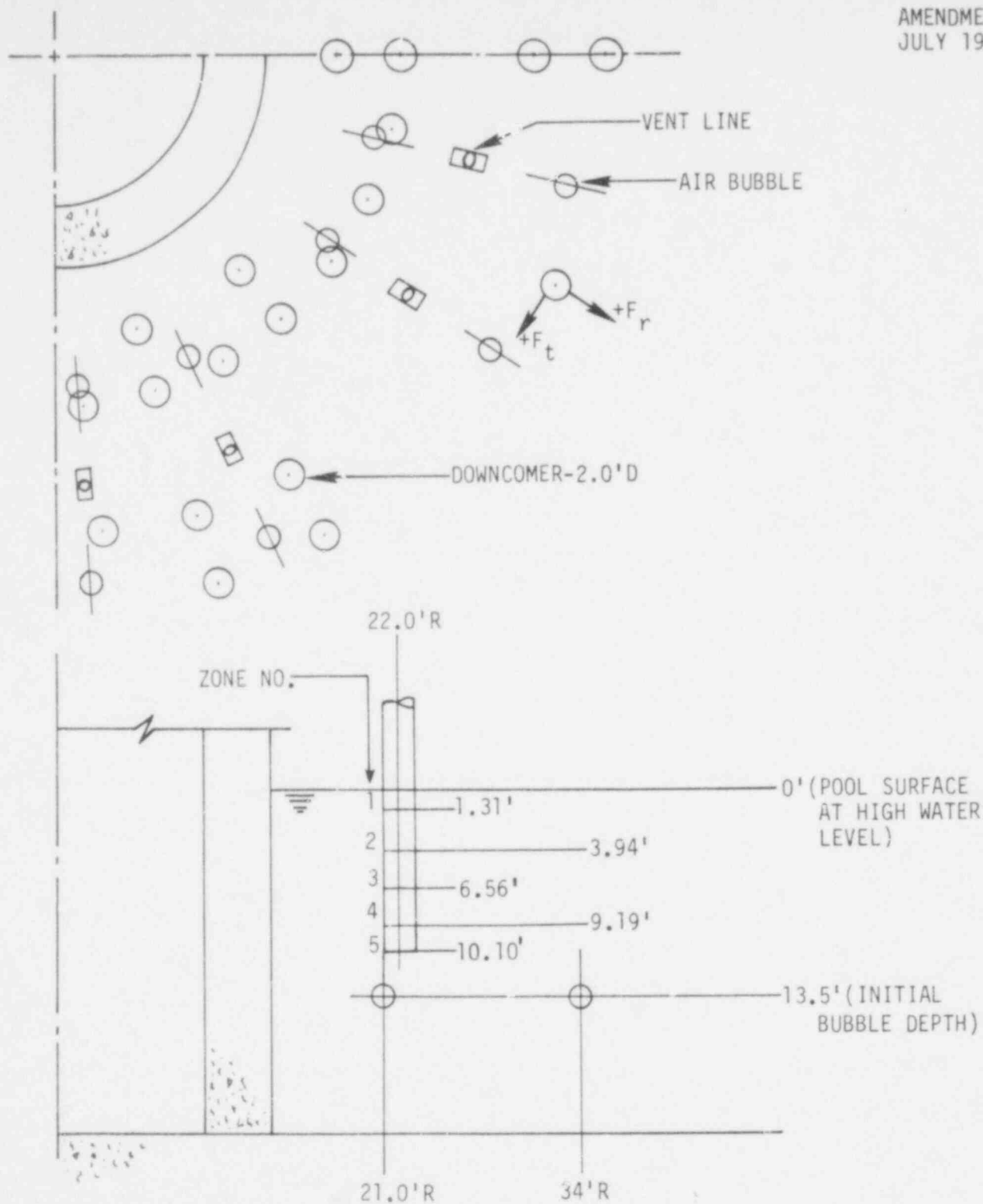
12

8

LIST OF FIGURES (Cont'd)

<u>NUMBER</u>	<u>TITLE</u>
F.5-6	Interaction Diagram for Containment Section 4 - Hoop Forces
F.5-7	Interaction Diagram for Containment Section 11 - Meridional Forces
F.5-8	Interaction Diagram for Containment Section 11 - Hoop Forces
F.5-9	Interaction Diagram for Base Mat Section 2 - Meridional Forces
F.5-10	Interaction Diagram for Base Mat Section 2 - Hoop Forces
F.5-11	Interaction Diagram for Base Mat Section 3 - Meridional Forces
F.5-12	Interaction Diagram for Base Mat Section 3 - Hoop Forces

12



NOTE:

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

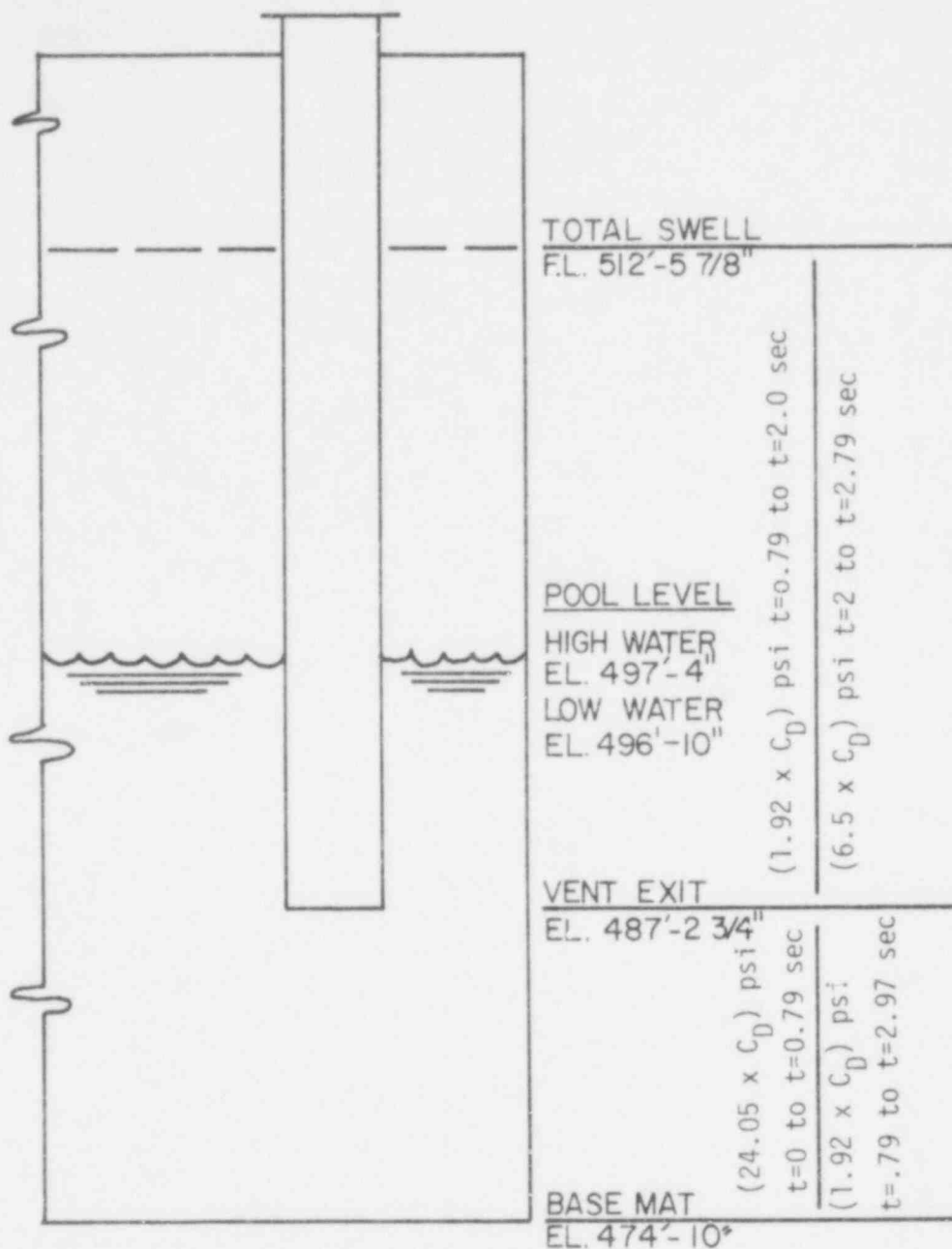
DOWNCOMER ELEVATION

488 200

WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1  
MARK II DESIGN ASSESSMENT REPORT

FIGURE 3.2-18  
DOWNCOMER VENT GEOMETRY





NOTE:

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

488 201

WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

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

WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

12

488 202

TABLE OF CONTENTS

	<u>PAGE</u>	
F.1.0 <u>INTRODUCTION</u>	F.1-1	
F.2.0 <u>LOADS</u>	F.2-1	
F.3.0 <u>STRUCTURAL ANALYSIS MODEL</u>	F.3-1	
F.4.0 <u>METHOD OF ANALYSIS AND RESULTS</u>	F.4-1	
F.5.0 <u>DESIGN ASSESSMENT</u>	F.5-1	

12

488 203

LIST OF TABLES

<u>NUMBER</u>	<u>TITLE</u>	<u>PAGE</u>
F.5-1	Forces on Containment Section 1 for Individual Loads	F.5-2
F.5-2	Forces on Containment Section 4 for Individual Loads	F.5-3
F.5-3	Forces on Containment Section 11 for Individual Loads	F.5-4
F.5-4	Forces on Basemat Section 2 for Individual Loads	F.5-5
F.5-5	Forces on Basemat Section 3 for Individual Loads	F.5-6
F.5-6	Design Load Combinations	F.5-7

12

488 204

LIST OF FIGURES

<u>NUMBER</u>	<u>TITLE</u>
F.2-1	LOCA Jet Impingement Pressure Distribution
F.2-2	Drywell/Wetwell Pressure History for Main Steamline Break
F.2-3	Pool Swell Symmetric Load
F.2-4	Pool Swell Asymmetric Load
F.3-1	Structural Model Including Soil
F.5-1	Key Containment Design Sections
F.5-2	Notations and Sign Conventions for Force and Moments
F.5-3	Interaction Diagram for Containment Section 1 - Meridional Forces
F.5-4	Interaction Diagram for Containment Section 1 - Hoop Forces
F.5-5	Interaction Diagram for Containment Section 4 - Meridional Forces
F.5-6	Interaction Diagram for Containment Section 4 - Hoop Forces
F.5-7	Interaction Diagram for Containment Section 11 - Meridional Forces
F.5-8	Interaction Diagram for Containment Section 11 - Hoop Forces
F.5-9	Interaction Diagram for Base Mat Section 2 - Meridional Forces
F.5-10	Interaction Diagram for Base Mat Section 2 - Hoop Forces
F.5-11	Interaction Diagram for Base Mat Section 3 - Meridional Forces
F.5-12	Interaction Diagram for Base Mat Section 3 - Hoop Forces

2

488 205

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.

488 206

## 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.

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.

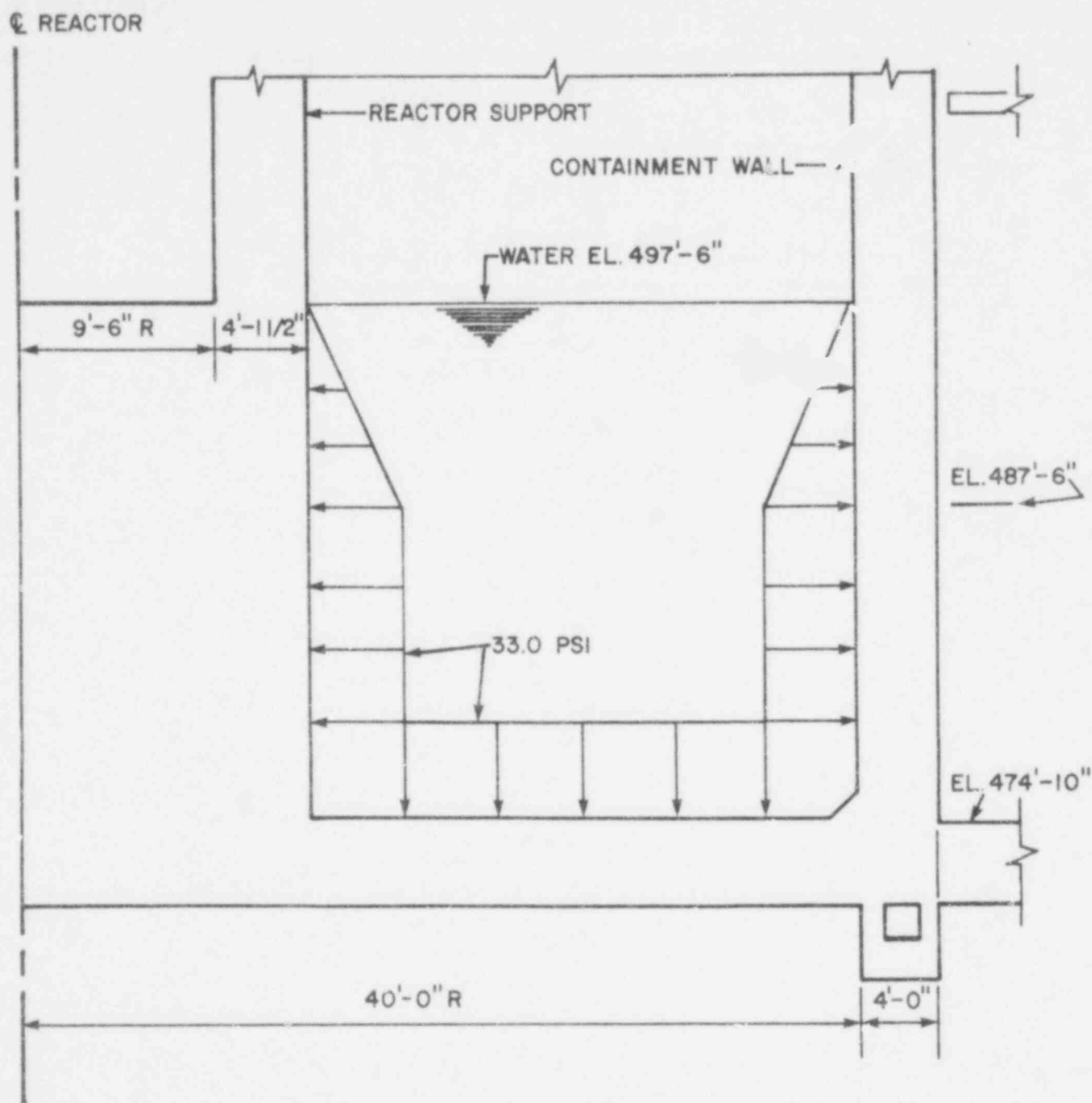
#### F.2.2.2 Asymmetric Pool Swell Load

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.

12



488 208

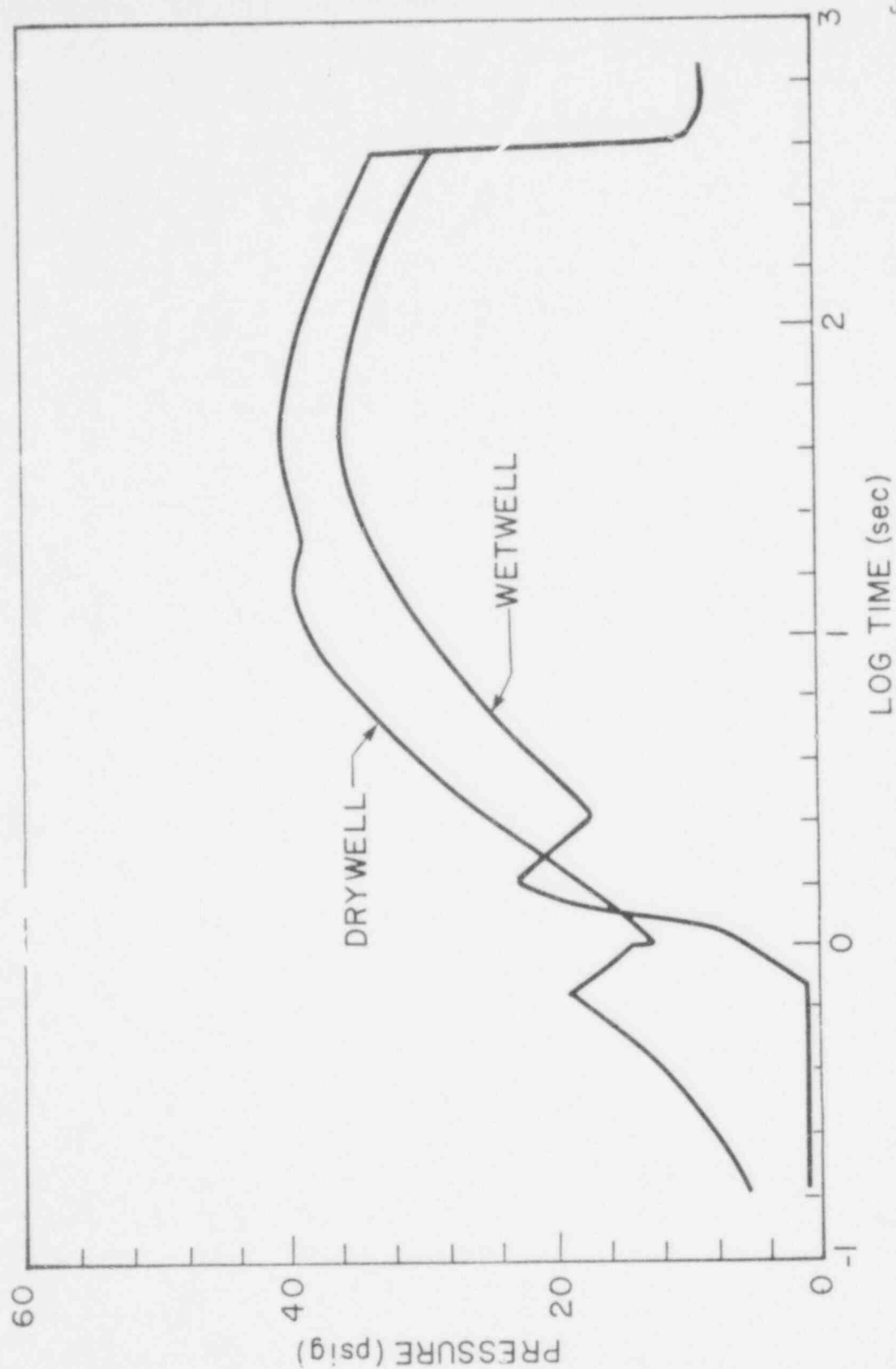
WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

FIGURE F.2-1

LOCA JET IMPINGEMENT PRESSURE  
DISTRIBUTION





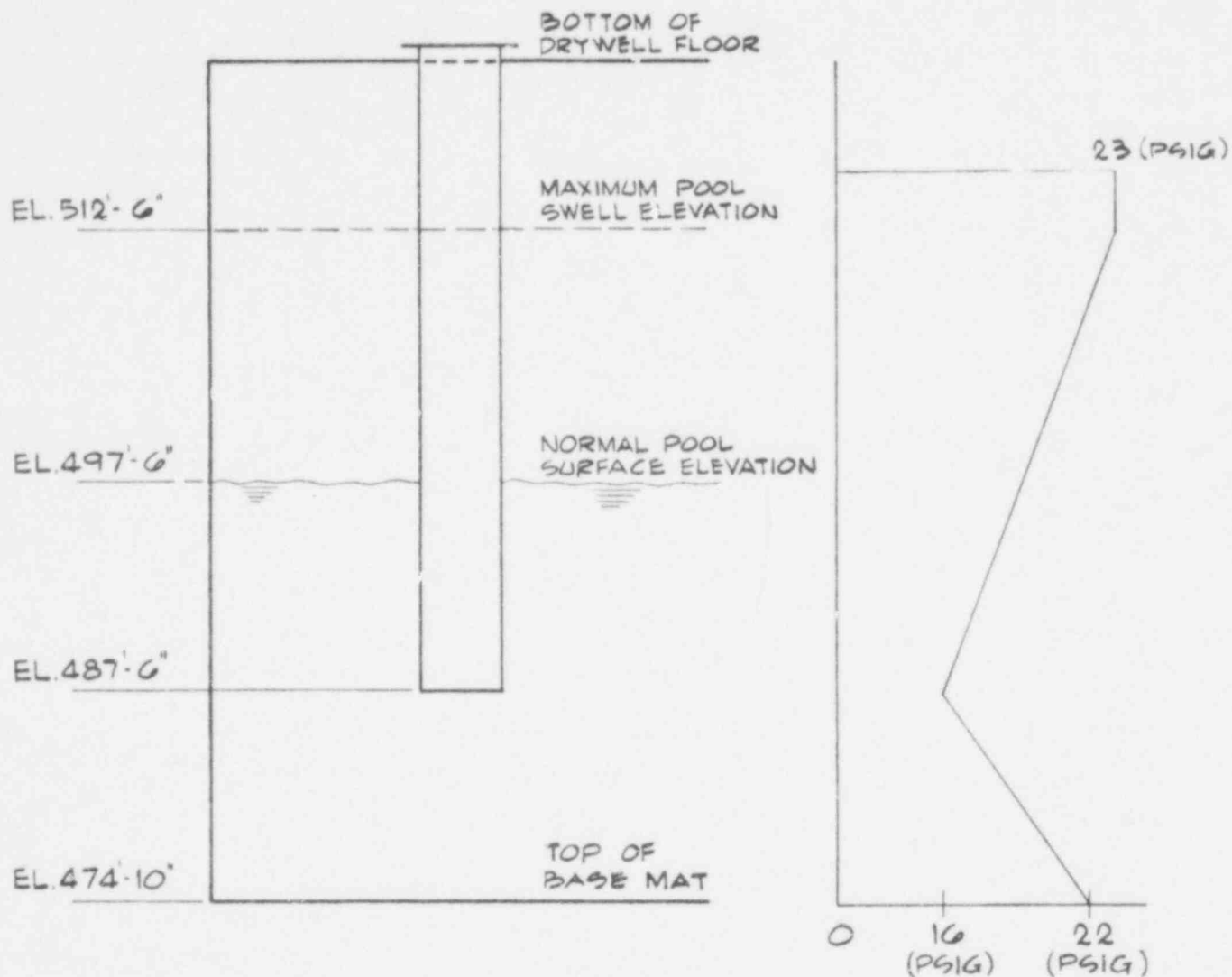
WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

FIGURE F.2-2

DRYWELL/WETWELL PRESSURE HISTORY FOR  
MAIN STEAMLINE BREAK

488 209

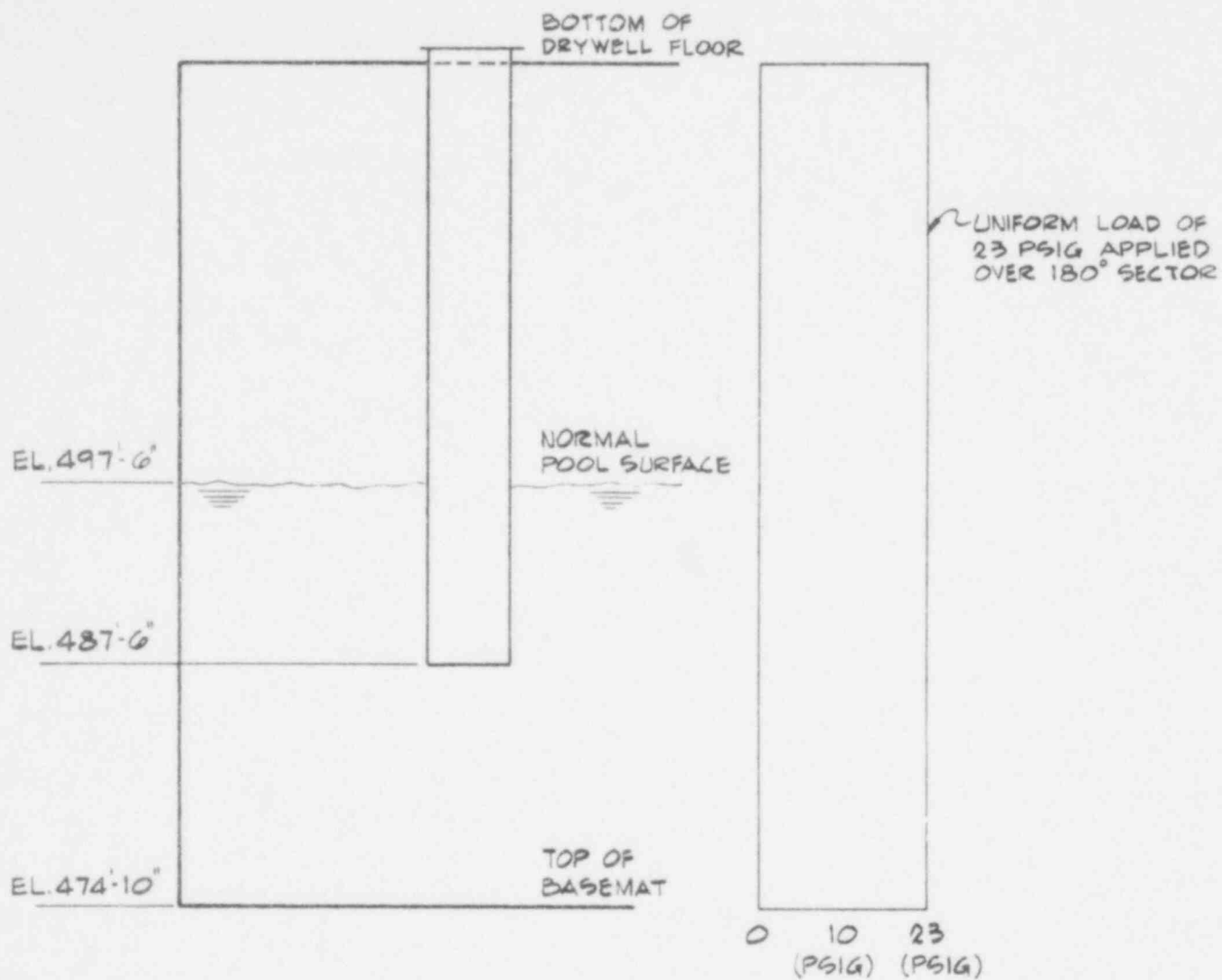


488 210

WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1  
MARK II DESIGN ASSESSMENT REPORT

FIGURE F.2-3

POOL SWELL SYMMETRIC LOAD



WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1  
MARK II DESIGN ASSESSMENT REPORT

FIGURE F.2-4

### POOL SWELL ASYMMETRIC LOAD

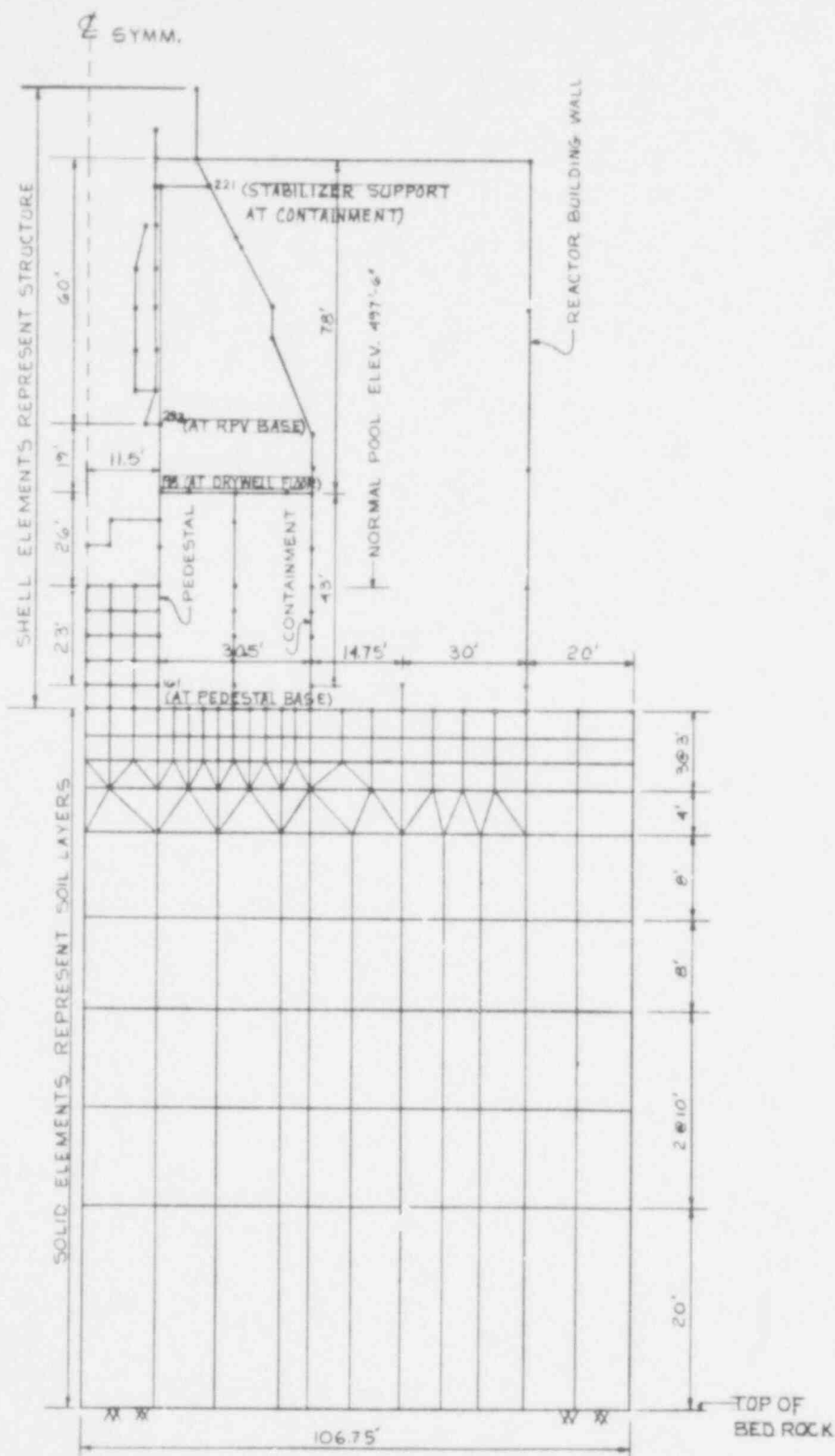
488 211

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

488 212



WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

FIGURE F.3-1

STRUCTURAL MODEL INCLUDING SOIL

488 213

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
- e. containment Section 11 in the conical drywell wall.

12

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	$M_\phi$ (kip-ft/ft)	$M_\theta$ (kip-ft/ft)	$N_\phi$ (kip/ft)	$N_\theta$ (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

12

ZPS-1-MARK II DAR

AMENDMENT 12  
JULY 1979

F.5-2

488 216



TABLE F.5-2

FORCES ON CONTAINMENT SECTION 4 FOR INDIVIDUAL LOADS

<u>LOAD DESCRIPTION</u>	$M_\phi$ (kip-ft/ft)	$M_\theta$ (kip-ft/ft)	$N_\phi$ (kip/ft)	$N_\theta$ (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	21.05	3.36	21.16	2.39	-1.15	0	0

TABLE F.5-3

FORCES ON CONTAINMENT SECTION 11 FOR INDIVIDUAL LOADS

<u>LOAD DESCRIPTION</u>	$M_\phi$ (kip-ft/ft)	$M_\theta$ (kip-ft/ft)	$N_\phi$ (kip/ft)	$N_\theta$ (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

ZP. MARK II DAR

AMENDMENT 12  
JULY 1979

12

F.5-4

488 218

TABLE F.5-4

## FORCES ON BASEMAT SECTION 2 FOR INDIVIDUAL LOADS

Load Description	$M_\phi$ (kip-ft/ft)	$M_\theta$ (kip-ft/ft)	$N_\phi$ (kip/ft)	$N_\theta$ (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

ZPS-1-MARK II DAR

12

AMENDMENT 12  
JULY 1979

TABLE F.5-5

## FORCES ON BASEMAT SECTION 3 FOR INDIVIDUAL LOADS

Load Description	$M_\phi$ (kip-ft/ft)	$M_\theta$ (kip-ft/ft)	$N_\phi$ (kip/ft)	$N_\theta$ (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 ALL	-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	19.30	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

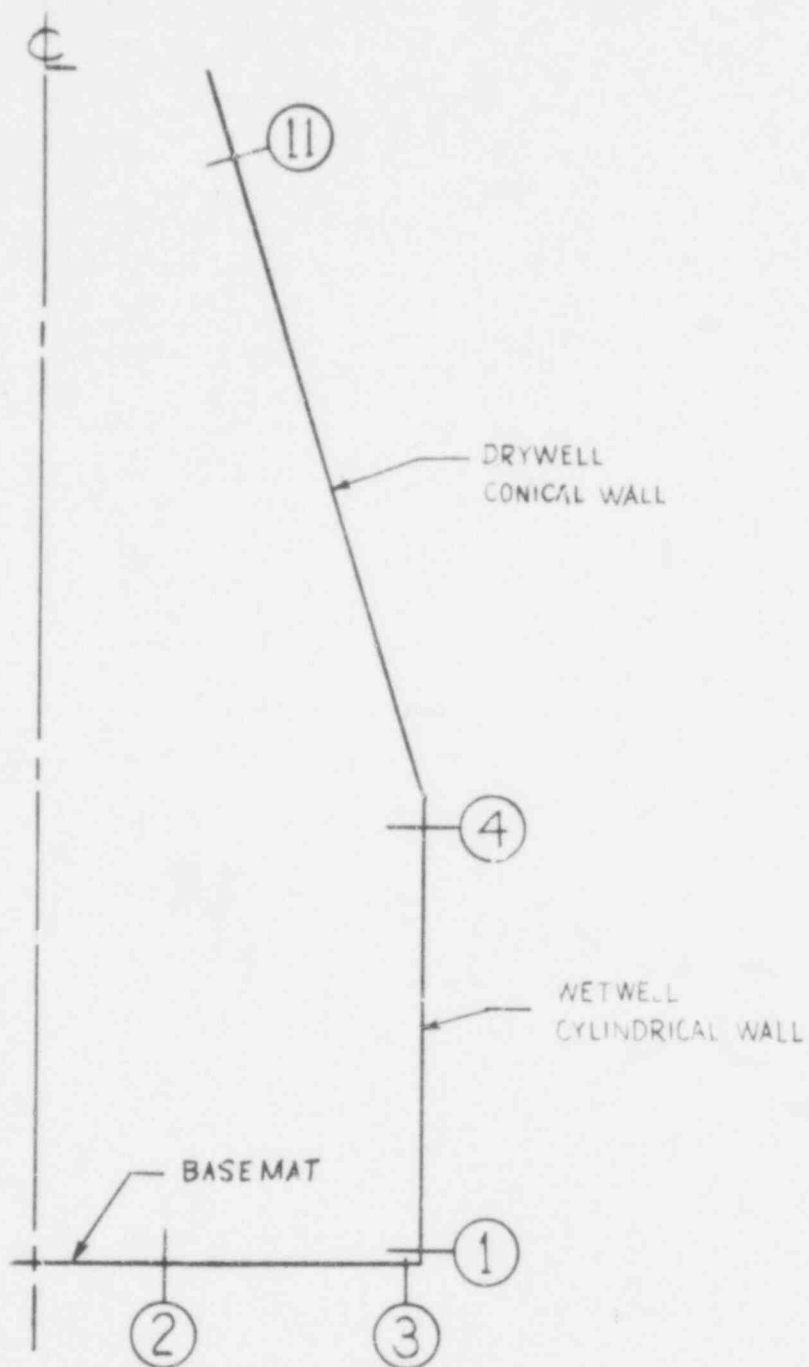
TABLE F.5-6

## DESIGN LOAD COMBINATIONS

EQN	LOAD COND	D	L	F	P <sub>Q</sub>	T <sub>Q</sub>	R <sub>Q</sub>	E <sub>Q</sub>	E <sub>SS</sub>	P <sub>R</sub>	P <sub>A</sub>	T <sub>A</sub>	R <sub>A</sub>	R <sub>R</sub>	SRV	ADS	ASSTMET-	
																	ALL	RICAL
1	Normal w/o Temp	1.4	1.7	1.0	1.0	-	-	-	-	-	-	-	-	-	1.5	0	X	X
2	Normal w/Temp	1.0	1.3	1.0	1.0	1.0	1.0	-	-	-	-	-	-	-	1.3	0	X	X
3	Normal Sev. Env.	1.0	1.0	1.0	1.0	1.0	1.0	1.25	-	-	-	-	-	-	1.25	0	X	X
4	Abnormal	1.0	1.0	1.0	-	-	-	-	-	1.25	-	1.0	1.0	-	1.25	X	0	X
4a		1.0	1.0	1.0	-	-	-	-	-	-	1.25	1.0	1.0	-	1.0	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
5a		1.0	1.0	1.0	-	-	-	1.1	-	-	1.1	1.0	1.0	-	1.0	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
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
7a		1.0	1.0	1.0	-	-	-	-	1.0	-	1.0	1.0	1.0	1.0	1.0	0	0	X

## LOAD DESCRIPTION

D	=	Dead Loads	E <sub>SS</sub>	=	Safe Shutdown Earthquake
L	=	Live Loads	P <sub>R</sub>	=	SBA and IBA Pressure Load
F	=	Prestressing Loads	T <sub>A</sub>	=	Pipe Break Temperature Load
T <sub>Q</sub>	=	Operating Temperature Loads	R <sub>A</sub>	=	Pipe Break Temperature Reactions Load
R <sub>Q</sub>	=	Operating Pipe Reactions	P <sub>A</sub>	=	DEA Pressure Loads (including all pool hydrodynamic loadings)
P <sub>Q</sub>	=	Operating Pressure Loads	R <sub>R</sub>	=	Reactions arising due to Pipe Break
SRV	=	Safety/Relief Valve Loads	IBA	=	Intermediate Break Accident
E <sub>Q</sub>	=	Operating Basis Earthquake			
SBA	=	Small Break Accident			



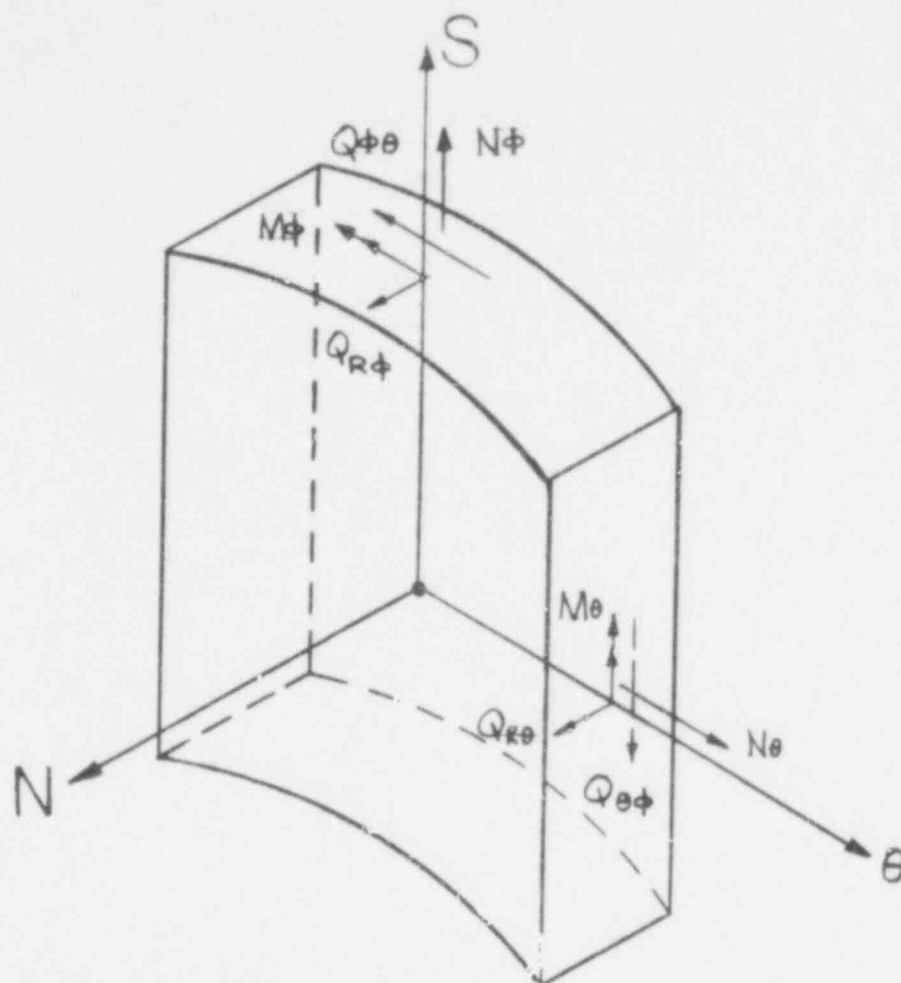
488 222

WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

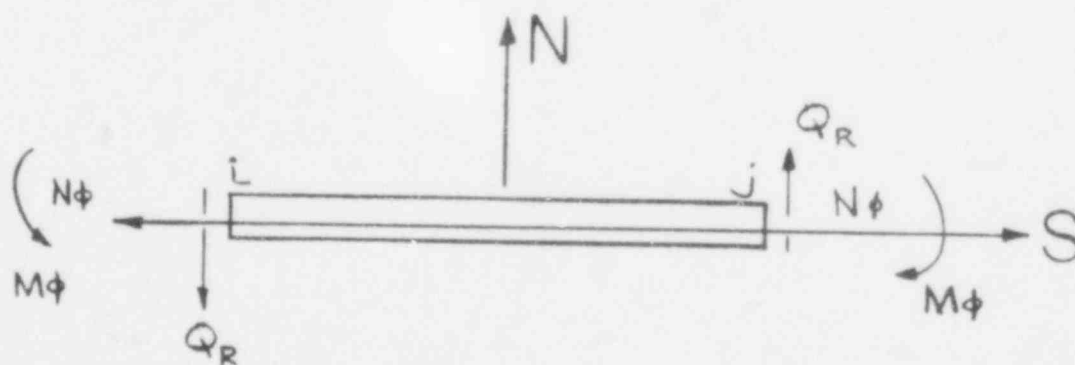
MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-1

KEY CONTAINMENT DESIGN SECTIONS



CONTAINMENT AND PEDESTAL WALL



BASEMAT

488 223

WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

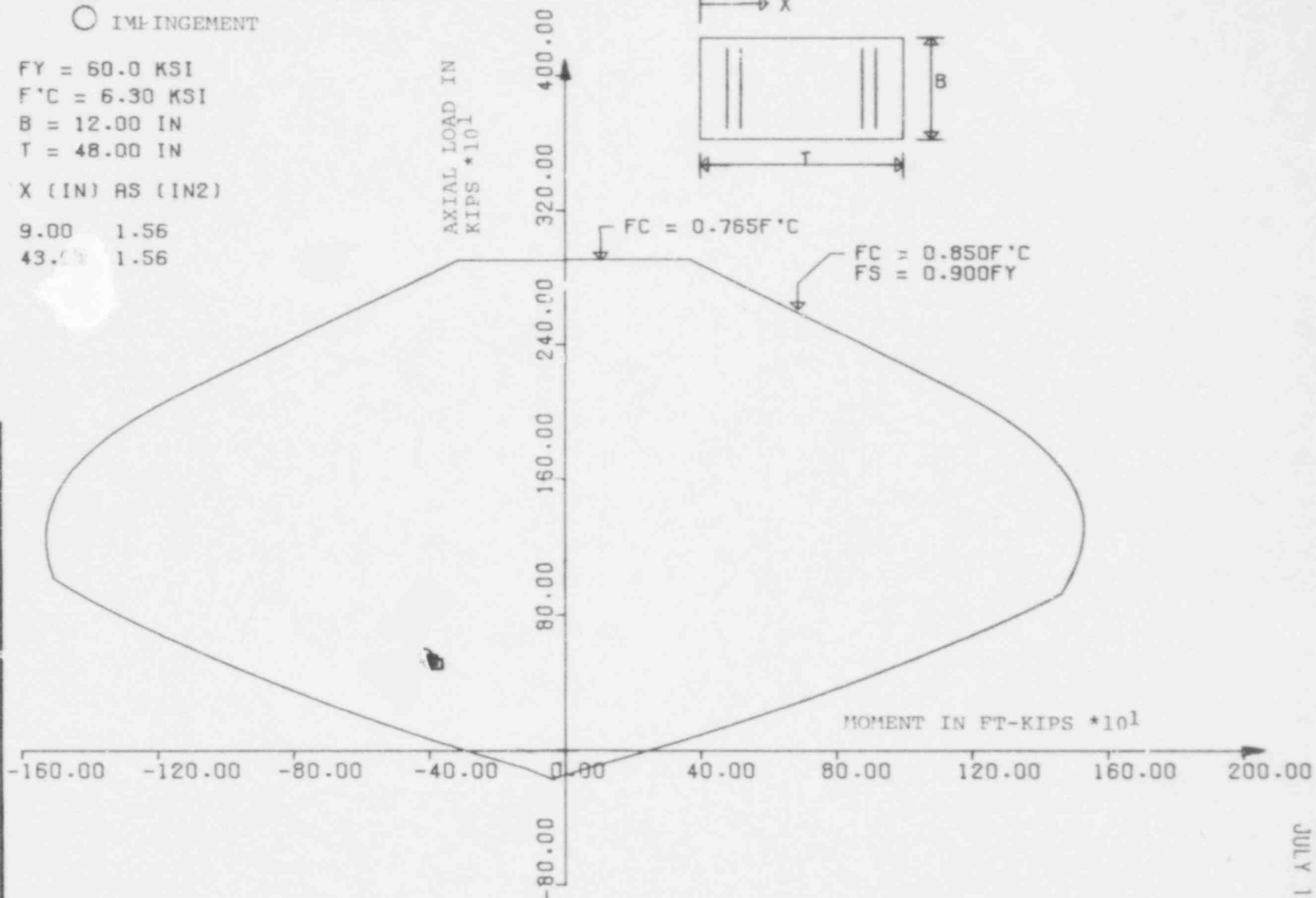
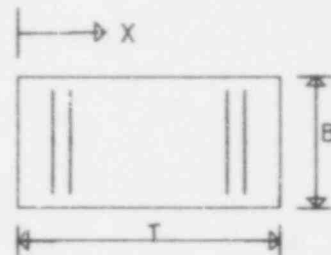
FIGURE F.5-2

NOTATIONS AND SIGN CONVENTIONS FOR  
FORCES AND MOMENTS

# NOTATION

- SYMMETRIC POOL SWELL
- ASYMMETRIC POOL SWELL
- IMPINGEMENT

$FY = 60.0 \text{ KSI}$   
 $F'C = 6.30 \text{ KSI}$   
 $B = 12.00 \text{ IN}$   
 $T = 48.00 \text{ IN}$   
 $X \text{ (IN)} \quad AS \text{ (IN}^2\text{)}$   
 $9.00 \quad 1.56$   
 $43.1 \quad 1.56$



488 224

WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-3

INTERACTION DIAGRAM FOR CONTAINMENT  
SECTION 1 - MECHANICAL FORCES

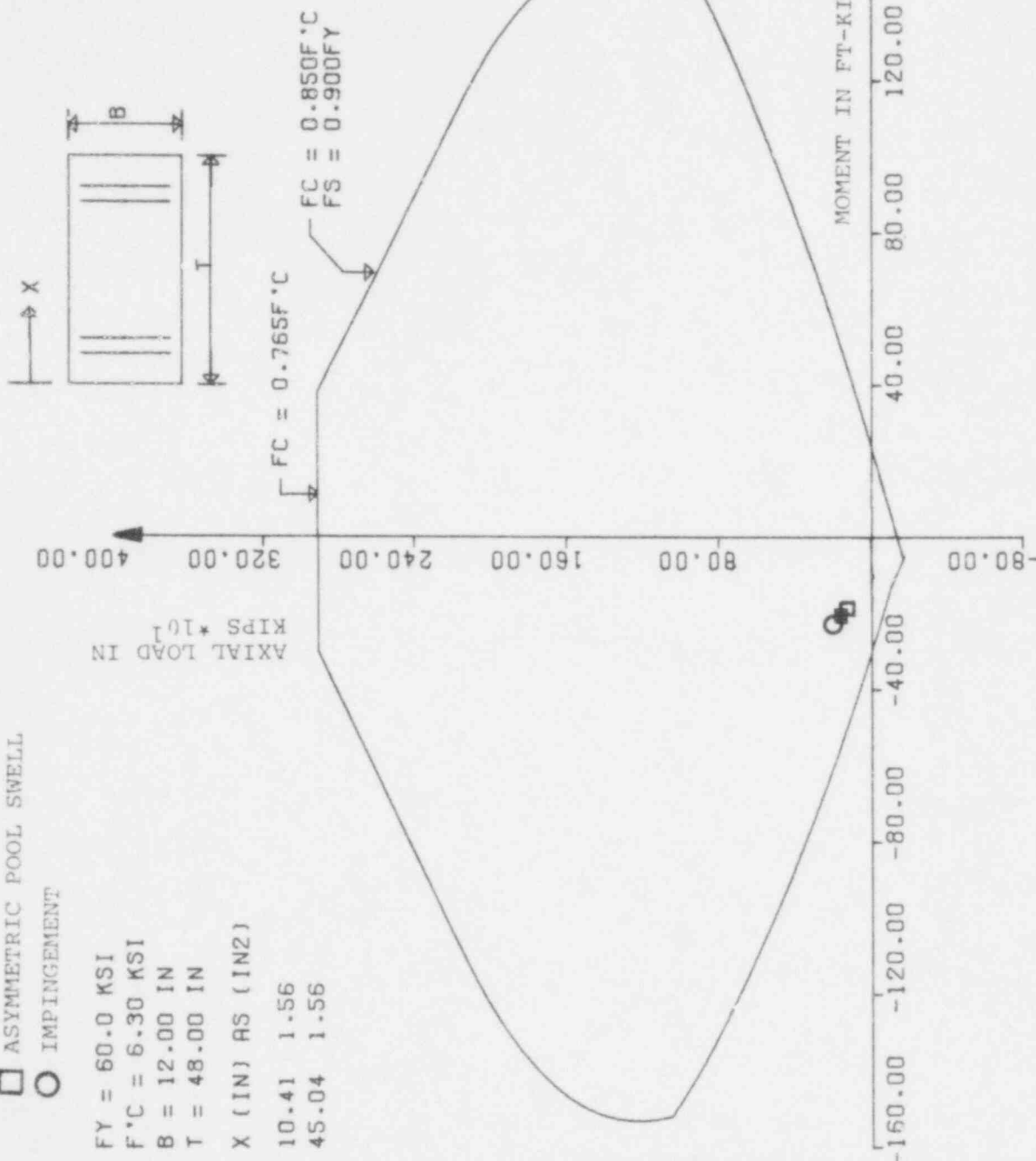
AMENDMENT 12  
JULY 1979



NOTATION

- SYMMETRIC POOL SWELL
- ASYMMETRIC POOL SWELL
- IMPINGEMENT

$F_Y = 60.0 \text{ KSI}$   
 $F'C = 6.30 \text{ KSI}$   
 $B = 12.00 \text{ IN}$   
 $T = 48.00 \text{ IN}$   
 $X \text{ (IN) AS (IN2)}$   
 $10.41 \quad 1.56$   
 $45.04 \quad 1.56$



WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-4

INTERACTION DIAGRAM FOR CONTAINMENT  
SECTION 1 - HOOP FORCES

488 225

NOTATION

■ SYMMETRIC POOL SWELL

□ ASYMMETRIC POOL SWELL

○ IMPINGEMENT

FY = 60.0 KSI

F'C = 6.30 KSI

B = 12.00 IN

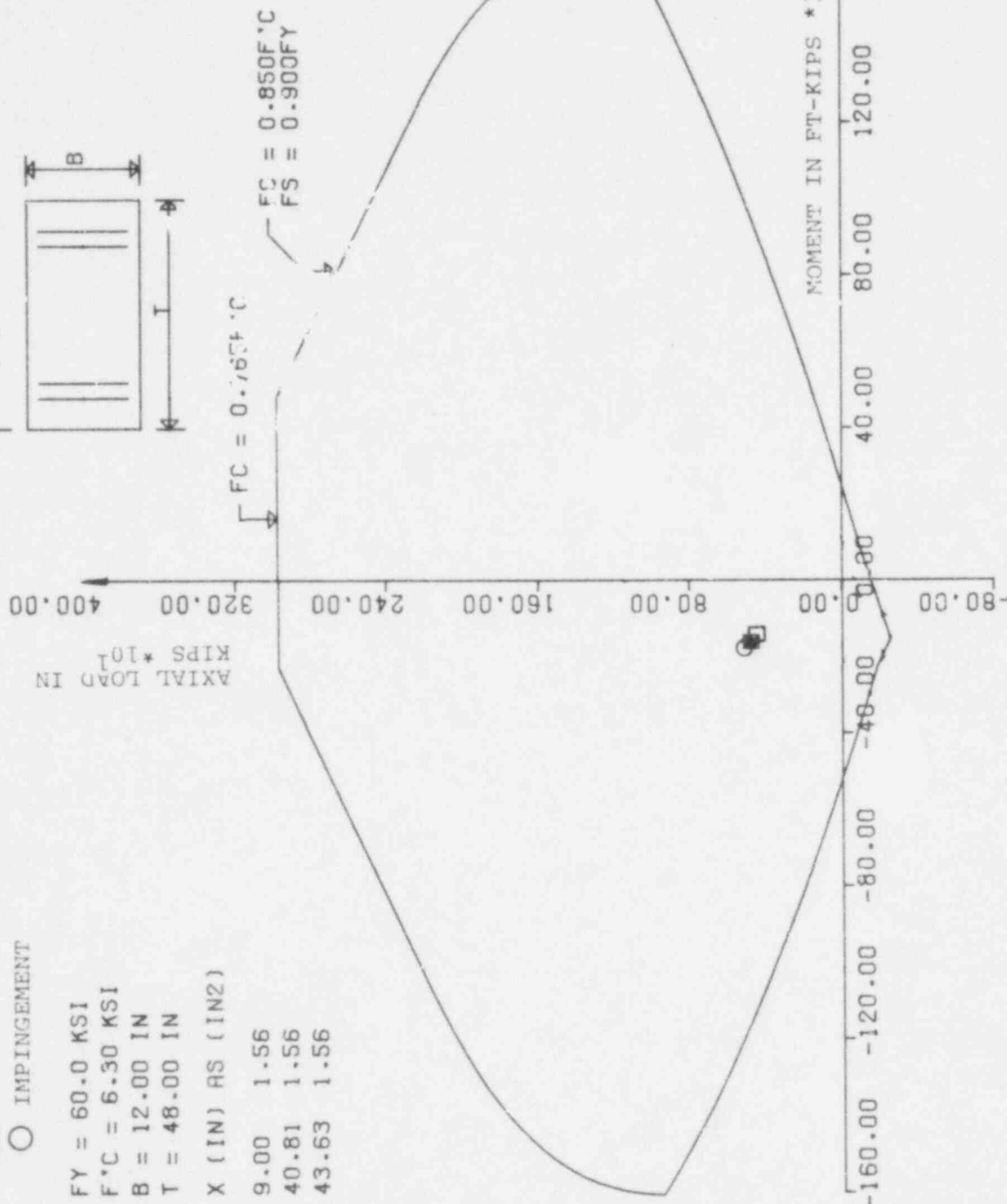
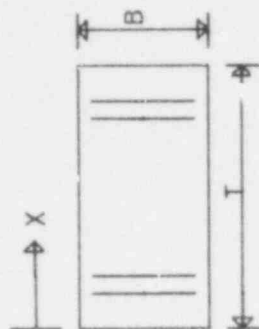
T = 48.00 IN

X (IN) RS (IN2)

9.00 1.56

40.81 1.56

43.63 1.56



WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-5

INTERACTION DIAGRAM FOR CONTAINMENT  
SECTION 4 - MERIDIONAL FORCES

488 226

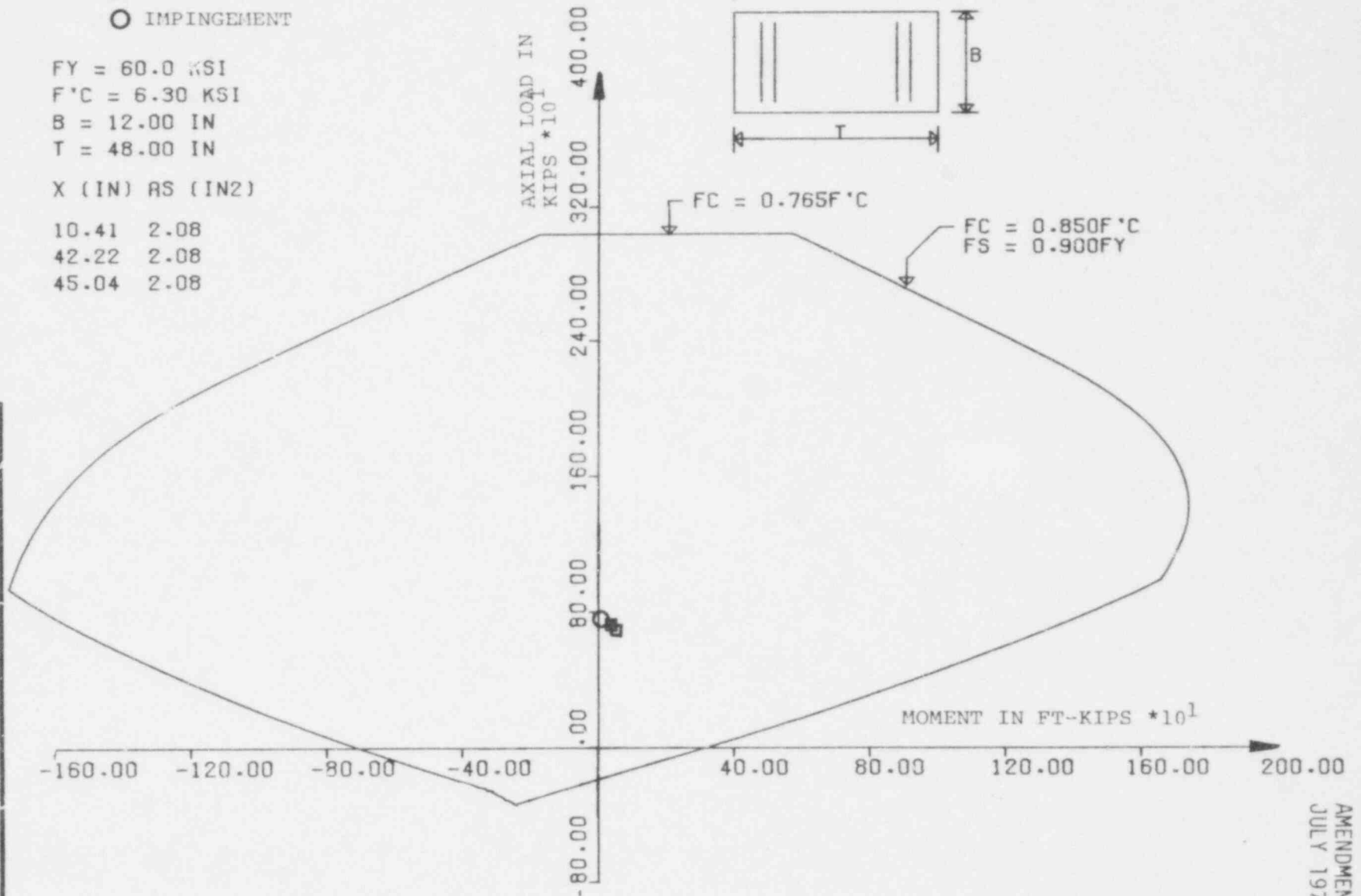
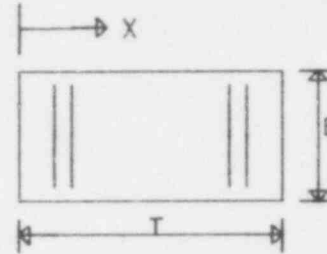
# NOTATION

- 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 (IN<sup>2</sup>)

10.41 2.08  
 42.22 2.08  
 45.04 2.08



WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-6

INTERACTION DIAGRAM FOR CONTAINMENT  
 SECTION 4 - HOOP FORCES

488 228

WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

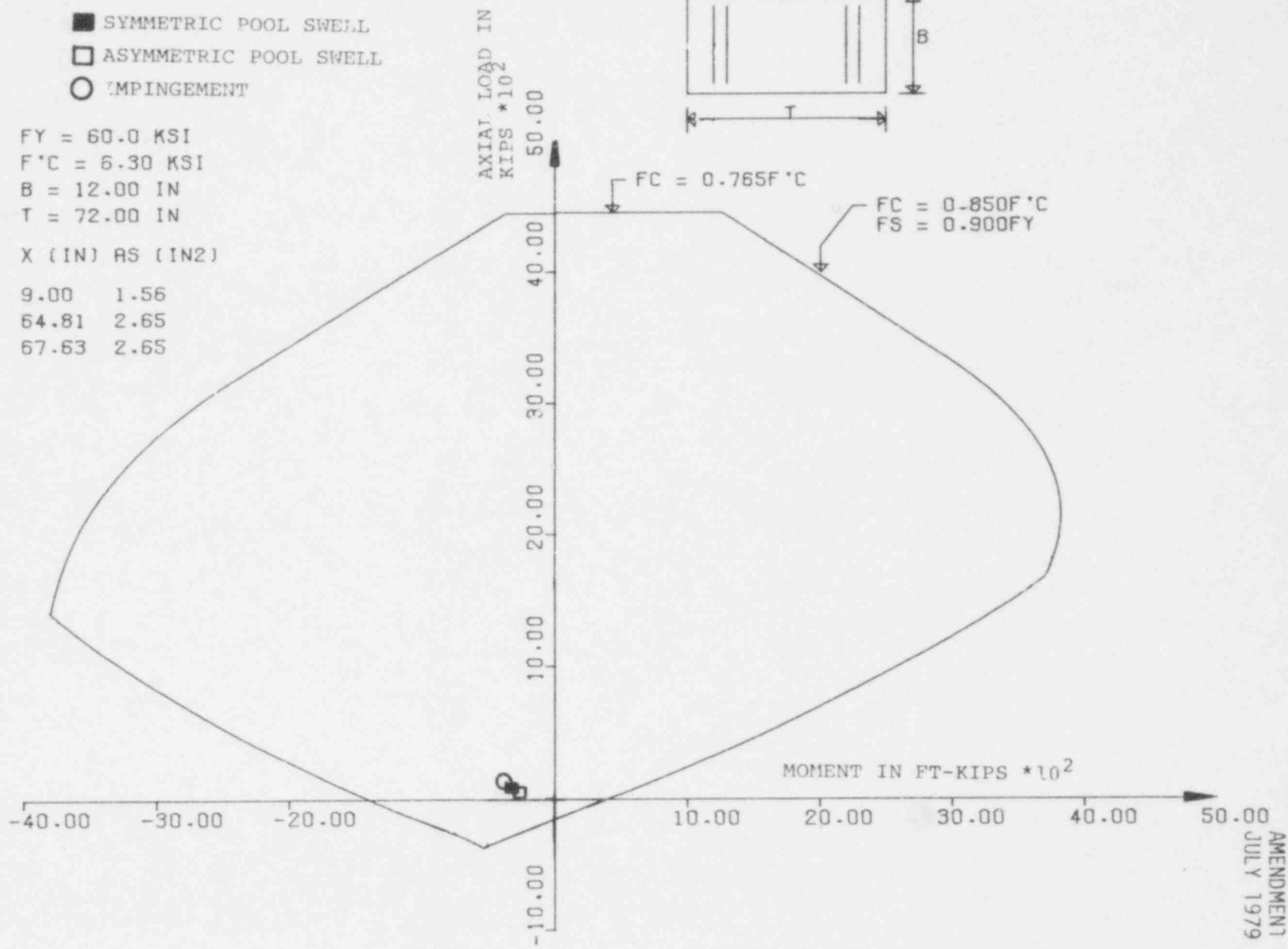
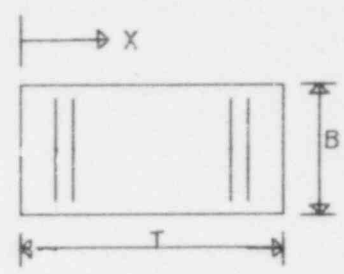
FIGURE F.5-7

INTERACTION DIAGRAM FOR CONTAINMENT  
SECTION 11 - MERIDIONAL FORCES

NOTATION

- SYMMETRIC POOL SWELL
- ASYMMETRIC POOL SWELL
- IMPINGEMENT

FY = 60.0 KSI  
 F'C = 6.30 KSI  
 B = 12.00 IN  
 T = 72.00 IN  
 X (IN) AS (IN2)  
 9.00 1.56  
 64.81 2.65  
 67.63 2.65

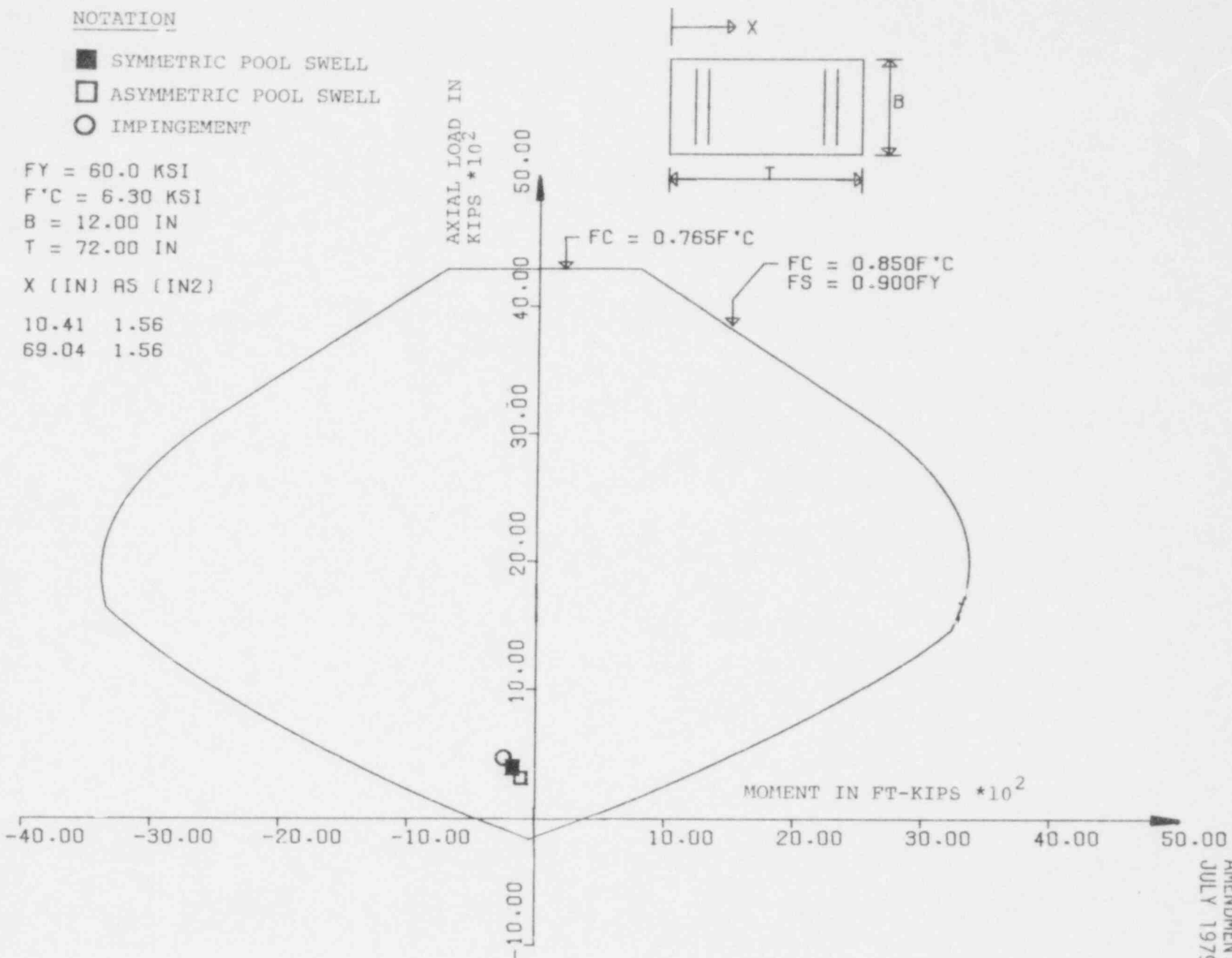


☒ SYMMETRIC POOL SWELL  
☐ ASYMMETRIC POOL SWELL  
☐ IMPINGEMENT

```
FY = 60.0 KSI
F'C = 6.30 KSI
B = 12.00 IN
T = 72.00 IN
```

```
X (IN) AS (IN2)
```

10.41	1.56
69.04	1.56



WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-8

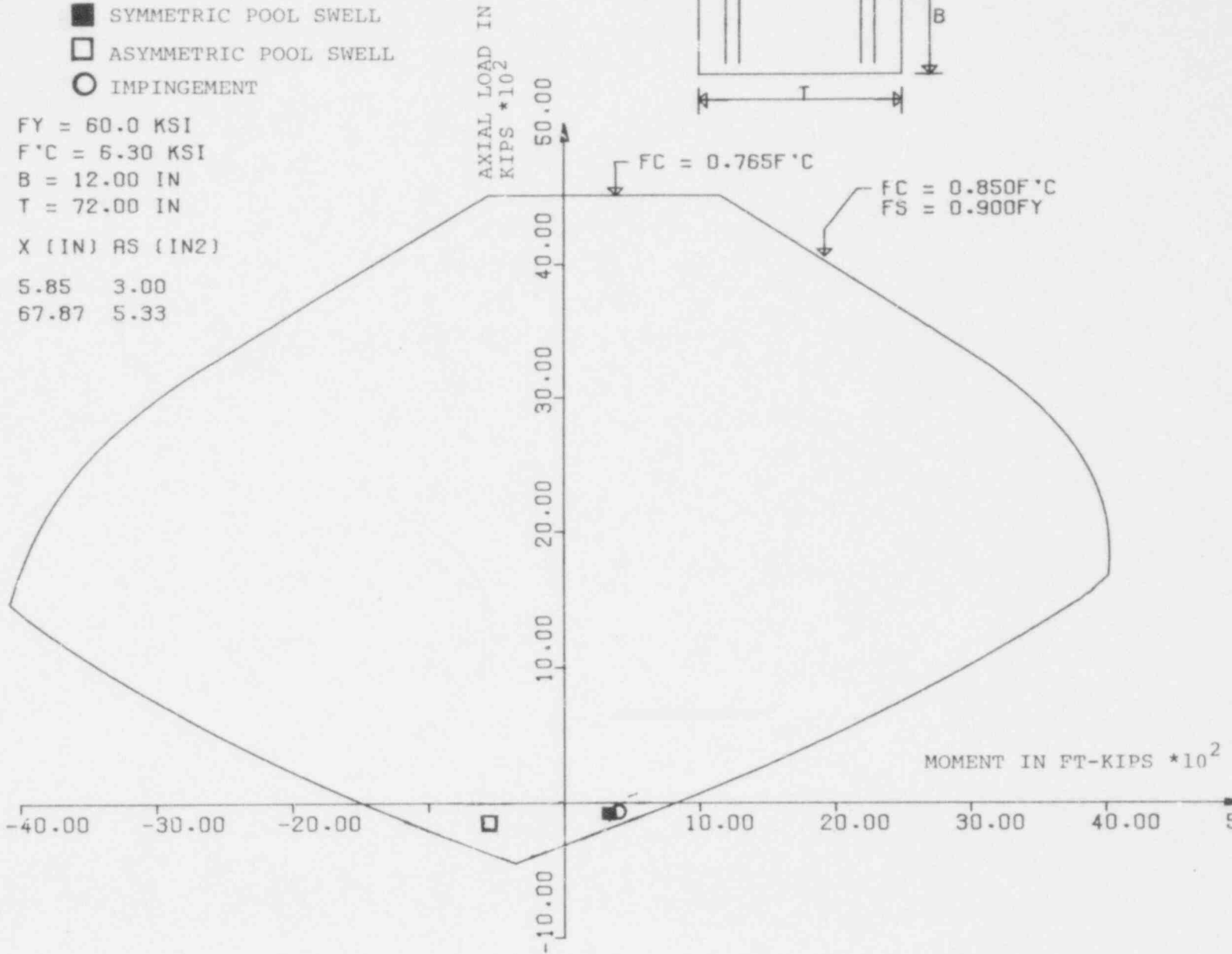
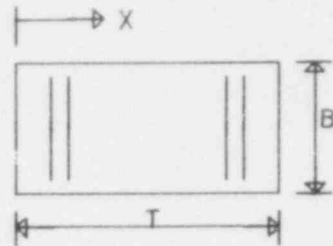
INTERACTION DIAGRAM FOR CONTAINMENT  
SECTION 11 - HOOP FORCES

## NOTATION

- ☒ SYMMETRIC POOL SWELL  
☐ ASYMMETRIC POOL SWELL  
☐ IMPINGEMENT

FY = 60.0 KSI  
F'C = 6.30 KSI  
B = 12.00 IN  
T = 72.00 IN

X (IN)	AS (IN2)
5.85	3.00
67.87	5.33



WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

# MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-9

INTERACTION DIAGRAM FOR BASE MAT  
SECTION 2 - MERIDIONAL FORCES

488 230

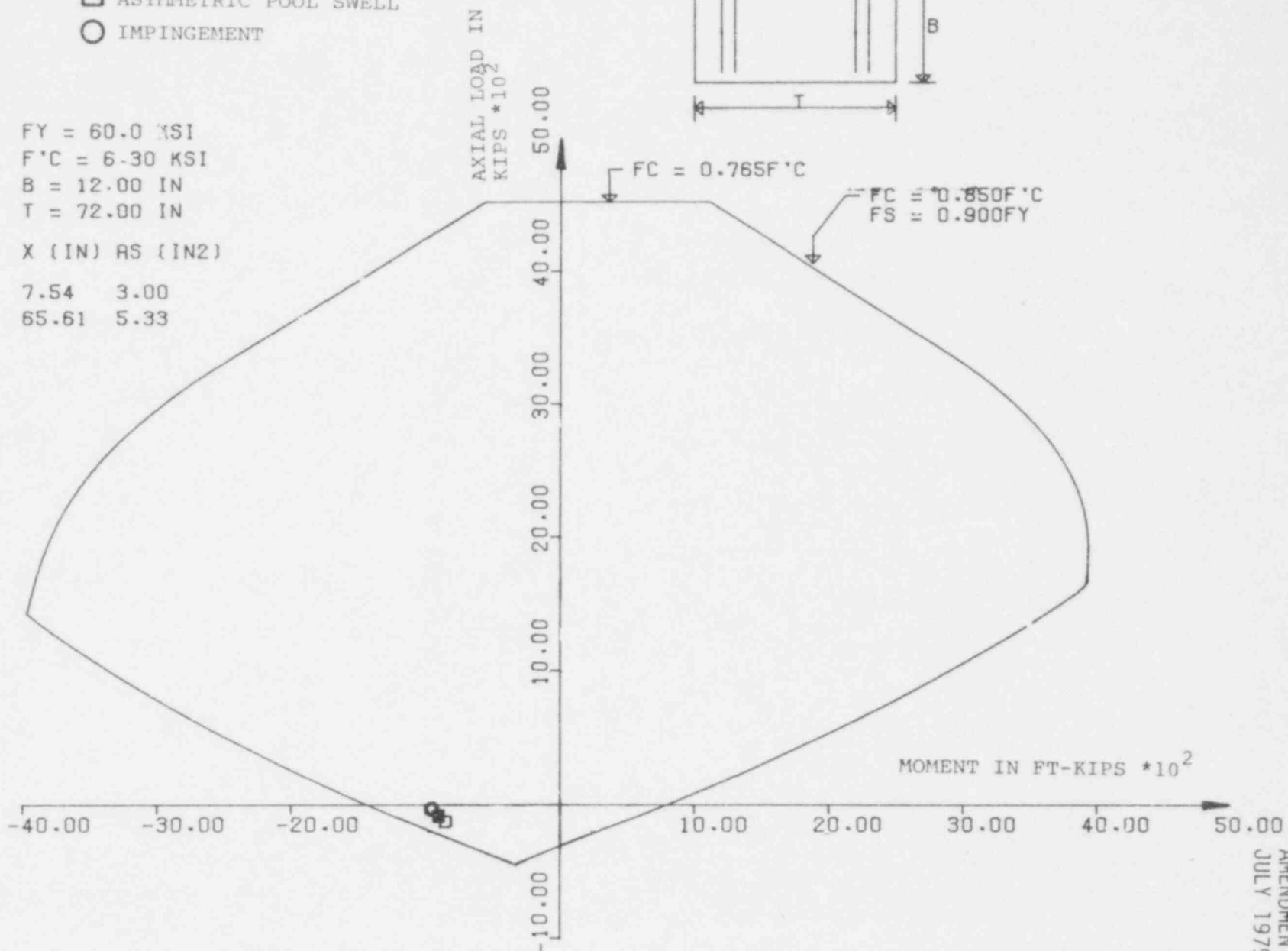
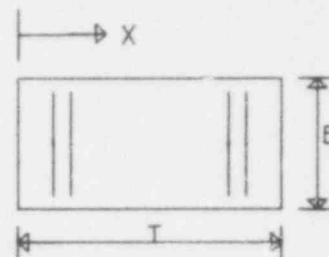
NOTATION

- SYMMETRIC POOL SWELL
- ASYMMETRIC POOL SWELL
- IMPINGEMENT

FY = 60.0 KSI  
F'C = 6.30 KSI  
B = 12.00 IN  
T = 72.00 IN

X (IN) AS (IN2)

7.54 3.00  
65.61 5.33



WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-10

INTERACTION DIAGRAM FOR BASE MAT  
SECTION 2 - HOOP FORCES

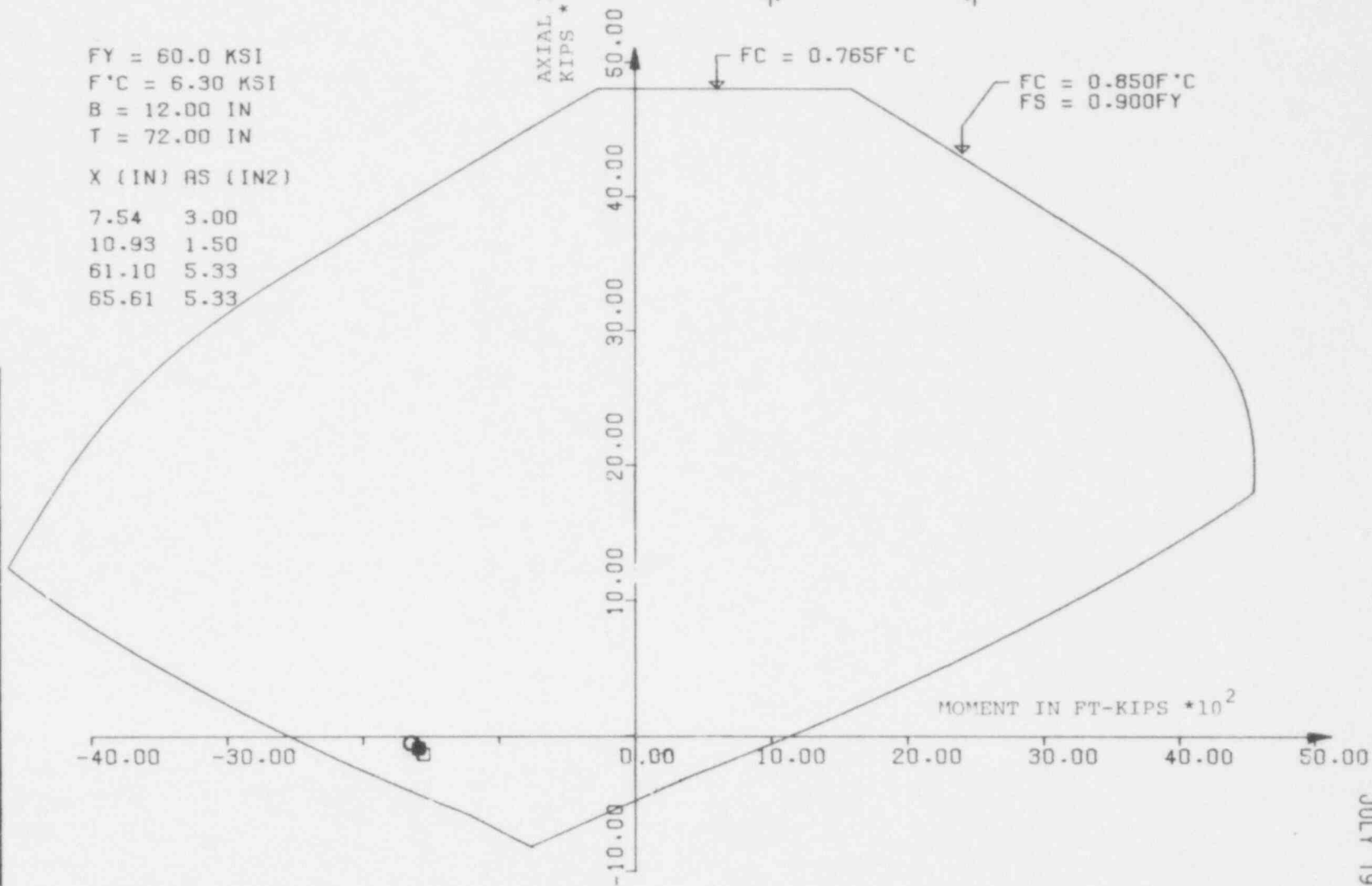
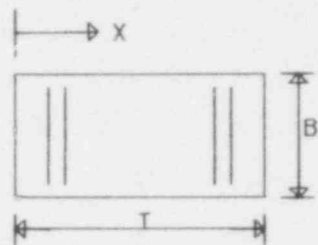
488 231

NOTATION

- SYMMETRIC POOL SWELL
- ASYMMETRIC POOL SWELL
- IMPINGEMENT

FY = 60.0 KSI  
F'C = 6.30 KSI  
B = 12.00 IN  
T = 72.00 IN

X (IN) RS (IN2)  
7.54 3.00  
10.93 1.50  
61.10 5.33  
65.61 5.33



WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1

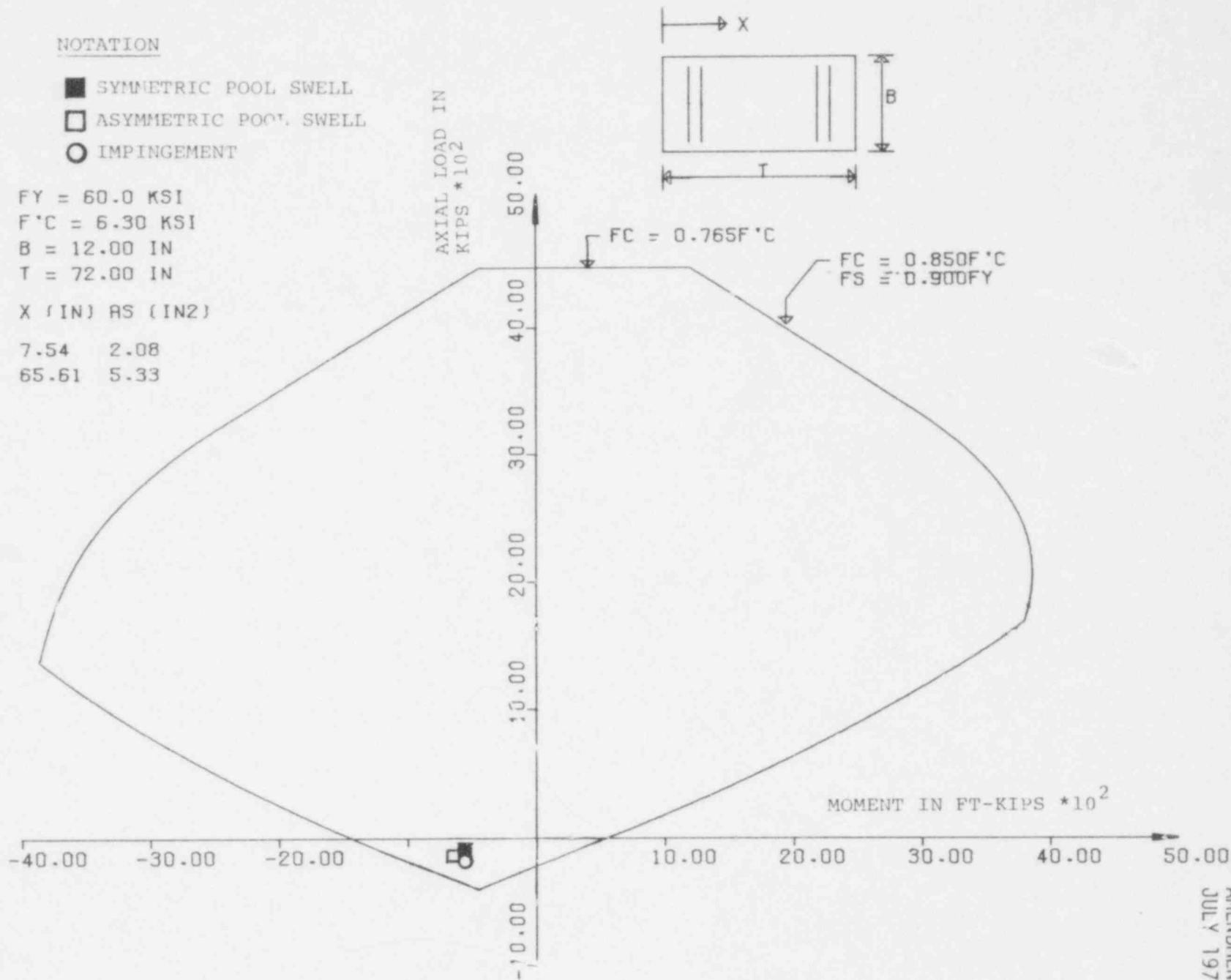
MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-11

INTERACTION DIAGRAM FOR BASE MAT  
SECTION 3 - MERIDIONAL FORCES

488 232





WM. H. ZIMMERMAN NUCLEAR POWER STATION, UNIT 1  
MARK II DESIGN ASSESSMENT REPORT

FIGURE F.5-12

INTERACTION DIAGRAM FOR BASE MAT  
SECTION 3 - HOOPE FORCES

488 233