Westinghouse Electric Corporation Energy Systems

Box 355
Pittsburgh Pennsylvania 15230-0355

AW-94-573

January 21, 1994

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: MR. R. W. BORCHARDT

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

SUBJECT: PRESENTATION MATERIALS FROM THE JANUARY 20 & 21, 1994 MEETING ON AP600 SEISMIC AND STRUCTURAL ISSUES

Dear Mr. Borchardt:

The application for withholding is submitted by Westinghouse Electric Corporation ("Westinghouse") pursuant to the provisions of paragraph (b)(1) of Section 2.790 of the Commission's regulations. It contains commercial strategic information proprietary to Westinghouse and customarily held in confidence.

The proprietary material for which withholding is being requested is identified in the proprietary version of the subject report. In conformance with 10CFR Section 2.790, Affidavit AW-94-573 accompanies this application for withholding setting forth the basis on which the identified proprietary information may be withheld from public disclosure.

Accordingly, it is respectfully requested that the subject information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10CFR Section 2.790 of the Commission's regulations.

Correspondence with respect to this application for withholding or the accompanying affidavit should reference AW-94-573 and should be addressed to the undersigned.

Very truly yours,

N. J. Liparulo, Manager
Nuclear Safety And Regulatory Activities

/nja

cc: Kevin Bohrer NRC 12H5

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A PDR

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In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Section (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR2.790(b)(1).

AW-94-573

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Brian A. McIntyre, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Corporation ("Westinghouse") and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

Brian A. McIntyre, Manager
Advanced Plant Safety & Licensing

Sworn to and subscribed
before me this 24 day
of January, 1994

Rose Marie Payne
Notary Public

Notarial Seal
Rose Marie Payne, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Nov. 4, 1996
Member, Pennsylvania Association of Notaries

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(1) I am Manager, Advanced Plant Safety and Licensing, in the Nuclear Technology Division, of the Westinghouse Electric Corporation and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Energy Systems Business Unit.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Energy Systems Business Unit in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) Enclosed is Letter NTD-NRC-94-4046, January 21, 1994, being transmitted by Westinghouse Electric Corporation (W) letter and Application for Withholding Proprietary Information from Public Disclosure, N. J. Liparulo (W), to Mr. R. W. Borchardt, Office of NRR. The proprietary information as submitted for use by Westinghouse Electric Corporation is in response to questions concerning the AP600 plant and the associated design certification application and is expected to be applicable in other licensee submittals in response to certain NRC requirements for justification of licensing advanced nuclear power plant designs.

This information is part of that which will enable Westinghouse to:

(a) Demonstrate the design and safety of the AP600 Passive Safety Systems.

(b) Establish applicable verification testing methods.

(c) Design Advanced Nuclear Power Plants that meet NRC requirements.

(d) Establish technical and licensing approaches for the AP600 that will ultimately result in a certified design.

(e) Assist customers in obtaining NRC approval for future plants.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for advanced plant licenses.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar advanced nuclear power designs and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended for developing analytical methods and receiving NRC approval for those methods.

Further the deponent sayeth not.

ATTACHMENT 1

Meeting Agenda for Seismic Analysis and Structural Design Criteria
Westinghouse Energy Center, Monroeville, Pennsylvania
Thursday, January 20 , 1994

General

Introduction Purpose of meeting AP600 Design status	P.R.Mandava	8.00 am
NRC review status Future NRC structural audit NRC Staff Positions on Advanced Plants	G.Bagchi	8.15 am
AP600 ITAAC Status	B.McIntyre	9.00 am
Summary of Structural Differences from Prior PWR Plants Site Interface Parameters	R.Orr	9.15 am
SSAR Chapter 3.3 - Wind and Tornado Loadings (RAI 220.24)	R.Orr	
SSAR Chapter 3.7 - Seismic Design		
Seismic Classification (RAI 230.24 thru 26)	R.Orr	
Seismic Input (RAI 230.27 thru 30)	K.Gross	9.30 am
Seismic System Analysis of Nuclear Island Structures Soil sensitivity studies (RAI 230.31-33) Soil-Structure Interaction Analyses (RAI 230.34 thru 45) Effects of Concrete Cracking for C-I Structures (RAI 220.40) Accidental Torsion (RAI 220.46)		
(1.0,0.4,0.4) Method for Seismic Loads (RAI 220.29 and 44)		
3.8.4 Other Category I Structures	K.Gross	11.00 am
Embedded Portion of Exterior Walls of NI (RAI 220.41) Settlement of Adjacent Buildings (RAI 220.43) Stability Evaluation for Safety-Related-Structure (RAI 220.43) Safety-Related-Structure Roof Drainage (RAI 220. 42) Use of Epoxy Coated Reinforcing Steel (RAI 220.46) Critical Stress Locations RAI 220.48		
Lunch		12.00

Seismic Category II Structures (RAI 220.47 and 49)	R.Orr	1.00 pm
3.8.5 Foundations	K.Gross	1.15 pm
Basemat design and analysis Foundation Mat Construction Procedures FS against Sliding and Overturning of NI due to Tornado and Wind (RAI 220.50)		
Passive Containment Systems	D.McDermott	2.00 pm
Containment System Passive Containment Cooling System Impacts on structural design		
3.8.2 Steel Containment	R.Orr	2.30 pm
Design Description (RAIs 220.26, 27, 29, 35, 36, 37) Penetrations Requirements Most Stressed Portion of SCV Pre-Operational SIT Measurements Corrosion		
Dynamic Stability of CV and CIS (RAI 230.47)	K.Gross	3.00 pm
Seal Material at Transition Region (RAI 220.25)		
Ultimate Capacity (RAIs 220.30 thru 34, 38 thru 39)	R.Orr	
3.8.4 Air Baffle (RAI 220.28)	R.Orr	4.00 pm
Design and Effects on SCV and SB Flexible Seal Connection to SB Roof		
Summary	P.R.Mandava G.Bagchi	4.30 pm

Meeting Agenda for Seismic Analysis and Structural Design Criteria
Westinghouse Energy Center, Monroeville, Pennsylvania
Friday, January 21 , 1994

Passive Core Cooling Systems	T.L.Schulz	8.00 am
Impacts on structural design		
3.8.3 Concrete and Steel Internal Structures		
Potential Sources of a Missile or High Pressure inside/outside SCV from High-Energy Line Break (RAIs 220.27 and 45)	R.Orr	8.30 am
IRWST Design for Service Level C		
SSAR Appendix 3A Structural Modules	K.Gross	9.00 am
General Description of Modules Procedures for Design and Fabrication Design Examples Integrity of Joints Seismic Damping Values Stiffness Degradation QA and QC Requirements for Transportation and Installation Verification Testing after Installing Modules Codes Analysis Methods and Design Criteria for Severe Accident Impulse Loads		
Test data related to structural modules	R.Orr	11.00 am
SSAR Chapter 3.7.3 - Seismic Design		
Seismic Analysis of Miscellaneous Structures, Including Equipment and Piping Modules (RAI 230.49)	R.Orr	11.30
Summary	P.R.Mandava G.Bagchi	12.00

ATTACHMENT 2

Westinghouse Electric Corporation
Presentation on AP600
Seismic and Structural Issues
to
United States
Nuclear Regulatory Commission

Westinghouse Energy Center
January 20 & 21, 1994

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3.7 SEISMIC DESIGN

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

SOIL SENSITIVITY STUDIES

PROCESS USED TO SELECT THE DESIGN SOIL PROFILES USED IN THE SEISMIC SSI ANALYSIS OF THE AP600 NUCLEAR ISLAND STRUCTURES

- SURVEY OF SELECTED EXISTING NUCLEAR POWER PLANT SITES IN THE U.S.
  - 22 COMMERCIAL POWER PLANT SITES IN THE U.S. WERE SURVEYED TO IDENTIFY THE RANGE OF SOIL PROFILES, PROPERTIES, AND PARAMETERS AT THESE PLANT SITES
  - A SET OF HISTOGRAMS FOR DEPTH TO BASE ROCK, DEPTH TO WATER TABLE, AND EMBEDMENT DEPTH OF MAJOR STRUCTURES IN THE PLANTS WERE PREPARED
  - SOIL PROFILES AND LAYERING SEQUENCE FOR THE PLANTS WERE PLOTTED
  - SHEAR WAVE VELOCITY PROFILES FOR THE PLANTS WERE PLOTTED

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

COMMERCIAL NUCLEAR POWER STATIONS SURVEYED

3.7 SEISMIC DESIGN

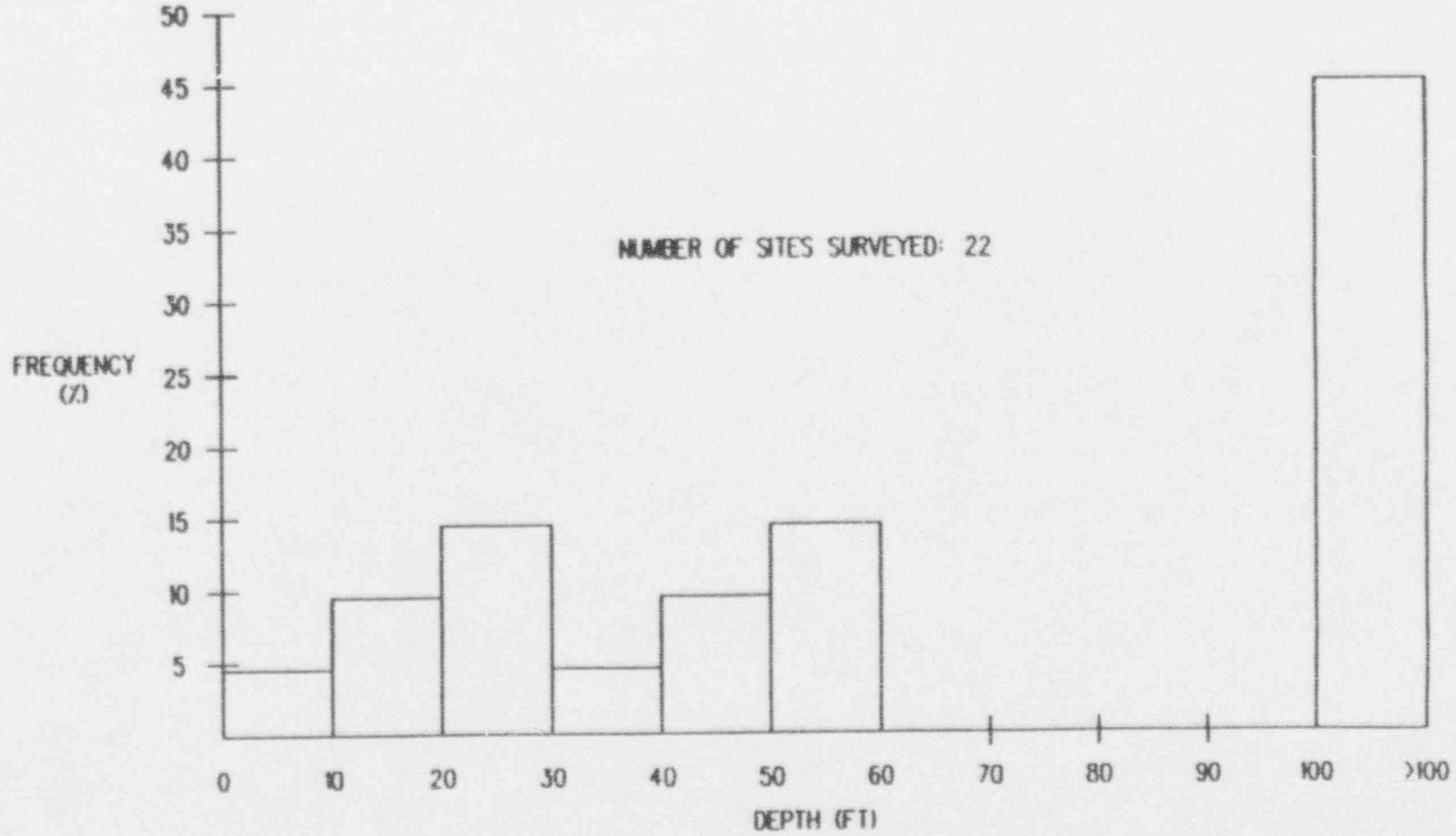
SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

Plant ID Number	Nuclear Plant and Unit(s)	Location (State)	Type	CB or TB Embedment Depth (Ft)	Depth to Rock (Ft)	Backfill Under CB or TB Foundation (Ft)	Depth to Water (Ft)	ZPA (g)	
								SSE	OBE
1	Hope Creek, U-1	New Jersey	BWR	39-CB	1500-2000	10	0	0.2	0.1
2	Callaway, U-1	Missouri	PWR	30-CB	50	28	15	0.2	0.12
3	Palo Verde, U-1,2,3	Arizona	PWR	50-CB	334	None	44	0.2	0.1
4	Arkansas Nuclear One, U-2	Arkansas	PWR	30R-CB	30	None	11	0.2	0.1
5	Calvert Cliffs, U-1,2	Maryland	PWR	46-CB	2500	None	55	0.15	0.08
6	Wolf Creek, U-1	Kansas	PWR	40R-CB	20	None	3	0.12	0.06
7	Grand Gulf, U-1,2	Mississippi	BWR	47½-TB	>185	None	47½	0.15	0.075
8	Millstone, U-2	Connecticut	PWR	53R-CB	53	None	19	0.17	0.09
9	Farley, U-1,2	Alabama	PWR	60R-CB	59	None	5	0.1	0.05
10	Vogtle, U-1,2	Georgia	PWR	66-CB	950	12	55	0.2	0.12
11	Hatch, U-2	Georgia	BWR	55-TB	4000	None	55	0.15	0.08
12	Susquehanna, U-1,2	Pennsylvania	BWR	31R-CB	30	None	0	0.10	0.05
13	Monticello	Minnesota	BWR	40-CB	40	None	20	---	0.06(DBE)
14	Davis-Besse	Ohio	PWR	40R-CB	30	None	0	0.15	0.08
15	WNP-2	Washington	BWR	34-CB	557	9	60	0.25	0.125
16	South Texas, U-1,2	Texas	PWR	59-CB	4000-6000	None	5	0.10	0.05
17	San Onofre, U-2,3	California	PWR	44-CB	850	None	24	0.67	0.33
18	Fort St. Vrain	Denver	HTGR	55R-CB	55	None	23	0.10	0.05
19	Arnold	Iowa	BWR	49R-CB	49	None	17	0.12	0.06
20	Limerick, U-1,2	Pennsylvania	BWR	50R-CB	15	None	deep	0.15	0.075
21	Trojan	Oregon	PWR	33R-CB	< 5	None	>33	0.25	0.15
22	Midland, U-1,2	Michigan	PWR	57-CB	300	None	39	0.12	0.06

Abbreviations: CB = Containment Building; TB = Turbine Building; R = Foundation on Rock; U = Unit

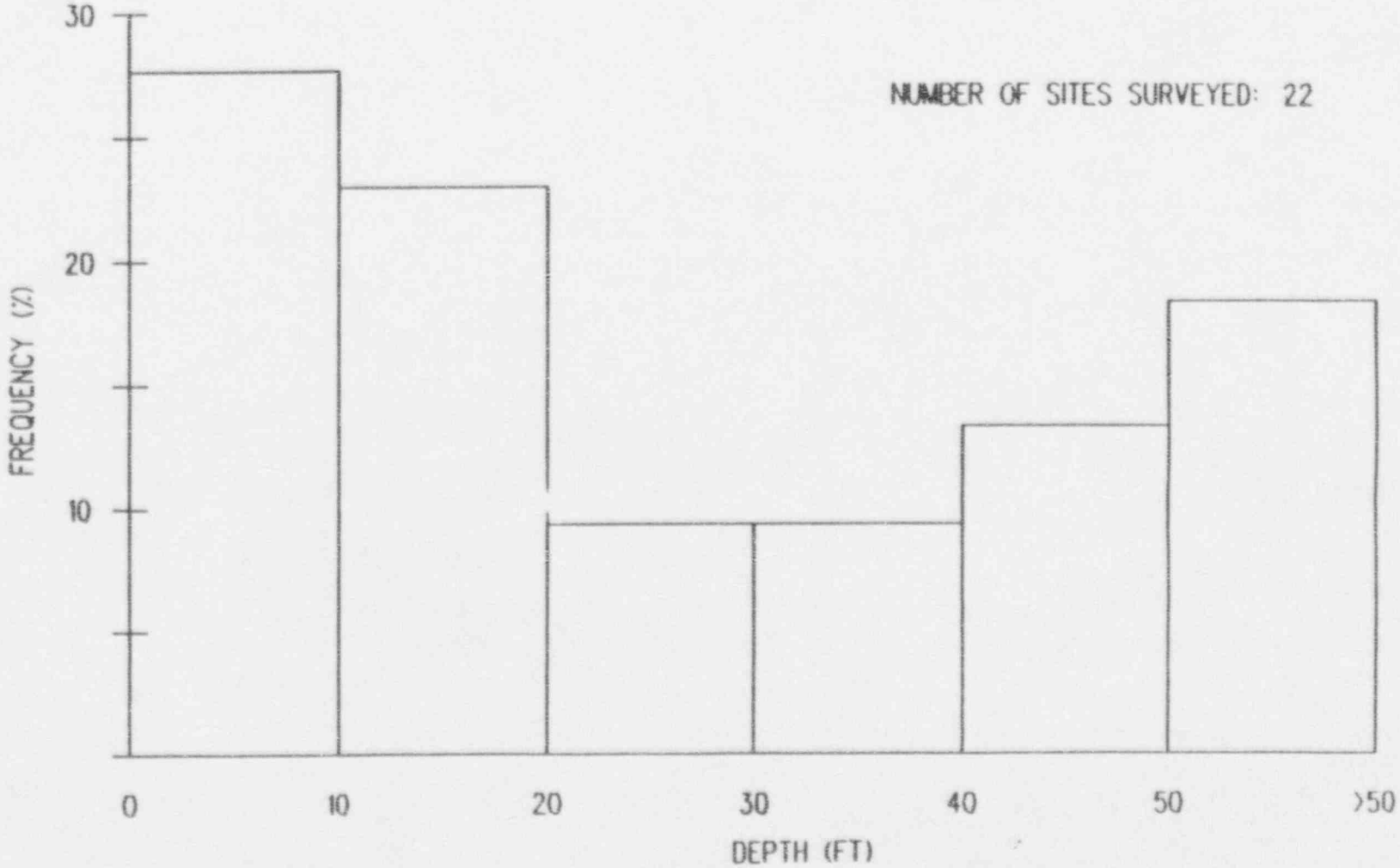
SUMMARY OF COMMERCIAL NUCLEAR POWER STATIONS SURVEYED

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



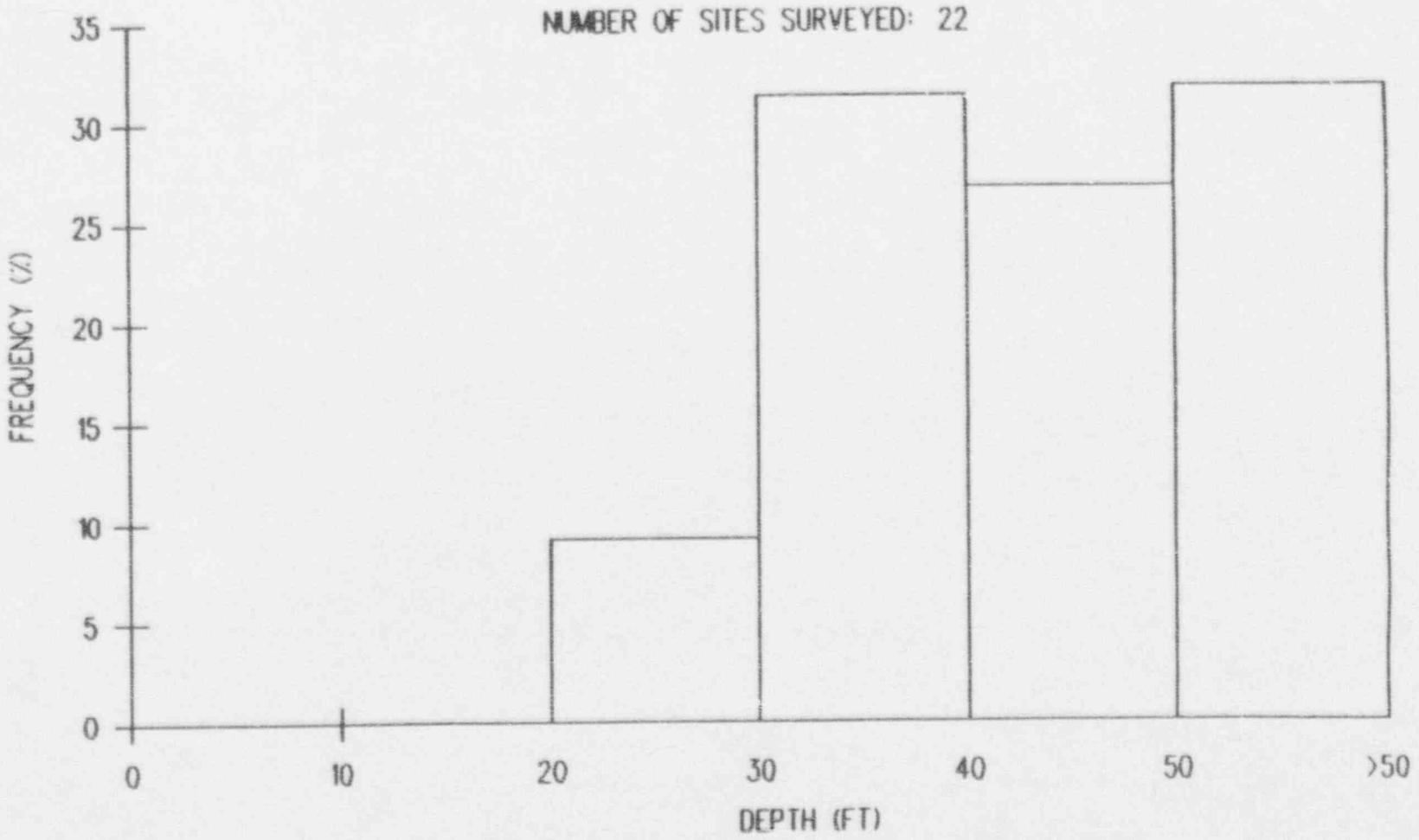
HISTOGRAH FOR DEPTH TO BASEROCK

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



HISTOGRAPH FOR DEPTH TO WATER TABLE

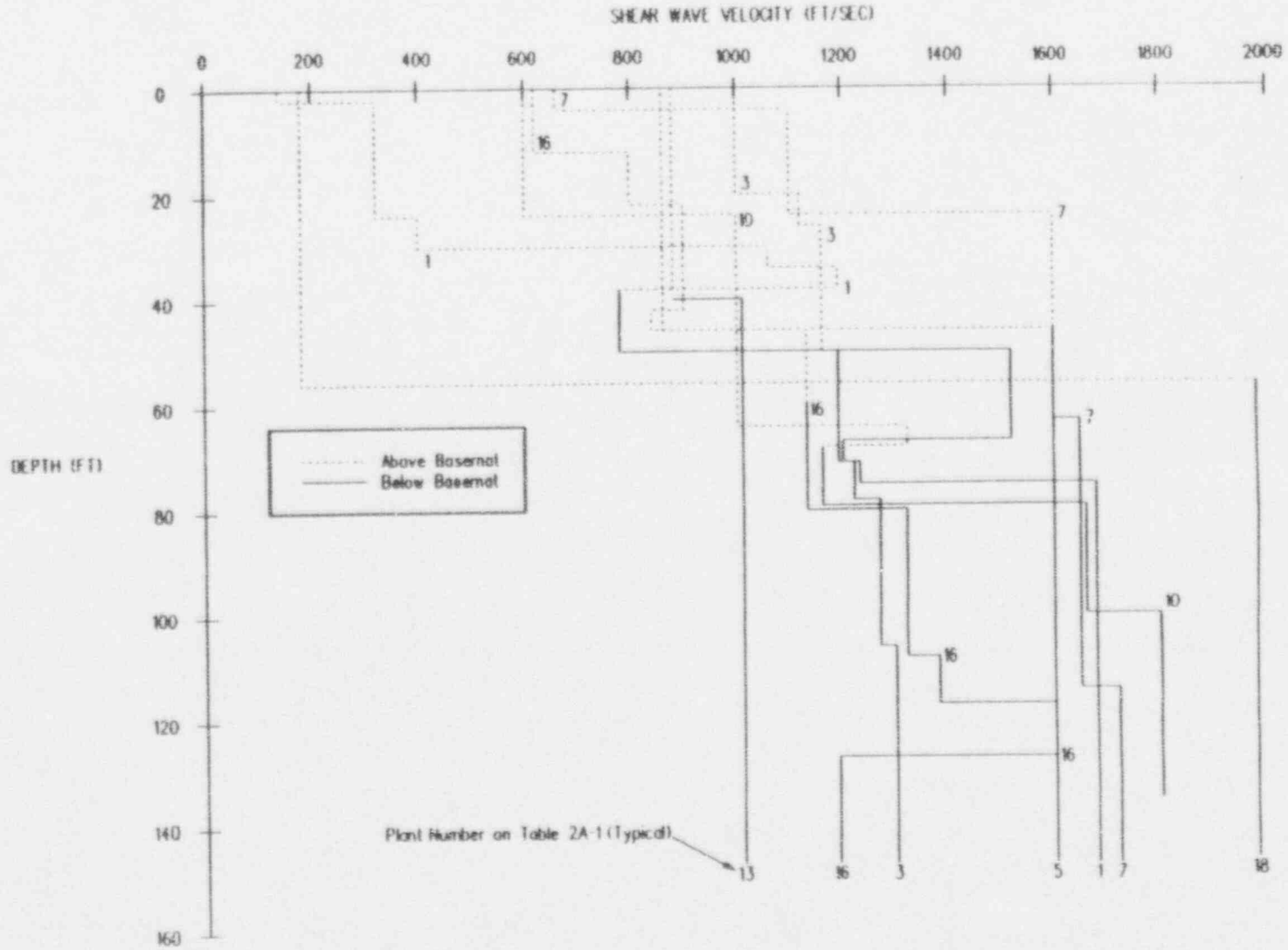
SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



HISTOGRAPH FOR EMBEDMENT DEPTH

3.7 SEISMIC DESIGN

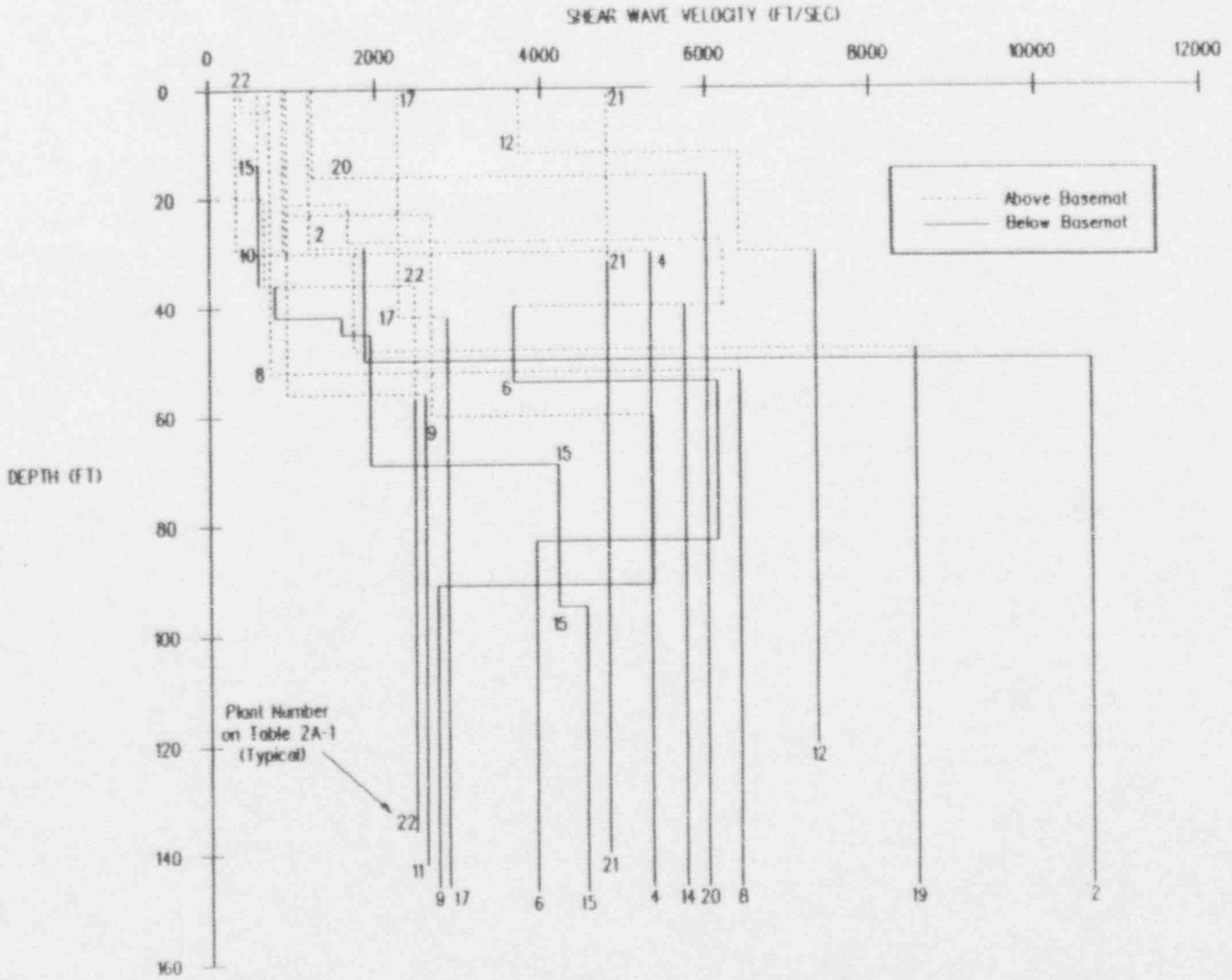
SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



SURVEYED NUCLEAR POWER PLANT SITES, V_S < 2000 fps.

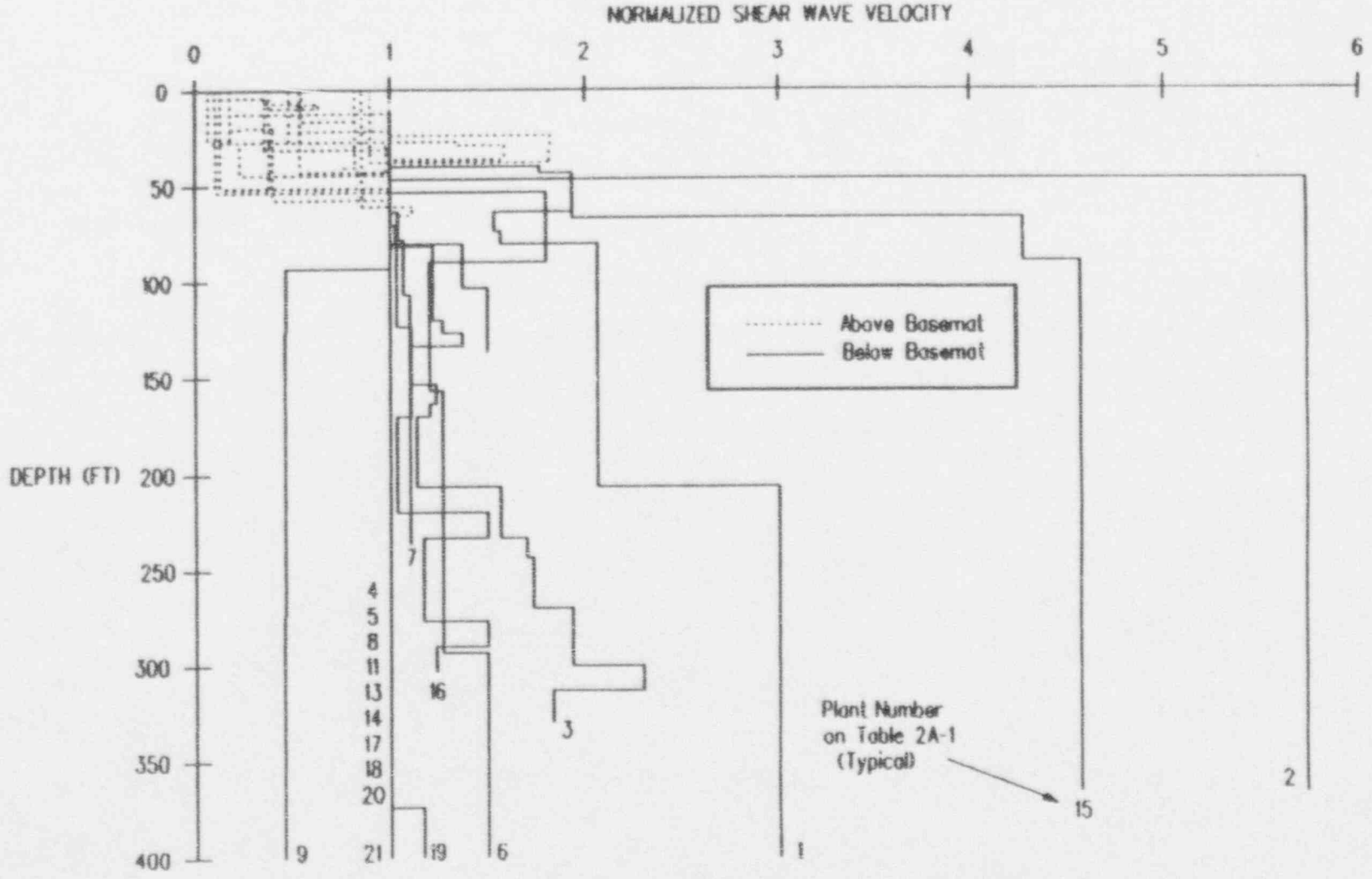
3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



SURVEYED NUCLEAR POWER PLANT SITES, V_S > 2000 fps.

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



SURVEYED NUCLEAR POWER PLANT SITES, V_S PROFILE NORMALIZED

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

- GENERIC SOIL PROFILES WERE ESTABLISHED BASED ON THE PLANT SURVEY
  - SOIL DEPOSIT THICKNESS

DEPTH TO BASE ROCK (FT)	NOTES
0	ROCK SITE
40	N.I. EMBEDDED TO THIS DEPTH
120	THIS DEPTH CORRESPONDS TO THE AVERAGE WIDTH OF THE N.I BASEMAT DIMENSION
VERY DEEP	DEEP SOIL PROFILES

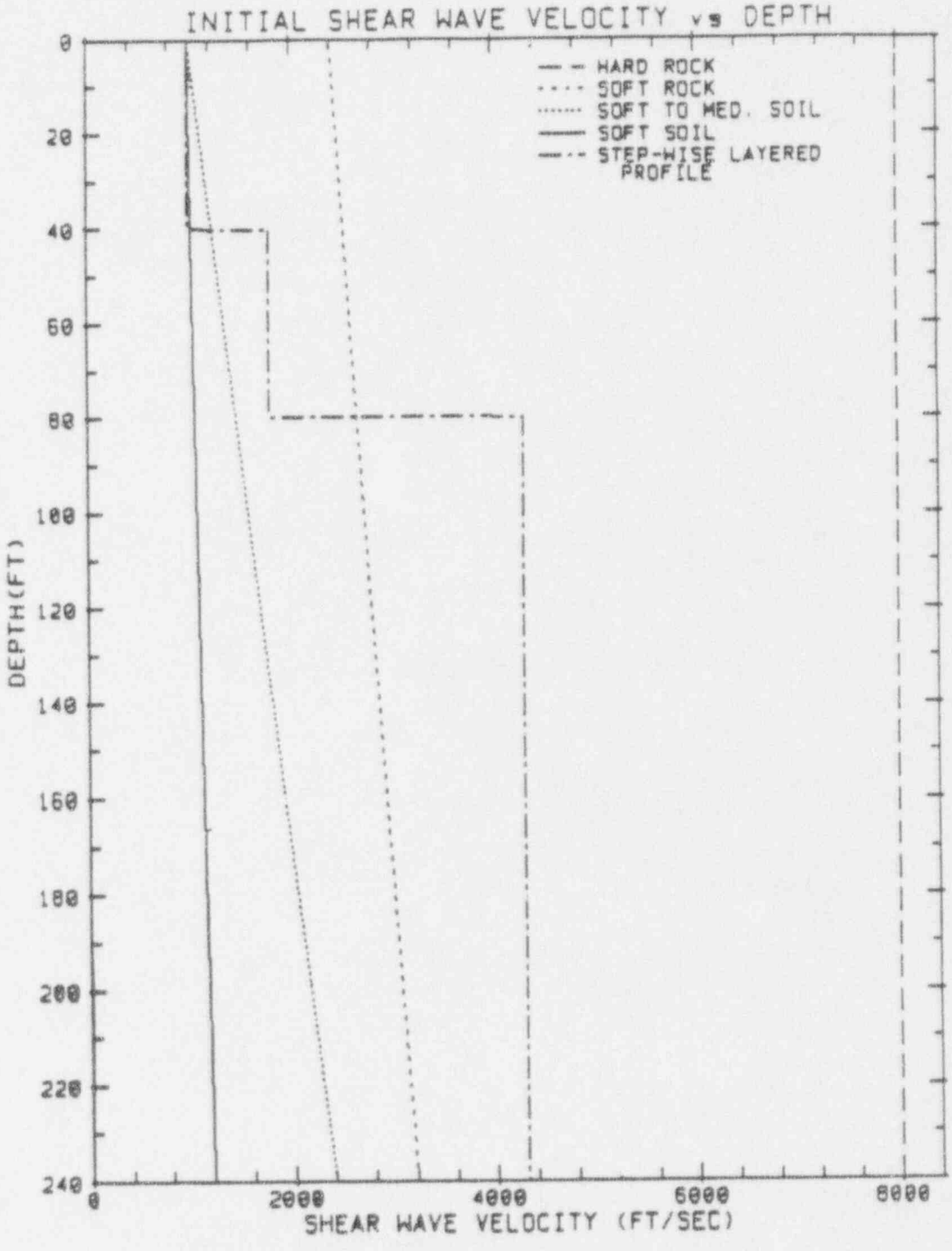
  - DEPTH TO WATER TABLE

DEPTH TO WATER TABLE (FT)	NOTES
0	SUBMERGED SITE
40	WATER TABLE AT THE BASEMAT LEVEL OF THE N.I.
VERY DEEP	DEEP WATER TABLE LOCATIONS

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

- SHEAR WAVE VELOCITY PROFILES
  - HARD ROCK (HR), CONSTANT SHEAR WAVE VELOCITY OF 8,000 FT/SEC
  - SOFT ROCK (SR), SHEAR WAVE VELOCITY OF 2,400 FT/SEC AT THE GROUND SURFACE, INCREASING LINEARLY TO 3,200 FT/SEC AT 240 FT
  - SOFT SOIL (S), BASED ON THE RESULTS OF THE SURVEY, THE LOWER-BOUND VELOCITY PROFILE HAVING A SHEAR WAVE VELOCITY OF 1,000 FT/SEC AT THE GROUND SURFACE, WITH A NOMINAL INCREASE TO 1,200 FT/SEC AT 240 FT
  - SOFT-TO-MEDIUM SOIL (SM), SHEAR WAVE VELOCITY OF 1,000 FT/SEC AT THE GROUND SURFACE, INCREASING LINEARLY TO 2,400 FT/SEC AT 240 FT
  - LAYERED SOIL PROFILE WITH STEP-WISE CHANGE IN SHEAR WAVE VELOCITY SIMILAR TO THE WNP-2 NUCLEAR STATION



GENERIC SHEAR WAVE VELOCITY PROFILES

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

- 2D SOIL-STRUCTURE INTERACTION ANALYSIS
  - TO IDENTIFY THE GOVERNING SOIL PROPERTIES AND PROFILES
  - 2D SSI ANALYSIS METHOD - SASSI
  - STRUCTURAL AND FOUNDATION MODELS - REPRESENTATIVE, TWO-DIMENSIONAL, LUMPED-MASS STICK MODELS OF THE N.I. AND BASEMAT WERE DEVELOPED
  - INPUT MOTION - HORIZONTAL AND VERTICAL TIME HISTORIES
  - 2D SSI ANALYSIS CASES
  - 2D SSI ANALYSIS RESULTS
  - AP600 DESIGN SOIL PROFILES
    - HARD ROCK (R1)
    - SOFT ROCK (A2)
    - SOFT-TO-MEDIUM-SOIL (B2W1)

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

Shear Wave Velocity Profile	Depth to Base Rock (Ft)	Depth to Water Table (Ft)	SSI Case ID			Notes
			(X-Shaking)	(Y-Shaking)	(Z-Shaking)	
Hard Rock	—	—	R1X	R1Y	R1Z	rigid base
Soft Rock	deep 120	deep deep	A1X A2X	A1Y A2Y	A1Z A2Z	depth to base rock study
Soft-to-Medium Soil	deep 120 40	deep deep deep	B1X B2X B3X	B1Y B2Y —	B1Z B2Z B3Z	depth to base rock study
Soft Soil	deep 120	deep deep	C1X C2X	C1Y C2Y	C1Z C2Z	depth to base rock study
Soft-to-M[illegible] Soil	120[1]	0 40 deep	B2XW1 B2XW2 B2X	— — —	B2ZW1 B2ZW2 B2Z	depth to water table study
Step-Wise Layered Soil	—[2]	60	B2XA	B2YA	B2ZA	layered site study
[illegible]il	120[1]	0 40 deep	C2XW1 C2XW2 C2X	— — —	C2ZW1 C2ZW2 C2Z	depth to water table study

(1) The governing case corresponding to the depth to base rock study is used

(2) Site parameters similar to the WNP-2 nuclear station is used

2D SSI ANALYSIS CASE IDENTIFICATIONS

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALTSIS OF NUCLEAR ISLAND STRUCTURES

SOIL SENSITIVITY STUDIES

- FREE FIELD SITE RESPONSE ANALYSIS
  - A SERIES OF ONE-DIMENSIONAL FREE-FIELD SOIL COLUMN ANALYSES, USING THE COMPUTER PROGRAM SHAKE, WAS PERFORMED TO OBTAIN THE STRAIN-COMPATIBLE SOIL PROPERTIES FOR SSI ANALYSIS

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

- 3D SOIL-STRUCTURE INTERACTION ANALYSIS

  - PERFORMED FOR ALL 3 DESIGN SOIL PROFILES
    HARD ROCK
    SOFT ROCK
    SOFT-TO-MEDIUM-STIFF

  - FOR HARD ROCK SITE WHERE THE SHEAR WAVE VELOCITY IS IN EXCESS OF 8,000 FT/SEC, THE SOIL-STRUCTURE INTERACTION EFFECT IS NEGLIGIBLE. THEREFORE, THE N.I. IS ANALYZED AS A FIXED-BASE STRUCTURE, USING BSAP WITHOUT THE FOUNDATION MEDIA.

  - FOR THE OTHER DESIGN SOIL PROFILES THE SEISMIC SOIL-STRUCTURE INTERACTION ANALYSIS OF THE COUPLED N.I. AND SOIL FOUNDATION MODEL IS PERFORMED USING SASSI.

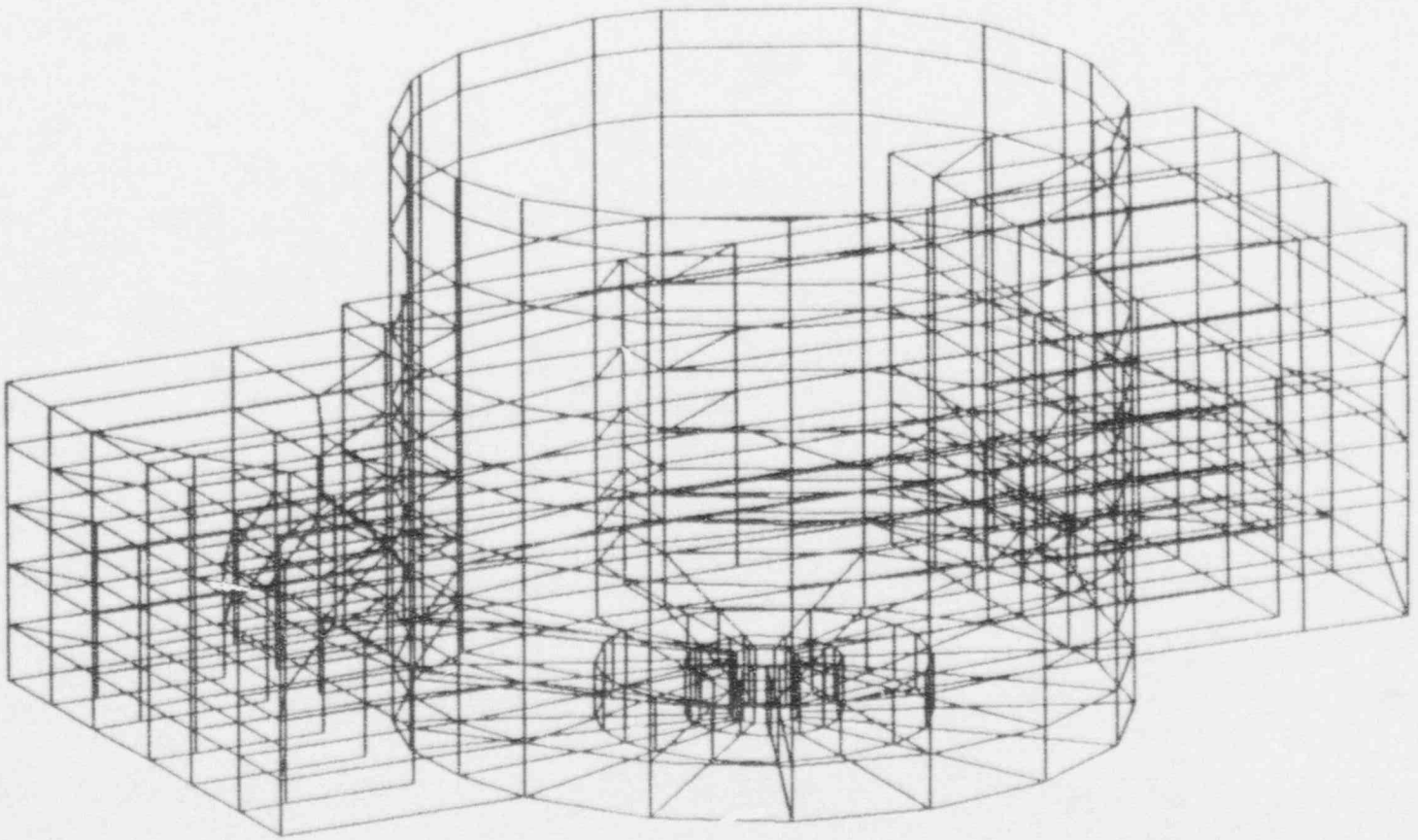
  - PROCEDURE USED FOR MODELING

    - 3D FINITE ELEMENT MODEL PROVIDES THE BASES FOR THE DEVELOPMENT OF THE LUMPED MASS STICK MODEL OF THE N.I. STRUCTURES

    - 3D LUMPED MASS STICK MODELS ARE USED IN THE SSI ANALYSIS

3.7 SEISMIC DESIGN

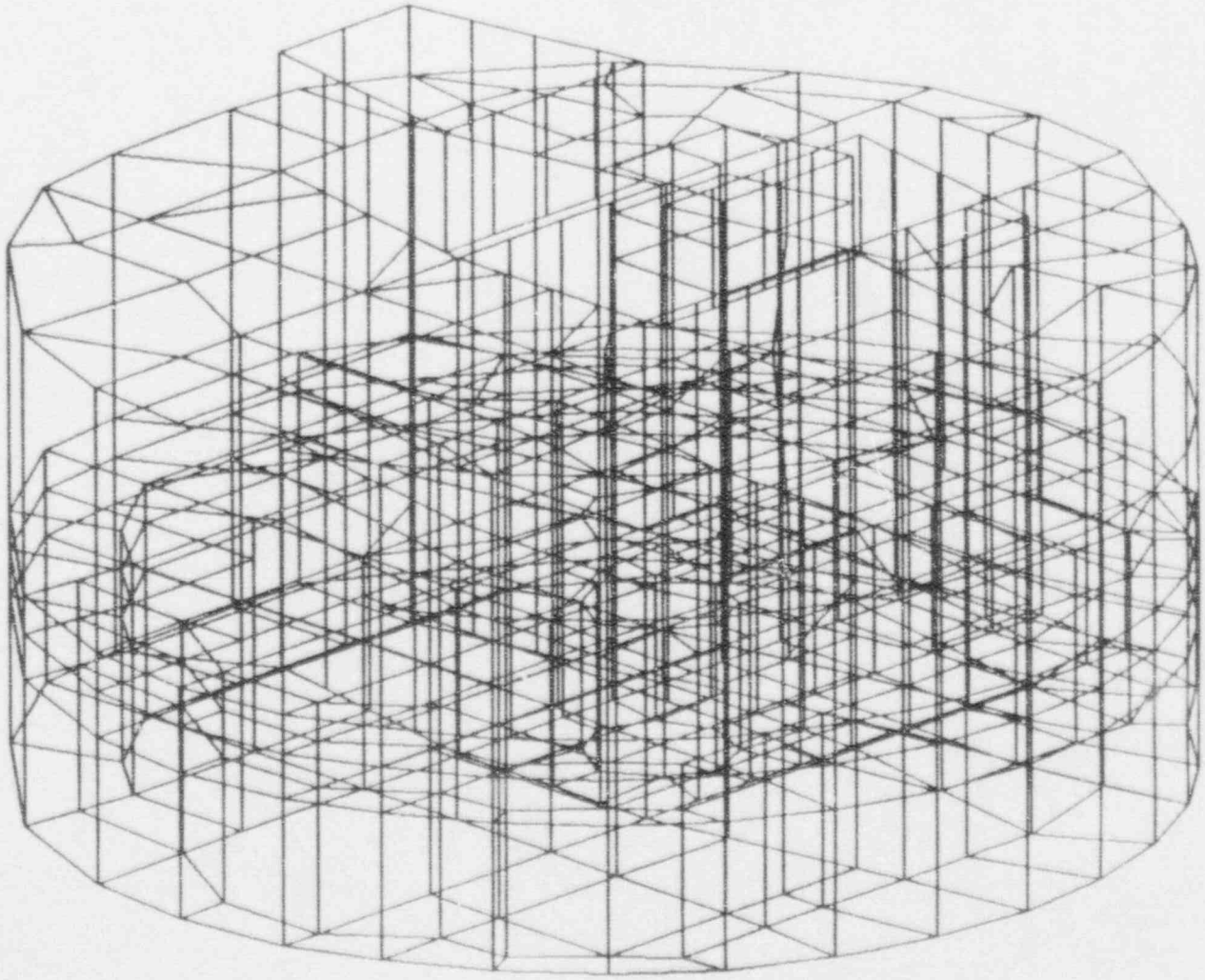
SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



3D FEM OF COUPLED SHIELD AND AUXILIARY BUILDINGS

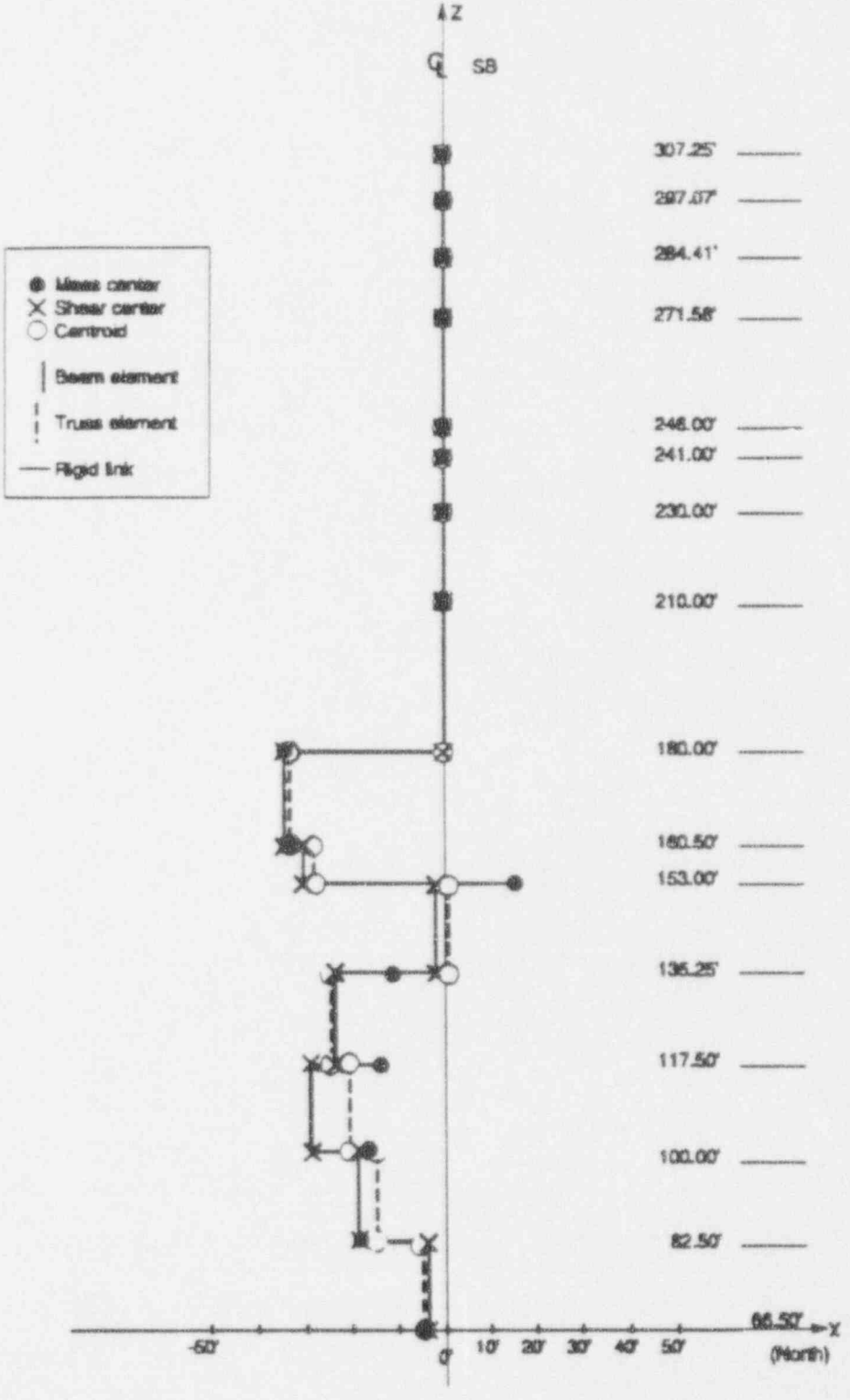
3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



3D FEM OF CONTAINMENT INTERNAL STRUCTURES

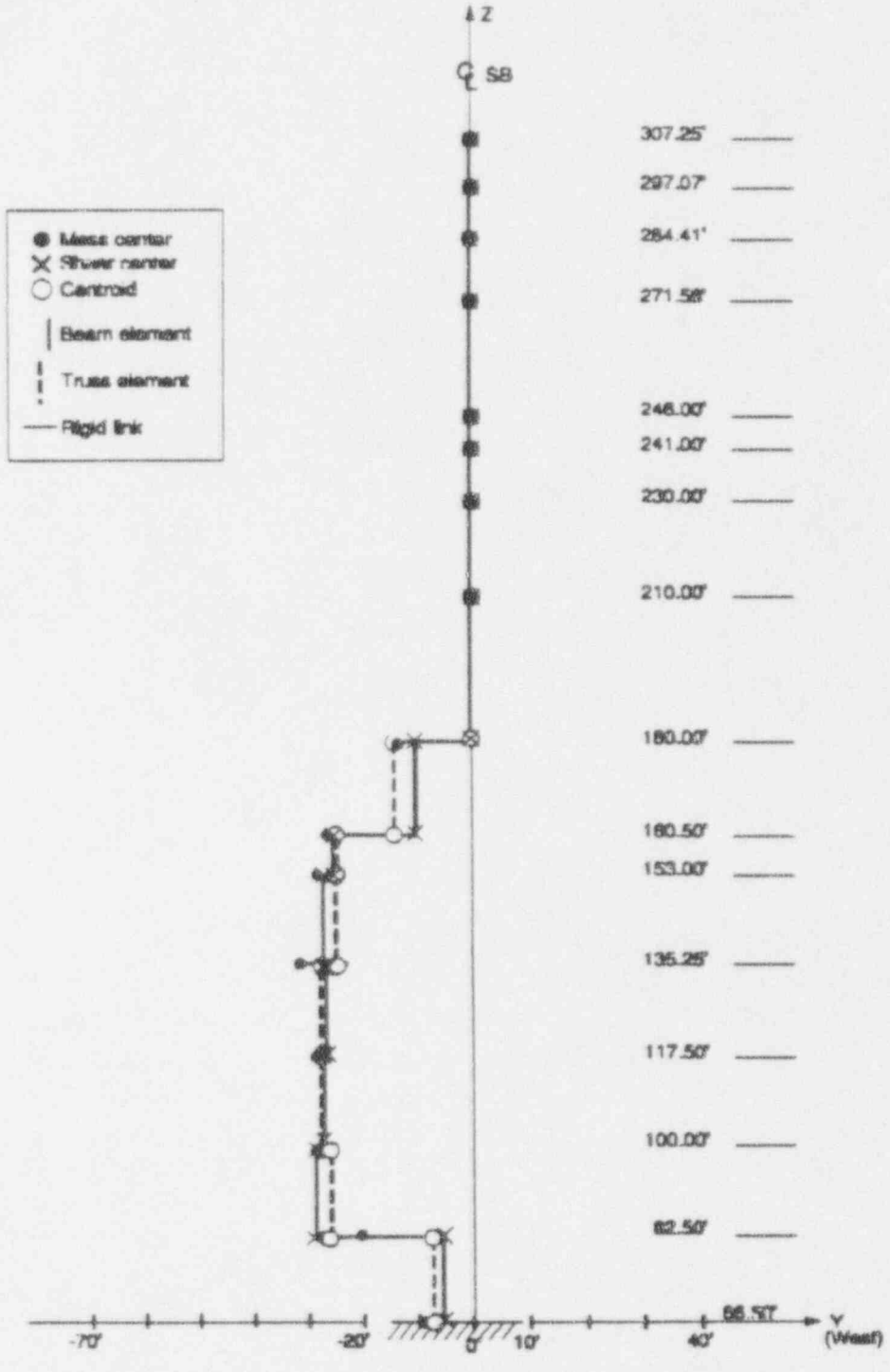
SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



COUPLED SHIELD & AUXILIARY BUILDINGS, N-S STICK MODEL

3.7 SEISMIC DESIGN

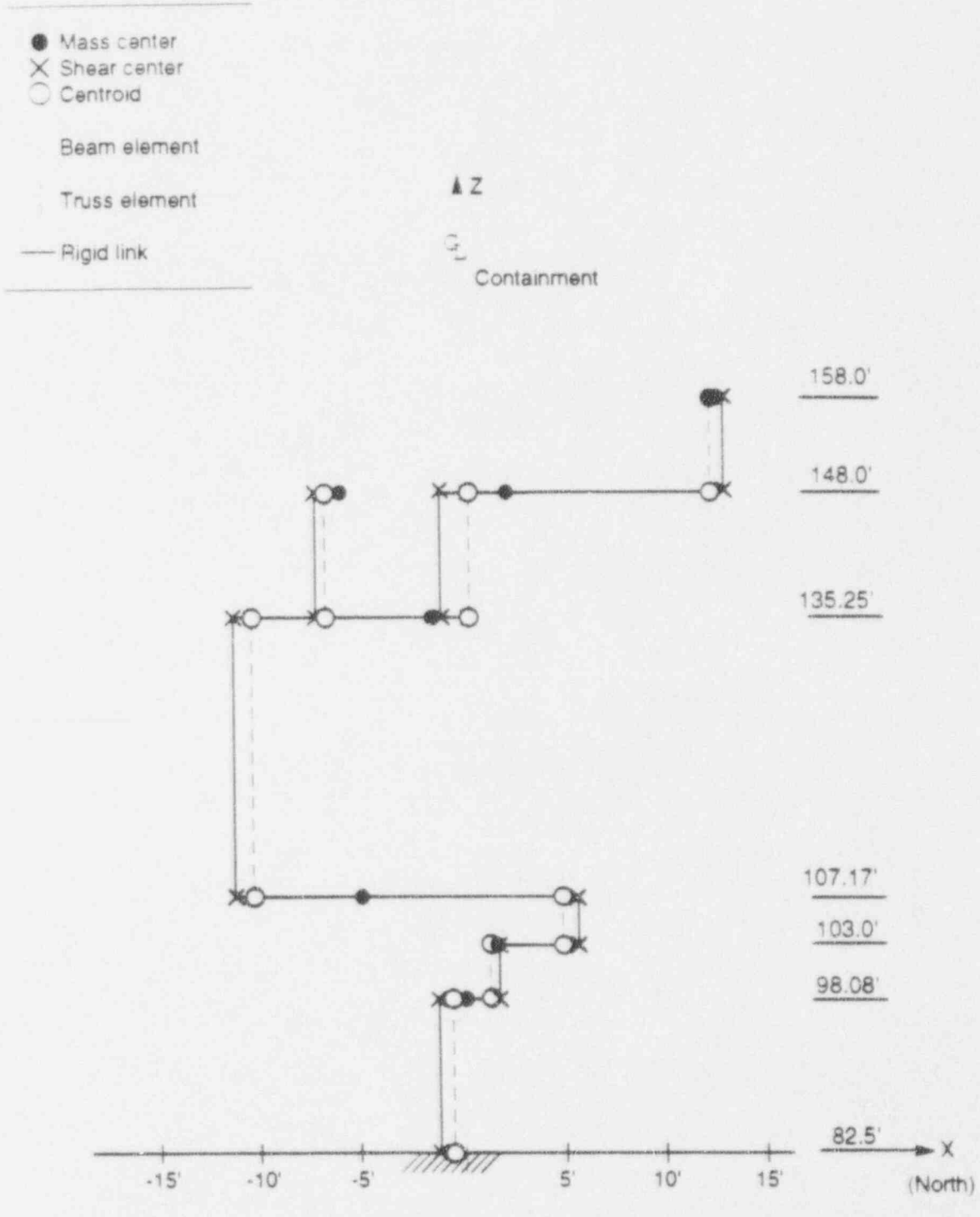
SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



COUPLED SHIELD & AUXILIARY BUILDINGS, E-W STICK MODEL

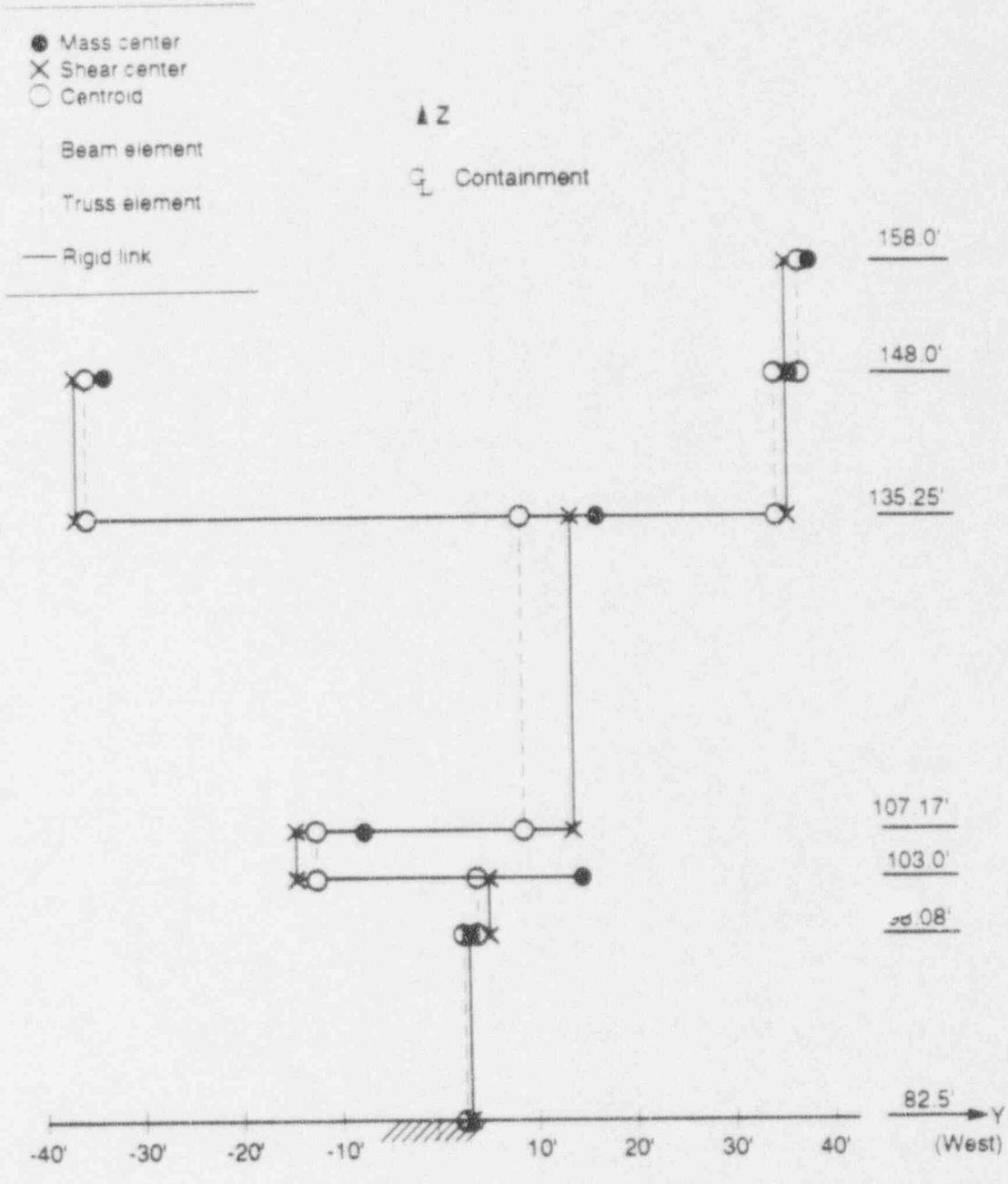
3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



CONTAINMENT INTERNAL STRUCTURES, N-S STICK MODEL

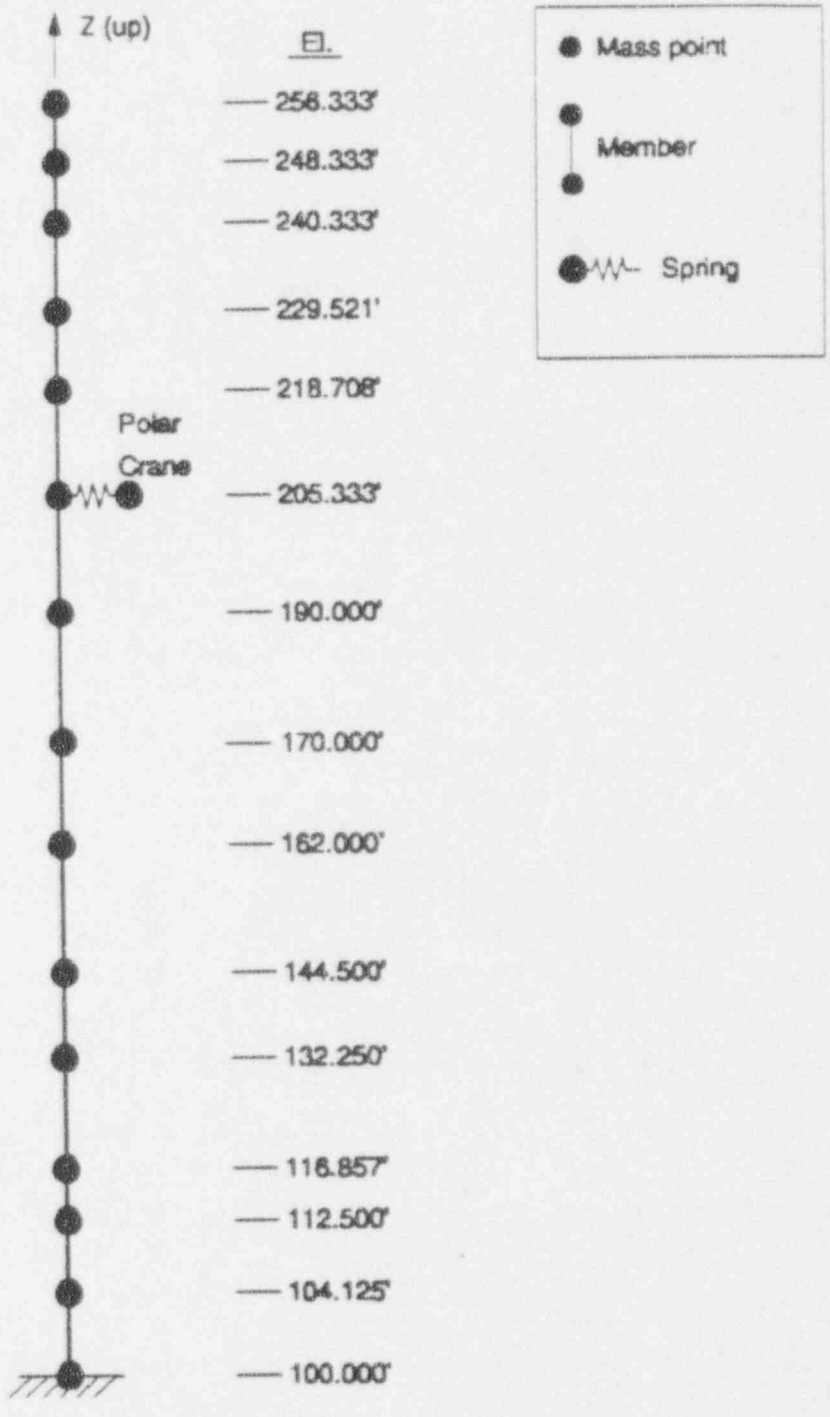
SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



CONTAINMENT INTERNAL STRUCTURES, E-W STICK MODEL

3.7 SEISMIC DESIGN

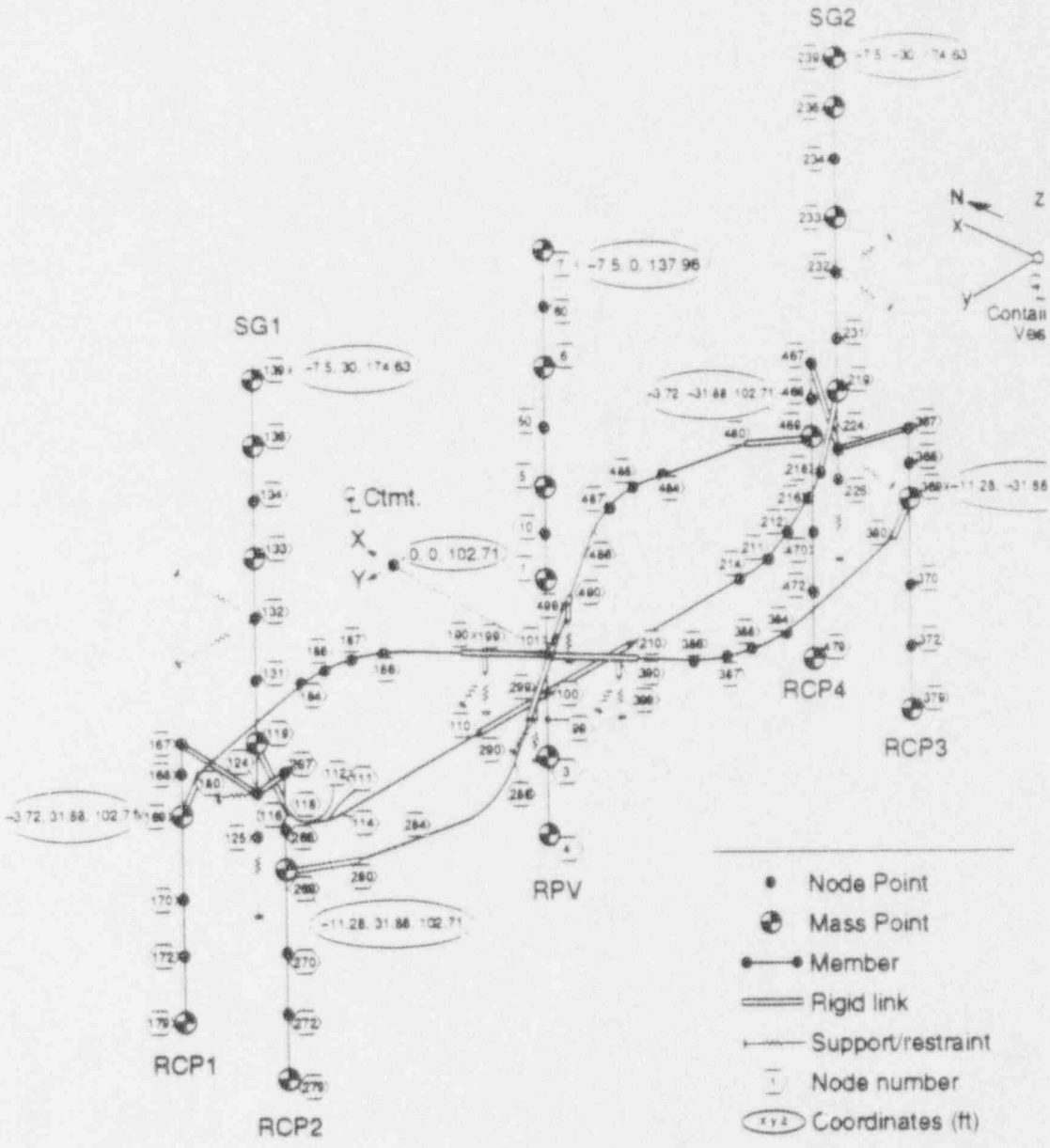
SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



STEEL CONTAINMENT VESSEL, LUMPED MASS STICK MODEL

3.7 SEISMIC DESIGN

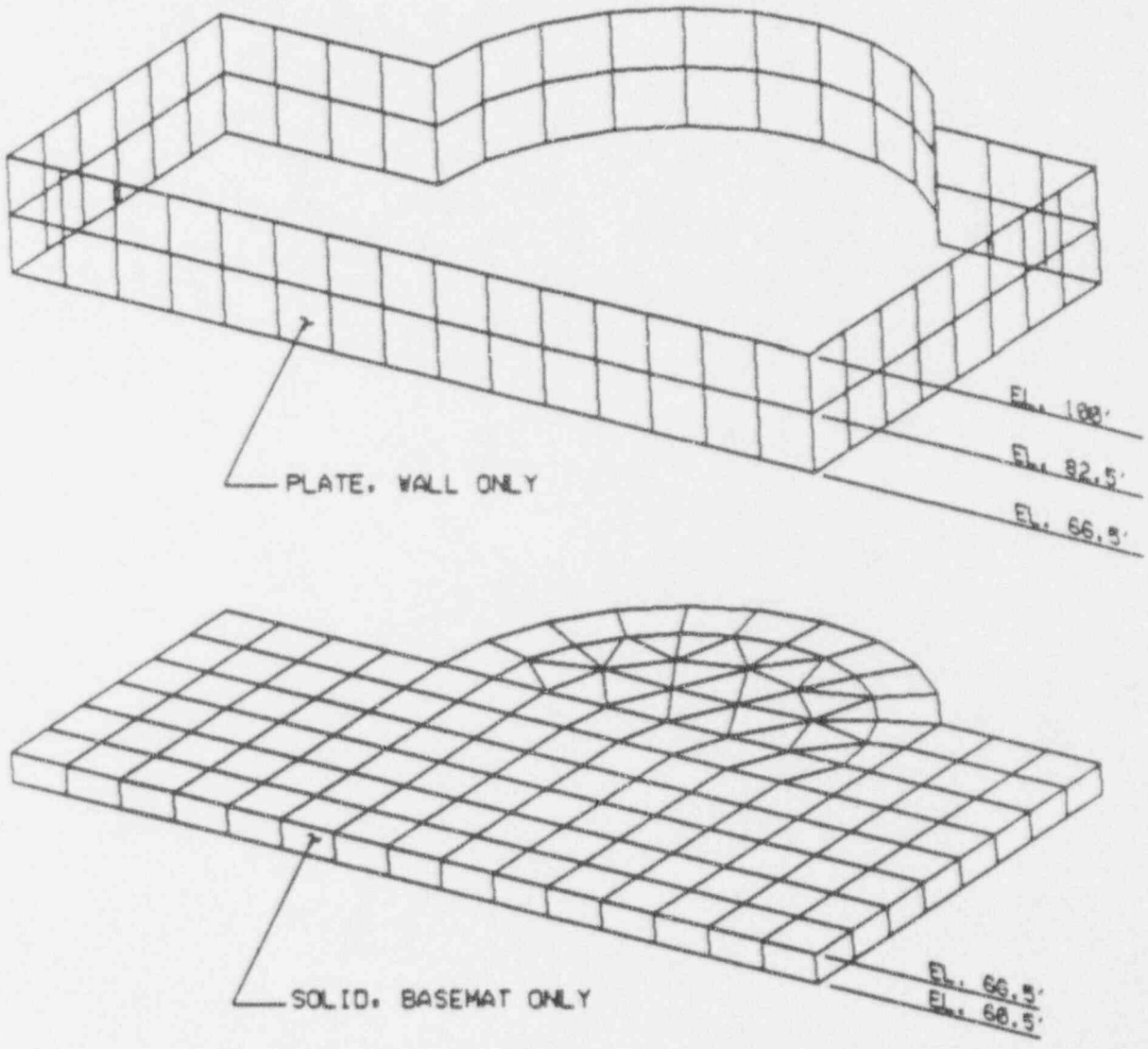
SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



REACTOR COOLANT LOOP, LUMPED MASS STICK MODEL

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



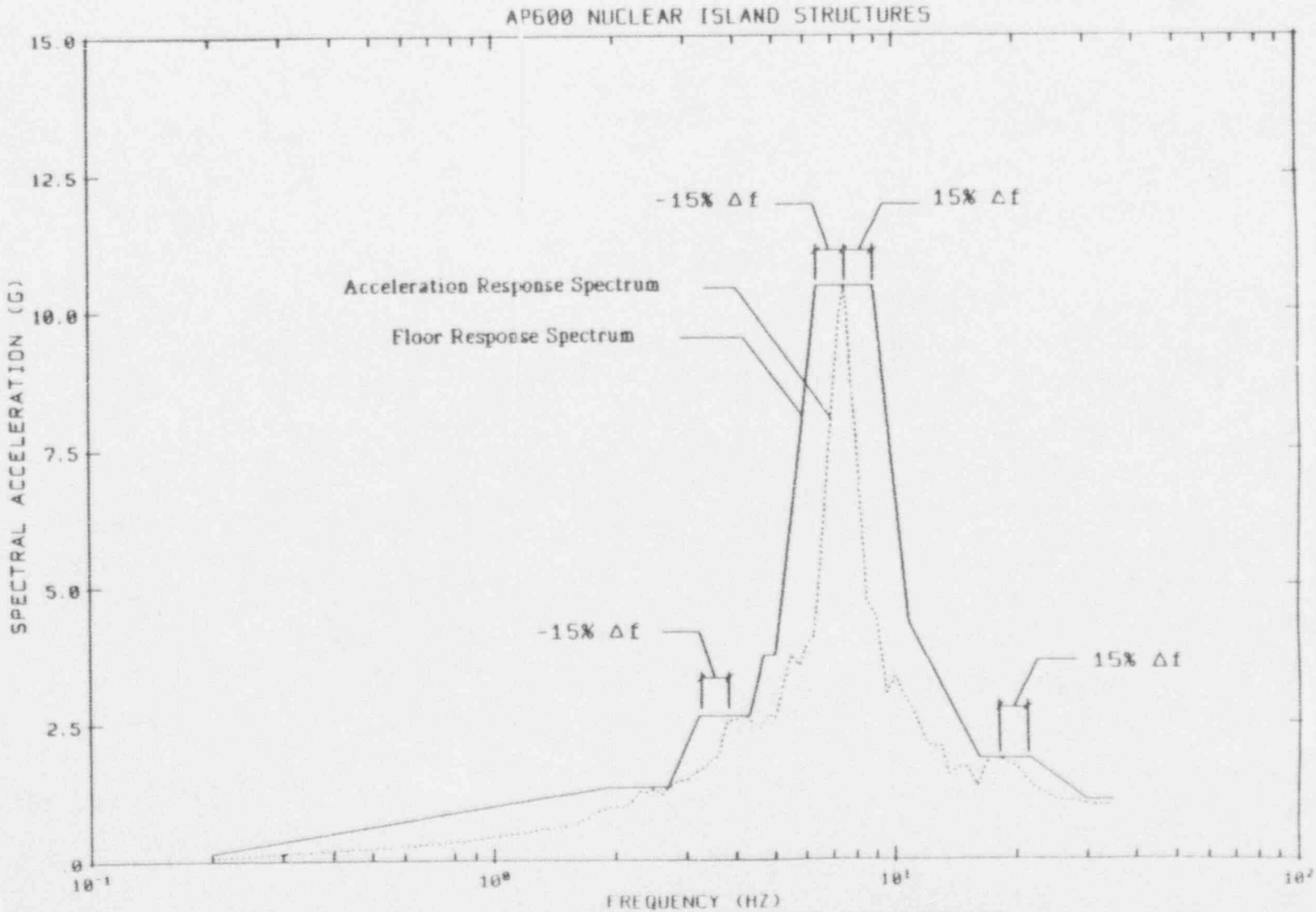
NI FOUNDATION MODEL FOR SEISMIC ANALYSIS

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

- DEVELOPMENT OF FLOOR RESPONSE SPECTRA
  - GENERATED ACCORDING TO R.G. 1.122
  - COMPUTED USING THE NODAL TIME-HISTORY RESPONSES DETERMINED FROM THE N.I. SEISMIC TIME-HISTORY ANALYSIS OF THE THREE DESIGN SOIL PROFILES
  - DEVELOPED FOR ASME CODE CASE N411 DAMPING AND FOR DAMPING VALUES EQUAL TO 2,3,4,5,7,10, AND 20 PERCENT OF CRITICAL DAMPING
  - FLOOR RESPONSE SPECTRA FOR THE DESIGN OF SUBSYSTEMS AND COMPONENTS ARE DEVELOPED BY ENVELOPING THE NODAL RESPONSE SPECTRA DETERMINED FOR THE THREE DESIGN SOIL PROFILES
  - ENVELOPED FLOOR RESPONSE SPECTRA ARE SMOOTHED AND BROADENED BY ± 15%

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES



TYPICAL DESIGN FLOOR RESPONSE SPECTRUM

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

- EFFECTS OF CONCRETE CRACKING FOR C-1 STRUCTURES
  - EFFECTS OF CONCRETE CRACKING ARE INCLUDED IN THE ± 15% BROADENING OF THE FLOOR RESPONSE SPECTRA
  - THE ASCE WORKING GROUP ON STIFFNESS OF LOW RISE REINFORCED CONCRETE SHEAR WALLS APPEAR TO ENDORSE THAT POSITION

3.7 SEISMIC DESIGN

SEISMIC SYSTEM ANALYSIS OF NUCLEAR ISLAND STRUCTURES

- ACCIDENTAL TORSION

  - THE LUMPED MASS STICK MODELS OF THE NUCLEAR ISLAND STRUCTURES ARE BASED ON FINITE ELEMENT MODELS WHICH ACCURATELY REPRESENT THE ACTUAL ECCENTRICITIES; THEREFORE, ADDITIONAL TORSION NEED NOT BE CONSIDERED

  - THE COMMENTARY TO ASCE STANDARD 4-86 FOR SEISMIC ANALYSIS OF SAFETY-RELATED NUCLEAR STRUCTURES, SEPTEMBER 1986 ALSO INPLIES THAT IF AN ECCENTRICITY BETWEEN THE CENTER OF MASS AND THE CENTER OF RIGIDITY IS ALREADY CONSIDERED, ADDITIONAL ECCENTRICITY NEED NOT BE CONSIDERED.

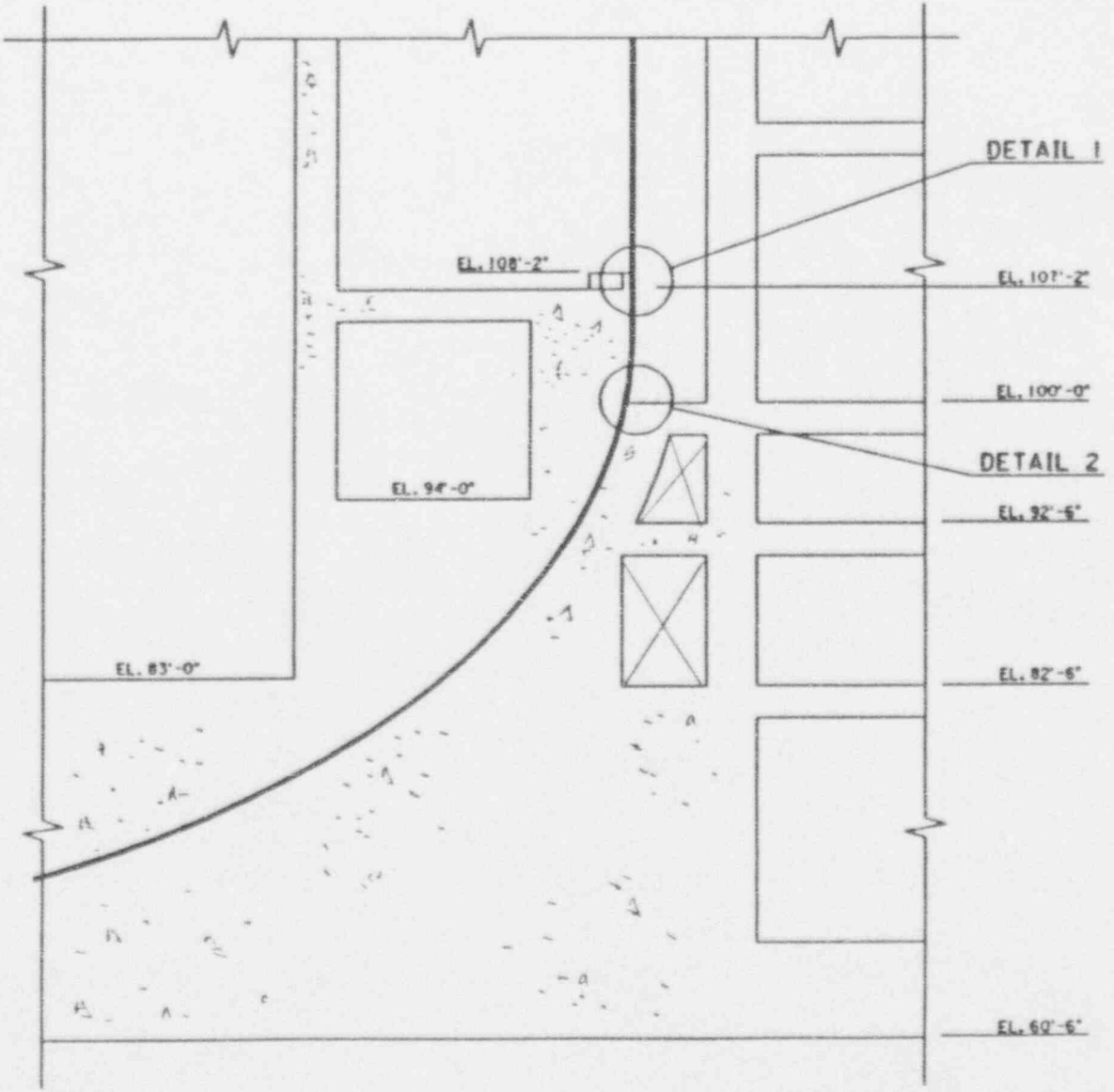
3.7 SEISMIC DESIGN

(1.0, 0.4, 0.4) METHOD FOR SEISMIC LOADS

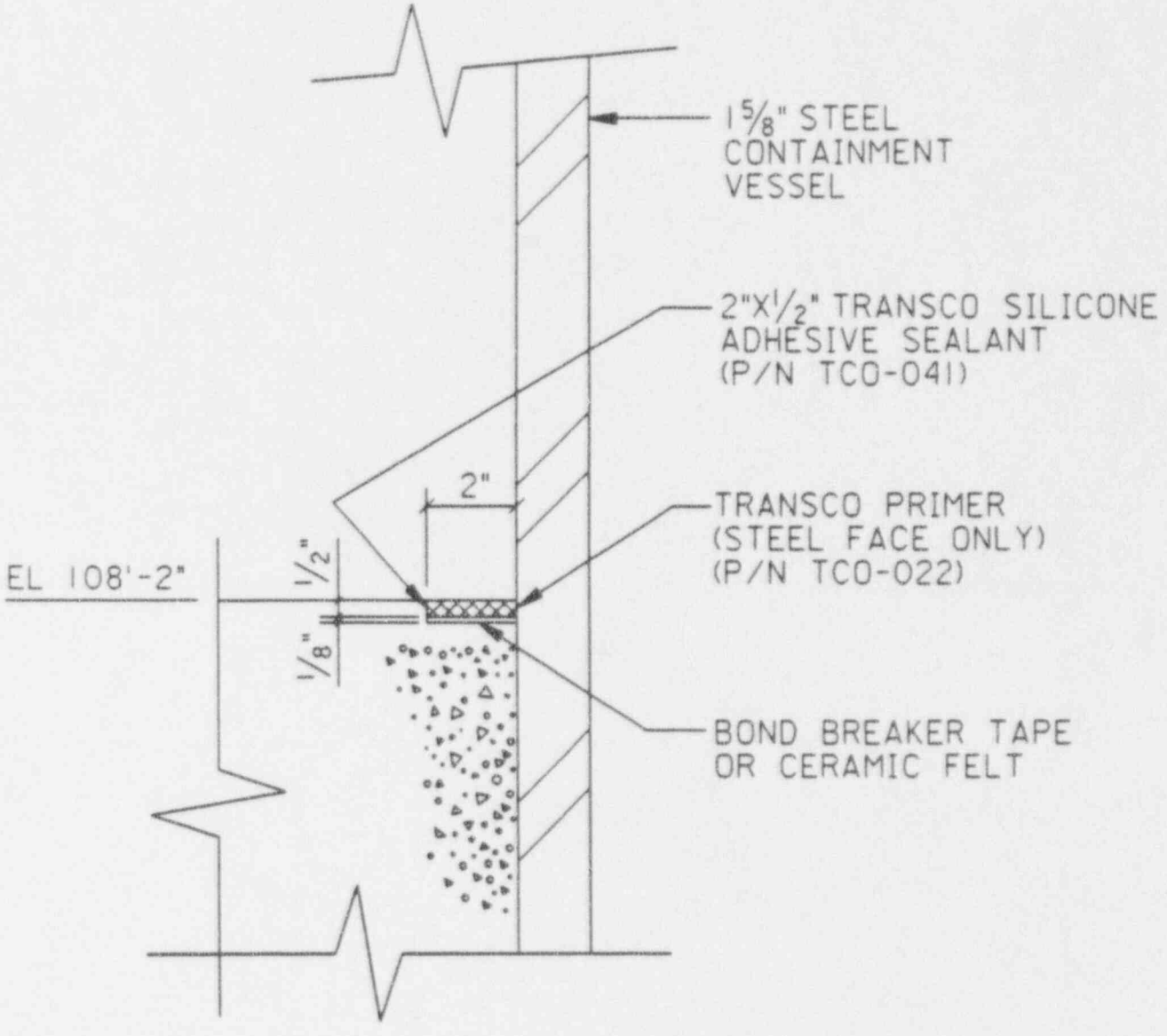
- REFERENCES
  - ASCE STANDARD 4-86 FOR SEISMIC ANALYSIS OF SAFETY-RELATED NUCLEAR STRUCTURES, SEPTEMBER 1986
  - DEVELOPMENT OF CRITERIA FOR SEISMIC REVIEW OF SELECTED NUCLEAR POWER PLANTS, NATHAN M. NEWMARK CONSULTING ENGINEERING SERVICES, MAY 1978 (NUREG/CR-0098)

3.8.2 STEEL CONTAINMENT

SEAL MATERIAL AT TRANSITION REGION



3.8.2 STEEL CONTAINMENT
SEAL MATERIAL AT TRANSITION REGION



DETAIL 1

(DETAIL 2 Similar)

3.8.2 STEEL CONTAINMENT

SEAL MATERIAL AT TRANSITION REGION

- SEALS ARE NOT SAFETY-RELATED
- FUNCTION OF SEALS IS TO PREVENT MOISTURE INGRESS BETWEEN VESSEL AND CONCRETE UNDER ANTICIPATED OPERATING CONDITIONS, INCLUDING TESTING, NORMAL OPERATION, AND TRANSIENT CONDITIONS TO 150 F.
- FUNCTION OF SEAL IS NOT REQUIRED FOR MORE SEVERE EVENTS (LARGE OR SMALL LOCA, OR EXTENDED OPERATION OF PASSIVE RHR). SEAL WOULD BE INSPECTED AND REPLACED, IF NECESSARY, PRIOR TO RESTART AFTER SUCH AN EVENT.
- MAXIMUM RADIAL DEFLECTION OF CONTAINMENT AT ELEVATION 108'2" UNDER ANTICIPATED OPERATING CONDITIONS IS APPROXIMATELY 0.5". SEAL IS DESIGNED TO ACCOMMODATE THIS DEFLECTION.

3.8.2 STEEL CONTAINMENT

SEAL MATERIAL AT TRANSITION REGION

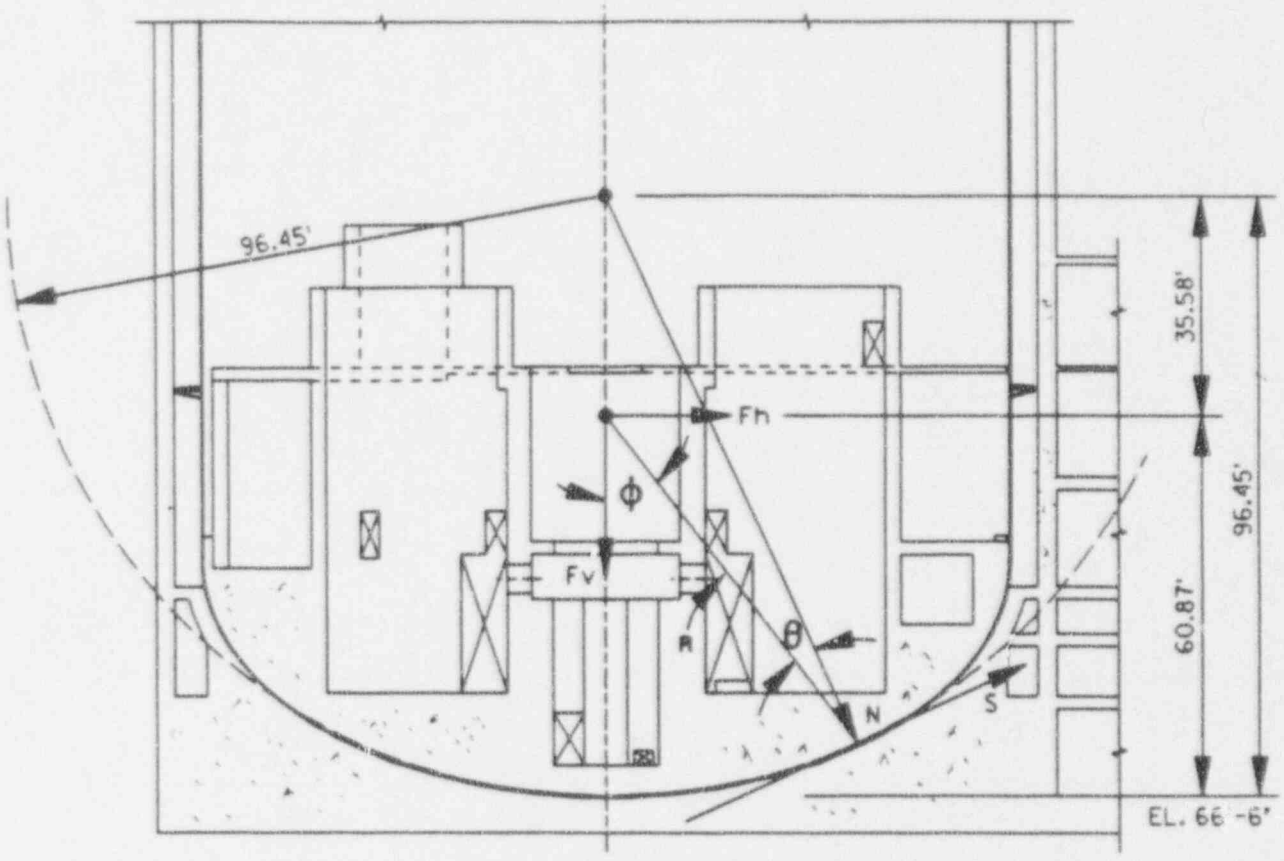
- SEAL MATERIAL BEING EVALUATED IS A TRANSCO SILICONE ADHESIVE SEALANT (P/N TCO-041), WHICH IS A NEUTRAL METHANOL CURE SILICONE DESIGNED ESPECIALLY FOR CONCRETE AND MASONRY SUBSTRATES. THIS SILICONE SEALANT IS A ULTRA-LOW MODULUS MATERIAL WITH THE FOLLOWING AS CURED PROPERTIES:

- DUROMETER HARDNESS (Shore A, points - ASTM D2240)	15
- ULTIMATE TENSILE STRENGTH (psi) @ MAXIMUM ELONGATION (ASTM D412)	100
- ELONGATION, PERCENT MAXIMUM (ASTM D412)	1600
- PEEL STRENGTH (#/in, MIL-S-8802)	25
- TENSILE ADHESION WITH 25% EXTENSION (ASTM C1135)	15
- TENSILE ADHESION WITH 50% EXTENSION (ASTM C1135)	20
- JOINT MOVEMENT CAPABILITIES, EXTENSION:	100%
- JOINT MOVEMENT CAPABILITIES, COMPRESSION:	-50%

- STAYS RUBBERY FROM -45 TO 300°F
- AGED IN ATLAS WEATHEROMETER (TT-S-001543) FOR 6000 HRS. WITH SLIGHT REDUCTION IN HARDNESS, ELONGATION, AND TENSILE/PEEL STRENGTHS.
- RADIATION DATA IS NOT AVAILABLE. HOWEVER, WE EXPECT IT TO HAS A HIGH RADIATION RESISTANCE CAPABILITY SIMILAR TO OTHER SILICONE COMPOUNDS.

- AGING TESTS (RADIATION AND TEMPERATURE) FOLLOWED BY PRESSURE TEST WILL BE PERFORMED TO DEMONSTRATE BOTH DESIGN FUNCTION AS WELL AS DESIGN LIFE.

CONTAINMENT STABILITY - SLIDING



Total Weight of Structures, W = 70,137 Kips

SSE Loads @ Elevation 66'-6":

Fx = 27,782 Kips, Fy = 23,382 Kips, and Fz = 23,002 Kips

Myy = 1,742,453 Kip-ft, Mxx = 1,359,953 Kip-ft, and Mt = 160,830 Kip-ft

$Fh = \sqrt{(Fx)^2 + (Fy)^2} = 36{,}312$ *Kips*, $Fv = W - Fz = 47{,}135$ *Kips*

$\phi = Tan^{-1}\frac{Fh}{Fv} = 37.61°$

$R = \sqrt{(Fh)^2 + (Fv)^2} = 59{,}500$ *Kips*, $Mr = \sqrt{(Mxx)^2 + (Myy)^2} = 2{,}210{,}343$ *Kips-ft*

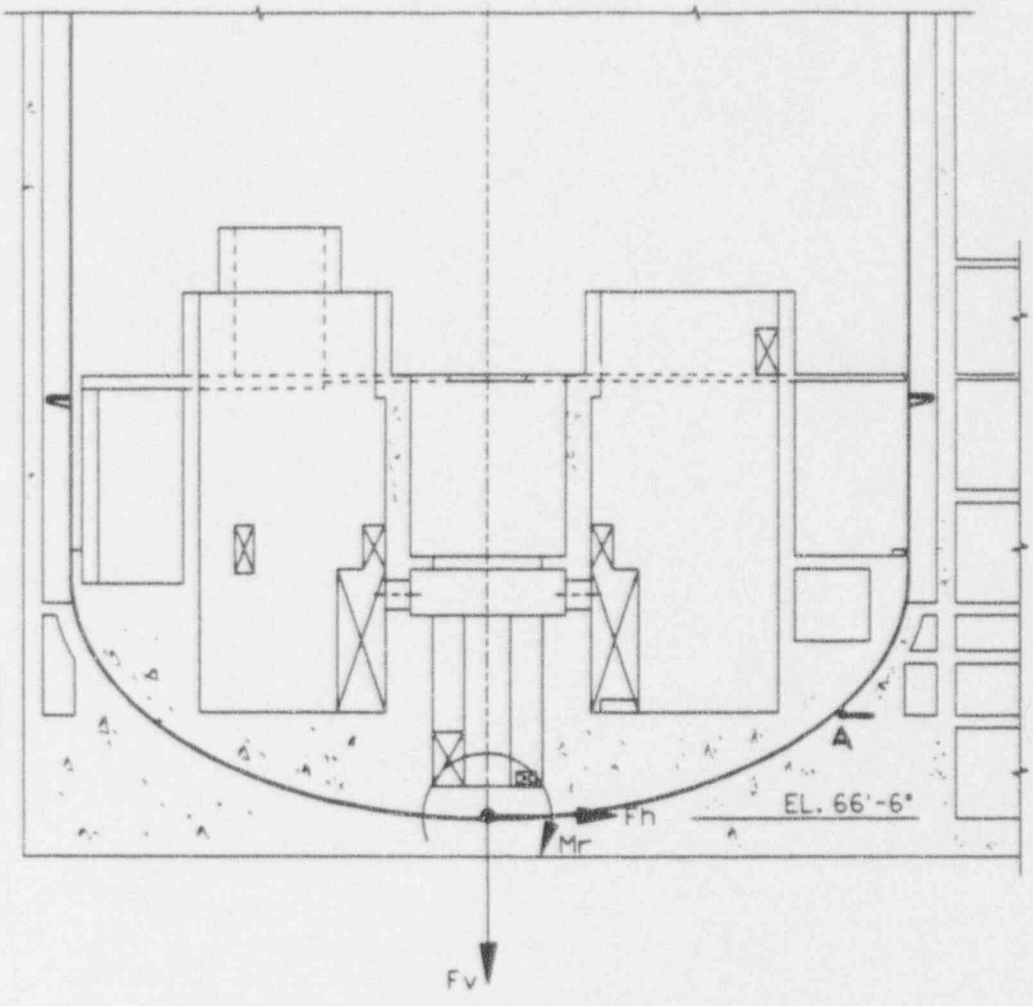
$h = \frac{Mr}{Fh} = 60.87$ *ft*

$\theta = Sin^{-1}\frac{(96.45 - h) \times Sin(180 - \phi)}{96.45} = 13.01°$

$S = R\ Sin\ \theta = 13{,}395$ *Kips*, $N = R\ Cos\ \theta = 57{,}973$ *Kips*

$\mu\ req'd = \frac{S}{N} = 0.23 \leq 0.3$

CONTAINMENT STABILITY - OVERTURNING



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$$Fh = \sqrt{(Fx)^2 + (Fy)^2} = 36{,}312 \text{ Kips}$$

$$Fv = W - Fz = 47{,}135 \text{ Kips}$$

$$Mr = \sqrt{(Mxx)^2 + (Myy)^2} = 2{,}210{,}343 \text{ Kips-ft}$$

Assumed Overturning above Point "A" @ El.82'-6" and 53.2' from Center of Containment

$$\text{Factor of Safety} = \frac{(Fv \times 53.2)}{Mr - (Fh \times 16)} = 1.54 \leq 1.1$$

3.8.4 OTHER CATEGORY I STRUCTURES

3.8.4 OTHER CATEGORY I STRUCTURES

EMBEDDED PORTION OF EXTERIOR WALLS OF N.I.

DESIGN

- CODE
  - ACI-349-90
- LOADS
  - DEAD LOADS
  - LIVE LOADS
  - SSE LOADS
  - HYDROSTATIC LOADS DUE TO GROUNDWATER AND PROBABLE MAXIMUM FLOOD
  - STATIC SOIL PRESSURE LOADS
  - SURCHARGE LOADS
  - SOIL PRESSURE INDUCED BY EARTHQUAKE (SSE)

3.8.4 OTHER CATEGORY I STRUCTURES

EMBEDDED PORTION OF EXTERIOR WALLS OF N.I.

- BACKFILL AND DESIGN ASSUMPTIONS

- GROUNDWATER	2 FT BELOW GRADE
- PROBABLE MAXIMUM FLOOD	LESS THAN THE FINISHED GRADE
- SURCHARGE	250 PSF OR ADJ. STRUCT.
- DRY UNIT WEIGHT OF BACKFILL	120 PCF
- SATURATED UNIT WEIGHT OF BACKFILL	150 PCF
- SUBMERGED UNIT WEIGHT OF BACKFILL	87.6 PCF
- ANGLE OF INTERNAL FRICTION OF BACKFILL	35^{o}
- ANGLE OF FRICTION FORCE OF BACKFILL	$17\text{-}1/2^{o}$

3.8.4 OTHER CATEGORY I STRUCTURES

EMBEDDED PORTION OF EXTERIOR WALLS OF N.I.

STATIC SOIL PRESSURE

- WALLS BELOW GRADE ARE DESIGNED FOR AT - REST SOIL PRESSURE
- COEFFICIENT OF EARTH PRESSURE FOR THE AT - REST CONDITION (K_o) IS DETERMINED AS FOLLOWS:

  $K_o = 1 - \sin \phi$

- THE AT - REST UNIT EARTH PRESSURE IS CALCULATED AS FOLLOWS:

  $P_o = K_o \gamma H$

  γ = DRY UNIT WEIGHT OF BACKFILL ABOVE WATER TABLE

  γ = SUBMERGED (BUOYANT) UNIT WEIGHT OF BACKFILL BELOW WATER TABLE

3.8.4 OTHER CATEGORY I STRUCTURES

EMBEDDED PORTION OF EXTERIOR WALLS OF N.I.

SOIL PRESSURE INDUCED BY EARTHQUAKE

- DYNAMIC EARTH PRESSURE FROM THE BACKFILL IS BASED ON THE MONONOBE - OKABE FORMULA

  $$P^{\circ}_{AE} = 1/2\ \gamma_{soil} H^2 (1 \pm a_v) K^{\circ}_{AE} + 1/2\ \gamma H^2 K_A (\pm a_v)$$

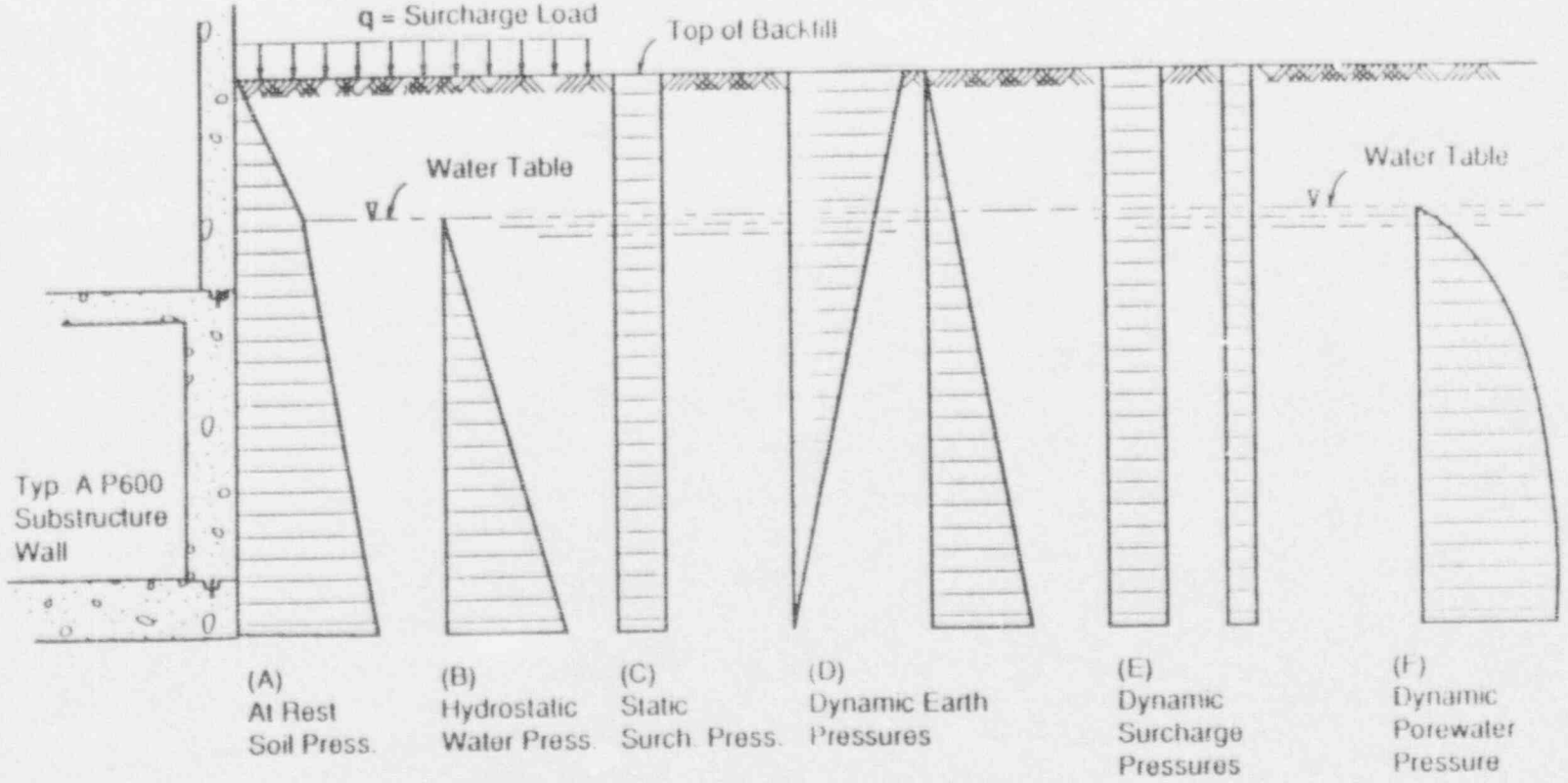
- DYNAMIC POREWATER PRESSURE

  $$P_y = 7/8\ a_h\ \gamma_w\ (h_y)^{1/2}$$

  where γ_w is the unit weight of water, h is the total depth of water and a_h is the acceleration

3.8.4 OTHER CATEGORY I STRUCTURES

EMBEDDED PORTIONS OF EXTERIOR WALLS OF N.I.



LATERAL EARTH PRESSURES AND WATER LOADINGS

3.8.4 OTHER CATEGORY I STRUCTURES

SETTLEMENT OF ADJACENT BUILDINGS

INTEGRITY OF UNDERGROUND PIPING OR TUNNEL

- THERE ARE NO SAFETY RELATED UNDERGROUND PIPING OR TUNNELS

3.8.4 OTHER CATEGORY I STRUCTURES

STABILITY EVALUATION FOR SAFETY - RELATED STRUCTURES

- ALL THE AP600 CATEGORY I STRUCTURES ARE FOUNDED ON A COMMON SINGLE BASEMAT WHICH MINIMIZES THE EFFECTS OF FOUNDATION REBOUND AND SETTLEMENT

- FOUNDATION REBOUND

  - FOUNDATION REBOUND IS SITE SPECIFIC AND WILL BE ADDRESSED BY THE COMBINED LICENSE APPLICANT.

- SETTLEMENT

  - SETTLEMENT IS SITE SPECIFIC AND WILL BE ADDRESSED BY THE COMBINED LICENSE APPLICANT.

- DIFFERENTIAL SETTLEMENT

  - SETTLEMENT IS SITE SPECIFIC AND WILL BE ADDRESSED BY THE COMBINED LICENSE APPLICANT.

- BEARING CAPACITY

  - $\geq$ 12000 POUNDS/SQUARE FOOT STATIC BEARING PRESSURE UNDER ALL SPECIFIED CONDITIONS

3.8.4 OTHER CATEGORY I STRUCTURES

SAFETY - RELATED - STRUCTURE ROOF DRAINAGE

- NO SAFETY - RELATED ROOF DRAINAGE
- CURRENTLY THERE ARE NO PLANS TO USE PIPING FOR ROOF DRAINAGE
- ROOFS WILL BE SLOPED TOWARDS THE EDGES WHERE GUTTERS WILL COLLECT DRAINAGE AND DIRECT IT TO DOWN SPOUTS
- THERE WILL NOT BE ANY PARAPETS

3.8.4 OTHER CATEGORY I STRUCTURES

USE OF EPOXY COATED REINFORCING STEEL

- EPOXY COATED REINFORCING STEEL IS NOT BEING USED ON THE AP600

3.8.4 OTHER CATEGORY I STRUCTURES

CRITICAL LOCATIONS

AUX. BUILDING - WALL ON COLUMN LINE 1 - COMBINED LOADS

LOCATION	LOAD COMB.	F_x k/ft	F_y k/ft	F_{xy} k/ft	M_x ft k/ft	M_y ft k/ft
66'-6" to 82'-6"	U-1		-101.1		66.8	137.7
	U-2	47.7	-22.7	20.7	47.9	98.5
	U-3		-72.2		39.3	85.5
	U-4	47.7	-22.7	20.7	47.9	98.5
	U-5		-75.8		51.1	104.8
82'-6" to 100'-0"	U-1		-85.0		30.1	78.2
	U-2	40.0	-26.4	13.9	55.1	99.3
	U-3		-60.7		17.7	49.6
	U-4	40.0	-26.4	13.9	55.1	99.3
	U-5		-63.7		23.0	59.4
100'-0" to 135'-3"	U-1		-66.8			20.6
	U-2	38.6	+8.8	29.8	103.5	101.9
	U-3		-47.7		90.0	104.7
	U-4	38.6	+8.8	29.8	133.2	131.6
	U-5		-50.1		78.4	93.8
135'-3" to 180'-0"	U-1		-41.9			33.4
	U-2	36.4	+2.3	32.0	113.9	171.4
	U-3		-29.9		108.1	131.9
	U-4	36.4	+2.3	32.0	151.0	208.5
	U-5		-31.4		92.3	117.3

U-1 $1.4D + 1.7L + 1.7H$
U-2 $1.0D + 1.0L + 1.0H + 1.0E_s + 1.0T_o$
U-3 $1.0D + 1.0L + 1.0H + 1.5P_a + 1.0T_o$
U-4 $1.0D + 1.0L + 1.0H + 1.0E_s + 1.0P_a + 1.0T_o$
U-5 $1.05D + 1.3L + 1.3H + 1.3T_o$

3.8.4 OTHER CATEGORY I STRUCTURES

AUXILIARY BUILDING - WALL ON COLUMN LINE 1 - MARGINS

LOCATION	VERTICAL DIRECTION		HORIZONTAL DIRECTION	
	A_s Reqrd. ins	A_s Prov. ins	A_s Reqrd. ins	A_s Prov. ins
Elevation 66'-6" to 82'-6"	1.46	1.50	1.67	2.34
Elevation 82'-6" to 100'-0"	1.41	1.50	1.63	2.34
Elevation 100'-0" to 135'-3"	2.25	2.34	2.15	2.34
Elevation 135'-3" to 180'-0"	2.78	3.0	2.5	3.0

3.8.4 OTHER CATEGORY I STRUCTURES

CRITICAL LOCATIONS

AUX. BUILDING - WALL ON COLUMN LINE 7.3 - COMBINED LOADS

LOCATION	LOAD COMB.	F_x k/ft	F_y k/ft	F_{xy} k/ft	M_x ft k/ft	M_y ft k/ft
66'-6" to 82'-6"	U-1		-62.6			
	U-2	12.5	+0.4	4.0	2.1	2.9
	U-3		-44.7			
	U-4	12.5	+0.4	4.0	2.1	2.9
	U-5		-46.9			
82'-6" to 100'-0"	U-1		-49.8			
	U-2	46.2	+13.8	23.4	3.9	2.8
	U-3		-35.6			
	U-4	46.2	+13.8	23.4	3.9	2.8
	U-5		-37.4			
100'-0" to 117'-6"	U-1		-35.6			
	U-2	26.8	+25.5	65.4	2.9	2.7
	U-3		-25.4			
	U-4	26.8	+25.5	65.4	2.9	2.7
	U-5		-26.7			
117'-6" to 135'-3"	U-1		-24.5			
	U-2	9.6	+46.0	69.8	3.7	3.4
	U-3		-17.5			
	U-4	9.6	+46.0	69.8	3.7	3.4
	U-5		-18.4			
135'-3" to 160'-6"	U-1		-14.6			
	U-2	47.6	+57.7	77.3	19.7	14.2
	U-3		-10.4			
	U-4	47.6	+57.7	77.3	19.7	14.2
	U-5		-10.9		-	

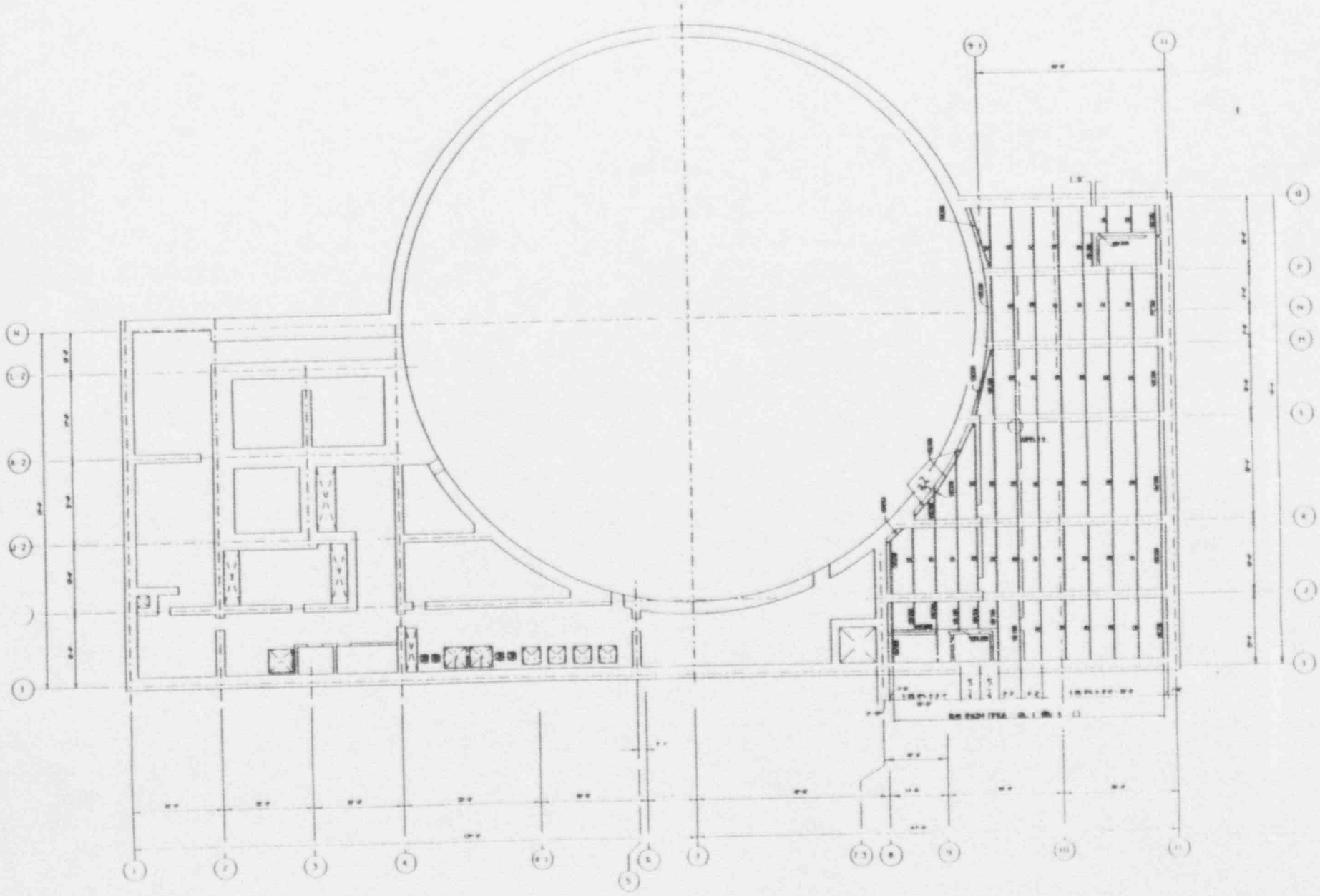
3.8.4 OTHER CATEGORY I STRUCTURES

AUXILIARY BUILDING - WALL ON COLUMN LINE 7.3 - MARGINS

LOCATION	VERTICAL DIRECTION		HORIZONTAL DIRECTION	
	A_s Reqrd. ins	A_s Prov. ins	A_s Reqrd. ins	A_s Prov. ins
Elevation 66'-6" to 82'-6"	1.06	1.19	1.06	1.19
Elevation 82'-6" to 100'-0"	1.06	1.50	1.22	1.5
Elevation 100'-0" to 117'-6"	1.37	1.50	1.38	1.5
Elevation 117'-6" to 135'-3"	1.61	2.34	1.27	1.5
Elevation 135'-3" to 166'-6"	1.96	2.34	1.93	2.34

3.8.4 OTHER CATEGORY I STRUCTURES

MARGINS



3.8.5 FOUNDATIONS

3.8.5 FOUNDATIONS

N.I. BASEMAT ANALYSIS AND DESIGN

- SOFT TO MEDIUM SOIL PROFILE USED IN ANALYSIS
- SSE BASED ON SOFT ROCK ANALYSIS RESULTS
- LOADS AND LOAD COMBINATIONS
  - 1.4D + 1.7L + 1.7H
  - 1.0D + 1.0L + 1.0H + 1.0E_{ss}
  - ABOVE EL. 100', SSE APPLIED AS EQUIVALENT STATIC LOADS
  - BELOW EL. 100', SSE APPLIED AS INERTIA LOADS
  - WATERTABLE AT EL. 100'
  - STATIC AND DYNAMIC SOIL PRESSURES
  - NO RESISTANCE FROM SIDEWALLS CONSIDERED
- MODEL
  - ANSYS REV. 4.4A1
  - MODEL EXTENDS TO EL.100' FT FOR THE AUXILIARY BUILDING AND EL.236 FOR THE

3.8.5 FOUNDATIONS

N.I. BASEMAT ANALYSIS AND DESIGN
(CONT)

SHIELD BUILDING

- BASEMAT, WALLS, AND SLABS SIMULATED BY SHELL TYPE ELEMENTS
- CONTAINMENT INTERNAL STRUCTURES SIMULATED WITH TETRAHEDRAL TYPE ELEMENTS
- COMPRESSION ONLY SPRINGS BETWEEN SOIL AND BASEMAT AND BETWEEN CONTAINMENT INTERNALS AND BASEMAT

- ANALYSIS
  - USED 1.0, 0.4, 0.4 COMBINATION FOR SSE LOADS
  - TOTAL OF 49 LOAD COMBINATIONS (48 EXTREME AND 1 NORMAL)
  - ITERATIVE PROCESS WAS PERFORMED FOR 12 WORST CASES, BASED ON RESULTS OBTAINED IN THE FIRST LINEAR ANALYSIS
  - THE 12 LOAD CASES CONVERGED BETWEEN THE THIRD AND FIFTH ITERATION AND SHOWED AN AVERAGE INCREASE OF 5 TO 10% OVER THE FIRST ITERATION RESULTS

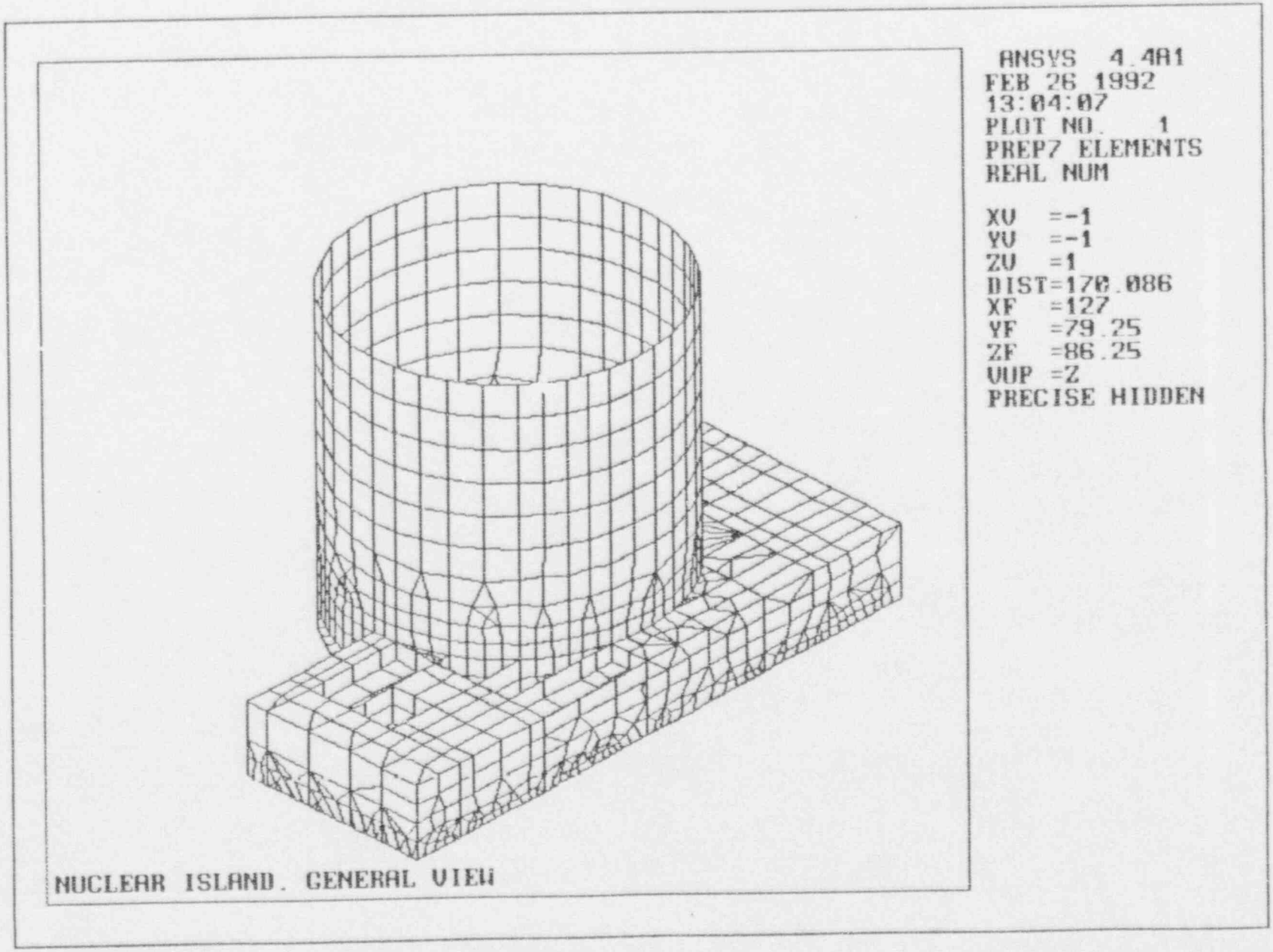
3.8.5 FOUNDATIONS

N.I. BASEMAT ANALYSIS AND DESIGN
(CONT)

- ANALYSIS RESULTS
  - RESULTS INCLUDED FORCES, SHEARS, AND MOMENTS IN THE BASEMAT, BEARING PRESSURES UNDER THE BASEMAT, AND AREA OF THE BASEMAT THAT IS UPLIFTED
  - MAXIMUM BEARING PRESSURE UNDER THE BASEMAT FOR NORMAL CONDITIONS, 11 KSF
  - MAXIMUM BEARING PRESSURE UNDER THE BASEMAT DURING SSE, 33.6 KSF
- DESIGN
  - REINFORCEMENT CALCULATION WAS PERFORMED AFTER CONVERGANCE FOR EACH LOAD CASE AND ENVELOPED TO FORM THE REINFORCEMENT REQUIREMENTS
  - MARGINS AND CRITICAL LOCATIONS ARE SHOWN ON TABLES 1 AND 2

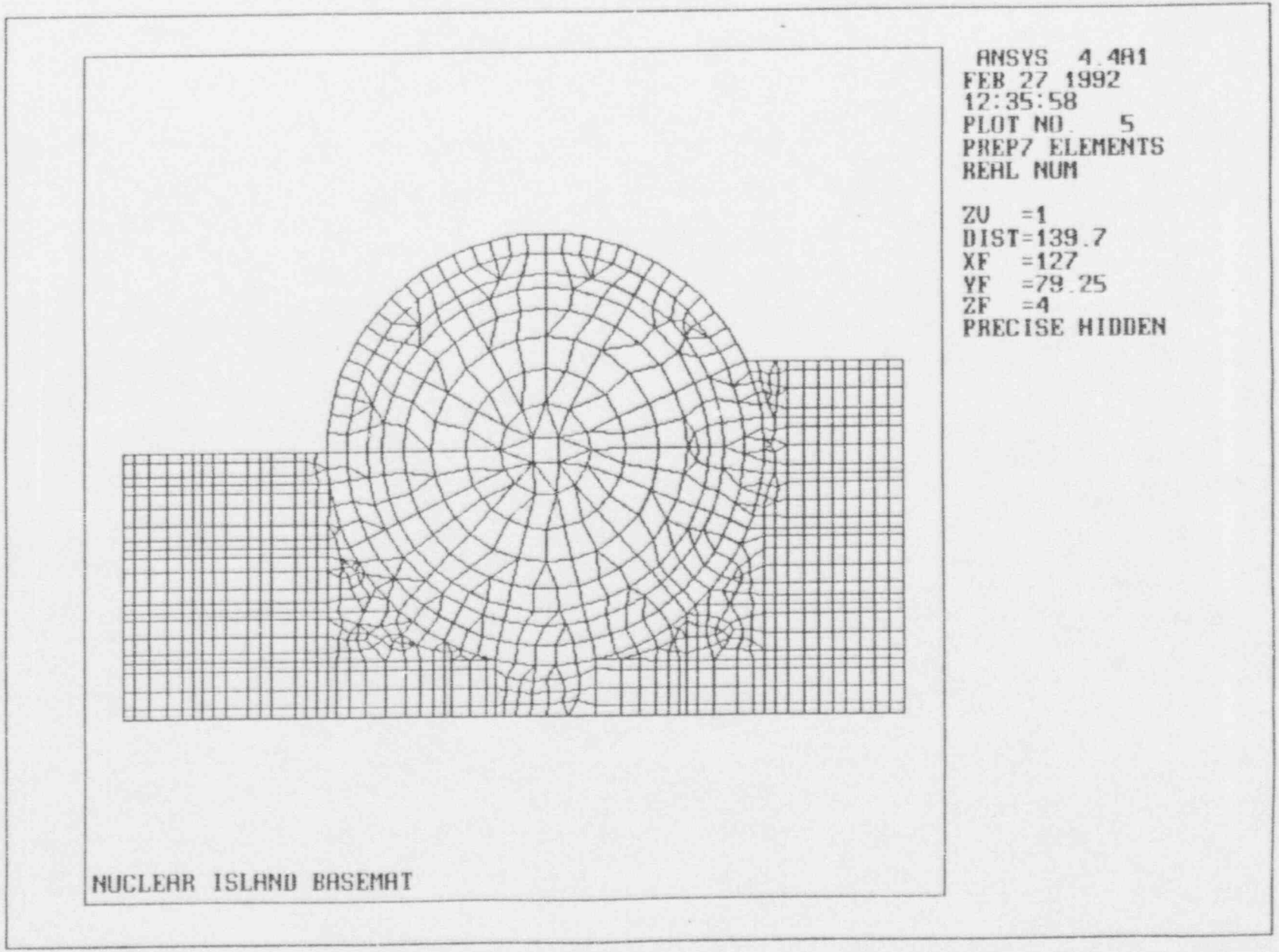
3.8.5 FOUNDATIONS

N.I. BASEMAT ANALYSIS AND DESIGN



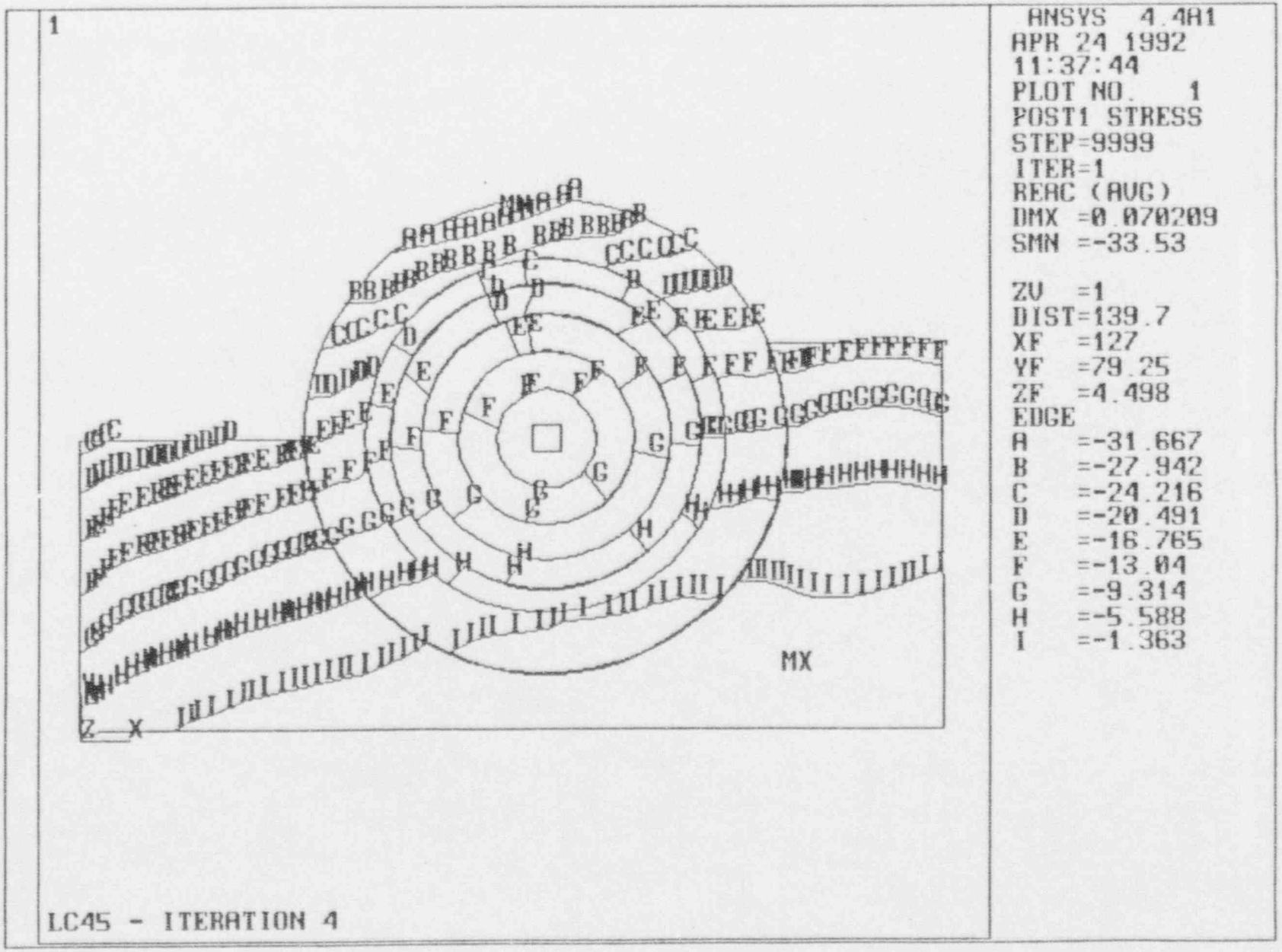
3.8.5 FOUNDATIONS

N.I. BASEMAT ANALYSIS AND DESIGN



3.8.5 FOUNDATIONS

N.I. BASEMAT ANALYSIS AND DESIGN



3.8.5 FOUNDATIONS

N.I. BASEMAT ANALYSIS AND DESIGN

TABLE 1 - CRITICAL LOCATIONS AND MARGINS - D + L

LOCATION	As Reqrd. ins.	As Prov. ins.	Margin %
Shield Bldg./Containment top x-dir. Zone D	1.055	6	+468
Shield Bldg./Containment bottom x-dir. Zone D	1.248	5.26	+321
Shield Bldg./Containment bottom Y-dir. Zone D	1.248	5.94	+376
Auxiliary Building top X-dir. Zone I	1.055	2.479	+135
Auxiliary Building top y-dir. Zone I	1.012	2.479	+145
Auxiliary Building bottom x-dir. Zone J	1.422	2.969	+108
Auxiliary Building bottom y-dir. Zone I	1.248	1.485	+19

3.8.5 FOUNDATIONS

N.I. BASEMAT ANALYSIS AND DESIGN

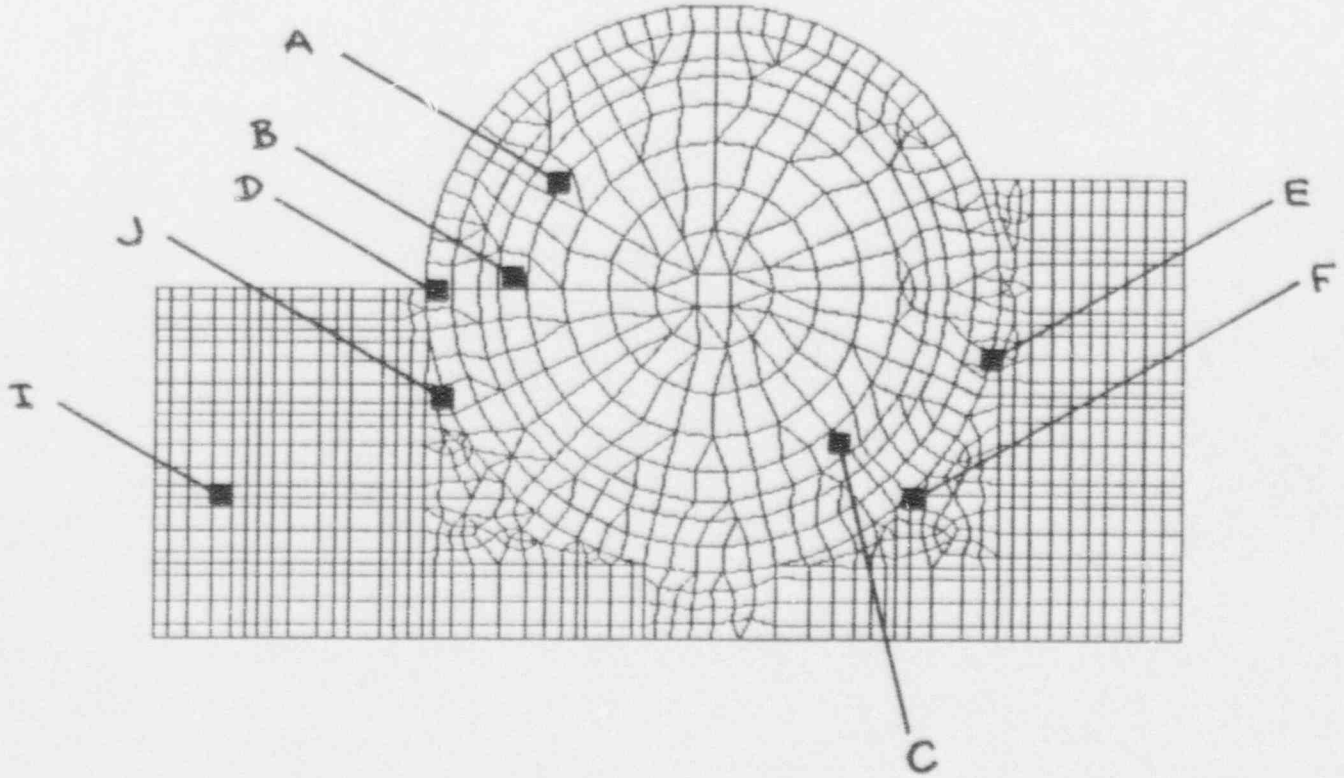
TABLE 2 - CRITICAL LOCATIONS AND MARGINS - D+L+SSE

LOCATION	As Reqrd. ins.	As Prov. ins	Margin %
Shld. Bldg./Cont., Top x-dir.(radial). Zone A	5.008	6	+21
Shld. Bldg./Cont., Top y-dir. (tangential). Zone B	5.867	7.425	+26
Shld. Bldg./Cont., Bottom x-dir. (radial). Zone C	2.000	2.969	+48
Shld. Bldg./Cont., Bottom x-dir. Zone C	2.23	2.969	+33
Shld. Bldg./Cont., Bottom y-dir. Zone D	5.739	5.94	+3.5
Auxiliary Building, Top x-dir. Zone E	1.988	2.969	+49
Auxiliary Building, Top y-dir. Zone E	1.988	2.969	+49
Auxiliary Building, Bottom x-dir. Zone F	4.000	5.94	+48
Auxiliary Building, Bottom y-dir. Zone F	2.479	5.94	+139

3.8.5 FOUNDATIONS

N.I. BASEMAT ANALYSIS AND DESIGN

CRITICAL LOCATIONS AND MARGINS



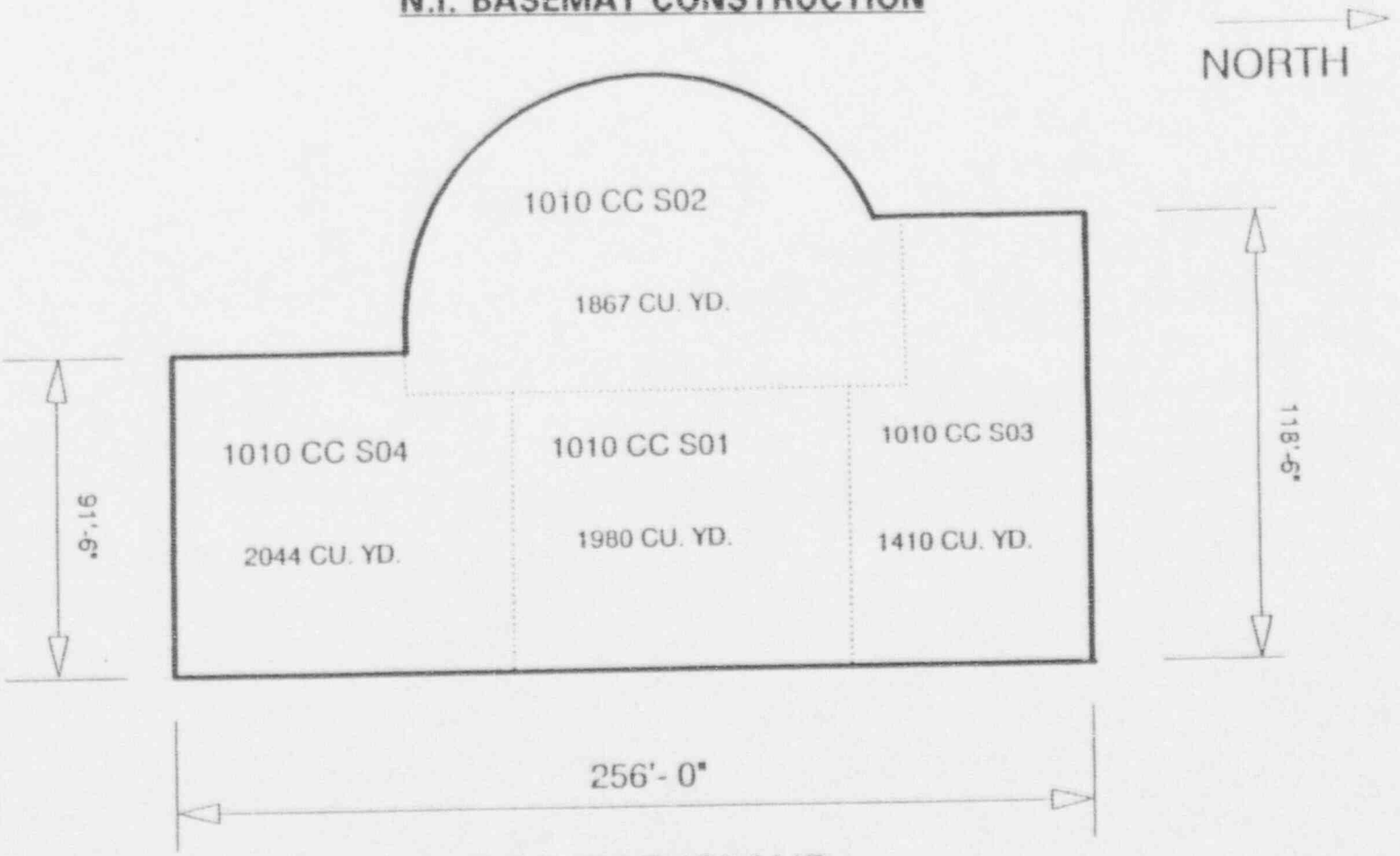
3.8.5 FOUNDATIONS

N.I. BASEMAT CONSTRUCTION

- COMMON 6 FT. THICK FLAT BASEMAT ON 6 IN. WORKSLAB
- CONCRETE PLACED IN FOUR FULL HEIGHT PLACEMENTS - NO HORIZONTAL CONSTRUCTION JOINTS
- TOP REBAR SUPPORTED BY FRAMES
- EXPANDED METAL USED AS BULKHEADS AT VERTICAL CONSTRUCTION JOINTS

3.8.5 FOUNDATIONS

N.I. BASEMAT CONSTRUCTION



NUCLEAR ISLAND

BASEMAT CONCRETE PLACEMENTS

ELEVATION 66'-6"

3.8.5 FOUNDATIONS

FS AGAINST SLIDING AND OVERTURNING OF N.I. DUE TO TORNADO AND WIND

- **TORNADO**

		E-W	N-S
	OVERTURNING	8.0	19.6
	SLIDING	6.0	6.8
• WIND	OVERTURNING	22.8	47.3
	SLIDING	9.3	10.2

ADS BLOWDOWN INTO IRWST

ADS BLOWDOWN INTO A HOT TANK IS PLANT CONDITION 4

EMERGENCY CONDITION - ASME SERVICE LEVEL C

IRWST IS A STRUCTURAL TANK

ALLOWABLE STRESSES AND LOAD FACTORS ARE ADJUSTED SIMILAR TO THOSE PERMITTED FOR AN ASME TANK

ALLOWABLE STRESSES FOR STEEL PORTIONS - 1.33 x AISC N690

LOAD FACTORS FOR CONCRETE ARE REDUCED BY 0.75

ADS BLOWDOWN OCCURS MANY HOURS AFTER THE INITIATING EVENT AND IS NOT COMBINED WITH SEISMIC

HIGH ENERGY LINE BREAK

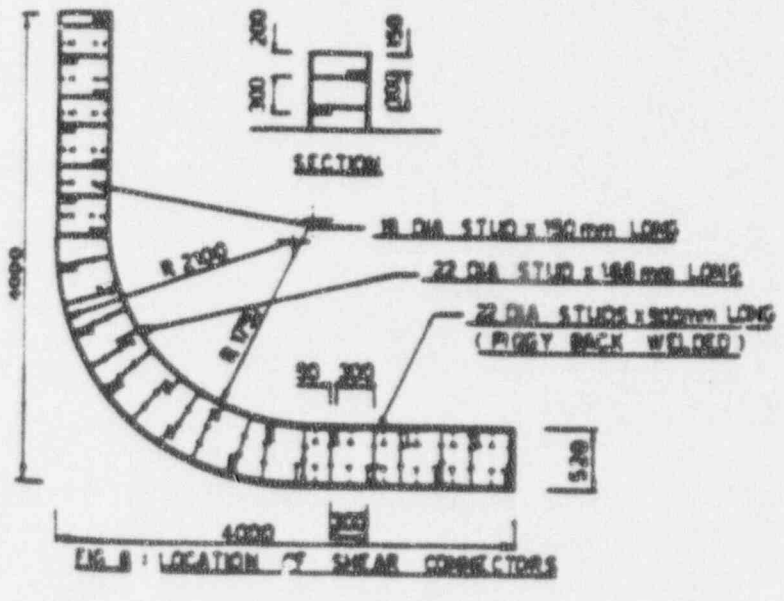
- HIGH ENERGY LINES INSIDE CONTAINMENT GREATER THAN OR EQUAL TO 4" NOMINAL DIAMETER ARE BEING QUALIFIED TO LBB
- SUBCOMPARTMENT PRESSURIZATION IS BASED ON RUPTURE OF THE LARGEST LINE NOT QUALIFIED TO LBB, AND ON LEAKAGE CRACKS IN LINES QUALIFIED TO LBB
- MAIN STEAM, FEEDWATER AND SG BLOWDOWN PIPING ARE ENCLOSED BY A GUARDPIPE THROUGH THE ANNULUS
- MSIV COMPARTMENTS ARE EVALUATED FOR ONE SQUARE FOOT BREAK
- A LIMITED NUMBER OF CREDIBLE MISSILES ARE IDENTIFIED IN SSAR SECTION 3.5. THESE ARE EVALUATED ON A CASE BY CASE BASIS WHEN DESIGN DATA IS AVAILABLE ON THE SOURCE EQUIPMENT

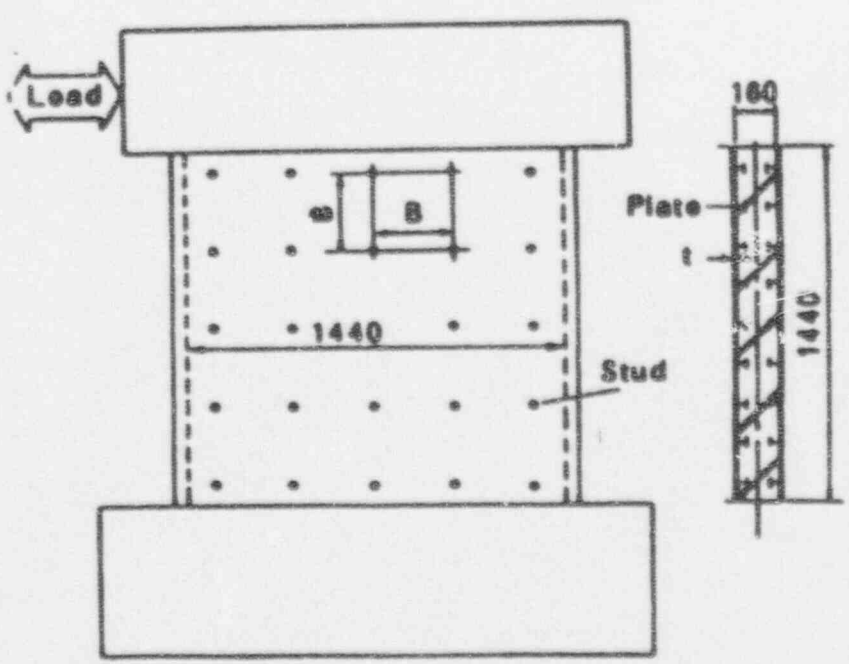
REFERENCES FOR STRUCTURAL MODULES

REFERENCE	SCOPE
ASCE, Composite and Mixed Construction, Proceedings of the U.S./Japan Joint Seminar, July 18-20, 1984	Multiple papers on composite construction
ASCE, Composite Construction in Steel and Concrete, Proceedings of an Engineering Foundation Conference, New Hampshire, June 7-12, 1987.	Multiple papers on composite construction
H.Takeuchi, H.Okamura, "Composite Structure of Concrete and Steel Plate", IABSE Symposium, Paris-Versailles, 1987.	Concrete slab with stiffened steel bottom plate - design of shear connectors
T. Fukumoto, B. Kato, et al, "Concrete Filled Steel Bearing Walls," IABSE Symposium, Paris-Versailles, 1987.	Shear and compression tests of various configurations of plates and shear connectors
R.Narayan, H.D.Wright, H.R.Evans, R.W.Francis, " Load Tests on Double Skin Composite Girders", Proceedings - Composite Construction in Steel and Concrete, 1987, Published by ASCE.	Bending tests on curved beams with stud shear connectors
A.Kaneuji, Y.Okuda, K.Hara, H.Masumoto, "Feasibility Study of Concrete Filled Steel (SC) Structure for Reactor Building", 10th International Conference on Structural Mechanics in Reactor Technology, 1989.	Overview of steel plate construction approach
H. Akiyama, H. Sekimoto, M. Tanaka, K. Inoue, M. Fukihara, Y. Okuda, "1/10th Scale Model Test of Inner Concrete Structure Composed of Concrete Filled Steel Bearing Wall", 10th International Conference on Structural Mechanics in Reactor Technology, 1989.	Tests of a concrete filled steel plate model of typical PWR internal structures for cyclic loads and comparison with similar tests for a reinforced concrete model.
H.Akiyama, H.Sekimoto, M.Fukihara, K.Nakanashi, K.Hara, "A Compression and Shear Loading Test of Concrete Filled Steel Bearing Wall", 11th International Conference on Structural Mechanics in Reactor Technology, 1991.	Cyclic compression and shear tests of concrete filled steel plate wall models.

LOAD TESTS ON DOUBLE SKIN COMPOSITE GRIDERS

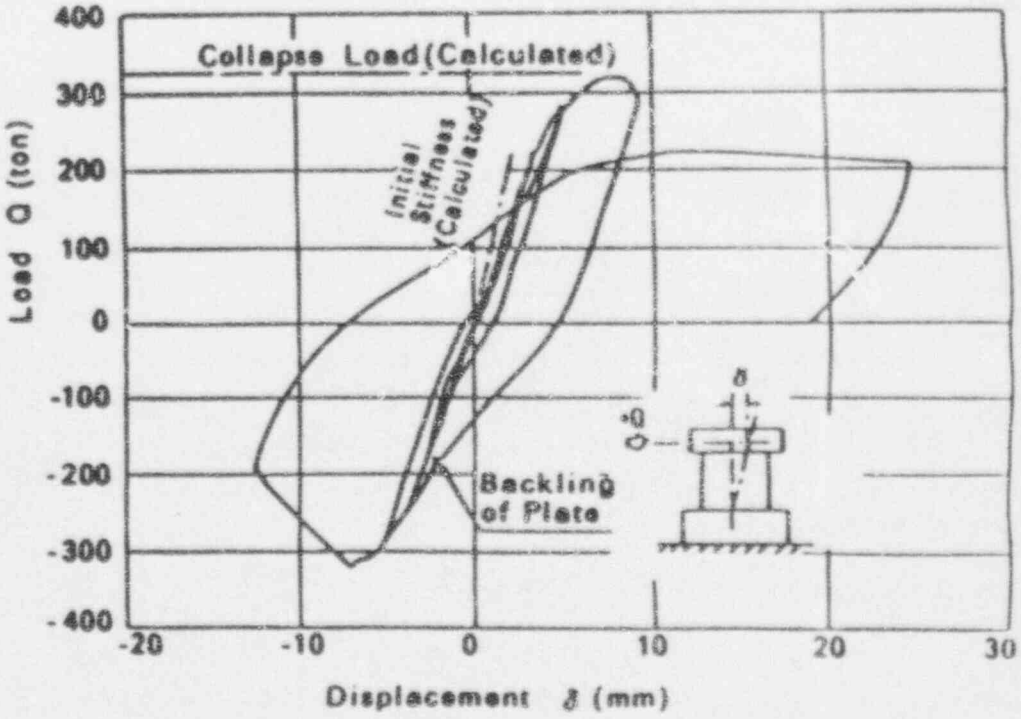
R. Narayanan, H.D. Wright, H. R. Evans and R. W. Francis





Thickness of Plate	(t)	3.2 mm
Stud Pich	(B)	320 mm
	(B/t)	100

Dimension of Specimen



Relationship of Shearing Load and Displacement

Specimen	Cross Section	Structure	Width Thickness Ratio	Stiffening Method
Non Stiffening 200K		SC	200	Non Stiffening
One Insert Plate 100k		SC	100	Insert Plate (1-PL-3.2)
Two Insert Plates 67K		SC	67	Inser Plate (2-PL-3.2)
Angle 67A		SC	67	Angle (4-L50×50×4)
Stud 35S		SC	35	Headed Stud (φ8, ℓ=40, @80)
Steel 100S		Steel	100	Insert Plate (1-PL-3.2)
Concrete OC(Com.) 1C(Shear)	OC / 1C	Concrete	—	—

※ Concrete : Fc240 Surface Plate : PL.-3.2
Side Plate : PL.-22(Com.),PL-19(Shear)

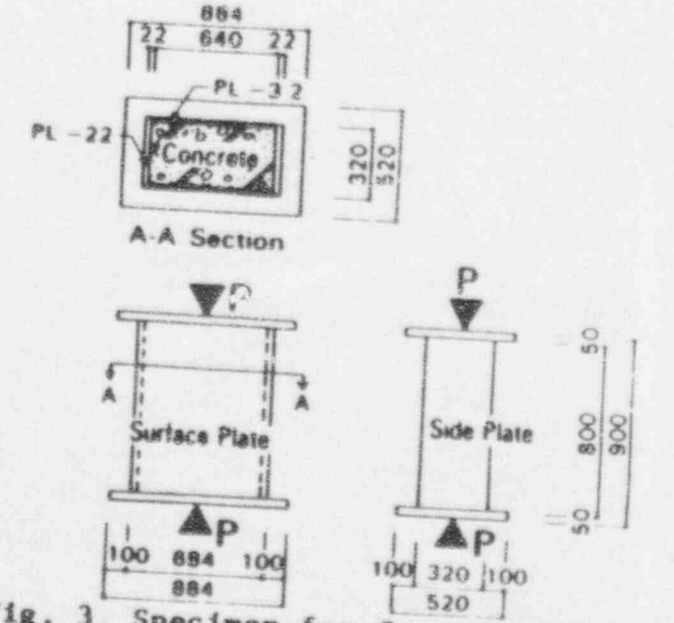


Fig. 3 Specimen for Compression Test

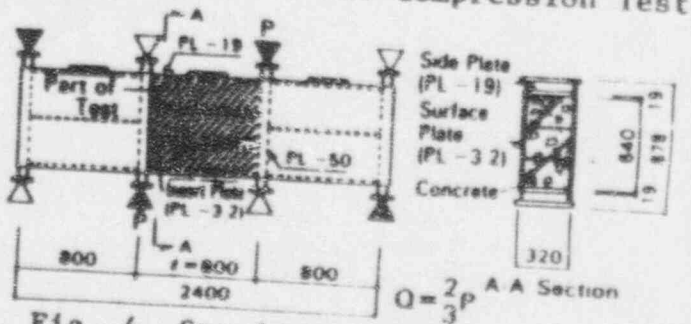
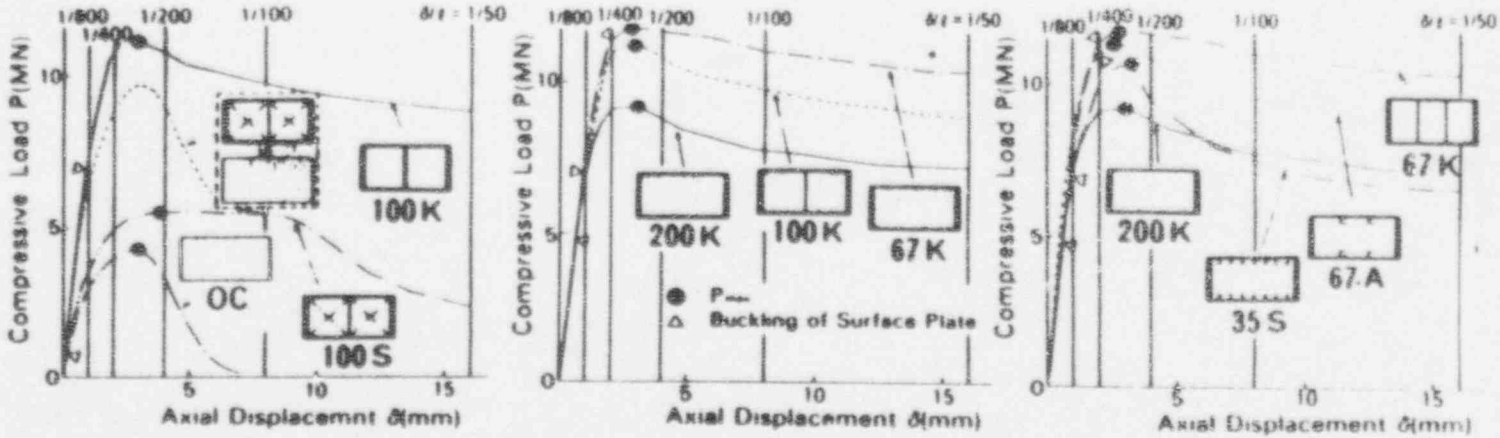
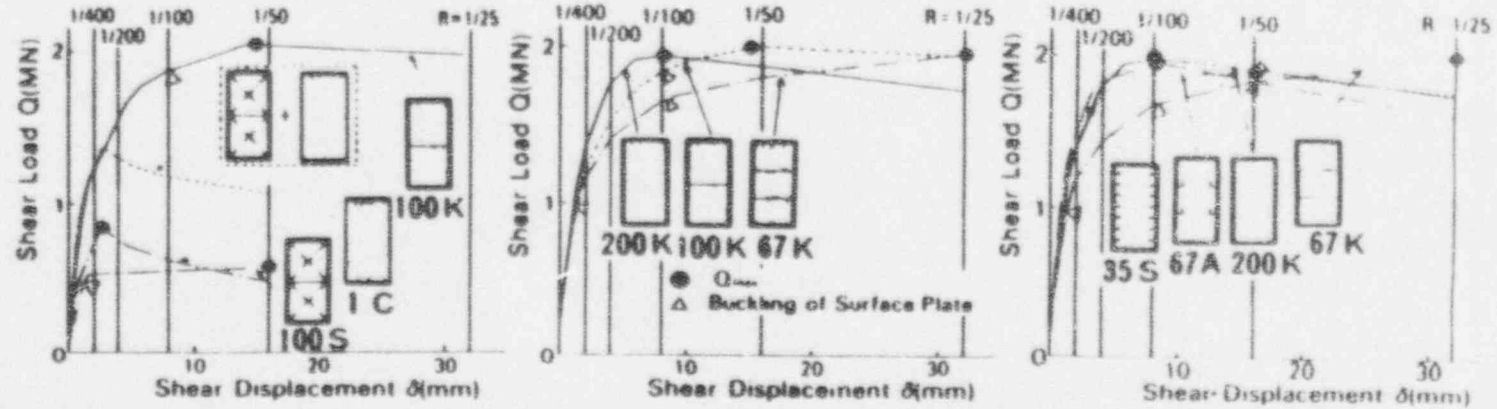


Fig. 4 Specimen for Shear Test



(a) Composite Effects (b) Effects of Insert Plate (c) Stiffening Methods

Fig. 5 Load-Displacement Relationship for Each Parameter in Compression Tests



(a) Composite Effects (b) Effects of Insert Plate (c) Stiffening Methods

Fig. 6 Load-Displacement Relationship for Each Parameter in Shear Tests

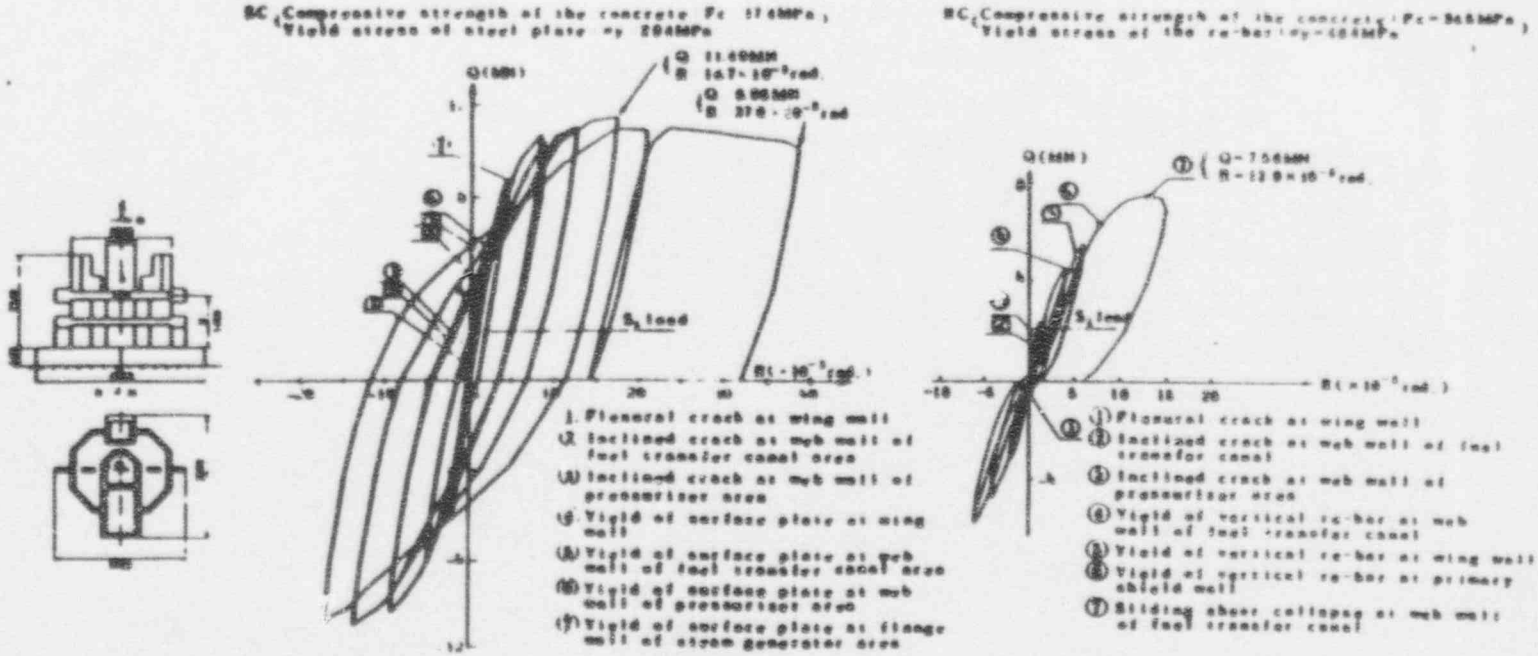


Fig. 3 Load Relative Rotation Angle Relationship

STRUCTURAL MODULE DESIGN DEVELOPMENT

- O DESIGN CRITERIA ESTABLISHED AND DOCUMENTED IN SSAR
- O PRELIMINARY DESIGN DESCRIBED IN SSAR; DETAILED DESIGN IS PART OF FIRST-OF-A-KIND ENGINEERING
- O CONSERVATIVE DESIGN APPROACH IS SUPPORTED BY EXISTING CODES AND TEST DATA
- O SEISMIC MARGIN IS SUCH THAT THE CONTAINMENT INTERIOR STRUCTURE HCLPF EXCEEDS THOSE OF MANY COMPONENTS AND DOES NOT CONTRIBUTE TO SEISMIC RISK
- O ADDITIONAL TESTING COULD QUANTIFY MARGIN AND PERMIT RELAXATION OF DESIGN CRITERIA