NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

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March 23, 1984

Docket No. 50-423

B11088

Director of Nuclear Reactor Regulation
Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

References: (1) B. J. Youngblood to W. G. Counsil, Request for Additional Information for Millstone Nuclear Power Station, Unit No. 3, dated December 5, 1983.

(2) B. J. Youngblood to W. G. Counsil, Draft Safety Evaluation Report (DSER) for Millstone Nuclear Power Station, Unit No. 3, dated December 20, 1983.

(3) E. L. Doolittle memorandum to B. J. Youngblood, NRC Structural Audit of Millstone 3 - Agenda, dated February 14, 1984.

Dear Mr. Youngblood:

Millstone Nuclear Power Station, Unit No. 3
Meeting Summary of NRC Structural Audit
Transmittal of Responses to Confirmatory Items

On February 27 - March 2, 1984 the NRC conducted a structural design audit of Millstone Unit No. 3. As defined in References (1), (2), and (3) and SRP Section 3.8.4, the structural audit was performed by the NRC - Structural and Geotechnical Engineering Branch (SGEB) as part of the Staff's review of the operating license for Millstone Unit No. 3.

A tour of the site was conducted on February 27, 1984 to provide the SGEB reviewers an overview of the structural design of the safety-related structures within Unit 3. Representatives from Northeast Nuclear Energy Company (NNECO) and Stone & Webster conducted the tour. A list of Attendees is provided in Enclosure 1. February 28 - March 2 meetings were held at Stone & Webster offices in Boston. Enclosure 2 contains the audit agenda and list of Attendees.

Enclosure 3 provides the list of discussion items developed during the audit and the status of each item as discussed and agreed upon at the exit meeting, March 2, 1984. The status of each item is defined by one of the following three categories:

B001
1/40

Closed -- No further NNECO input or action needed.

Confirmatory -- NNECO to provide requested information on the Millstone Unit No. 3 docket, either by letter or FSAR amendment.

Open -- No resolution at this time, NNECO to address.

Enclosure 4 provides responses to open items listed in the Draft Safety Evaluation Report (Reference 2). The attached responses simply formalize resolutions or commitments given orally at the meeting.

Enclosure 5 to this letter contains written responses to items resolved during the audit, but requiring submittal of written responses (i.e. items designated Confirmatory in Enclosure 3). Responses to Items 1, 2, 6, 7, 9, 10, 11, 12, 13, 16, 19, 20, 23, 26, 29, 32, 33, and 39 are contained herein.

Responses to Confirmatory Items 14 and 15, and Open Items 3, 8, 17, 25, 27, 38, and 42 will be provided by April 13, 1984.

A schedule for submittal of responses to Items 35 and 36 cannot be provided at this time. Information will be provided as it becomes available.

A copy of the Stone & Webster topical report on tornado missiles was forwarded on March 6, 1984 to your Ms. E. L. Doolittle to be provided to Mr. David Jeng and Mr. Nilesh Chokski for review, therefore, Item 41 (Questions 220.12, 220.13, and 220.15) requires no further response at this time.

If you have any concerns related to the information contained herein or any questions related to our responses, please contact our Licensing representative, Ms. C. J. Shaffer at (203) 665-3285.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY, ET Al
By Northeast Nuclear Energy Company, Their Agent

W. G. Counsil
Senior Vice President

STATE OF CONNECTICUT)
) ss. Berlin
COUNTY OF HARTFORD)

Then personally appeared before me W. G. Counsil, who being duly sworn, did state that he is Senior Vice President of Northeast Nuclear Energy Company, applicant herein, that he is authorized to execute and file the foregoing information in the name and on behalf of the applicants herein and that the statements contained in said information are true and correct to the best of his knowledge and belief.

Lorraine J. D'Amico
Notary

My Commission Expires March 31, 1988

cc: Ms. E. L. Doolittle
Mr. David C. Jeng-SGEB
Mr. Nilesh Chokshi - SGEB

ENCLOSURE 1

NRC Structural Audit Site Tour -- February 27, 1984

Name	Organization
Nilesh Chokski	NRC-SGEB
David C. Jeng	NRC-SGEB, Section Leader
Fred Wozniak	SWEC - Lead Structural Engineer
K. Lakshmi	SWEC - Structural Div., Principal Engineer
Frank Vetere	SWEC - Lead Geotech.
Dennis Hoisington	NUSCO - Project Engineer
Walt Briggs	NUSCO - Generation Civil Engineering
W. R. Rotherforth	NUSCO - Generation Civil Engineering
Carol Shaffer	NUSCO - Generation Facilities Licensing

ENCLOSURE 2

MILLSTONE NUCLEAR POWER STATION, UNIT NO. 3

NRC STRUCTURAL DESIGN AUDIT AGENDA

February 27 - March 2, 1984

MILLSTONE NUCLEAR POWER STATION - UNIT 3
AGENDA OF SWEC PRESENTATION
FOR
NRC STRUCTURAL AUDIT
FEBRUARY 27, 1984 TO MARCH 2, 1984

MONDAY 2/27/84		1.	SITE VISIT	
TUESDAY 2/28/84	8:30 AM	1.	INTRODUCTION OF PROJECT GROUP WITH AN OVERVIEW OF HOW IN GENERAL RESPONSIBLE ENGINEER'S INVOLVEMENT DURING THE AUDIT PERIOD. INFORM NRC AUDITORS THAT OTHER DISCIPLINES WOULD SUPPORT IN PROVIDING NECESSARY INFORMATION.	F. WOZNIAK W. EMERSON
	9:00 AM	2.	OVERVIEW OF PLANT DESIGN	F. WOZNIAK

a. CONSTRUCTION STATUS, PERCENT COMPLETION OF CONCRETE/STEEL

b. DESIGN STATUS, PERCENT COMPLETION OF PRODUCTION DRAWINGS

c. HIGHLIGHTS OF SPECIAL DESIGN CRITERIA

- 10CFR50.55(E)
- COMPLIANCE WITH CODES
- S.E.R. OUTSTANDING ITEMS

9:30 AM	3.	REVIEW OF SEISMIC ANALYSIS	K. LAKSHMI

a. SEISMIC ANALYSIS CRITERIA AND PROCEDURE

- GROUND RESPONSE SPECTRA FOR SSE AND OBE CASE
- SYNTHETIC TIME HISTORY RESPONSE
- MATHEMATICAL MODEL
- RESPONSES OF STRUCTURE AND ARS PLOTS
- SEISMIC INPUT
- 3-D DESIGN OF STRUCTURE

10:30 AM b. SOIL STRUCTURE INTERACTION — F. VETERE

(i) DESCRIPTION OF SUBGRADE UNDER EACH CATEGORY I BUILDING

- BASIL TILL DEPTHS UNDER 'EGE' BUILDING AND HOW EVALUATED

- SHEAR MODULUS
  - STRAIN VS DAMPING
  - USE OF SHAKE PROGRAMS
- DATA TRANSMITTAL TO STRUCTURAL GROUP

11:30 AM (ii) STRUCTURAL USE OF GEOTECHNICAL DATA — B.A. LAWTON

- PLAXLY COMPUTER PROGRAM
- EGE BUILDING PLAXLY FINITE ELEMENT MODEL
- E-W AND N-S DIRECTIONS
- OUTPUT OF TIME HISTORY PLOTS AT FREE FIELD AND FOUNDATION LEVEL
- EGE BUILDING SEISMIC MODEL WITH PLAXLY
- BUILDING RESPONSES

1:00 PM 4. CONTAINMENT DETAIL PRESENTATION — K. LAKSHMI

a. SEISMIC ANALYSIS

- BRIEF DESCRIPTION OF SEISMIC ANALYSIS AS TO SELECTION OF LUMPED MASSES
- STIFFNESS PROPERTIES
- COMPUTER PROGRAMS USED FOR STRUCTURAL RESPONSES AND ARS
- RESULTS
- PROGRAM FOR DISTRIBUTION OF RESULTS
- CONTROL OF ARS

2:00 PM	b.	<u>ULTIMATE CAPACITY ANALYSIS</u>	<u>K. LAKSHMI</u>

PRESENTATION OF WORK DONE IN CONTAINMENT FAILURE MODE ANALYSIS

- METHODOLOGY
- USE OF COMPUTER PROGRAM
- MODEL AND RESULTS

3:00 PM	c.	<u>LINER PLATE ANALYSIS</u>	<u>K. LAKSHMI</u>

- LOADING CRITERIA; FSAR AND ASME III SUBSECTION NE; CLASS MC USED AS A GUIDE
- BRIEF DESCRIPTION GENERAL LINER STRESSES, "KALNIN'S" COMPUTER PROGRAM USAGE AND RESULTS
- KNUCKLE PLATE (WALL/MAT) ANALYSIS AND RESULTS
- DISCONTINUITY AT HATCH/RING AREA
- INSERT PADS FOR PIPE SUPPORTS

WEDNESDAY 2/29/84

8:30 AM 1. CONTAINMENT DESIGN — K. LAKSHMI

a. CYLINDER AND DOME

- LOADS AND LOADING COMB.
- USE OF COMPUTER PROGRAM
- FORCES IN CYLINDER
- REBAR REQUIREMENTS

b. UNBALANCED FORCES AT DOME/CYLINDER JUNCTION

- MERIDIONAL REBAR CUT-OFF IN DOME SEGMENT AND DISCONTINUITY FORCES

c. HATCHES - ANALYSIS PHILOSOPHY DESIGN AND REINFORCEMENT CRITERIA

d. MAT DESIGN AND MAT FORCES

9:30 AM 2. INTERIOR STRUCTURE — K. LAKSHMI

a. DESIGN PHILOSOPHY/METHOD OF SUPERPOSITION OF SEGMENTAL ANALYSIS

- LOADS DESCRIPTION
- JET LOADS
- PRESSURES
- TEMPERATURES
- LOAD COMBINATIONS

b. STRUCTURAL ANALYSIS AND MODELING

- FRAME ANALYSIS
- FINITE ELEMENT ANALYSIS OF

  (i) STEAM GENERATOR CUBICLES

  (ii) 51'-4" SLAB

  (iii) CRANE WALL ABOVE 51'-4"

  (iv) PIPE RUPTURE EFFECT

  (v) CRANE IMPACT

- ANALYSIS OF PRIMARY SHIELD WALL COLUMNS, COLUMN FOR STEAM GENERATOR

c. SEISMIC DESIGN

- GENERATION OF SEISMIC FORCES
- LOAD PATH OF SHEAR AND TENSION
- EFFECT OF SEISMIC ON CRANE WALL COLUMNS
- PRIMARY SHIELD WALL TRANSFER OF REACTOR VESSEL INLET/OUTLET NOZZLE BREAK LOADS
- GROUT INTERFACE BETWEEN PRIMARY SHIELD WALL AND NEUTRON SHIELD TANK

1:00 PM 3. OTHER CATEGORY I STRUCTURES

FUEL BUILDING	- P. MARTIN
FUEL POOL	- M. KIRMANI
MAIN STEAM VALVE BUILDING	- P. SMITH
EMERGENCY GENERATOR ENCLOSURE	- B. LAWTON

- BRIEF DESIGN SUMMARY OF THE FOLLOWING:

a. LOADS AND LOADING COMBINATION

b. TREATMENT OF SEISMIC FORCES

c. BEARING CAPACITY EVALUATION, STABILITY AND ANALYSIS

e. RESULTS

THURSDAY 3/1/84 8:30 AM 1. CONTAINMENT/FUEL BUILDING CRANES — P.F. MARTIN/N. KENNEDY

- STRESS REPORT REVIEW
- CRANE RAIL - ANCHORING SYSTEM
- DRAWINGS REVIEW

9:30 AM 2. WIND AND TORNADOS, MISSILE PROTECTION — P.F. MARTIN

- REVIEW OF DESIGN PHILOSOPHY
- PRESSURE DROP (3 PSI)
- MISSILE SPECTRUM
- BRIEF DESCRIPTION OF SWEC REPORT — J. STEER/ P. F. MARTIN

1:00 PM	3.	<u>TANKS</u>	<u>N. KENNEDY</u>
		a. SEISMIC DESIGN, MODELLING OF TANKS,	
2.00 PM	4.	<u>CABLE TRAY SUPPORTS, CONDUITS</u>	<u>F. WOZNIAK</u>
		a. AUXILIARY/CONTROL BUILDING TUNNEL	
		b. UNDERGROUND DUCT BANKS, PIPE ENCASEMENTS	<u>F. VETERE</u>
		c. DISCHARGE TUNNEL	<u>R. CURRIER</u>
		d. SEA WALL	<u>R. CURRIER</u>
3:00 PM	5.	FUEL RACK ANALYSIS	<u>N. KENNEDY</u>

Millstone Nuclear Power Station, Unit No. 3

NRC Structural Audit -- Stone & Webster, Boston
February 28 -- March 2, 1984

Name	Organization
David C. Jeng	NRC-SGEB, Section Leader
Nilesh Chokski	NRC-SGEB
E. L. Doolittle	NRC - Project Manager
Walt Briggs	NUSCO - Generation Civil Engineering
W. R. Rotherforth	NUSCO - Generation Civil Engineering
Drina Beauregard	NUSCO - Generation Civil Engineering
Dennis Hoisington	NUSCO - Project Engineer
Carol Shaffer	NUSCO - Generation Facilities Licensing
Fred Wozniak	SWEC - Lead Structural Engineer
K. Lakshmi	SWEC - Structural Div., Principal Engineer
John A. Curtain	SWEC - Structural Div., Supervisor
Owen Lowe	SWEC - Assistant Project Engineer
Frank Vetere	SWEC - Lead Geotech.
Brian Lawton	SWEC - Structural Division
W. F. Emerson	SWEC - Lead Licensing
Donna J. Theodossiou	SWEC - Licensing

ENCLOSURE 3

STATUS OF STRUCTURAL AUDIT DISCUSSION ITEMS
INCLUDING DSER OPEN ITEMS
AND 220 SERIES QUESTIONS

(determined at audit exit meeting March 2, 1984)

ENCLOSURE 3

MILLSTONE UNIT 3 - STRUCTURAL AUDIT
DISCUSSION ITEMS - FEBRUARY 28, 1984

		Status
Item 1	An example of seismic design of discharge tunnel should be provided for review. The example was reviewed and the item resolved.	Confirmatory
Item 2	Justify the use of 5 percent damping for bolted steel structures instead of 4 percent when subject to OBE loading. For bolted steel structures compare the actual stress level to the associated stress limits in the FSAR damping table.	Confirmatory
Item 3	SEB-09, 10 and 11 refer to differences between codes used in plant design and staff acceptance criteria. Demonstrate that, the Applicant meets at least the intent of the SRP in these issues. (See attached questions)	Open
Item 4	Provide an example on how changes in loads are handled in design procedures. Two load change examples were reviewed to indicate this procedure and the issue was resolved.	Closed
Item 5	Discuss how artificial time history is generated using SIMQKE program.	Closed
Item 6	Provide an example of the results of composite modal damping for review. One example of the main steam valve building was presented and the issue was resolved. The Applicant will provide this response.	Confirmatory
Item 7	Provide velocity and displacement time history profiles for the input ground motions to demonstrate that appropriate baseline correction was implemented.	Confirmatory
Item 8	Provide justification for not considering uncracked sections on containment internals in seismic analysis.	Open
Item 9	Provide comparison of development of torsional constants using computer program SECPROP versus classical shell theory for crane wall.	Confirmatory
Item 10	Consider the effect of embedment of Category I structures on the seismic response.	Confirmatory

		Status
Item 11	How do the shear moduli obtained by artificial time history compare with shear moduli from real earthquakes. Shake results for the artificial time history were provide by F. Vetere and the issue was resolved. The Applicant will provide this response.	Confirmatory
Item 12	Show how the 2 degrees of freedom Plaxly soil element is transferred into a rotational input for the lumped mass structural model. Demonstrate how the control building was considered in the soil model. Provide description similar to EGE building for control building showing soil structure interaction. Provide description on the modified halfspace analysis.	Confirmatory
Item 13	Indicate how the effect of the NSSS systems were accounted for in the seismic evaluation, of internal structures.	Confirmatory
Item 14	Provide a detailed discussion on how the CM and CR are considered in development of stiffness matrix.	Confirmatory
Item 15	With respect to ultimate capacity of containment o Were elements that yielded prior to final yielding, continuously checked to insure that they were within acceptable ductility limits? o Provide justification to indicate why the calculated ultimate pressure is the median of the probability distribution. o Review the basic shell/mat junction and demonstrate that compressive failure modes were adequately considered. Item resolved pending the review of report and additional information.	Confirmatory
Item 16	Provide examples on how the 3 components of the earthquake are combined to comply with Regulatory Guide 1.92.	Confirmatory
Item 17	Provide justification as to why vertical flexibility of floor slabs is not considered in generation of floor response spectra.	Open

MILLSTONE UNIT 3 - STRUCTURAL AUDIT
ACTIONS ITEMS - FEBRUARY 29, 1984

		Status
Item 18	How does the applicant obtain subgrade modules (k) for the rock in the design of containment mat. Explanation was provided and considered to be resolved.	Closed
Item 19	Provide a comparison of results in internal structure from Finite Element analysis and STRUDL Resolved. Lakshmi will provide sketches and documentation.	Confirmatory
Item 20	Perform simplified assessment of basemat design to demonstrate that equations 7 and 9 from FSAR Page 3.8-13 do not govern. In case of some exceedance in allowable stresses for the two conditions, the as-built material strength can be used to show that at least the intent is met.	Confirmatory
Item 21	Provide actual re-bar calculations for the base mat.	Closed
Item 22	Show how the wall tangential shear and overturning moment is handled.	Closed
Item 23	Provide design follow-up including load definitions through re-bar quantity determination of steam generator cubicle barrier wall (central radial wall). Also consider the three component combination aspects in the earthquake analysis.	Confirmatory
Item 24	Copy from microfilm the results from STRUDL analysis for element 341. (Equipment hatch)	Closed
Item 25	Provide a verification example for RIG No. 4 computer program.	Open
Item 26	With respect to the EGE Seismic Analysis, please assess the effect of combining 2 directional response versus that of the 3 component combination as required in the staff position.	Confirmatory
Item 27	Provide justification for generation of ARS based upon one component of input motion.	Open
Item 28	Method of Peak Broadening has to be reviewed. Method was reviewed creating another item (38) to remain open.	Closed
Item 29	Provide the Finite Element-Frame Analysis comparisons for the Spent Fuel Pool Analysis.	Confirmatory
Item 30	Provide design calculations of pipe support R7L.	Closed

		Status
Item 31	Provide the technical basis for how the fluid sloshing effects are modeled in the fuel pool seismic analysis.	Closed

MILLSTONE UNIT 3 - STRUCTURAL AUDIT ACTION ITEMS - MARCH 1, 1984

	Missile Barrier	Status
Item 32	Discuss how venting was considered for internal cubicle pressurization (Sec. FSAR 3.3.3). Item resolved if a sentence to reflect actual venting is included in FSAR, i.e., that all structures except for fuel building were designed for nonventing situation.	Confirmatory
Item 33	Justification of unity DLF of pressure drop provided description and results as presented. Resolved.	Confirmatory
	Cranes	
Item 34	Fuel building crane required for review, look at stress report shear checks, bolts.	Closed
Item 35	Demonstrate that the applicant complies with SRP 3.8.4, Appendix D in the design of fuel racks. Refer to NRC Question 220.6.	Open
Item 36	Provide assessment of Cat. I tanks to include consideration of flexibility and demonstrate that the intent of NRC is met. For those tanks which are judged not to require assessment, provide basic reasons for not doing so.	Open
Item 37	Provide calculations on retaining wall designs. Resolved.	Closed
Item 38	Justify the peak broadening procedure in relation to Reg. Guide 1.122.	Open
Item 39	A review of accidental torsion SEB Item 08 should be performed. Reviewed and found acceptable. Resolved.	Confirmatory
Item 40	Provide discussion of containment liner designs to show that the intent of ASME III Division 2 is met. This item will be included in Item 3.	Closed
Item 41	Questions 220.12, 13, and 15 deal with SWEC topical report on tornado missiles. This item will be resolved pending confirmation of this report.	Open

		Status
Item 42	Question 220.9 concerns the ability of structural steel frames to withstand tornado pressure prior to siding blowout.	Open
Item 43	Question 220.8 concerns the capability of foundations to transfer stress. Information was reviewed and found acceptable.	Closed

RESOLUTION STATUS OF 220 SERIES QUESTIONS

Questions	Status
220.5	Closed
220.6	Closed
220.7	Closed
220.8	Closed
220.9	Open (Item 42)
220.10	Closed
220.11	Closed
220.12, 13 & 15	Open (Item 41)
220.14	Confirmatory
220.16	Closed, GSB open item
220.17	Closed
220.18	Confirmatory (Item 2)
220.19	Confirmatory (Item 12)
220.20	Open (Item 8)
220.21	Confirmatory (Item 39)
220.22	Closed
220.23	Closed
220.24	Closed
220.25	Closed
220.26-220.29	Open, (Item 3)
220.30	Closed
220.31	Closed
220.32	Open (Item 3)
220.33-220.35	Closed
220.36-220.37	Open, (Item 3)
220.38	Closed

ENCLOSURE 4

STRUCTURAL AND GEOTFCHNICAL ENGINEERING BRANCH

RESPONSES TO DRAFT SAFETY EVALUATION REPORT OPEN ITEMS

SEB-01	Barrier Design Procedures (Draft SER Section 3.5.3)
SEB-02	Design Response Spectra - Reg. Guide 1.60 (Draft SER Section 3.7.1)
SEB-03	Accidental Torsion (Draft SER Section 3.7.3)
SEB-12	5% of Critical Damping for Bolted Steel Structures (Draft SER Section 3.7.1)

Millstone Nuclear Power Station, Unit No. 3

Open Items

Structural and Geotechnical Engineering Branch

SEB-01 Barrier Design Procedures (Draft SER Section 3.5.3)

Structural Audit Item

The staff concludes that the barrier design is acceptable for local effects such as penetration and meets the recommendations of SRP Section 3.5.3. However, the staff had identified a need for additional information in several areas related to the overall structural response of a barrier when impacted by a missile. The applicant has submitted additional information in Amendment 3 to the FSAR. This information is currently under review by the staff and the staff findings will be reported in the SER. It is expected that this issue also will be discussed in detail in the forthcoming structural audit in January 1984 (tentative).

Response

Stone and Webster Topical Report on tornado missiles was transmitted to E. L. Doolittle, Project Manager, Licensing Branch No. 1 on March 6, 1984 to Resolve Structural Audit Item 41 and Questions 220.12, .13 and .15.

This report addresses the design of barriers to resist missile impact based upon the overall structural response.

NUSCO considers the above Draft SER Open Item (SEB-01), Structural Item 41 and Questions 220.12, .13, and .15 to be resolved pending the staff's review of the Stone & Webster Topical Report.

Millstone Nuclear Power Station, Unit No. 3

Open Items

Structural and Geotechnical Engineering Branch

SEB-02 Seismic Input (Draft SER Section 3.7.1)

Design Response Spectra - Regulatory Guide 1.60

Structural Audit Item

The horizontal peak acceleration value of the safe shutdown earthquake (SSE), chosen for the rock level, is 0.17g. The corresponding peak acceleration for the operating basis earthquake (OBE) is 0.09g. The horizontal design response spectra are smooth spectra anchored to the above accelerations. The vertical design response spectra are taken to be two-thirds of the horizontal design spectra. These spectra do not comply with the recommendations of Regulatory Guide 1.60. The staff is currently reviewing the adequacy of these spectra and the conclusions reported in this section are dependent upon the outcome of this review.

Response

The applicant's proposed resolution to SEB-07 is that the applicable Design Response Spectrum will be resolved by NRC/Geosciences as related to Draft SER Item 2.5.2.6 Safe Shutdown Earthquake, this closes Question 220.16.

This resolution was discussed at the Structural Audit and NRC structural reviewers concurred.

Millstone Nuclear Power Station, Unit No. 3

Open Items

Structural and Geotechnical Engineering Branch

SEB-03 Seismic System and Subsystem Analysis - Accidental Torsion (Draft SER Section 3.7.3)

Structural Audit Item

The system and subsystem anal ses were performed by the applicant on an elastic and linear basis. Mor . response spectrum multidegree-of-freedom methods form the bases for analyses of all major Category I structures, systems, and components. I applying the modal response spectrum method, governing response parameters ere combined in conformance with one position of Regulatory Guide 1.92. The absolute sum of the modal responses was used for modes with closely spaced frequencies. The square root of the sum of the squares (SRSS) of the maximum element results provided more severe results than the half-space representation. The staff plans to review these studies in detail during the forthcoming structural audit and will report its findings in the final SER.

The current staff position requires that an additional eccentricity effect based on a consideration of ±5% of the maximum building dimension at the level under consideration shall be assumed to account for accidental torsion. The applicant's analyses of Category I structures do not account for the accidental torsional effects. In a response to a staff question on the above issue, the applicant noted that the Millstone Unit 3 design was finalized before the development of the above staff position. The applicant has provided no information to assess the effects on the plant structures that might result from the implementation of the staff position. The staff plans to examine this issue in detail during the structural audit. Therefore, the following conclusions are subject to resolution of unresolved items.

Response

This item was closed at the Structural Audit and is listed under Items No. 16 and 39 of the Structural Audit Meeting Summary.

An example of the distribution of the seismic load to the crane wall columns of the internal structure was reviewed showing how three components of the SSE are combined to comply with Regulatory Guide 1.92.

The effects of accidental torsion were evaluated for the fuel building, control building containment structure internals, and the containment structure shell. Calculations performed for these buildings indicate that all are able to accommodate 5 percent accidental torsion.

Millstone Nuclear Power Station, Unit No. 3

Open Items

Structural and Geotechnical Engineering Branch

SEB-12 5% of Critical Damping for Bolted Steel Structures vs. Regulatory Guide 1.61 (Draft SER Section 3.7.1)

Structural Audit Item

The specific percentage of critical damping values used in the seismic analysis of Category I structures, systems, and components, in general, is more conservative than that specified in Regulatory Guide 1.61. The only exception is the value used for the bolted steel structures. The applicant has used 5% of critical damping for bolted steel structures when the stresses are limited to 0.5 yield stress. For this situation Regulatory Guide 1.61 specifies 4% of critical damping. This issue will be further discussed with the applicant in the forthcoming structural audit and the findings will be reported in the final SER.

Response

This item was resolved at the Structural Audit and is listed as Item 2 of the Structural Audit Meeting Summary. This also closes out Question 220.18. A review was performed of structural dynamic analysis for all structures; the only structures which were determined to have used 5 percent damping for bolted steel members for the OBE were the Turbine Building and the Containment Structure Enclosure. The overall impact of this was evaluated by developing an OBE design response spectra based on 4 percent damping which produced spectral accelerations no more than 10 percent greater than the spectral accelerations from 5 percent damping. The resulting increase in stress levels from the OBE structural responses produces stress levels which remain within the allowable.

ENCLOSURE 5

STRUCTURAL AND GEOTECHNICAL ENGINEERING BRANCH

WRITTEN RESPONSES TO CLOSE

CONFIRMATORY ITEMS -

ITEMS 1, 2, 6, 7, 9, 10, 11, 12, 13, 16, 19, 20, 23, 26, 29, 32, 33, and 39.

ITEM 1 An example of seismic design of the discharge tunnel should be provided for review. The example was reviewed and the item resolved.

The example provided described why relative motion and the transmission of seismic waves were not considered in the design of the discharge tunnel. The Applicant will provide this reponse.

Response:

The effects of seismic wave transmission and relative motion were not controlling factors in the design of the discharge tunnel because of the small resulting axial strains that will be applied to the structure. The discharge tunnel is approximately 1700 ft in length, and is founded mainly on bedrock, with the exception of two relatively short sections that are founded on till. Because of the shallow depth to bedrock at the site, the seismic waves propagate as shear waves through the bedrock.

The axial strain induced by seismic wave propagation is conservatively calculated from the equation:

$$\text{Axial strain} = \frac{\text{Particle velocity}}{\text{Seismic wave propagation velocity}}$$

The particle velocity in the above equation is assumed equal to .17 times the particle velocity for a 1g earthquake, which is conservatively assumed to be equal to 48 in./sec. The seismic wave velocity, equal to the shear wave velocity of the bedrock at the Millstone site, has been determined to be 6500 fps. The resulting axial strain is consequently very small.

The design of the discharge tunnel does not include any external anchor points along the length of the tunnel or at the turning points. Therefore, no large concentration of loads is expected to be induced by relative motions as a result of seismic wave transmission.

Differential movements are not expected between rock founded and soil founded portions of the tunnel. The high shear wave velocity of the rock with respect to the soil results in the bedrock wave propagation controlling the displacements of the tunnel.

ITEM 2 Justify the use of 5 percent sampling for bolted steel structures instead of 4 percent when subject to OBE loading. For bolted steel structures, compare the actual stress level to the associated stress limits in the FSAR damping table. The affects of this criteria on the Turbine Building were presented and the issue was resolved. The Applicant will provide this response.

Response:

By inspection of structural dynamic analyses for all structures, the only structures which were determined to have used 5 percent damping for bolted steel members for OBE loading were the Turbine Building and the Containment Structure Enclosure.

The OBE structural response of the CSE was produced by a dynamic model which included the concrete Reactor Containment superstructure. The modal dampings utilized in the analysis were based on 2 percent structural damping for concrete members and 5 percent structural damping for steel members. The modal dampings which resulted for all significant modes were less than 4 percent.

The OBE structural response of the Turbine Building was produced by a dynamic model which utilized a constant 5 percent modal damping for all modes. An OBE design response spectra based on 4 percent damping produces spectral accelerations no more than 10 percent greater than the spectral accelerations from 5 percent damping. The resulting increase in OBE structural responses for the building produces stress levels which remain within the allowables.

ITEM 6 Provide an example of the results of composite modal damping for review. One example of the main steam valve building was presented and the issue was resolved. The Applicant will provide this response.

Response:

The method used to calculate equivalent (composite) modal damping is explained in Section 3.7B.2.15 of the FSAR and is summarized below:

Damping and Strain Energy Methods

An important factor in determining structural response is the damping phenomenon. Two types of damping are generally recognized: viscous (in which the energy dissipated per cycle is proportional to frequency) and hysteretic (in which no frequency dependence is seen). Most structural elements display hysteretic behavior, while supporting soils appear to combine both hysteretic and viscous damping mechanisms.

For certain applications (e.g., pipe breaks) in which foundation motion can be neglected, only hysteretic damping need be considered. Whitman's (1973) analysis of Biggs' formula gives a useful approximation for the damping of each mode when material damping varies from element to element. His expression for the equivalent viscous modal damping is obtained by a strain-energy weighting of element damping:

$$B^j_{eqv} = \frac{\sum_{i=1}^{N} D_i E^j_i}{\sum_{i=1}^{N} E^j_i} \qquad (3.7B\text{-}5)$$

where:

B^j_{eqv} = Equivalent viscous damping ratio (fraction of critical) for structure vibrating in mode j.

N = Number of elements.

D_i = Hysteretic damping ratio for element i.

E^j_i = Strain energy in element i when deflected into mode shape j.

In particular, when damping is uniform (i.e., $D_1 = D$) then $B_{eqv} = D$ for all modes. When damping is not uniform, modal damping is weighted toward those elements which make the largest contribution to the energy of each mode. In other applications (e.g., earthquakes) in which foundation motion is significant, viscous damping also must be considered. Current practice treats the soil damping as viscous for translational motion, and hysteretic

for rotational motion. Roesset et al (1973) extended Biggs' formula to include the viscous damping contributions of the soil:

$$B^j_{eqv} = \frac{\sum_{i=1}^{N_H} D_i E^j_i + \sum_{k=1}^{N_V} \frac{W^j}{W^k_k} B_k E_k}{\sum_{i=1}^{N_H} E^j_i + \sum_{i=1}^{N_V} E^j_k} \qquad (3.7B-6)$$

where:

N_H = Number of hysteretically damped elements,

N_V = Number of viscously damped elements,

W^j = Frequency of structure mode j (radians per second),

W_K = Frequency of element k (radians per second),

B_K = Critical damping ratio of element k at frequency k.

The square of the natural frequency w^2 of the soil element, is equal to the ratio of the soil spring stiffness to total mass of the structure plus foundation.

This formula reflects the fact that the energy dissipation per cycle by the viscous mechanism is propotional to frequency of motion. Any element which displays both hysteretic and viscous damping appears in both summations of the numerator, but is not repeated in the dnominator.

Each element strain energy is evaluated from the element stiffness matrix and the displacement of the element's boundary joints. After comparing the Biggs and Roesset modal damping ratios calculated from Equations 3.7B-5 and 3.7B-6, the lower value for each node is selected for use in the dynamic analysis, thus assuring that the composite modal damping value never exceeds the hysteretic damping value. In no case do modal damping values exceed 10. percent.

As an example, the results of the Main Steam Valve Building equivalent modal damping is presented on the following pages. It is evident by reviewing the resulting equivalent modal dampings, that for the significant modes of vibration (Mode 9 frequency = 34.3 Hz), the resulting damping is very close to the assigned structural damping of 5 percent and 2 percent for SSE and 1/2 SSE respectively.

This indicates that for rock founded structures where half-space springs were used in the seismic response analysis, the effective damping used was essentially structural damping. (i.e. little effect of the subgrade damping of 10 percent translational and 5 percent rotational).

0.5 SSE DAMPING. J0390000

MEMBER HYSTERETIC DAMPING

MEMBER	DAMPING IN EACH COMPONENT											
1	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200
2	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200
3	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200	0.0200

SUPPORT SPRING DAMPING

JOINT	DAMPING IN EACH COMPONENT					
1	0.1000	0.1000	0.1000	0.0500	0.0500	0.0500

MODE	DAMP (BIGGS)	DAMP (ROSSET)	EDV	ESH	EDM	ESP	EMEM	ETOTAL	OMEGA SQUARE
1	0.02317	0.02204	1.0597E+01	1.3053E+01	5.2906E+01	2.3613E+02	2.4453E+03	2.0014E+03	2.0014E+03
2	0.02370	0.02220	1.4396E+01	1.9769E+01	6.5142E+01	3.2580E+02	3.2571E+03	3.5829E+03	3.5829E+03
3	0.02088	0.02085	9.3394E+00	9.5711E+00	1.2003E+02	1.0807E+02	6.4015E+03	6.5096E+03	6.5096E+03
4	0.02649	0.02326	1.1106E+02	1.0098E+02	3.9179E+02	2.0317E+03	1.9590E+04	2.1621E+04	2.1621E+04
5	0.02643	0.02289	1.0465E+02	1.0714E+02	4.2012E+02	1.8724E+03	2.1404E+04	2.3279E+04	2.3279E+04
6	0.03200	0.02650	2.3245E+02	4.2737E+02	4.4024E+02	4.2826E+03	2.2413E+04	2.6695E+04	2.6695E+04
7	0.02211	0.02170	9.0376E+01	1.0466E+02	6.5404E+02	1.6107E+03	3.2702E+04	3.4313E+04	3.4312E+04
8	0.02360	0.02316	2.1030E+02	2.3840E+02	6.4205E+02	3.6043E+03	4.2102E+04	4.5707E+04	4.5707E+04
9	0.02310	0.02256	1.7546E+02	2.0103E+02	8.9201E+02	2.7182E+03	4.4601E+04	4.7319E+04	4.7319E+04
10	0.03005	0.04116	2.4649E+03	2.1898E+03	1.4254E+03	2.3742E+04	7.1271E+04	9.5012E+04	9.5011E+04
11	0.03676	0.03927	2.3219E+03	2.0708E+03	1.4276E+03	2.2627E+04	7.4380E+04	9.7007E+04	9.7006E+04
12	0.05025	0.06041	6.0790E+03	4.9949E+03	1.0004E+03	5.0046E+04	5.4422E+04	1.0447E+05	1.0446E+05
13	0.02540	0.02509	1.2703E+03	1.2009E+03	2.3717E+03	2.2066E+04	1.1859E+05	1.4065E+05	1.4065E+05
14	0.04275	0.05204	5.0702E+03	4.4917E+03	1.0437E+03	5.5994E+04	9.2305E+04	1.4830E+05	1.4830E+05
15	0.04273	0.05042	5.6415E+03	4.4856E+03	1.9379E+03	5.3446E+04	9.6894E+04	1.5034E+05	1.5034E+05
16	0.04047	0.06149	1.4541E+04	7.9655E+03	4.0034E+03	8.0420E+04	2.3017E+05	3.1059E+05	3.1059E+05
17	0.05061	0.08778	2.9333E+04	1.5494E+04	3.3433E+03	2.0507E+05	1.6717E+05	3.7224E+05	3.7224E+05
18	0.04346	0.07592	2.6330E+04	1.2903E+04	4.0057E+03	1.6687E+05	2.4429E+05	4.1116E+05	4.1115E+05
19	0.04030	0.05454	2.3636E+04	1.6264E+04	4.7490E+03	2.8298E+05	2.3749E+05	5.2047E+05	5.2047E+05
20	0.03402	0.06633	3.0566E+04	1.1611E+04	9.3413E+03	1.3460E+05	4.6707E+05	6.0164E+05	6.0165E+05
21	0.03450	0.04693	2.8610E+04	1.8420E+04	9.0681E+03	3.2666E+05	4.9340E+05	8.2006E+05	8.2006E+05
22	0.03966	0.06703	5.1659E+04	2.6375E+04	1.0264E+04	4.1061E+05	5.1321E+05	9.2382E+05	9.2382E+05
23	0.03108	0.03252	3.2612E+04	3.1405E+04	1.9395E+04	6.2650E+05	9.6974E+05	1.5962E+06	1.5963E+06
24	0.02803	0.04069	4.0414E+04	2.3770E+04	3.0802E+04	4.0479E+05	1.5401E+06	1.9449E+06	1.9449E+06

EDV - ENERGY STORED IN SUPPORT SPRING WITH VISCOUS & HYSTERETIC DAMPING
ESH - ENERGY STORED IN SUPPORT SPRING WITH HYSTERETIC DAMPING
EDM - ENERGY STORED IN MEMBER WITH HYSTERETIC DAMPING
ESP - ENERGY STORED IN SUPPORT SPRING
EMEM - ENERGY STORED IN MEMBER
ETOTAL - ENERGY STORED IN STRUCTURE (ESP+EMEM)
THIS VALUE SHOULD BE SAME AS OMEGA SQUARE
ALL ENERGY COMPUTATIONS FACTOR 1/2 IS NOT IN

BIGGS METHOD - ALL DAMPING AS HYSTERETIC TYPE

✓ = VALUES U D

SSE DAMPING 00330009

MEMBER HYSTERETIC DAMPING

MEMBER	DAMPING IN EACH COMPONENT											
1	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
2	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500
3	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500	0.0500

SUPPORT SPRING DAMPING

JOINT	DAMPING IN EACH COMPONENT					
1	0.1000	0.1000	0.1000	0.0500	0.0500	0.0500

MODE	DAMP (BIGGS)	DAMP (ROSSET)	EDV	ESH	EDH	ESP	EMEM	ETOTAL	OMEGA SQUARE
1	0.05071	0.04950 ✓	1.0597E+01	1.3053E+01	1.3226E+02	2.3613E+02	2.6453E+03	2.8814E+03	2.8814E+03
2	0.05097	0.04947 ✓	1.4394E+01	1.9769E+01	1.6284E+02	3.2580E+02	3.2571E+03	3.5829E+03	3.5829E+03
3	0.05003	0.04999 ✓	9.3394E+00	9.5711E+00	3.2000E+02	1.0807E+02	6.4015E+03	6.5096E+03	6.5096E+03
4	0.05367	0.05044 ✓	1.1105E+02	1.0000E+02	9.7940E+02	2.0317E+03	1.9590E+04	2.1621E+04	2.1621E+04
5	0.05402	0.05047 ✓	1.0465E+02	1.0714E+02	1.0703E+03	1.8734E+03	2.1406E+04	2.3279E+04	2.3279E+04
6	0.05799	0.05069 ✓	2.3245E+02	4.2737E+02	1.1206E+03	4.2826E+03	2.2413E+04	2.6695E+04	2.6695E+04
7	.05070	0.05029 ✓	9.0376E+01	1.0466E+02	1.6351E+03	1.6107E+03	3.2702E+04	3.4313E+04	3.4312E+04
8	0.05110	0.05074 ✓	2.1030E+02	2.3040E+02	2.1051E+03	3.6043E+03	4.2102E+04	4.5707E+04	4.5707E+04
9	0.05130	0.05004 ✓	1.7544E+02	2.0103E+02	2.2300E+03	2.7182E+03	4.4601E+04	4.7319E+04	4.7319E+04
10	0.06655 ✓	0.06365	2.4044E+03	2.1098E+03	3.5635E+03	2.3742E+04	7.1271E+04	9.5012E+04	9.5011E+04
11	0.05977 ✓	0.06227	2.3219E+03	2.0700E+03	3.7190E+03	2.2627E+04	7.4380E+04	9.7007E+04	9.7006E+04
12	0.07300 ✓	0.08424	6.0790E+03	4.9969E+03	2.7211E+03	5.0046E+04	5.4422E+04	1.0447E+05	1.0446E+05
13	0.05069 ✓	0.05119	1.2703E+03	1.2009E+03	5.9293E+03	2.2066E+04	1.1059E+05	1.4065E+05	1.4065E+05
14	0.06144 ✓	0.07073	5.0702E+03	4.4917E+03	4.6192E+03	5.5914E+04	9.2305E+04	1.4830E+05	1.4830E+05
15	0.06206 ✓	0.06975	5.6416E+03	4.4056E+03	4.0447E+03	5.3446E+04	9.6894E+04	1.5034E+05	1.5034E+05
16	0.06270 -	0.08367	1.4541E+04	7.9655E+03	1.1509E+04	8.0420E+04	2.3017E+05	3.1059E+05	3.1059E+05
17	0.06900 ✓	0.10126	2.9333E+04	1.5494E+04	8.3503E+03	2.0507E+05	1.4717E+05	3.7224E+05	3.7224E+05
18	0.06120 ✓	0.09375	2.4330E+04	1.2903E+04	1.2214E+04	1.6687E+05	2.4429E+05	4.1116E+05	4.1115E+05
19	0.05406 ✓	0.06023	2.3634E+04	1.4264E+04	1.1074E+04	2.8298E+05	2.3749E+05	5.2047E+05	5.2047E+05
20	0.05031 ✓	0.08962	3.0544E+04	1.1611E+04	2.3353E+04	1.3460E+05	4.6707E+05	6.0166E+05	6.0145E+05
21	0.05255 ✓	0.06490	2.0610E+04	1.0420E+04	2.4670E+04	3.2666E+05	4.9340E+05	8.2006E+05	8.2006E+05
22	0.05633 ✓	0.08370	5.1659E+04	2.6375E+04	2.5660E+04	4.1061E+05	5.1321E+05	9.2382E+05	9.2382E+05
23	0.05010 ✓	0.05074	3.2512E+04	3.1405E+04	4.0407E+04	6.2650E+05	9.6974E+05	1.5962E+06	1.5963E+06
24	0.05177 ✓	0.06442	4.0414E+04	2.3778E+04	7.7004E+04	4.0679E+05	1.5401E+06	1.9469E+06	1.9449E+06

EDV - ENERGY STORED IN SUPPORT SPRING WITH VISCOUS & HYSTERETIC DAMPING
ESH - ENERGY STORED IN SUPPORT SPRING WITH HYSTERETIC DAMPING
EDH - ENERGY STORED IN MEMBER WITH HYSTERETIC DAMPING
ESP - ENERGY STORED IN SUPPORT SPRING
EMEM - ENERGY STORED IN MEMBER
ETOTAL - ENERGY STORED IN STRUCTURE (ESP+EMEM)
THIS VALUE SHOULD BE SAME AS OMEGA SQUARE
ALL ENERGY COMPUTATIONS FACTOR 1/2 IS NOT IN

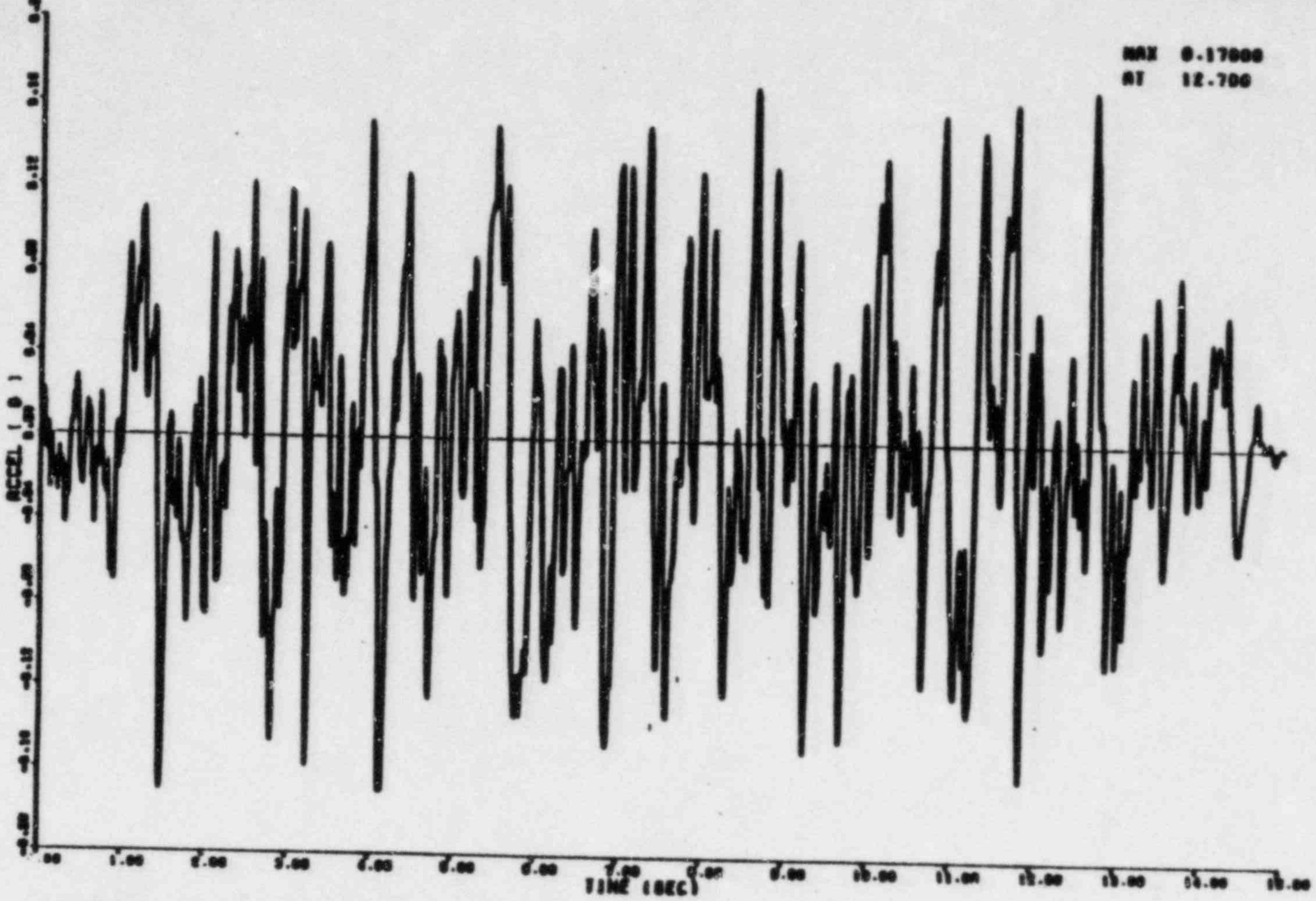
BIGGS METHOD - ALL DAMPING AS HYSTERETIC TYPE

✓ = VALUES USED

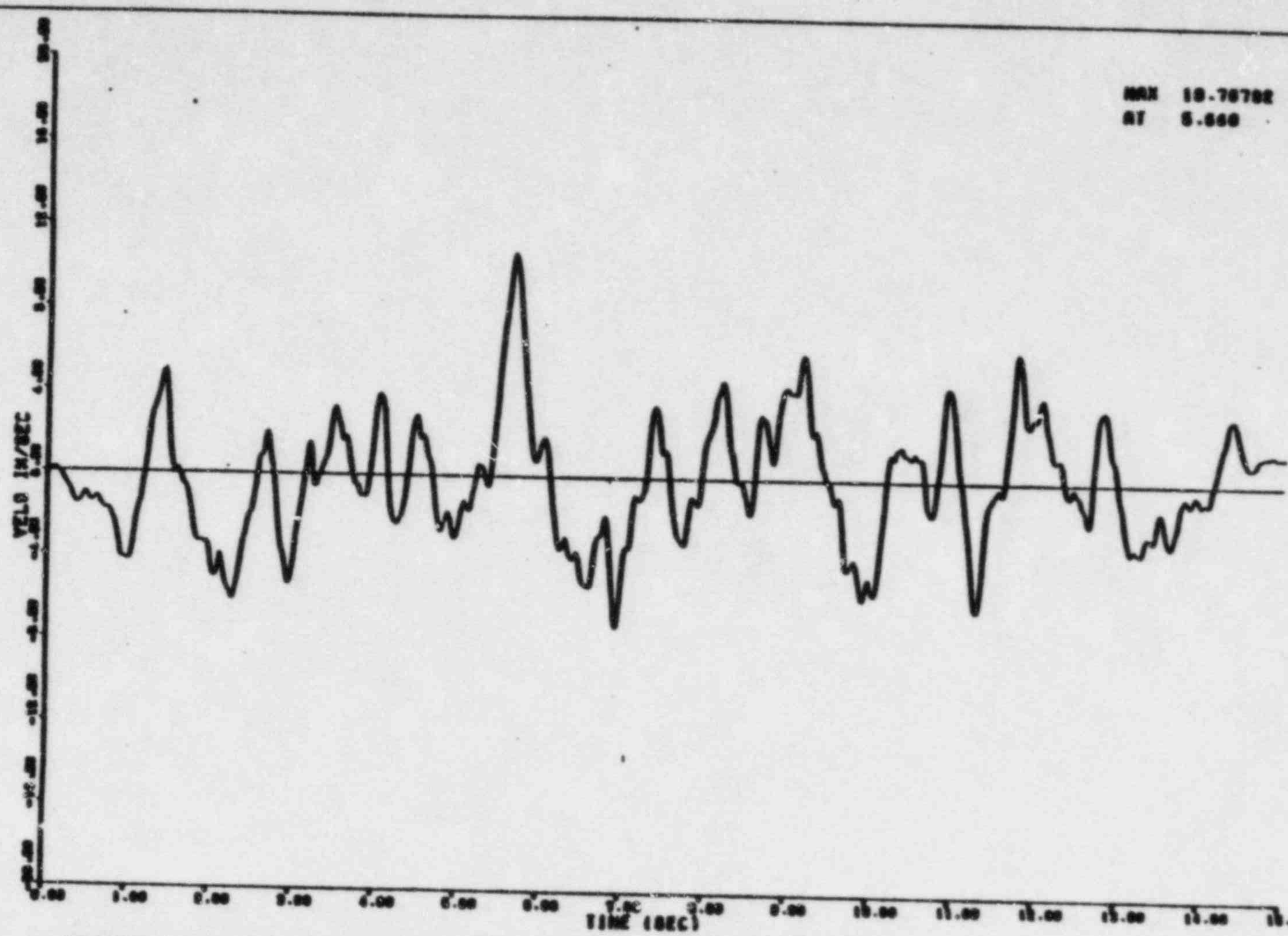
ITEM 7 Provide velocity and displacement time history profiles for the input ground motions to demonstrate that appropriate baseline correction was implemented. Profiles were presented and the issue was resolved. The Applicant will provide this response.

Response:

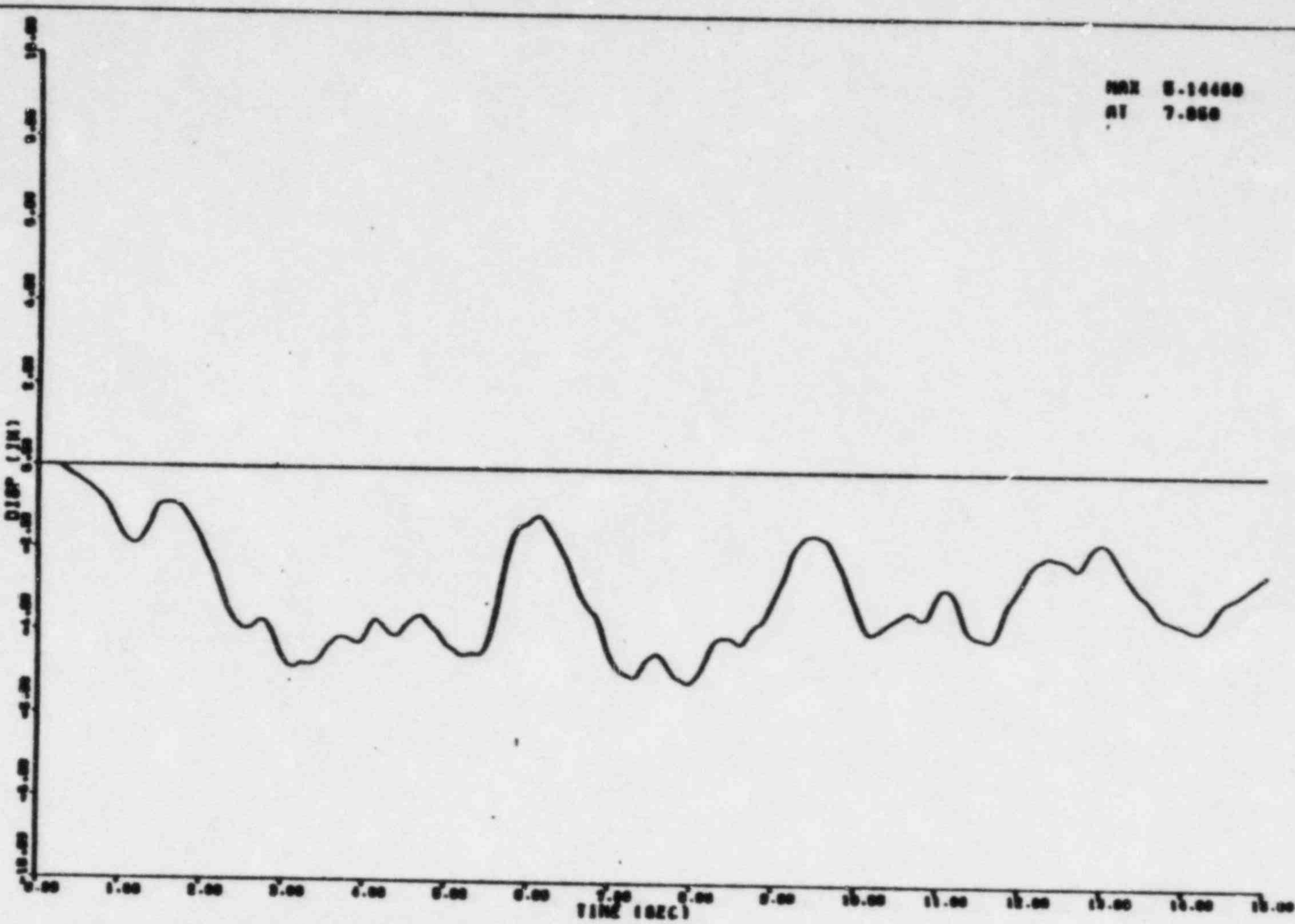
Attached are acceleration, velocity, and displacement time history plots of the Millstone 3 artificial earthquake used in the time history analysis of Categrory I buildings for the generation of building floor response spectra. These plots demonstrate that the artificial time history has been base line corrected.



ACCELERATION TIME HISTORY (MILLSTONE 3 ARTIFICIAL E.Q.)
INPUT ACCELERATION



VELOCITY TIME HISTORY (MILLSTONE 3 ARTIFICIAL E.Q.)
INPUT ACCELERATION

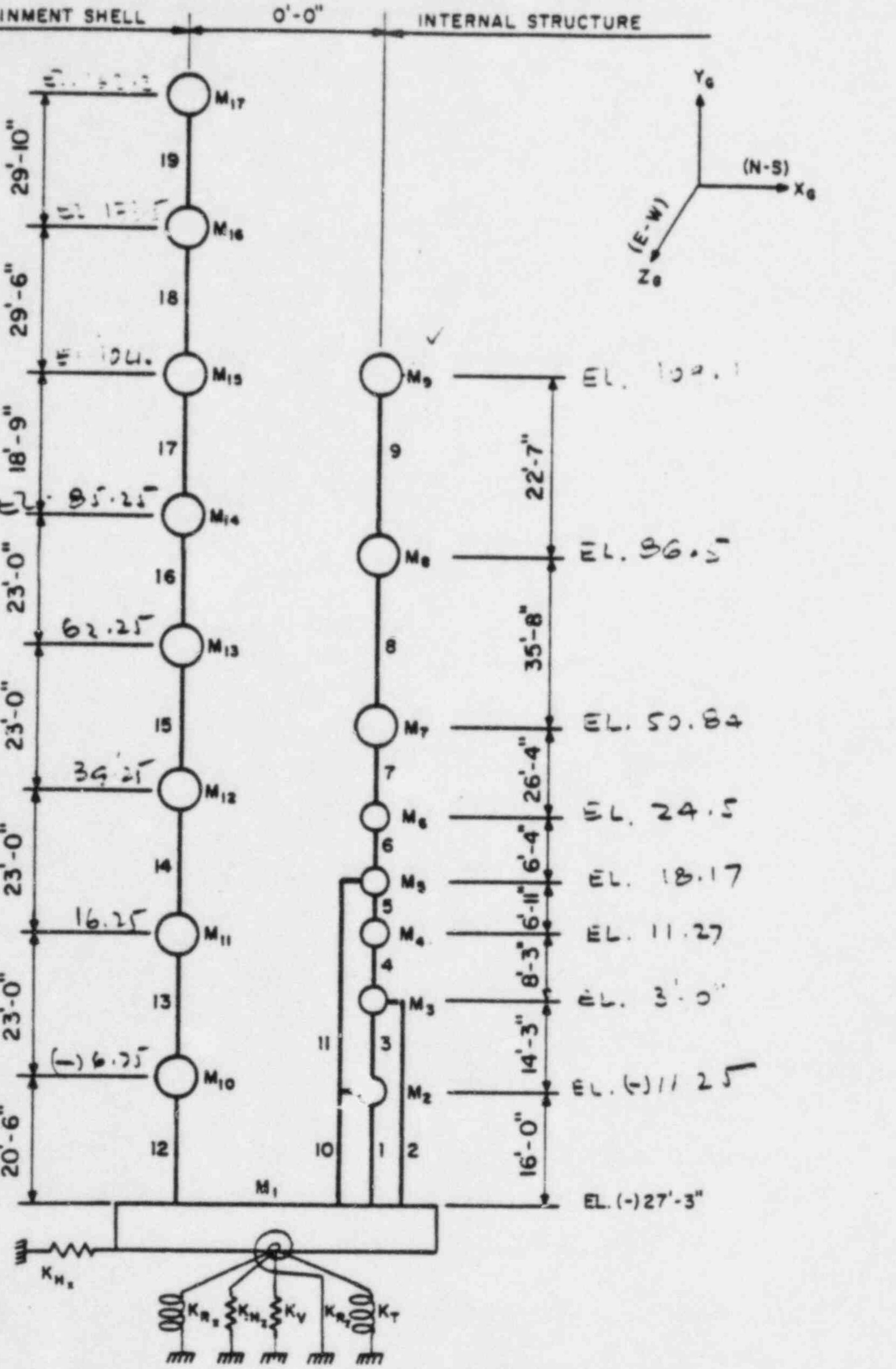


DISPLACEMENT TIME HISTORY (MILLSTONE 3 ARTIFICIAL E.Q.)
INPUT ACCELERATION

ITEM 9 Provide comparison of development of torsional constants using computer program SECPROP versus classical shell theory for crane wall. This issue was resolved. Applicant will provide this response.

Response:

A comparison was made between the torsional constants developed using Secprop 3 vs classical shell theory for the members of the dynamic model of the containment structure representing the internal structure. This comparison is presented in Table 1. Since a large difference is evident between the two methods for members 7 and 8, the containment dynamic model was rerun with revised torsional stiffness for members 4 through 8 based on the torsional constants developed from shell theory. A comparison of resulting frequencies and responses for the original and revised model are presented in Tables 2 and 3. It is clear from this comparison that no significant change in response resulted due to the change in torsional stiffness, therefore demonstrating that the original containment dynamic model is an adequate representation of the actual building.



K_H, K_V, K_R, K_T =
HORIZONTAL, VERTICAL, ROCKING AND TORSIONAL SUBGRADE SPRINGS

FIGURE 3.7B-9
DYNAMIC MODEL OF THE CONTAINMENT STRUCTURE
MILLSTONE NUCLEAR POWER STATION UNIT 3
FINAL SAFETY ANALYSIS REPORT

TABLE 1

MEMBER NO	TORSIONAL CONSTANT FROM SECPROP	TORSIONAL CONSTANT FROM CLASSICAL SHELL THEORY
4	3.65×10^6 FT^4	4.38×10^6 FT^4
5	3.45×10^6 "	4.38×10^6 "
6	4.02×10^6 "	4.38×10^6 "
7	2.09×10^6 "	3.35×10^6 "
8	0.45×10^6 "	1.91×10^6 "

FREQUENCY COMPARISON TABLE No. 2

MODE	ORIGINAL FREQUENCY	NEW FREQUENCY	CYCLES/SECOND
1	3.423598	3.423605	
2	3.423888	3.423885	
3	4.750050	4.766504	
4	5.544016	5.548941	
5	5.863437	5.864489	
6	6.133967	6.655751	
7	7.761329	7.761585	
8	7.761920	7.761922	
9	9.370814	9.370808	
10	9.694607	9.695242	

TABLE 3

ACCELERATIONS IN THE (X) N-S DIRECTION
1.0 SSE CRACKED* SECTIONS

JOINT	ORIGINAL MODEL DUE X EXCITATION	ORIGINAL MODEL DUE Y EXCITATION	ORIGINAL MODEL DUE Z EXCITATION	MODIFIED MODEL X	MODIFIED MODEL Y	MODIFIED MODEL Z
1	2.1848583	0.4777097	0.7014506	2.1595373	0.4228916	0.84688[illegible]
2	5.7902327	1.9334812	1.7535152	5.9050121	1.8044567	1.969435[illegible]
3	6.9861374	2.0989132	2.4067383	7.1265564	2.1363363	2.4945431
4	8.1005592	2.0938721	2.5088987	8.2919207	2.1163158	2.5218916
5	8.9531860	2.0896435	2.5237370	9.1696806	2.0955076	2.4803886
6	9.8772964	2.0512228	2.5798664	10.0851068	2.0520058	2.504920[illegible]
7	13.3099508	1.3928528	2.7033205	13.6071405	1.3904600	2.3224134
8	19.4733429	3.79080916	4.2561951	19.9733887	3.7995567	3.8342361
9	23.1154022	5.82966795	5.64545563	23.765564	5.8362675	5.3117905
10	4.6755848	0.8394193	1.6795292	4.7452374	0.8703875	1.6543255
11	7.1245289	1.10663423	2.1069393	7.1346159	1.1835909	2.1936445
12	9.3211317	1.0289993	2.0798941	9.3318367	1.0989361	2.1992331
13	11.3081865	0.6794098	1.8716717	11.3255224	0.6979827	1.787711[illegible]
14	13.3824387	0.32691160	1.2638884	13.419055	0.3406285	0.965513[illegible]
15	15.3117390	0.83882165	1.9557753	15.3329182	0.8923378	1.890974[illegible]
16	18.67939976	0.9271334	1.8637419	18.7146454	0.9899338	1.7388229
17	24.7827606	1.0016069	2.1477261	24.3293457	1.0067043	1.582[illegible]78

* CONTAINMENT SHELL CRACKED CASE

TABLE 3

ACCELERATIONS IN THE VERTICAL DIRECTION 1.0 SSE CRACKED* SECTIONS						
ORIGINAL MODEL				MODIFIED MODEL		
JOINT	DUE X EXITATION	DUE Y EXCITATION	DUE Z EXCITATION	X	Y	Z
1	0.543021	1.4843845	0.1384994	0.4807081	1.5356436	0.1293536
2	0.7270054	2.4066582	0.3522748	0.7243735	2.4192848	0.3572378
3	1.8269844	3.3185806	0.9120731	1.8746414	3.3283548	0.9837051
4	1.2672071	3.6058054	0.6776966	1.2985239	3.6141729	0.7085065
5	1.8332176	3.7435837	0.9115103	1.8832932	3.7528267	0.9647277
6	1.6457920	3.9189415	0.999905	1.6814222	3.9398546	1.0759335
7	2.2694263	4.5652475	1.2333412	2.3315697	4.5868807	1.3280087
8	3.2676477	5.5587721	1.6107101	3.3437738	5.574185	1.7581196
9	2.6597853	6.3018980	1.2384806	2.6877966	6.3163404	1.3412886
10	0.9318424	2.8753843	0.2086915	0.8344667	2.9485016	0.1808267
11	0.6924500	4.5411263	0.2157053	0.6561060	4.5474529	0.2180516
12	0.7104386	5.8990030	0.1683009	0.6567596	5.9109678	0.170947
13	0.9124996	7.3109226	0.1611456	0.823368	7.339475	0.135581
14	0.5608630	8.458865	0.2158113	0.5359232	8.4608335	0.2217497
15	0.6564966	9.073285	0.2544291	0.6006168	9.0784864	0.26101180
16	1.3459196	10.253885	0.2874166	1.2036972	10.2998056	0.2583969
17	1.4079723	11.4647770	0.3987461	1.3396721	11.4815044	0.4096356

* CONTAINMENT SHELL CRACKED CASE

TABLE 3

ACCELERATIONS IN THE E-W DIRECTION
1.0 SSE CRACKED* SECTIONS

	ORIGINAL MODEL			MODIFIED MODEL		
JOINT	DUE TO X EXCITATION	DUE TO Y EXCITATION	DUE TO Z EXCITATION	X	Y	Z
1	0.7014505	0.1218417	2.1951628	0.8468833	0.1137959	2.1404629
2	2.3180189	0.8497186	5.1438007	2.4765682	0.9356518	5.6375904
3	2.7344465	1.2573557	6.9527302	2.5940113	1.1828613	7.4817562
4	2.6768961	1.0394726	6.8930035	2.6927948	1.1420383	7.4804373
5	2.633895	1.044806	8.2853422	2.6070089	1.0813789	8.7783728
6	2.7087517	0.957394	8.7121725	2.7267723	1.0547810	9.183329
7	2.472838	0.36901	12.2041349	2.2094717	0.478023	12.4035912
8	4.4001245	1.176291	17.729339	3.7850180	1.3909206	18.172066
9	6.4112864	1.9254932	19.94882	5.5836306	2.219451	20.6893463
10	1.676589	0.479220	4.093013	1.6599582	0.4720328	4.1436958
11	2.1019087	0.646074	6.6667767	2.1841259	0.6404926	6.6738586
12	2.0738935	0.588027	9.1979523	2.1888027	0.5834777	9.1826658
13.	1.8700886	0.370076	11.4257765	1.7856770	0.3603433	11.4288244
14	1.2649832	0.18074116	13.633075	0.9659527	0.1768343	13.6214762
15	1.9551764	0.498559	15.5779648	1.8866959	0.4933146	15.5515118
16	1.8609085	0.5217572	18.8148041	1.7360411	0.5178144	18.8256836
17	2.1514244	0.404243	24.979858	1.5798168	0.3539756	25.0023651

* CONTAINMENT SHELL CRACKED CASE

ITEM 10 Consider the effect of embedment of Category I structures on the seismic response. An effective embedment was determined for Category I buildings of concern that demonstrated that embedment would have little effect on response. The issue was resolved. The Applicant will provide this reponse.

Response:

Embedment of Category I buildings are generally limited to one or two sides dependent upon the location with respect to adjacent buildings (i.e. a minimum 1 inch shake space is provided between all Category I buildings). To assess the effect of embedment on the seismic response of Category I buildings where half-space springs were used, an effective embedment was calculated based on the actual wall area of embedment divided by the perimeter of the building. These values are presented in the following table for the Category I buildings of concern and compared against a value of 15 percent of the least base dimension of the building. This comparison indicates that the embedment is very small and would have negligible effect on the response. In addition, since the founding rock is very stiff (i.e. shear wave velocity = 6,000 fps), building displacements are small and embedments of this degree would not change the response of the buildings.

TABLE 1

SUMMARY OF EFFECTIVE BUILDING EMBEDMENTS

BUILDING	EFFECTIVE EMBEDMENTS	15% OF LEAST BLDG DIME
FUEL BUILDING	6.5 FT	14.4 FT
E S F BUILDING	8.2 FT	9.6 FT
MAINSTEAM VALVE BLDG	6.3 FT	8.1 FT
AUXILIARY BLDG	7.3 FT	15.3 FT
HYDROGEN RECOVERY	2.7 FT	6.4 FT

ITEM 11 How do the shear moduli obtained by ariticial time history compare with shear moduli from real earthquakes. Shake results for the artificial time history were provided by F. Vetere and the issue was resolved. The Applicant will provide this response.

Response:

Real time histories from accelerograms recorded on bedrock sites were used to provide a statistical match to predict site ground motions in the free-field adjacent to the EGE. Three strong motion records were selected to model the Millstone site. The strain-corrected values of Shear Modulus and Damping were averaged and this mean value is used for input to the PLAXLY model.

A comparison of the soil properties obtained by SHAKE from the three real time histories with the Millstone artificial earthquake is made below for Shear Modulus (G) in ksf and Damping (D):

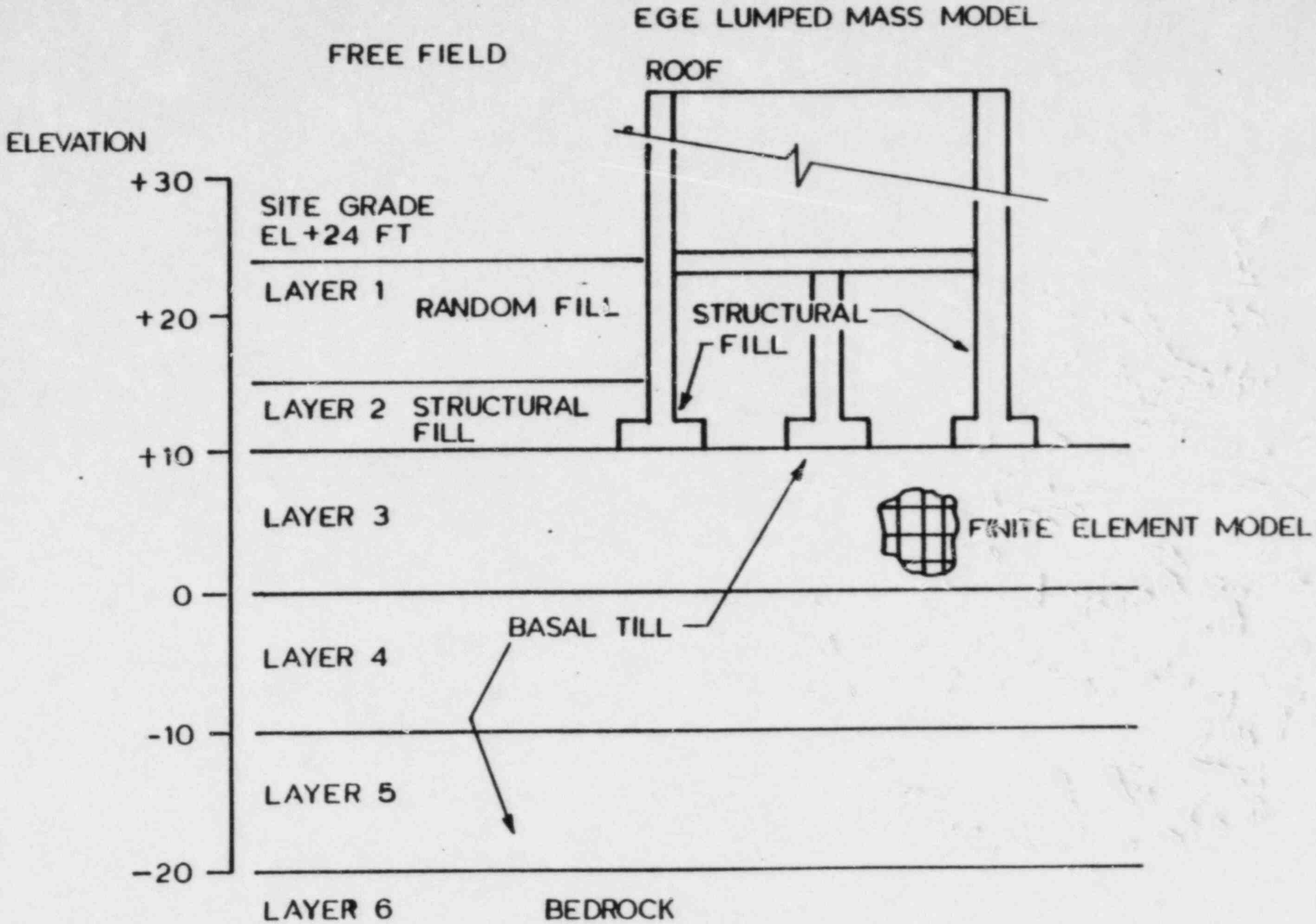
LAYER	TAFT		PARKFIELD		PACOIMA		ART.E.Q.	
	G	D	G	D	G	D	G	D
1	613	.087	457	.140	576	.101	492	.127
2	778	.104	825	.116	697	.120	638	.135
3	18800	.014	18715	.014	17968	.019	17704	.021
4	17850	.018	17249	.022	16913	.024	16258	.027
5	16981	.022	16077	.025	15470	.029	14946	.031
6	BEDROCK							

In general, soil properties obtained from the artificial earthquake analysis are in close agreement with values obtained from real earthquake analyses. Shear modulus values for the artificial earthquake fall within the lower range of values, indicating that strain levels for the artificial earthquake

are likely to be higher than for real earthquakes. However, the use of real time histories represents a sufficiently wide range of seismic input values to justify their use in design calculations.

SOIL-STRUCTURE INTERACTION
EMERGENCY GENERATOR ENCLOSURE

MILLSTONE 3



ITEM 12 Show how the 2 degree-of-freedom Plaxly soil element is transferred into a rotational input for the lumped mass structural model. Demonstrate how the control building was considered in the soil model. Provide a description similar to EGE building for control building showing soil structure interaction. Provide a description on the modified halfspace analysis. A discussion of the above items was presented and the issue was resolved. The Applicant will provide this response.

Response:

A group of elements representing the building within the finite element grid are given properties of a very rigid and massless body. (See Figure 3.7B-11). The lumped mass model of the structure containing 3 degrees-of-freedom per lumped mass (i.e., horizontal, vertical and rotational) is then coupled to the finite element grid at the nodal point representing the contact area center between the building and subgrade. Since the mat is modeled as a rigid body, vertical displacements along this interface line between the subgrade and mat are transferred into a rotation about the contact center representing the first lumped mass of the structure. The result is a rotational response of the lumped mass which is transmitted up into the lumped mass stick model of the structure. (See Figure 2).

The effect of the control building in the seismic response analysis of the emergency generator enclosure was considered as follows. An equivalent soil mass was calculated to represent the control building (elements 41, 42 and 43 of FSAR Figure 3.7B-11). An equivalent density based on the total mass of the building divided by the displaced volume of soil was calculated and used for these elements. Based on the fundamental frequency of the building and the depth of soil displaced by the structure, an equivalent shear modulus was calculated and used for these elements, as indicated on the following pages.

To demonstrate that the results for the plaxly analysis of the control building are comparable to those from a half-space analysis, an alternate dynamic model was developed. For this case a six degree-of-freedom lumped mass model was developed to represent the structure. To represent the subgrade, half-space springs were calculated based on rock properties. This was considered reasonable since the structure is founded on rock on the east end of the building and an average of 9 ft of dense basil till on the west end of the building (see FSAR Figure 2.5.4-54). A modal analysis was then performed for the half-space model for three independent directions of input motion and the resulting response components were combined by the square-root-sum-of-the-squares method to obtain the total response in each of the three orthogonal directions (i.e., N-S, E-W, Vert). A comparison was then made between the fundamental frequencies, seismic response accelerations and finally the total base shears and axial load resulting from the plaxly model and the half-space model. These results are given in Tables 1 through 3, which follow. The results are in extremely good agreement assuring that either method of analysis adequately represents the actual building response.

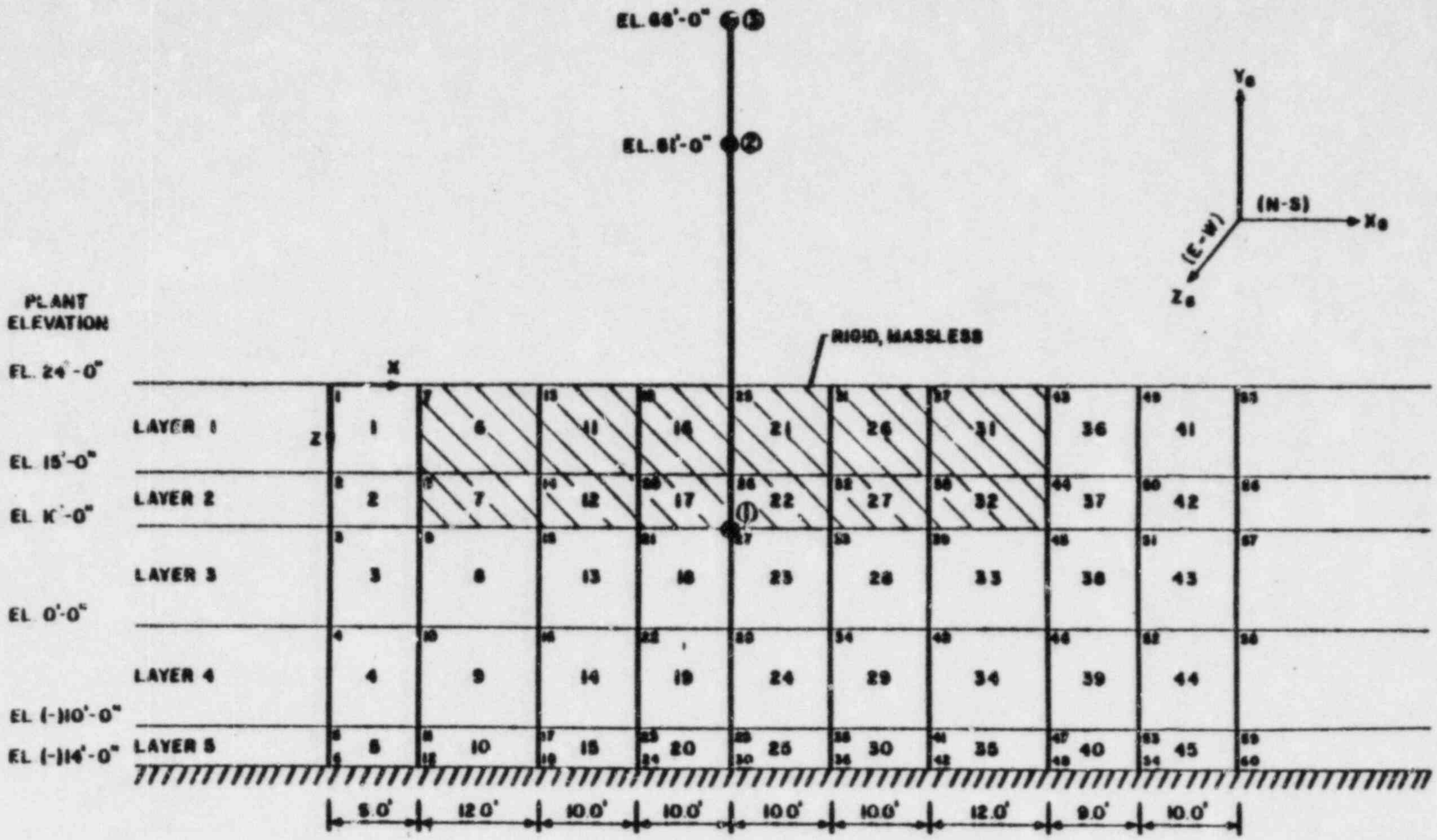
To demonstrate that the results from the plaxly analysis of the emergency generator enclosure an alternate dynamic model was developed. For this case a six-degree-of-freedom lumped mass model was developed to represent the structure. To represent the subgrade modified half-space springs were calculated based on the depth of basil till between the founding elevation of the structure and bedrock elevation. Several cases were considered based on recommended equations from reference 1 and 2. In addition, an analogy of a column of soil between the structure and bedrock was made utilizing shear beam theory as described on the following pages. Based on these results and the recommendations of the fore mentioned references, spring constants were selected that represented the actual conditions.

A modal time history analysis was then performed for the modified half-space model. A 5 percent (SSE) constant model damping was used conservatively for all modes (i.e., no consideration of higher damping due to subgrade). The same input time history used in the plaxly analysis scaled to 0.21 g's was used. This acceleration level was determined to be appropriate based on a study conducted to determine the free field amplification effects of the basil till. A comparison between resulting fundamental frequencies and seismic response accelerations are presented in Table 4 and 5 for the plaxly and modified half-space model. The results are in very close agreement thus demonstrating that either method of analysis adequately predicts the actual building response.

References:

1. Forced Vibrations of Circular Foundations on Layered Media, by E. Kausel, M.I.T. Department of Civil Engineering, Research Report No. R74-11, January 1974.

2. Vertical and Torsional Stiffness of Cylindrical Footings, E. Kausel and R. Uskijima, M.I.T. Department of Civil Engineering, Publication No. R79-6, February 1979.



NOTE:
O - INDICATES NODE OF STRUCTURE

FIGURE 3.7B-11
DYNAMIC MODEL OF THE EMERGENCY GENERATOR ENCLOSURE N-S VIEW
MILLSTONE NUCLEAR POWER STATION
UNIT 3
FINAL SAFETY ANALYSIS REPORT

12-3

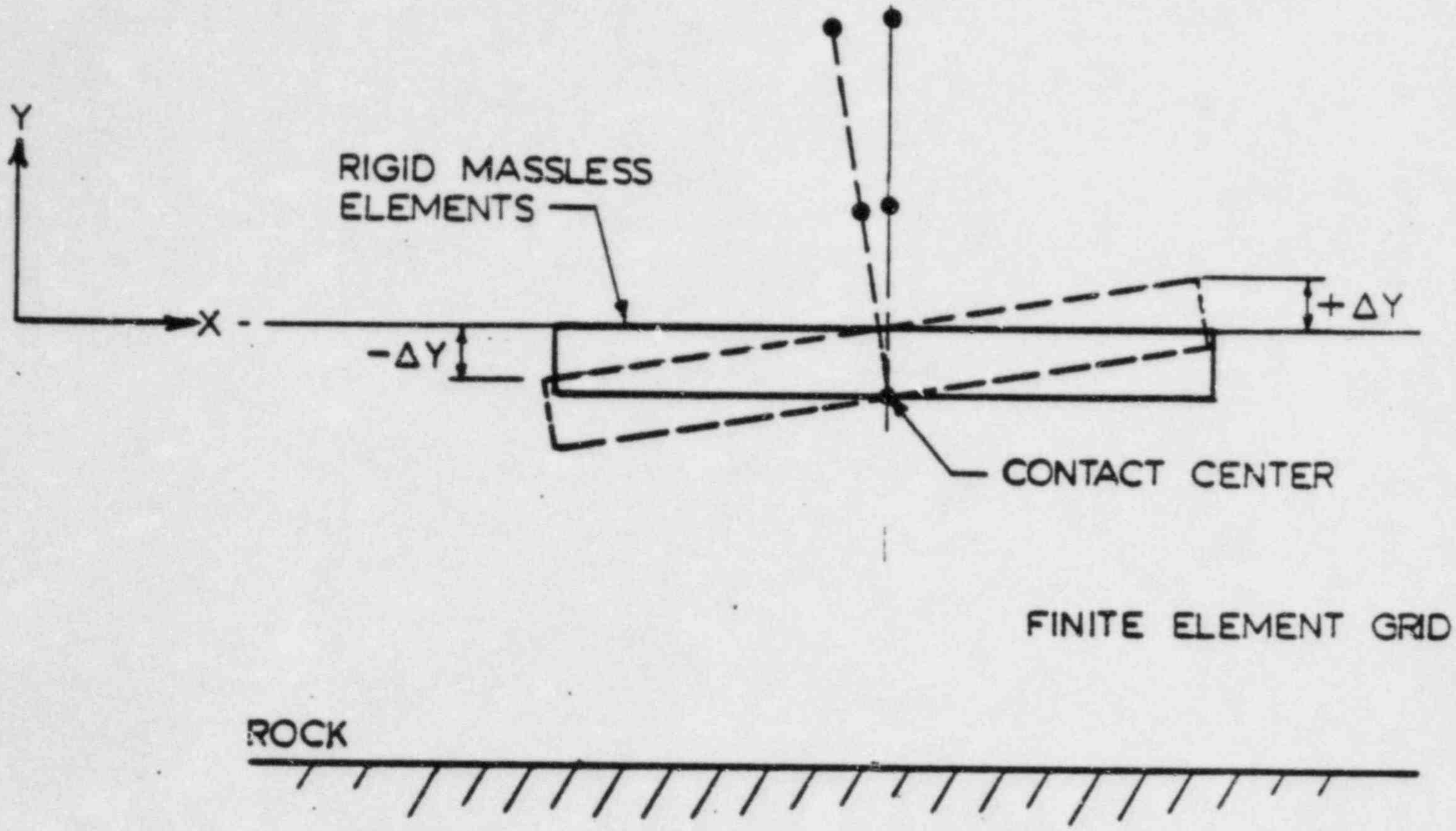
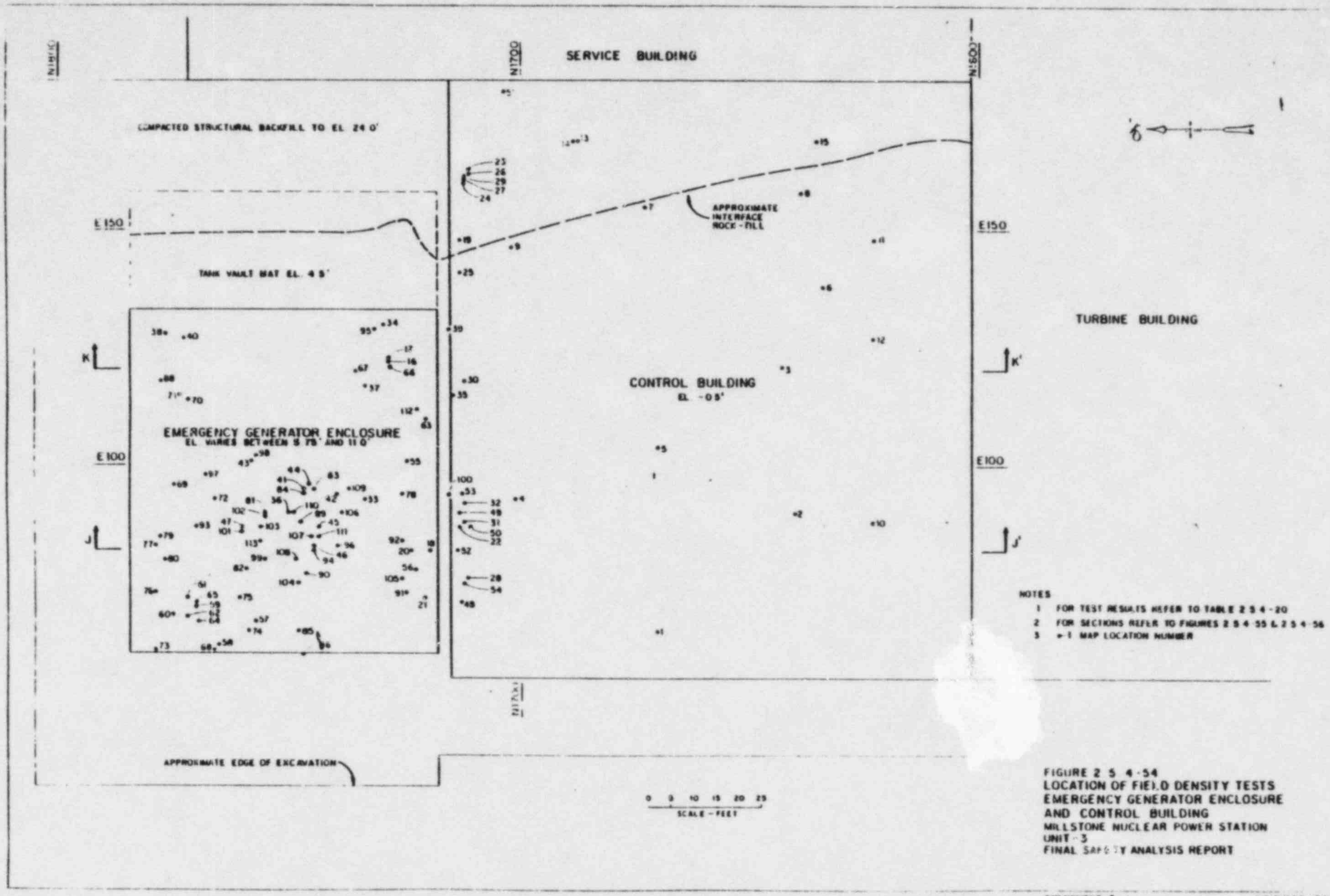

Y
X
RIGID MASSLESS
ELEMENTS
+ΔY
−ΔY
CONTACT CENTER
FINITE ELEMENT GRID
ROCK

FIGURE 2

12-5



NOTES
1 FOR TEST RESULTS REFER TO TABLE 2.5.4-20
2 FOR SECTIONS REFER TO FIGURES 2.5.4-55 & 2.5.4-56
3 •1 MAP LOCATION NUMBER

FIGURE 2.5.4-54
LOCATION OF FIELD DENSITY TESTS
EMERGENCY GENERATOR ENCLOSURE
AND CONTROL BUILDING
MILLSTONE NUCLEAR POWER STATION
UNIT 3
FINAL SAFETY ANALYSIS REPORT

CONTROL BLDG.

TOTAL MASS = 750.0 KLUGS

AREA OF MAT = 103.0' X 122.0' = 12566.0 FT^2

HEIGHT OF BUILDING = 86.0'

ELEVATION OF MAT = -0'-6" ASSUME 0'-0" FOR PLAXLY MODEL

FUNDAMENTAL FREQUENCY (FIXED BASE) f = 7.45 CYCLES/SEC

$$V_S = \sqrt{\frac{G}{\rho}} = 4fH$$

G = SHEAR MODULUS H = DEPTH OF SOIL
ρ = MASS DENSITY

BEARING PRESSURE OF BUILDING ON SOIL:

$$P = 750 \text{ K-SEC}^2/\text{FT} \, (32.2 \text{ FT/SEC}^2) \Big/ 12566.0 \text{ FT}^2$$

$$P = 1.922 \text{ KSF} = 1922 \text{ PSF}$$

CALCULATE EQUIVALENT UNIT WEIGHT FOR SOIL LAYER REPRESENTING BUILDING

$$\gamma = 1922 \text{ PSF} / 24.0' = \underline{80.0 \text{ PCF}}$$

$$V_S = 4fH = 4(7.45)\,24.0 = 715.0 \text{ FT/SEC}$$

$$G = V_S^2 \rho = (715.0)^2 \, .08/32.2 = 1271.0$$

HALF-SPACE SOIL SPRINGS ADJUSTED FOR SOIL LAYER OVER BEDROCK

$$K_V = \frac{4 G r_0}{1-\nu}\left(1 + 1.28\frac{r_0}{h}\right) \qquad \text{for } \frac{h}{r_0} > 2.0$$

$$r_0 = \left(\frac{64.34 \times 71.5}{\pi}\right)^{1/2} = 38.3'$$

$$\frac{h}{r_0} = .6266 < 2.0 \quad \therefore \text{CONSIDER LOWER BOUND OF } 2.0$$

springs for $h/r_0 = 2.0$:

$$K_V = \frac{4(18000\text{ KSF})(38.3')}{(1-.4)}(1+.64)$$

$$= 7.537 \times 10^6 \text{ K/FT}$$

$$K_H = \frac{8 G r_0}{2-\nu}\left(1 + \frac{r_0}{2h}\right)$$

$$= \frac{8(18000)38.3'}{(2-.4)}(1+.25)$$

$$= 4.309 \times 10^6 \text{ K/FT}$$

$$K_\theta = \frac{8 G r_o^3}{3(1-\nu)}\left(1 + \frac{r_o}{6h}\right)$$

$$r_o = \left[\frac{bL^3}{3\pi}\right]^{1/4} = \left[\frac{71.5(64.34)^3}{3\pi}\right]^{1/4} = 37.7'$$

$$K_\theta = \frac{8(18000\,\text{KSF})(37.7)^3}{3(1-.4)}(1+.0833)$$

$$= \underline{4.644 \times 10^9 \text{ K-FT/RAD}}$$ ← USE THIS VALUE

$$K_\varphi = \frac{16 G r_o^3}{3}(1.0)$$

$$r_o = \left[bL\frac{(b^2+L^2)}{6\pi}\right]^{1/4} = 38.76'$$

$$K_\psi = \frac{16(18000)(38.76)^3}{3}(1.0)$$

$$= \underline{5.60 \times 10^9 \text{ K-FT/RAD.}}$$ ← USE THIS VALUE

CALCULATION OF SOIL SPRINGS FOR

$\frac{h}{r_o} = 0.6266$

$K_V = 4596000 \times 3.043 = 1.3986 \times 10^7$ K/FT

SEE NOTE BELOW:

$K_H = 3447000 \times 1.798 = 6.1976 \times 10^6$ K/FT

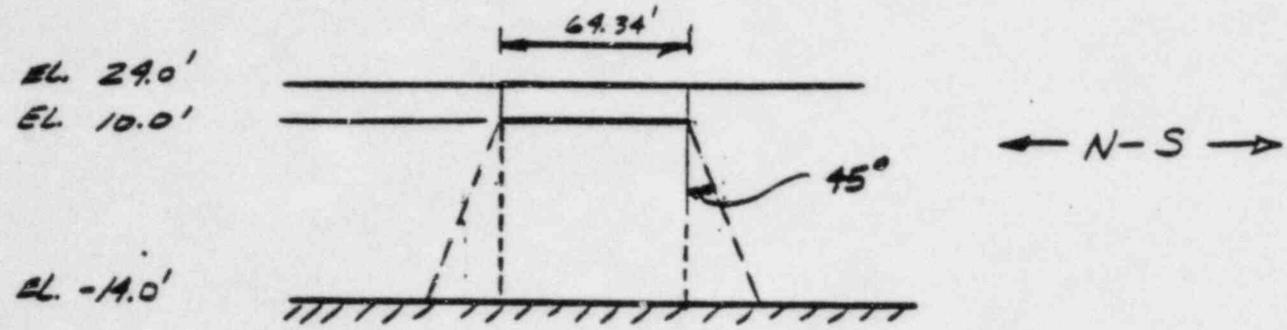
$K_\theta = 4286610639 \times 1.266 = 5.4268 \times 10^9$ K-FT/RAD

$K_\varphi = 5.60 \times 10^9$ K-FT/RAD

NOTE: IT IS BELIEVED THAT FOR $\frac{h}{r_o} < 2.0$ THE FLEXIBILITY OF THE BASE ROCK MUST BE CONSIDERED AND THESE EQUATIONS WILL OVERESTIMATE THE STATIC SPRING CONSTANTS.

THEREFORE THE SPRINGS (K_H, K_θ) THAT REPRESENT THE STRATUM THE BEST, FALL IN BETWEEN THE BOUNDS OF $0.6266 \le \frac{h}{r_o} \le 2.0$

SOIL SPRINGS BASED ON COLUMN OF SOIL UNDER STRUCTURE



USING SHEAR BEAM THEORY: CONSIDER 45° (TRUNCATED PYRAMID)

$$K_H = \frac{AG}{L}$$

$G = 18{,}000$ KSF

$L = 24.0'$

take average width of column

$$A = (71.5 + 24.0 \sin 45°)(64.34 + 24.0 \sin 45°) = 7194.0 \text{ FT}^2$$

$$K_H = \frac{7194.0 \text{ FT}^2 (18{,}000 \text{ KSF})}{24.0'}$$

$$= 5.3955 \times 10^6 \text{ K/FT}$$

← USE THIS VALUE

$K_v = \frac{EA}{L} = 2.8\,K_H = \underline{1.5107 \times 10^7\ K/FT}$

USE THIS VALUE

$G = \frac{E}{2(1+\nu)}$ for $\nu = 0.4$

BASED ON VERTICAL COLUMN OF SOIL

$A = 64.34 \times 71.5 = 4600\ FT^2$

$\frac{AG}{L} = K_H = \frac{4600\,(18000)}{24.0} = \underline{3.45 \times 10^6\ K/FT}$

$K_v = 2.8\,K_H = \underline{9.66 \times 10^6\ K/FT}$

TABLE I
CONTROL BUILDING

COMPARISON OF FUNDAMENTAL BUILDING FREQUENCY

MODE	DIRECTION	FREQUENCY (HZ)	
		PLAXLY MODEL	HALF-SPACE MODEL
1	N-S	7.6	8.1
2	E-W	8.0	8.4
3	N-S	13.8	12.3
4	VERT	18.5	18.6

TABLE 2
CONTROL BUILDING

COMPARISION OF BUILDING RESPONSE
SAFE SHUTDOWN EARTHQUAKE

DIRECTION	ELEVATION (FT)	ACCELERATION (g)	
		PLAXLY MODEL	HALF-SPACE MODEL
N-S	90.2	0.473	0.524
	63.7	0.397	0.382
	46.0	0.332	0.286
	24.1	0.243	0.173
	0.5	0.194	0.170
E-W	90.2	0.548	0.524
	63.7	0.432	0.381
	46.0	0.367	0.293
	24.1	0.248	0.184
	0.5	0.192	0.170
VERT	90.2	0.181	0.206
	63.7	0.157	0.163
	46.0	0.143	0.135
	24.1	0.124	0.120
	0.5	0.115	0.090

TABLE 3
CONTROL BUILDING

COMPARISON OF STORY FORCES
P!.AXLY MODEL VS HALF-SPACE MODEL

MASS NO.	ELEVATION (FT)	STATIC STORY FORCE (KIPS)					
		N-S		E-W		VERT	
		PM	HSM	PM	HSM	PM	HSM
5	90.2	1963	2175	2274	2175	751	855
4	63.7	2541	2445	2765	2438	1005	1043
3	46.0	1648	1420	1822	1455	710	670
2	24.1	1247	888	1272	944	636	616
1	0.5	1992	1746	1971	1756	1181	924
TOTAL BASE SHEAR		9391	8674	10104	8768	—	—
TOTAL VERT. FORCE		—		—		4283	4108

PM = PLAXLY MODEL

HSM = HALF-SPACE MODEL

TABLE 4

EMERGENCY GENERATOR ENCLOSURE

COMPARISION OF FUNDAMENTAL BUILDING FREQUENCY

MODE	DIRECTION	FREQUENCY (HZ)	
		PLAXLY SSI	MODIFIED HALF-SPACE
[illegible]	N-S	8.3	8.5
2	E-W	11.8	9.4
3	N-S	13.3	13.8
4 *	E-W	17.4	17.0
5 *	N-S	**	18.0
6	VERT	22.4	22.7

* SOIL MODE

** NO DISTINCT MODE EVIDENT

TABLE 5
EMERGENCY GENERATOR ENCLOSURE
COMPARISON OF BUILDING RESPONSE
SAFE SHUTDOWN EARTHQUAKE

DIRECTION	ELEVATION (FT)	ACCELERATION (g)	
		PLAXLY SSI	MODIFIED HALF-SPACE
N-S	10'-0"	0.304	0.282
	50'-0"	0.502	0.543
	65'-0"	0.641	0.649
E-W	10'-0"	0.270	0.301
	50'-0"	0.426	0.425
	65'-0"	0.528	0.519

ITEM 13 Indicate how the effect of the NSSS systems were accounted for in the seismic evaluation of internal structures. Item resolved pending receipt of documentation.

Response:

The internal structure seismic model (Figure 3.7B-9, Building Model) is combined with the 4-loop reactor coolant system (RCS) model as shown in the attached Figure 1. In this model, the numbers in circles and triangles represent the building stick model springs and mass points. Node Numbers 73, 74, 75, and 76 represent the RCS model's connectivity to building model mass points.

The two models are connected through very stiff members representing the steam generator's (SG) support floor at el 3 ft, steam generator and reactor coolant pump's snubbers at el 24 ft-5 in., and the operating floor at el 50.85±. These members connect the various major equipment support points and the mass points of the building model.

The seismic response of the combined model was obtained using input motion histories (6 degree of freedom) at top of the containment mat (Node 71) obtained from output of the building model seismic analysis with rock springs and ground motion history (.17 g).

In both models, the common spring is No. 1 and represents primary shield wall (psw), instrumentation tunnel, and the portion of crane wall. This member represents a major structural element which transfers seismic forces into the mat and has been selected to compare the forces (at bottom support) as evaluated both from the building model and the RCS combined model.

Table 1 shows the results are comparable and the model used in the seismic analysis of the structure adequately predicts the structural response to seismic motion.

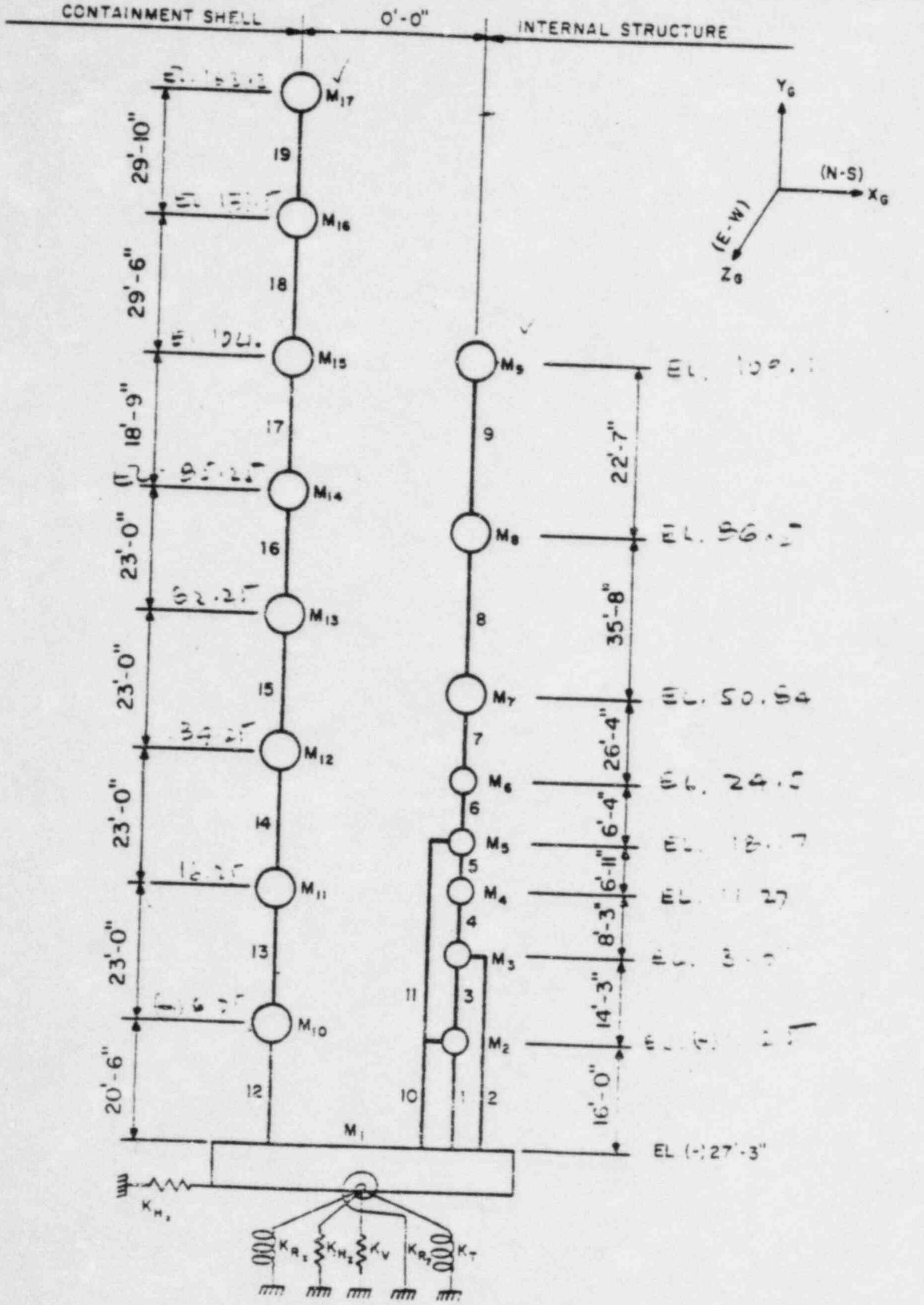
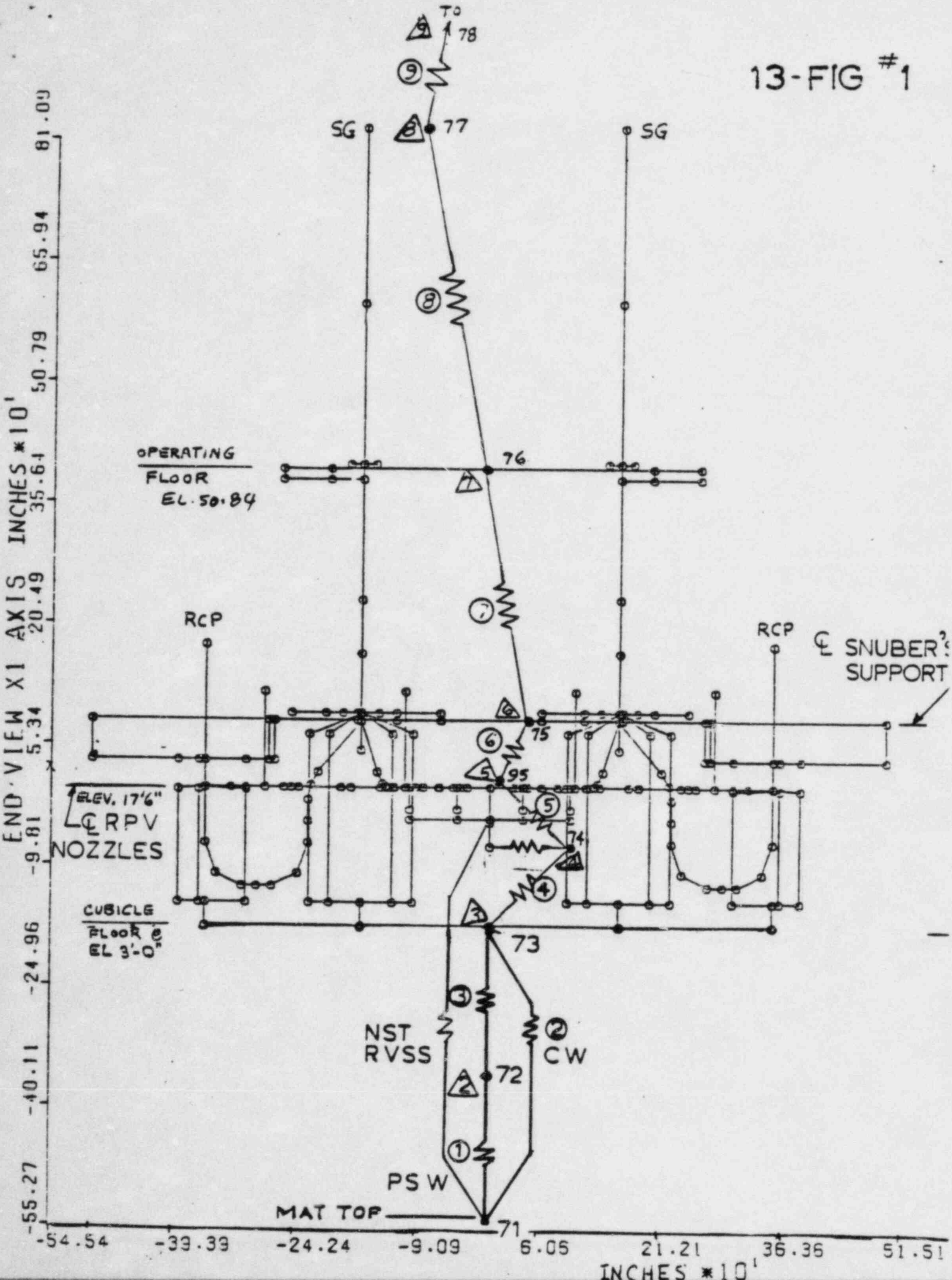


FIGURE 3.7B-9
DYNAMIC MODEL OF THE CONTAINMENT STRUCTURE
MILLSTONE NUCLEAR POWER STATION UNIT 3
FINAL SAFETY ANALYSIS REPORT

K_H, K_V, K_R, K_T =
HORIZONTAL, VERTICAL, ROCKING AND TORSIONAL SUBGRADE SPRINGS

13-FIG #1


TO
78
77
SG
SG
OPERATING
FLOOR
EL. 50.84
76
RCP
RCP
℄ SNUBER'S
SUPPORT
75
95
ELEV. 17'6"
℄ RPV
NOZZLES
74
CUBICLE
FLOOR @
EL 3'-0"
73
NST
RVSS
CW
72
PSW
MAT TOP
71
END VIEW X1 AXIS INCHES *10¹
81.09
65.94
50.79
35.64
20.49
5.34
-9.81
-24.96
-40.11
-55.27
-54.54
-39.39
-24.24
-9.09
6.05
21.21
36.36
51.51
INCHES *10¹

13 - TABLE #1

SPRING #1 AT BOTTOM OF SUPPORT

	E-W DIRECTION		N-S DIRECTION		SRSS	
	SHEAR KIPS	MOMENT IN KIPS	SHEAR KIPS	MOMENT IN KIPS	SHEAR	MOMENT
INTERIOR STRUCTURE STICK MODEL	14,131	11.606×10^6	16,467	6.775×10^6	21,699.	13.439×10^6
COMBINED MODEL WITH BUILT-IN RC	11,200.	12.536×10^6	14,050	5.508×10^6	17,970	13.692×10^6

ITEM 16 Provide examples on how the three components of the earthquake are combined to comply with Regulatory Guide 1.92. An example of the crane wall columns of the internal structure was presented and the issue was resolved. The Applicant will provide this reponse.

Response:

As an example of how three components of an earthquake are combined to comply with Regulatory Guide 1.92, the following example is given:

The distribution of seismic load to the crane wall columns of the internal strucutre is reviewed. To distribute the resulting seismic shear, overturning moment, and torsion, a stiffness model was developed representing the crane wall columns and primary shield wall/instrumentation tunnel between el (-)27 ft-3 in. and el 3 ft-8 in. (Figures 1 and 2). Rigid members were used (representing the el 3 ft-8 in. slab) to connect the center of mass and the center of rigidity of the actual members. Shear and bending deformations were considered in developing the stiffness of each member. The resulting acceleration profiles from the seismic response analysis were used to develop static story forces based on the associated mass of the internal structure (Tables 1 and 2). These forces were then carried down to the el 3 ft-8 in. slab. The resulting forces and moments were then applied to the stiffness model and distributed to the individual elements based on their relative stiffness (sse Figure 3). As an example, the force distribution due to the N-S shear is presented in Table 3. Similarly, the remaining forces were distributed to the individual elements. These resulting element forces were then combined by SRSSing the components due to N-S, E-W, and vertical except the torsion contribution was added directly as indicated in Table 4.

TABLE I

CONTAINMENT STRUCTURE ACCELERATION (g) PROFILES

N-S

EL.	1.0 SSE	0.5 SSE	1.0 SSE	0.5 SSE
109.1	1.07	0.694	0.317	0.199
86.5	0.855	0.552	0.324	0.207
50.8	0.541	0.349	0.251	0.162
24.5	0.451	0.290	0.204	0.132
18.2	0.421	0.270	0.202	0.130
11.3	0.395	0.260	0.172	0.111
3.0	0.357	0.230	0.188	0.121
-11.3	0.294	0.168	0.108	0.068
-37.3	0.17	0.09	0.113	0.06

E-W

EL.	1.0 SSE	0.5 SSE
109.1	1.01	0.685
86.5	0.821	0.558
50.8	0.517	0.352
24.5	0.456	0.309
18.2	0.447	0.304
11.3	0.397	0.272
3.0	0.414	0.283
-11.3	0.298	0.192
-37.3	0.17	0.09

TABLE 2

ACCELERATION LOADS FROM SEISMIC ANALYSIS (INTERNALS)

SSE

MASS NO.	ELEV. (FT)	MASS (KLUGS)	FORCE (KIPS) N-S	E-W	VERT
2	-11.25	130.24	1233.0	1250.0	453.0
3	3.0'	328.8	3780.0	4383.0	1990.0
4	11.3'	97.0	1234.0	1240.0	537.0
5	18.2'	116.5	1580.0	1677.0	758.0
6	24.5'	231.6	3058.0	3400.0	1521.0
7	50.8'	405.11	7057.0	6744.0	3274.0
8	86.5'	133.22	3668.0	3522.0	1390.0
9	109.1'	67.5	2326.0	2195.0	689.0

TOTAL SHEAR, AXIAL & MOMENT AT EL. 3.0'

S_{N-S} = 22703.0 KIPS

S_{E-W} = 23161.0 KIPS

AXIAL = 10159.0 KIPS

M_{N-S} = 958,222.0 FT-KIPS ABOUT N-S AXIS

M_{E-W} = 990,396.0 FT-KIPS ABOUT E-W AXIS

TABLE 3

FORCES-SSE (EXTRACT FROM COMP RUN # 345 D 6-11-80)
N-S EXCITATION
LOADING 1 $F_x = 22703^k$ (N-S SHEAR DUE TO SSE N-S)

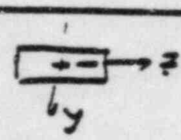
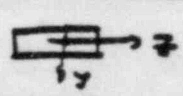
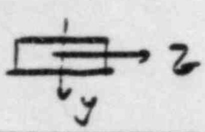
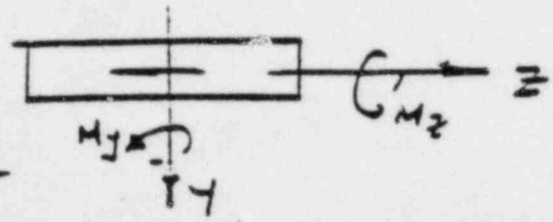
MEM #	FORCE DIRECT. (IN LOCAL AXES)	VERT FORCE IN KIPS	SHEAR Y-DIRECT. IN ± KIPS	SHEAR Z-DIRECT IN KIPS	MOM. M_y ± FT. KIPS	MOM M_z ± FT. KIPS	MOM M_x TORSION FT-KIPS
1		65.	18	320	4480.	253	–
2	DITTO	147	–	353	4936	(16.55) –	–
3	DITTO	333	20	312	4358	282	–
4	DITTO	456	35	203	2828	492	–
5		1852	560	1671	26280	7796	–
6		140.	18	312	4366	253	–
7		72	–	345	4820	(16.55) –	–
8		258	20	304	4244	283	–
9		380	35	195	2714	493	–
14		2495	17744	6000	100,532	343 324	42534

TABLE 4

MEMBER # 4 [SSE]

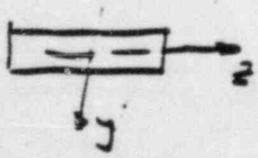


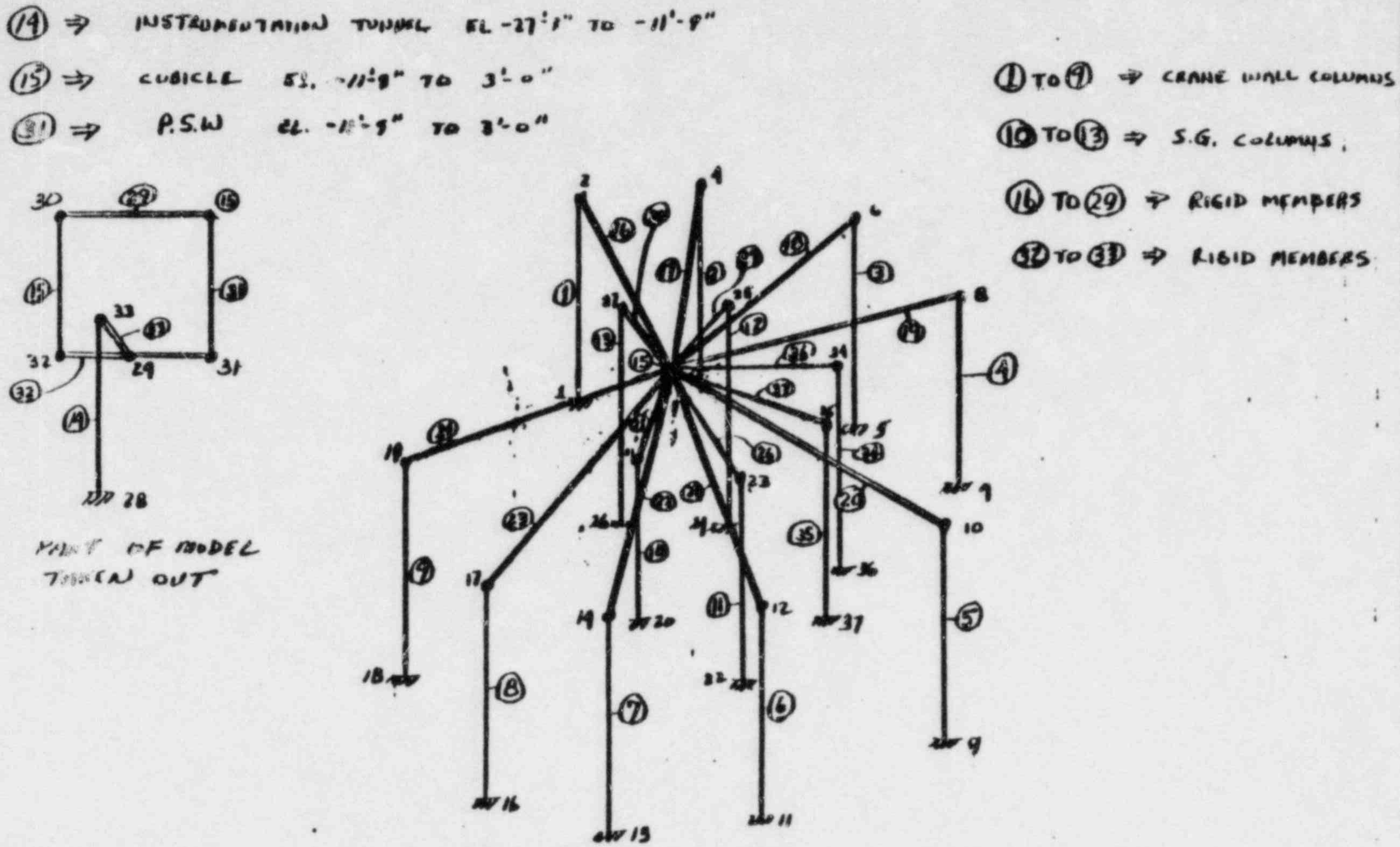
COMBINED FORCES AT BASE.

	DIRECTION OF EXCITATION	VERT. KIPS	F_y Kips	F_z Kips	M_y Ft. Kips	M_z Ft Kips	M_x TORSION
1	N-S EXCIT.						
	DUE TO SHEAR	456	35	203	2828	492	-
	" MOM.	1331	-	-	80	- (25)	-
	Σ N-S FORCES	1787	35	203	2908	492	-
2	E-W EXCIT.						
	DUE TO SHEAR	438	25	311	4358	353	- (9.0)
	DUE TO MOM.	1155	- (2.6)	- (23)	170	- (22)	-
	Σ E-W FORCES	1593	25	311	4528	353	-
3	VERT. EXCIT.						
	TOTAL VERT.	298	-	-	- (12.0)	-	-
	TORSION EFFECT	-	-	50	688	- (5.0)	- (9.0)

PROBABLE RESULTANT FORCES

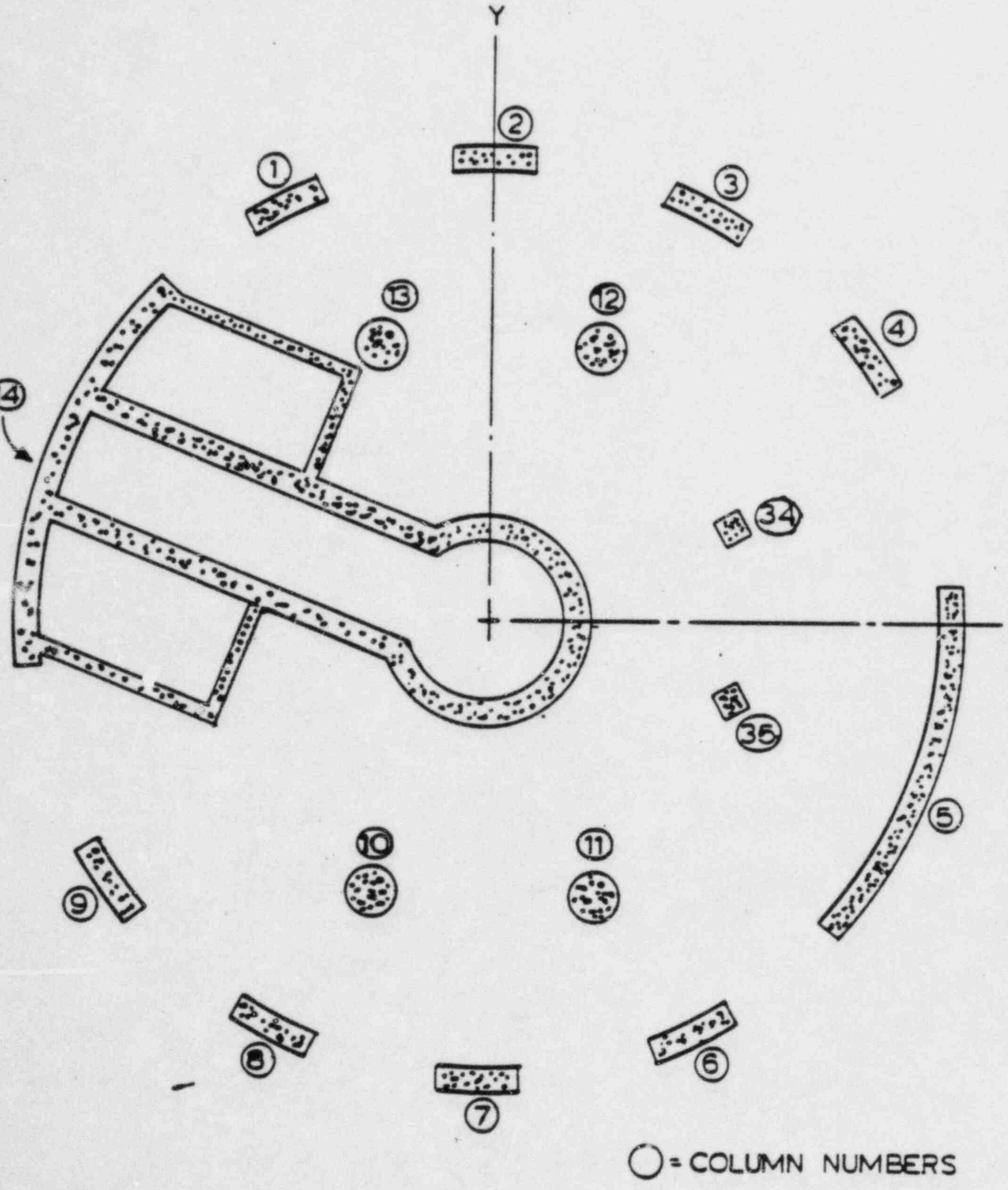
$$= \sqrt{(N\text{-}S)^2 + (E\text{-}W)^2 + (VERT)^2} + \text{TORSION EFFECT}$$

	MEMBER	VERT ±	SH F_y	SH F_z	MOM M_y	MOM M_z	MOM M_x TORSION
4		2412	43	421 (441)	6069	605 (644)	— (12.0)



STRUDL MODEL

FIGURE 1



CRANE WALL COLUMNS AND PSW / INSTRUMENTATION TUNNEL
EL (-) 27'-3"

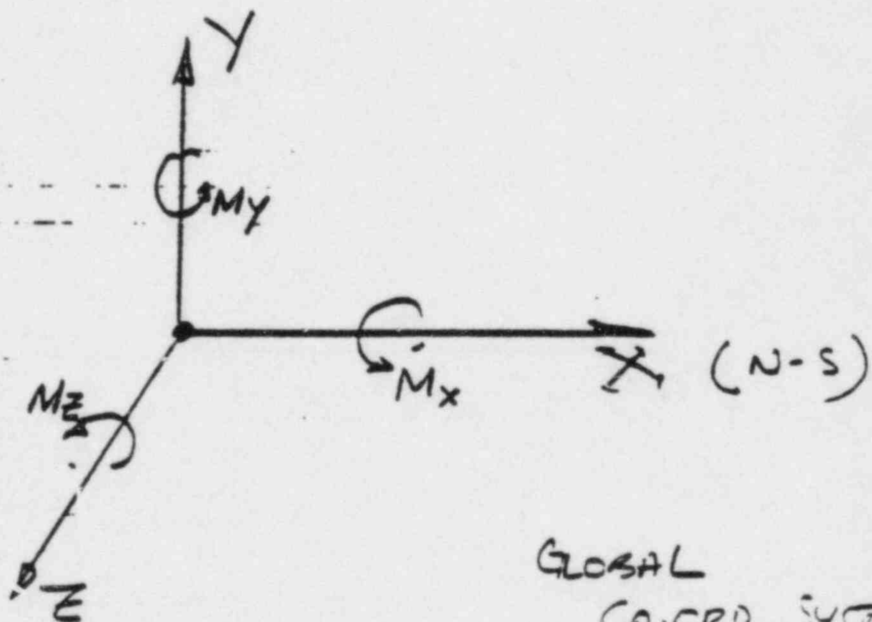
FIGURE 2

FIGURE 3

COMPUTER RUN # 345 DATE 6/11/80.

FORCES APPLIED. —

LOADING 1. SHEAR (N-S) DIRECT. —	FORCE X = 22,703 k
LOADING 2 MOM. ABOUT E-W AXIS.	M_z = 990,396 'k
LOADING 3 SHEAR (E-W) DIRECT.	FORCE Z = 23,161 k
LOADING 4 MOM. ABOUT N-S AXIS	M_x = 958,222 'k
LOADING 5 VERT. DIREC.	FORCE Y = 10,159 k
LOADING 6 TORSION	M_y = 117,628 'k



GLOBAL
CO-CRD. SYSTE[illegible]

FORCES APPLIED AS JOINT LOADS AT NODE #15.

ITEM 19 Provide a comparison of results in internal structure from Finite Element analysis and STRUDL. An example of the results of comparison was presented and the item was resolved. The Applicant will provide sketches and documentation.

Response:

There are four RCS loops and four steam generator cubicles. Each cubicle houses one Reactor Coolant Loop System (RCS). All four cubicles are similar in configuration and are subjected to the same forces.

Figure 1 shows the plan view of cubicle "B" at el 3 ft-8 in. Steam generator supports S_5, S_6, S_7, S_8, and RC pump supports P_4, P_5, and P_6 are shown in relation to hot leg bumper, cross over bumpers I and II, and steam generator column below el 3 ft-8 in. slab. For the frame analysis of slab at el 3 ft-8 in., walls of the cubicle and the slab is divided into frame sections. Frame sections I, II, and III have be selected and are shown on Figure 1. For stiffness analysis of the frame, STRUDL II computer program is used.

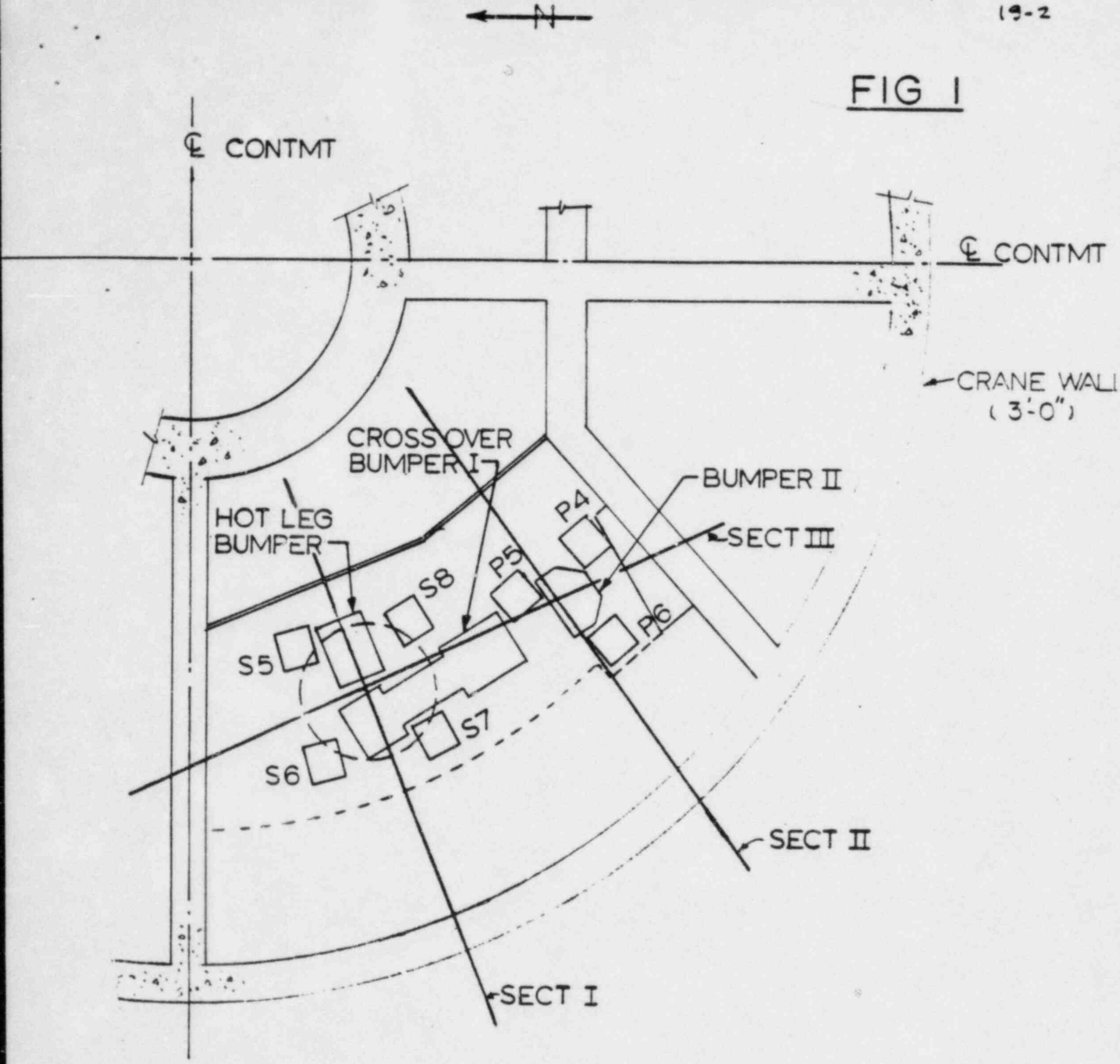
As a verification to frame analysis, a finite element analysis has been performed using bending and stretching elements. STRUDL II was used to analyze the model.

For the comparison of results, loading combination 1.0 D + 1.0 L + 1.5 Pa + 1.0 R_A + 1.0 T_A has been used.

Figures 2 through 5 show the graphical representation of member forces, moments, and shears on frame section III due to frame as well as finite element analysis.

In the design, forces obtained due to frame analysis were used as they governed the design.

FIG 1



BUMPERS, S.G. COL SUPTS & R.C.P. COL SUPTS.

PLAN
CUBICLE B

SCALE: $\frac{3}{32}$" = 1'-0"

MILLESTONE NUCLEAR POWER STATION UNIT NO 3
NORTHEAST NUCLEAR ENERGY COMPANY

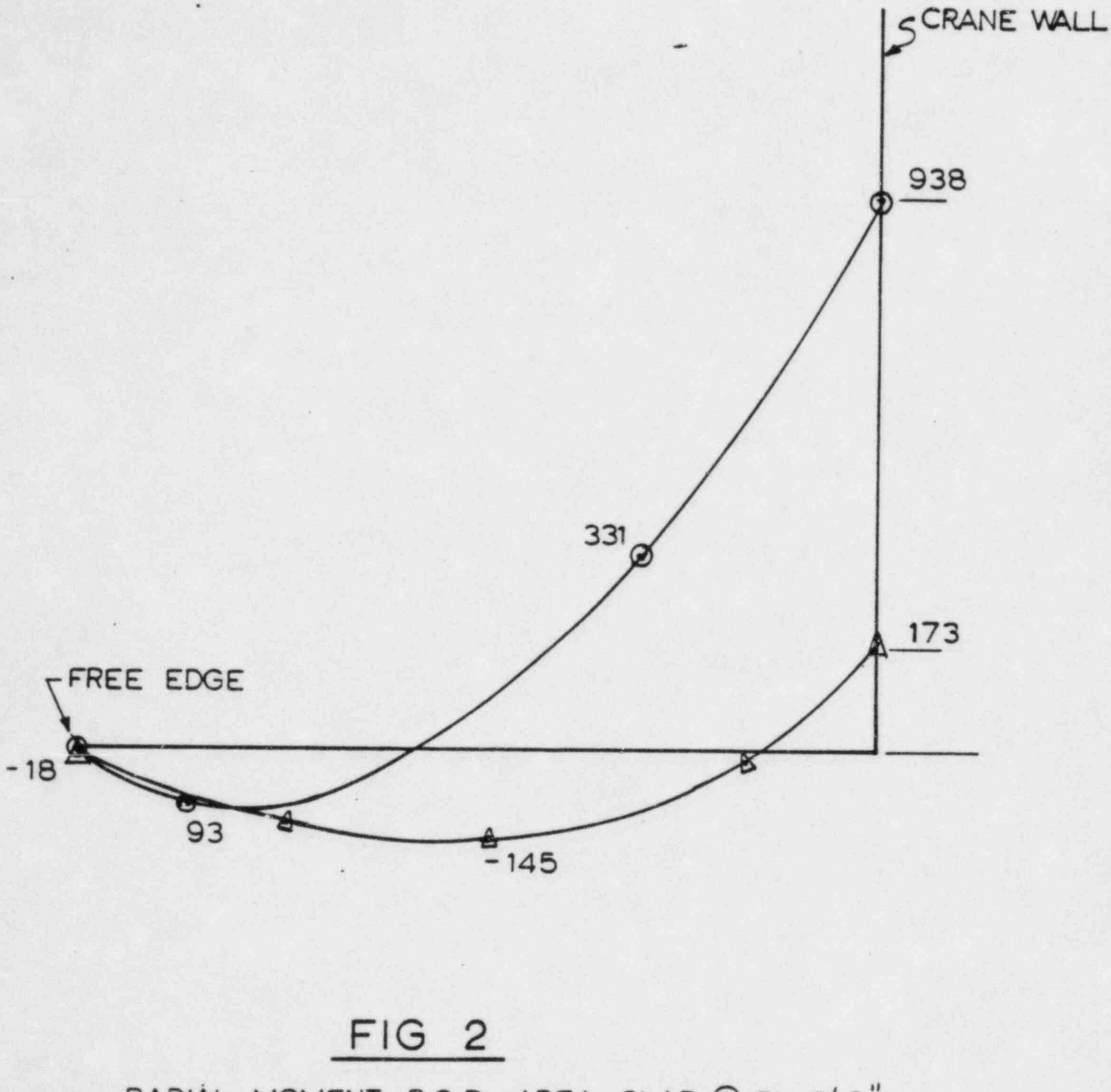


FIG 2

RADIAL MOMENT RCP AREA SLAB @ EL 3'-8"
(LOADING 'ONE')
(PLOTTED ON TENSION SIDE)

PLANER FRAME AT
⊙ SECT II

△ FINITE ELEMENT
AT SECT II

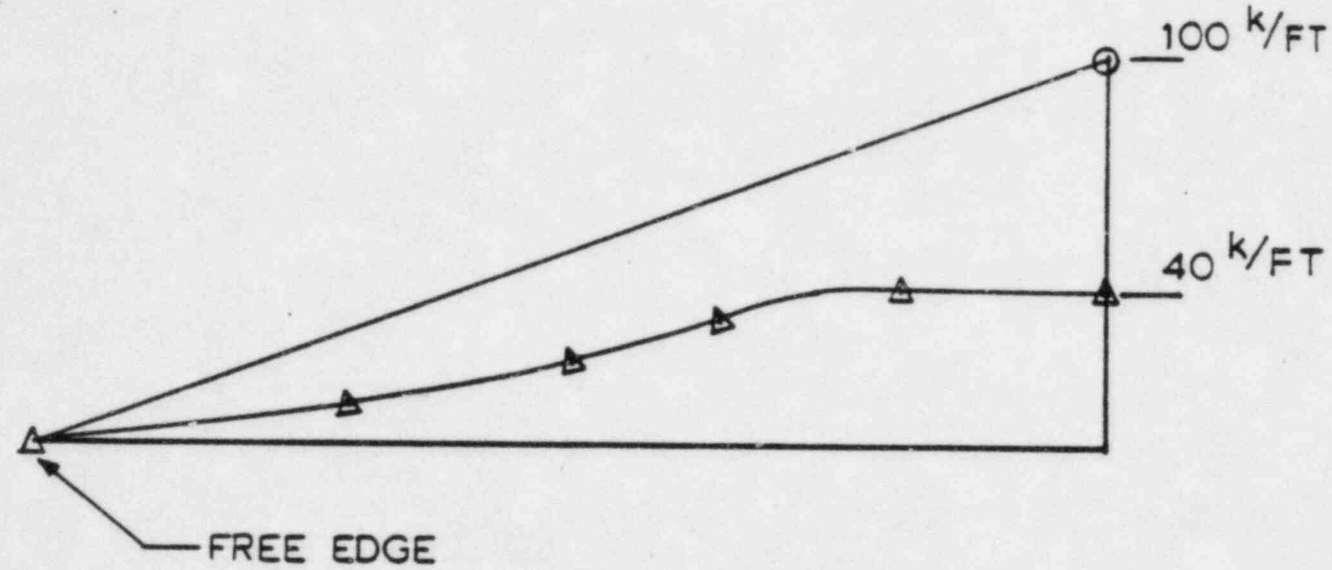


FIG 3

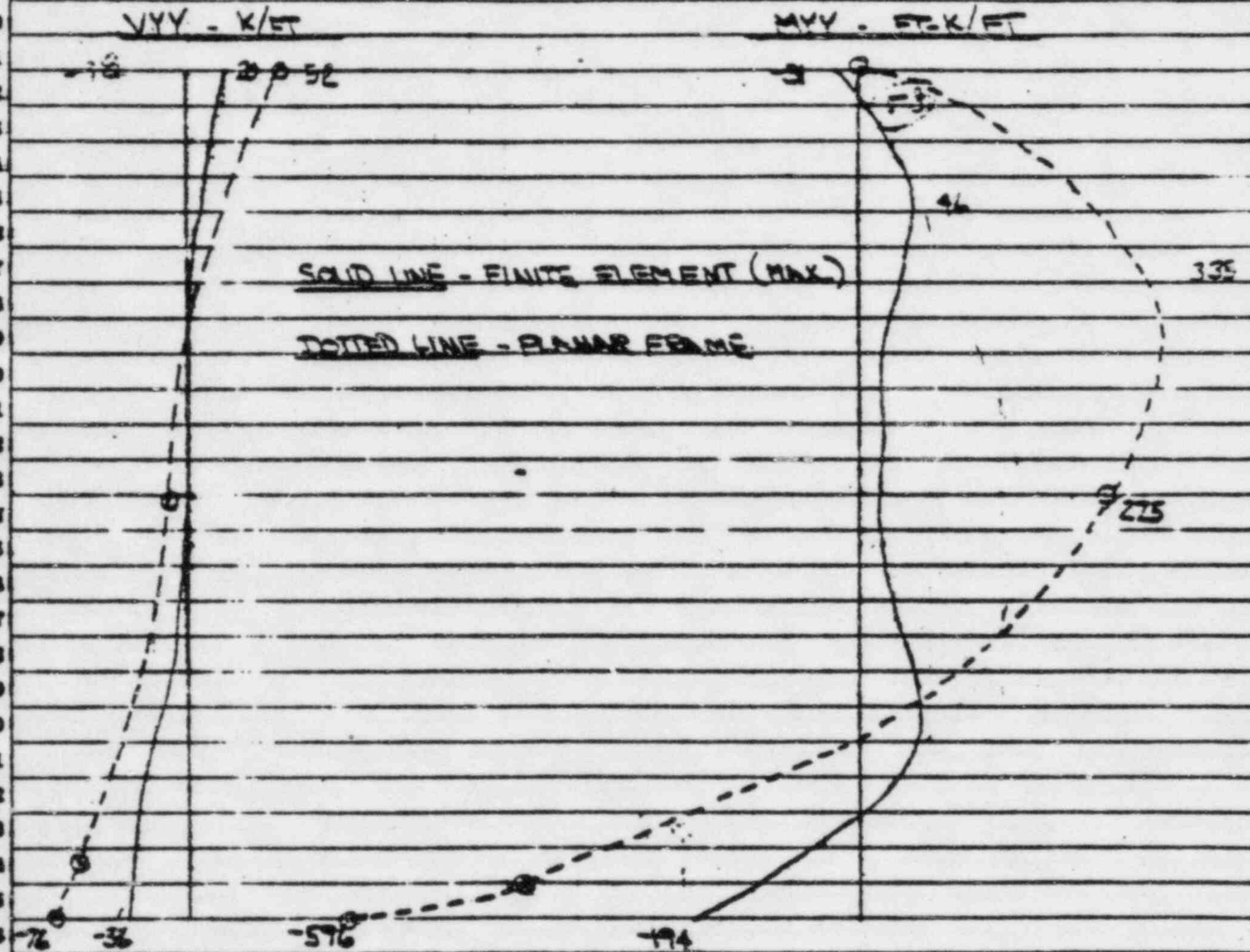
RADIAL-TENSION FOR RCP AREA OF SLAB AT EL 3'-8"
(LOADING 'ONE')

⊙ PLANAR FRAME SECT II
△ FINITE ELEMENTS

FIGURE 4.

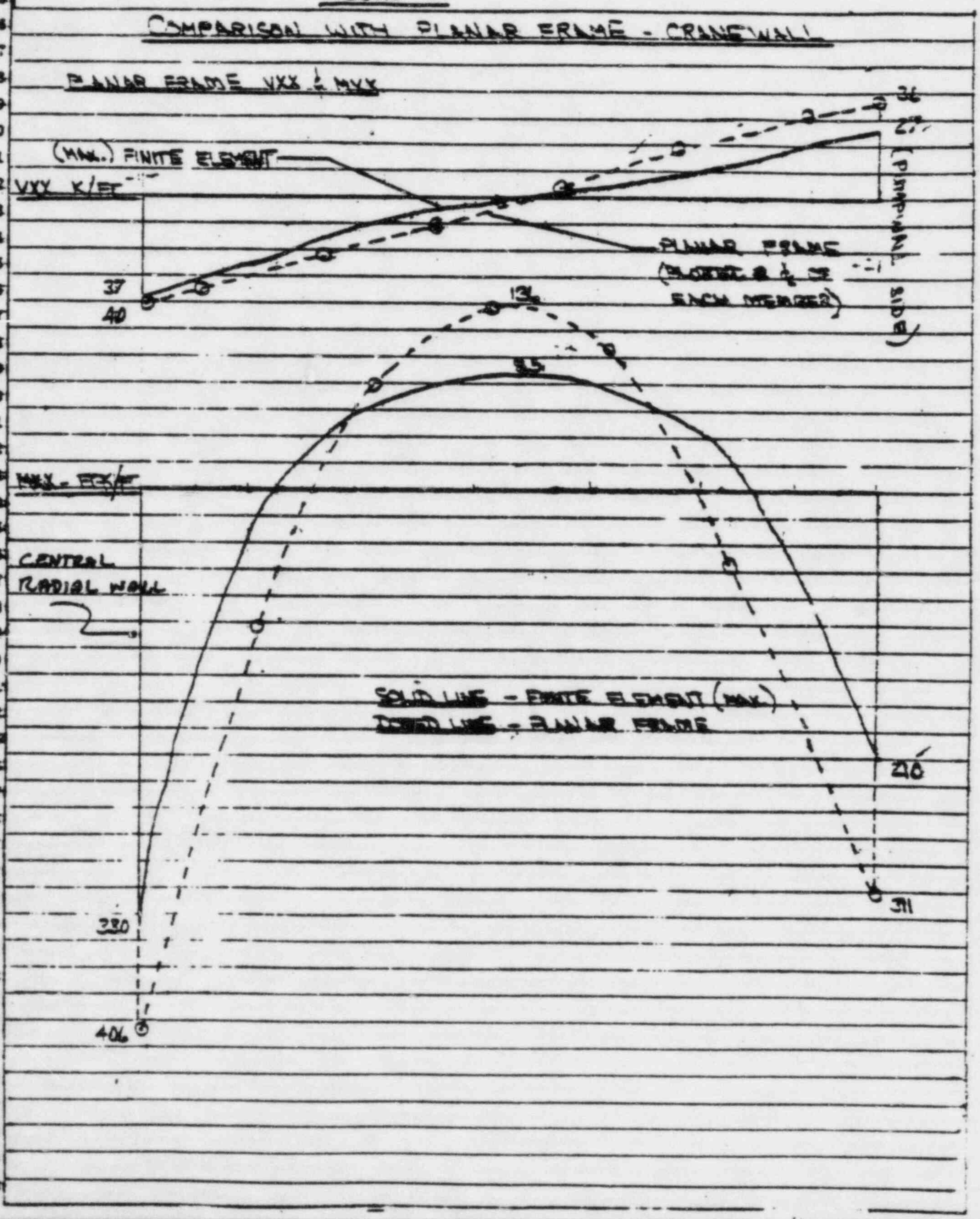
COMPARISON TO PLANAR FRAME - PUMPWALL

LOADING 'ONE'



LOADING 1.
$(1.0DL + 1.0L + 1.5P_A + 1.0R_a + 1.0T_A)$

Figure 5.


COMPARISON WITH PLANAR FRAME - CRANEWALL
PLANAR FRAME VXX & MXX
(MAX.) FINITE ELEMENT
VXX K/FT
PLANAR FRAME (PLOTTED @ ½ OF EACH MEMBER)
37
40
36
CENTRAL RADIAL WALL
SOLID LINE - FINITE ELEMENT (MAX.)
DOTTED LINE - PLANAR FRAME
380
406
311

ITEM 20 Perform simplified assessment of basemat design to demonstrate that equations from FSAR Page 3.8-13 do not govern. In case of some exceedence in allowable stresses for the two conditions, the as-built material strength can be used to show that at least the intent is met. Item resolved pending the documentation of the governing load condition.

Response:

The enclosed table indicates that Equations 9 and 10 do not govern basemat design.

F S A R TABLE 3.8-3	LOAD COMBINATIONS	RADIAL MOMENT K-FT/FT AT			TANGENTIAL MOMENT K-FT/FT AT			SHEAR K/FT AT			CONTMT WALL @ MAT	
		REAC SUPT	CRANEWALL	CONTMT WALL	REAC SUPT	CRANE WALL	CONTMT WALL	REAC SUPT	CRANE WALL	CONTMT WALL	MOMENT	SHEAR
EQ 8	$1.0D + 1.0L + 1.5P_a + 1.0T_a + 1.0R_a$	369	493	2510	334	98	537	108	156	243	1587	201
EQ 9	$1.0D + 1.0L + 1.25P_a + 1.0T_a + 1.0R_a + 1.25$ (OBE)	388	400	2067	53	91	442	96	102	206	1360	176
EQ 10	$1.0D + 1.0L + 1.0P_a + 1.0R_a + 1.0$ SSE	384	398	1645	136	84	350	68	76	197	1020	140

CONTAINMENT STRUCTURE MAT
MOMENT AND SHEAR TABLE

20 - TABLE 1

MILLSTONE NUCLEAR POWER STATION UNIT NO 3
NORTHEAST NUCLEAR ENERGY COMPANY

ITEM 23 Provide design follow-up including load definitions through re-bar quantity determination of Steam Generator cubicle barrier wall (central radial wall). Also consider the three component combination aspects in the earthquake analysis. Analysis of the cubicle barrier wall was presented and the issue was resolved. The Applicant will provide the design follow up for documentation.

Response:

The following load combinations governed the design of the Steam Generator cubicle barrier wall (central radial wall).

Reference FSAR Section 3.8-3.

1. $U = D + L + Ta + Ra + 1.5\ Pa.$

2. $U = D + L + Ta + Ra + 1.25\ Pa + 1.0\ (Yr + Yj + Ym) + 1.25E_o$

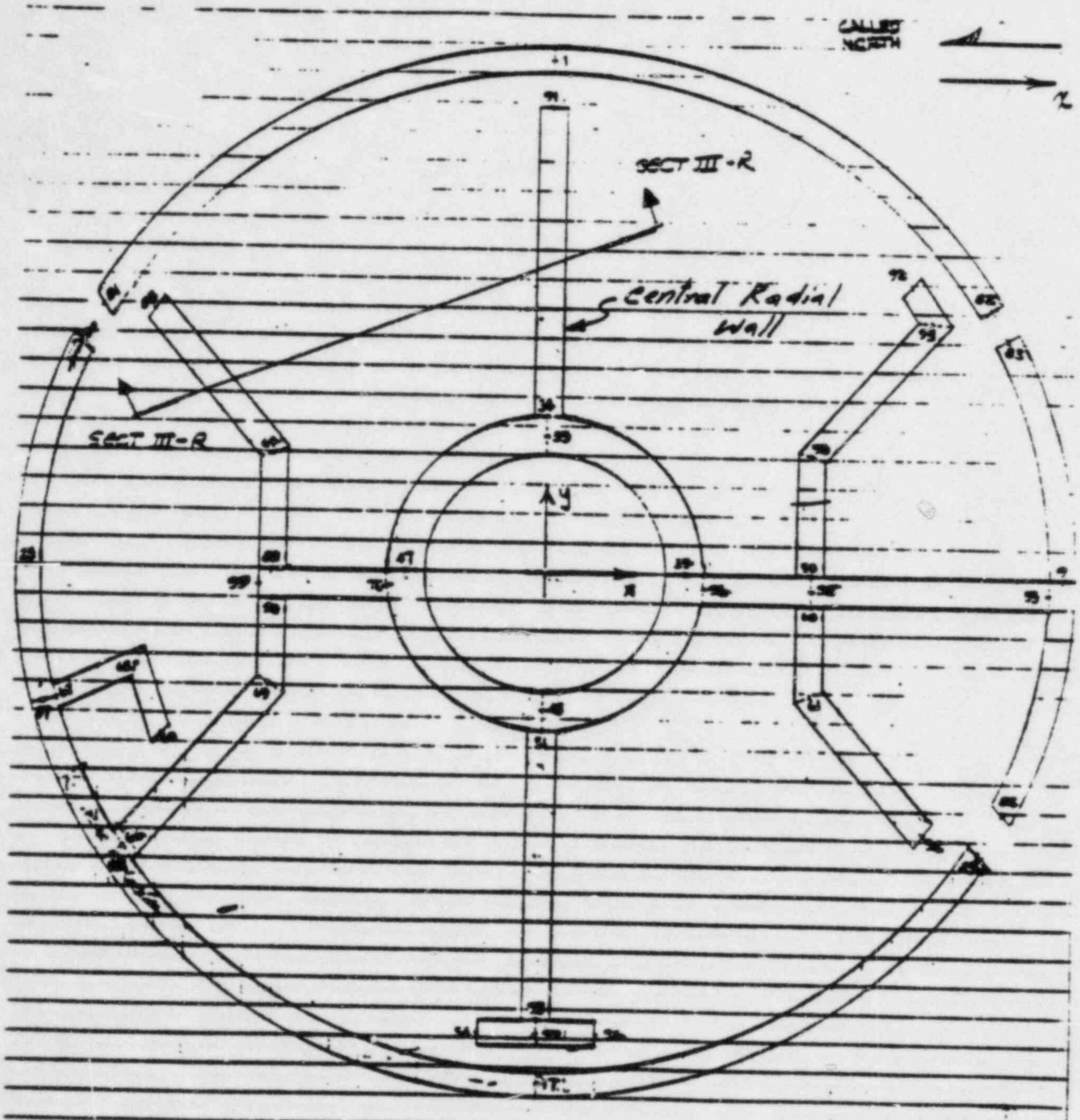
3. $U = D + L + Ta + Ra + 1.0\ Pa + 1.0\ (Yr + Yj + Ym) + 1.0E_s$

Design of the radial wall is done in two sections.

SECTION 1 - ITEM 25

PAGES 2 THROUGH 6

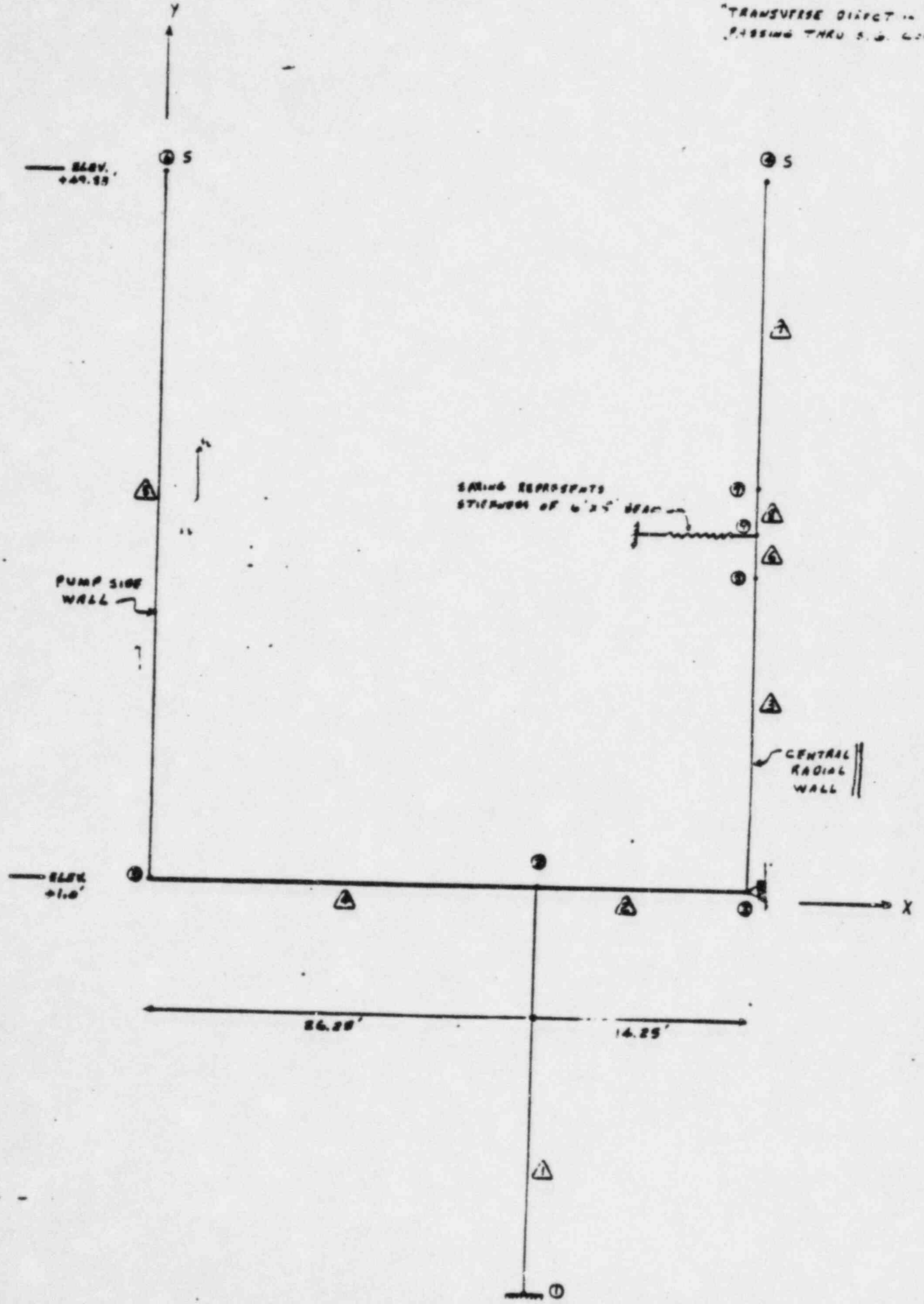
LOADING COMBINATION - 1



KEY PLAN @ EL. 3'-8"

SECTION III-R

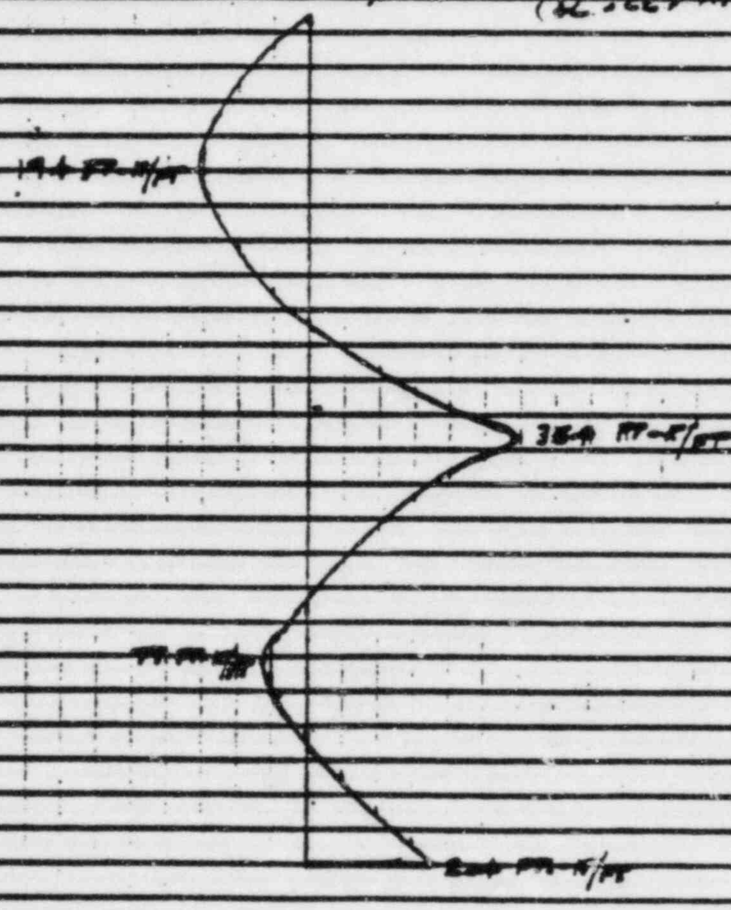
"TRANSVERSE DIRECT[illegible]
PASSING THRU S.G. [illegible]



CENTRAL RADIAL WALL

VERTICAL REINFORCEMENT

SECTION III-R IS A 23' SECTION. [illegible] MOMENT RESULTS ARE SHOWN BELOW FOR CRITICAL LOADING OF 1.5 P (NEGLECTING OWNWEIGHT) [illegible]



TENSION CARRIED BY FULL 40' SECTION, AT POINT OF MAX MOMENT, $T = \frac{1036}{40} = 25.9$ K/FT.

CENTRAL RADIAL WALL

VERTICAL REINFORCEMENT

1.5 P (SECTION III-R)

#11 @ 6" OUTSIDE ROW E.F.

#11 @ 12" INSIDE ROW E.F.

```
09.23.45 exec newsect
09.23.51 LOAD NEWSECT MATCH (XEQ)
EXECUTION:
fpc 5.0
yi 40.0
th 36.0
mom 354.0
fo 26.0
no 4
3.12 2.7
1.56 5.5
1.56 30.5
3.12 33.3
go
```

COMP STRENGTH OF CONCRETE = 0.5000D 04 (PSI)
STEEL YIELD STRENGTH = 0.4000D 05 (PSI)
SECTION DEPTH = 36.000 (IN)
SECTION WIDTH = 12.000 (IN)

MAX. STRAIN IN CONCRETE = 0.4278D-03
MAX. STRESS IN CONCRETE = 0.1810D 04 (PSI)
CONCRETE UNCRACKED LENGTH = 0.8925D 01 (IN)

STEEL NO	AREA (SQ IN)	DISTANCE (IN)	STRAIN	STRESS (KSI)	FORCE (KIPS)
1	3.120	2.700	0.1168D-02	35.051	109.360
2	1.560	5.500	0.1034D-02	31.025	48.399
3	1.560	30.500	-0.1642D-03	-4.925	-7.683
4	3.120	33.300	-0.2984D-03	-8.951	-27.928

FORCE IN CONCRETE = 0.96148D 02 (KIPS)

CALCULATED FORCE = 26.000 (KIPS) APPLIED FORCE = 26.000

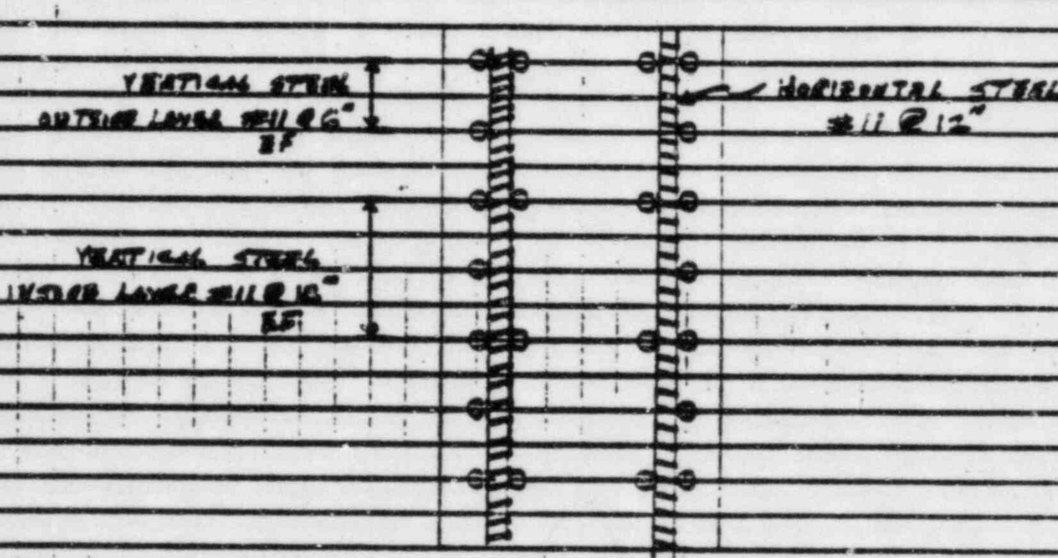
CALCULATED MOMENT = 354.000 (KIP-FT) APPLIED MOMENT = 354.000

****

CENTRAL RADIAL WALL

VERTICAL REINFORCEMENT

USING NEWSECT PROGRAM WITH M= 364 FT-K/FT AND T= 26.0 K/FT THE FOLLOWING SECTION IS ADEQUATE



PLAN

SECTION 2 - ITEM 23

PAGES 8 THROUGH 23

LOADING COMBINATIONS 2 and 3

CENTRAL RADIAL WALL

Summary

Sesimic shear forces at various elevations on the internal containment were obtained from a lumped mass analysis due to three components of earthquake on the structure. Seismic shear forces are to be resisted by the system of walls.

For the purpose of these calculations, the geometry is described in an X-Y coordinate system with the X-axis coinciding with the "Called North" on the drawings. Each system of walls is divided into rectangular and circular segments. Each end of the segment is assigned a node number so that each segment can be identified by the coordinates of its end points and its nodal incidence. Segment properties are calculated based on the geometry and the appropriate formulas for first moments of area about the neutral axis of the system of walls.

Calculations are tabulated and the values of "Q" in the formula $\tau = {}^{VQ}/_{It}$ are computed according to the connectivity of the segments comprising the system of walls. For cases where closed-cells occur in the overall cross-section, the problem becomes indetrminate, and the redundant shear flows are calculated by setting Qds = 0 for each closed cell.

Finally, the values of the shear stress is found from the formula $\tau = {}^{VQ}/_{It}$ where the values of V are obtained from the lumped-mass seismic analysis, I is the moment of intertia for the entire cross-section, and t is the thickness of the wall at the point under investigation.

Following is the summary of Total shear on the containment V_x & V_z

Elevation	Story shear	Total V_z	Total V_x
EL. 109.0'	V_z 1591^k, V_x 1654^k	1591^k	1654^k
EL. 86.5'	V_z 2741^k, V_x 2702^k	4332^k	4356^k
EL. 50.8'	V_z 5727^k, V_x 5531^k	10,059^k	9887^k
EL. 24.5'	V_z 2409^k, V_x 2409^k	12,468^k	12,296^k
EL. 18'	V_z 1163^k, V_x 1110^k	13,631^k	13,406^k
EL. 11.27'	V_z 828^k, V_x 846^k	14,459^k	14,252^k
EL. 3'-[illegible]"	V_z 2880^k, V_x 2530	17,339^k	16,782^k

To locate the point of maximum shear, a comparison can be made between sections to see which is most likely to maximize the equation $\tau = \frac{VQ}{It}$, assuming:

1) Wall thicknesses are generally constant from section to section

2) Q is a function of geometry and will be evaluated later

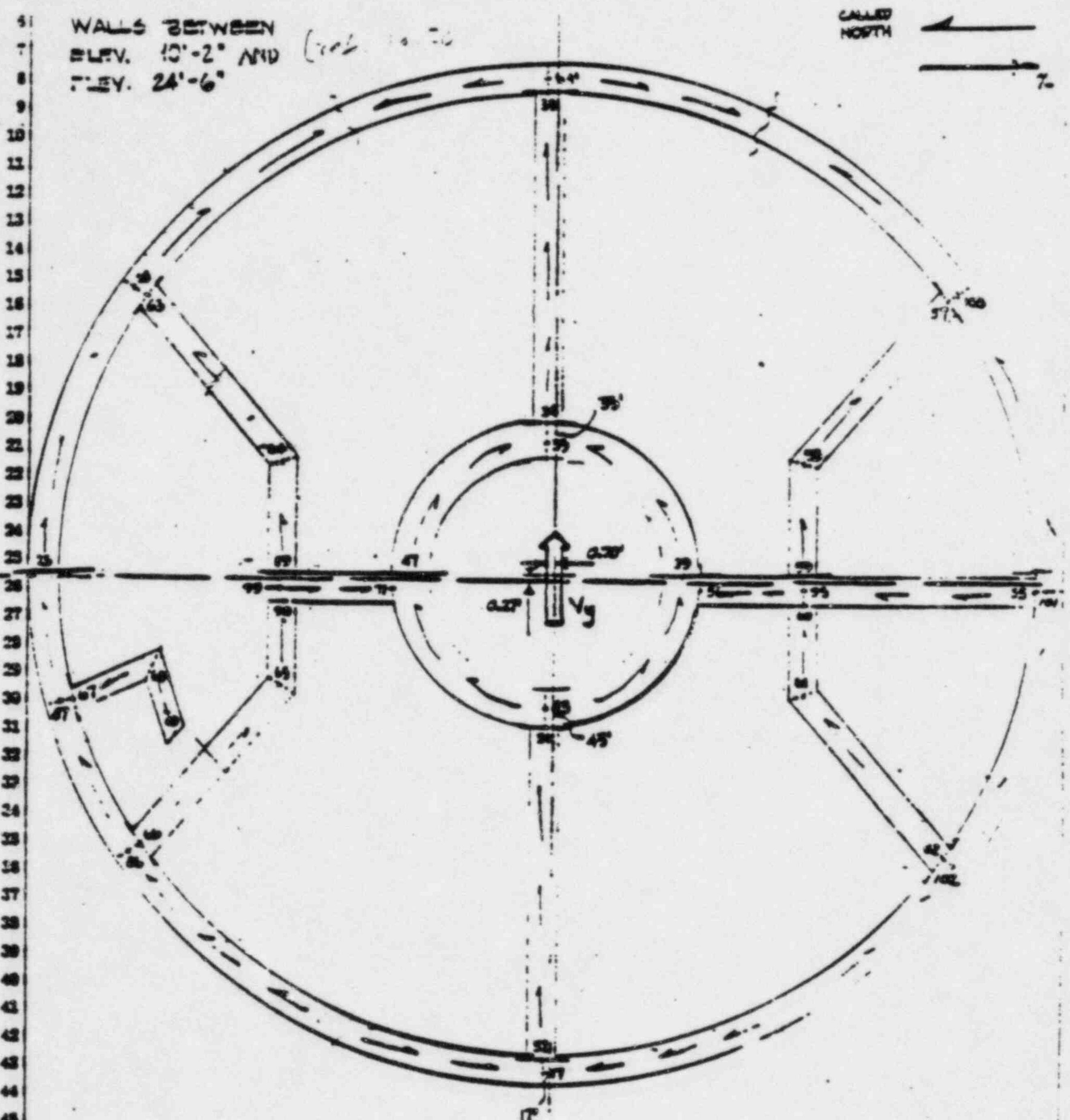
∴ If we compare the ratios V/I for each section, we can determine which might be critical.

Elevation	V_x	V_y	I_{xx}	I_{yy}	V_x/I_{yy}	V_y/I_{xx}
3'-8" - 10'-2"	14,252	14,459	2,162,568	2,474,182	.0057602	.0066594
10'-2" - 24'-6"	14,252	14,459	2,194,276	2,474,182	.0057602	.0065894
24'-6" - 31'-0"	9,987	10,059	2,192,621	2,997,486	.0033094	.0045876
31'-0" - 51'-4"	9,987	10,059	2,192,621	2,997,486	.0033094	.0045876

The most critical section by this criteria is the walls between El. 3'-8" & 10'-2" for a Y-direction excitation.

9.

WALLS BETWEEN
ELEV. 10'-2" AND
ELEV. 24'-6"



PLAN AT EL. 10'-2"

WALLS BETWEEN ELEV. 10'-2" AND 24'-6" — SHEAR FLOWS DUE TO V_u

TAKE A SECTION THROUGH THE NEUTRAL AXIS. THE SHEAR STRESSES AT EACH SEGMENT SECTION WILL BE EQUAL OR THE SHEAR FLOWS WILL BE IN PROPORTION TO THE SEGMENT THICKNESSES.

LET q_1 = SHEAR FLOWS AT SECTIONS 25, 89, 59, AND 101 WITH THICKNESSES OF 3 FT.

LET q_2 = SHEAR FLOWS AT SECTIONS 47 AND 73 WITH THICKNESSES OF 4.5 FT.

$$q_2 = \frac{4.5}{3} q_1 = 1.5 q_1$$

TOTAL SHEAR FLOW ACROSS THE SECTION IS

$$q_T = 4q_1 + 2q_2 = 7q_1 = \frac{V Q_{total}}{I} = \frac{V}{I} \Sigma(AQ_{xx})_{NA}$$

FOR AREA TO ONE SIDE OF NEUTRAL AXIS

$$\therefore q_1 = \frac{V \Sigma(AQ_{xx})_{NA}}{7I}$$

DEFINE $Q_{eff_1} = \frac{I}{V} q_1 = \frac{\Sigma(AQ_{xx})_{NA}}{7} = \frac{28484. + 28962}{14} = 4103.28 \text{ FT}^3$

AND $Q_{eff_2} = 1.5 Q_{eff_1} = 1.5 \times (4103.28) = 6154.92 \text{ FT}^3$

CENTRAL RADIAL WALL (contd.).

WALLS BETWEEN EL. 10'-2" & 24'-6"

SEGMENT	ΔQ_{xx} (FT.^{3})	ΔQ_{yy} (FT.^{3})
39 - 43	- 958.47	913.64
43 - 47	- 958.47	-1059.61
47 - 35	1014.78	- 1059.61

I.D. FOR WALL SECTIONS	AREAS CONTRIBUTING TO Q_{xx} (ΔQ_{xx})	$\Sigma \Delta Q_{xx}$ (FT.^{3})
43 ←	$-Q_{[illegible]} - \Delta Q_{43-47} = (-6154.92) - (-958.47)$	-5196.45
39 ↓	$-Q_{[illegible]}$	-6154.92
56 →	$Q_{56} = 0$	0
56 ←	$Q_{39\downarrow}$	-6154.92
43 →	$Q_{56\leftarrow} - \Delta Q_{43-39} = (-6154.92) - (-958.47)$	-5196.45
51	$Q_{43\leftarrow} + Q_{43\rightarrow} = -5196.45 - 5196.45$	-10,392.9

CENTRAL RADIAL WALL - IN PLANE SHEARS

$\frac{V}{I}$ = .006559 ELEV 10'-2" TO ELEV 24'-6" (CONTINUED)

MODEL PT.	I(ΔQxx)	$\frac{V}{I}$(ΣΔQxx)	Iwall	V_x(KSF)	V (PSI)
33	6228	41.0	3	13.7	95.1
34	10250	67.7	3	22.6	156.9
51	10392	68.5	3	22.9	158.3
52	6401	42.2	3	14.1	97.9

ELEV. 24'-6" TO ELEV. 31'-0"
(REF SK PRELIM PGS 49, 50, 56, 57)

MODEL PT.	V_x(KSF)''	V_y(KSF)''	V(SRSS)(KSF)	V(SRSS)(PSI)
41	5.1	.3	5.1	35.4
107	0	0	0	0
36	5.3	.3	5.3	36.8
103	0	0	0	0

ELEV. 31'-0" TO ELEV 51'-4"
(REF SK PRELIM PGS 69, 70, 77, 78)

MODEL PT.	V_x(KSF)	V_y(KSF)''	V(SRSS)(KSF)''	V(SRSS)(PSI)
36	0	8.9	8.9	61.8
88	0	2.7	2.7	18.8
41	0	8.1	8.1	56.3
96	0	2.0	2.0	13.9

CENTRAL RADIAL WALL - IN PLANE SHEARS

CENTRAL RADIAL WALL REINFORCEMENT 3' SECTION

IN PLANE SHEARS V_c ALLOWABLE (ACI 359 PROPOSED) $\rho = \frac{A_s}{bd}$

FOR $0 \leq \rho \leq .01$ $v_c = 12{,}000\,\rho$

AT $\rho \geq .015$ $v_c = 93 + 2700\,\rho$

ρ IS SMALLER OF VERT AND HORIZ REINFORCEMENT

THUS FOR HORIZONTAL REBAR $\rho = \frac{1.56}{12(36)} = .0036$

$v_c = 12{,}000(.0036) = 43.2$ psi

USE v_u MAX (NO H BENDING VERT SINCE PEAK LOAD IS USED NOT AVG)

$$v_u - v_c = 158.3 - 43.2 = 115.1 \text{ psi}$$

(ACI 318-71 11.16) $A_v = \frac{(v_u - v_c)\, b_w s}{f_y} = \frac{115.1(36)(12)}{40{,}000} = 1.24$ IN.^{2}

$\frac{1.24}{36(12)} = .0029 \geq .0025$ (11.16.4.1)

HORIZONTAL STEEL AVAILABLE IN COMP. ZONE $= \frac{1.56}{12(12)(12)} = .0036 > .0029$ O.K.

HORIZ IS O.K. THUS VERT NEED NOT BE CHECKED

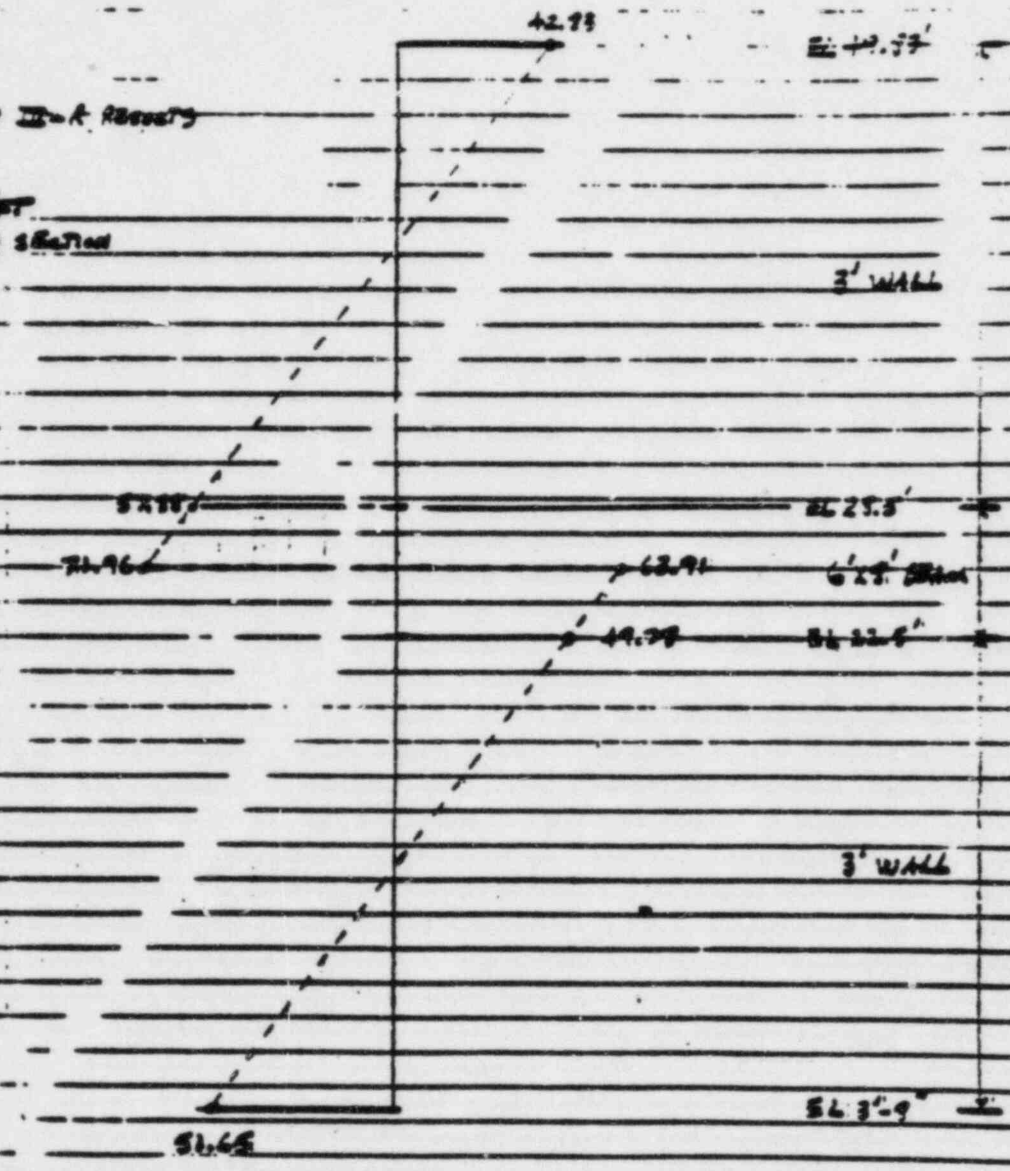
NO ADDITIONAL REINFORCING REQ'D FOR IN-PLANE SHEARS

CENTRAL RADIAL WALL — VERTICAL SHEAR DESIGN

1.5 P LOADING

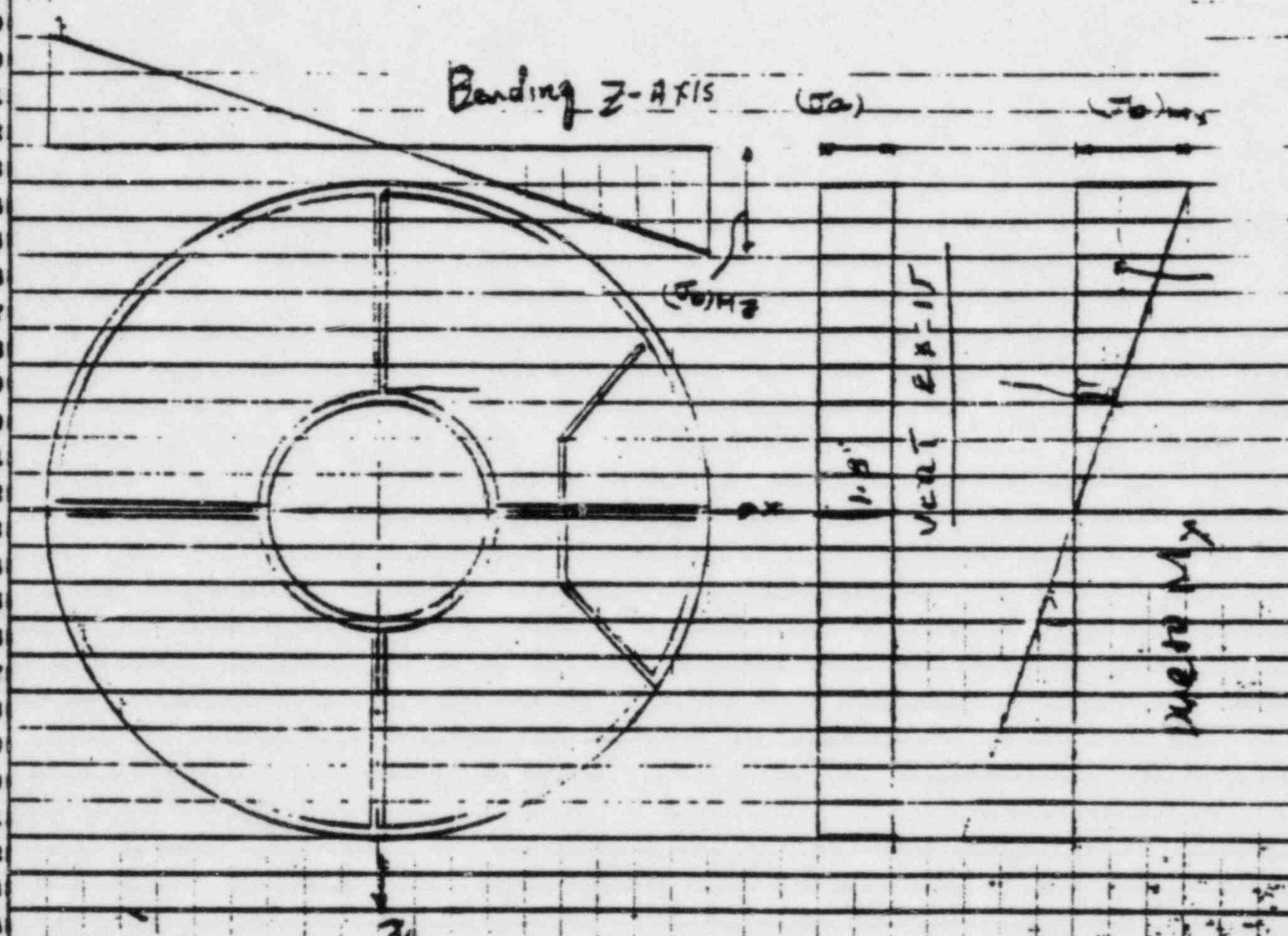
SECTION III-A RESULTS

SHEAR - KIPS/FT
FOR 23' WIDE SECTION



NOTE: THE 1.5 P LOADING ESSENTIALLY CONSTITUTES THE MOMENT ENVELOPE FOR THIS SECTION - IT IS USED FOR DESIGN

½ SSE



σ_a is axial stress due to vertical excitation.

σ_b " " " " " M's "

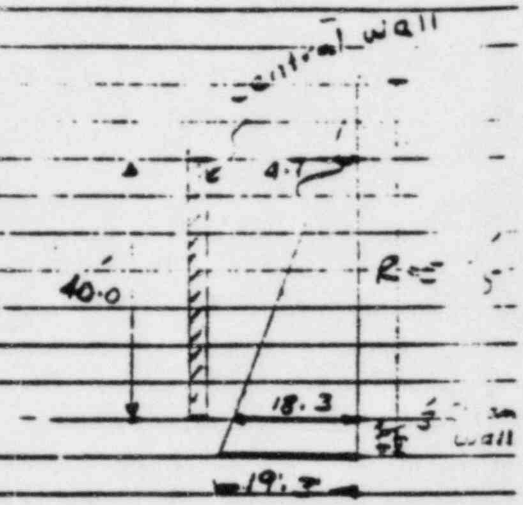
$\sigma_a = 1.43$, $\sigma_b = 15.43$

For 1.25 (½ SSE)

$\sigma_a = 1.43 \times 1.25 = 1.8\ ^{k}/_{ft}$, $(\sigma_b)_{Mz} = 15.43 \times 1.25 = 19.3\ ^{k}/_{ft}$

For Radial walls the design tensile stress will be taken as the average stress along the length of the wall.

Central wall



Average tensile stress

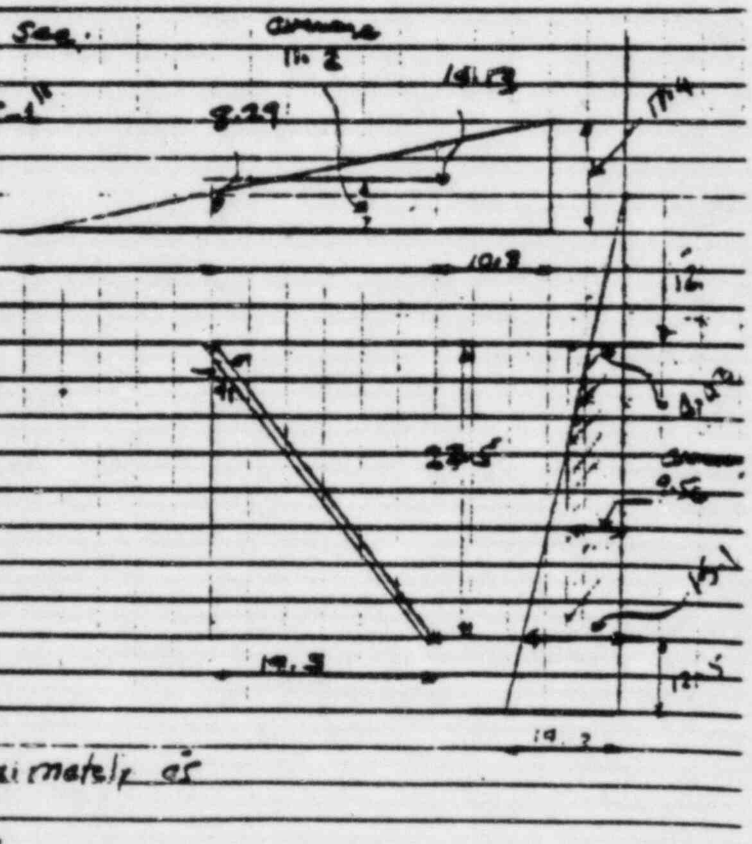
$= \frac{4.7 + 18.3}{2} + 1.8 = 13.3$ KSF

Tensile force = 13.3 x 3 (thickness) ≈ 40 K/'

Pump-side wall

For geometry of the wall see: "S&W DWG NO. 12179-EC-50J-1"

$(\sigma_b)_{H_E} = 13.92 \times 1.25 = 17.4$



Average from (N-S)

$= \frac{15.1 + 4.02}{2} = 9.56$

Average from E-W

$= \frac{14.13 + 8.29}{2} = 11.2$

The wall is inclined approximately as

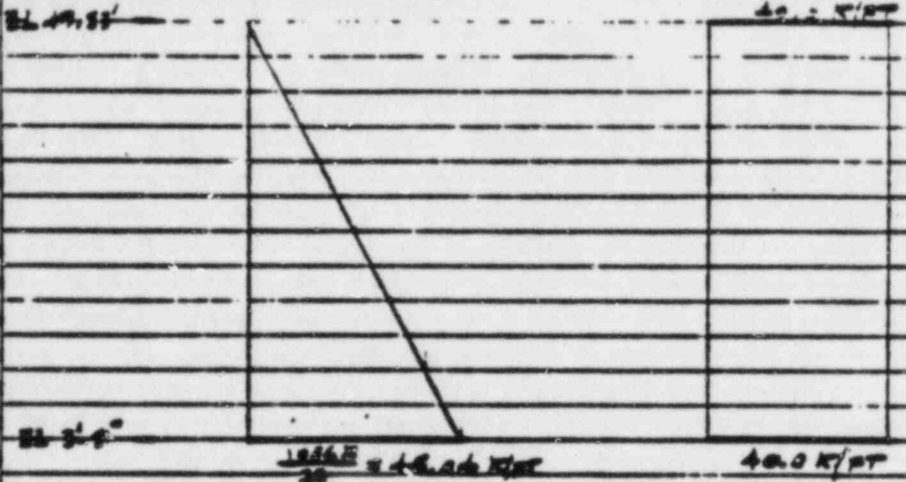
$\sigma_b = \sqrt{11.2^2 + 9.56^2} = 14.7$

Total stress = 14.7 + 1.8 = 16.5 Force = 16.5 x 3 ≈ 50 K/'

CENTRAL RADIAL WALL - VERTICAL SHEAR DESIGN

$1.5P^{*} + 1.25(1/2\ SSE)$

1.5 P AXIAL TENSION   1/2 SSE AXIAL TENSION*



(ASSUMED LINEAR DISTRIBUTION)

SHEAR REQUIREMENTS OF 3' WALL BELOW 6"x8' PORTION OF CENTRAL WALL - BELOW EL. 22.5'

CONSERVATIVELY USE MAXIMUM SHEAR AND MAXIMUM TENSION BETWEEN EL. 3'-9" AND EL. 22'-6"

@ 3'-9" V = 51.65 K/FT   T = 4[illegible].04 + 40.0 = [illegible]5.04 K/FT

$v_u = \frac{51650}{(.85)(12)(31)} = 163.4$ psi

$v_{uc} = 2\left(1.0 - \frac{[illegible]}{(12)(36)}\right) 70.7 = 55.7$ psi

$v_u - v_{uc} = 163.4 - 55.7 = 77.7$ psi

* Results of 1.5 P are used in ~~all the loading combinations~~ as it is more conservative ($1.5P > 1.25P$)

CENTRAL RADIAL WALL - VERTICAL SHEAR DESIGN

FOR #7 U-STIRRUPS AT 1 LEG/FOOT

$$S = \frac{A_v f_y}{(v_u - v_{cu})\, b_w} = \frac{(.60)(40{,}000)}{(77.7)(12)} = 25.7''$$

MAX SPACING $= \frac{d}{2} = \frac{31}{2} = 15.5''$

USE #7 U-STIRRUPS @ 15"

SHEAR REQUIREMENTS OF 3' WALL ABOVE 6'x3' PORTION OF CENTRAL WALL - ABOVE EL. 28.5'

USE MAX. SHEAR AND TENSION BETWEEN EL 28.5' AND EL 49.93'

MAX V = 57.98 K/FT @ EL 28.5'

MAX T = 46.04 $\left(\frac{[illegible]}{[illegible]}\right)$ + 40 = 59.67 K/FT @ EL 28.5'

$$v_u = \frac{57{,}980}{(.85)(12)(31)} = 183.0 \text{ psi}$$

$$v_{cu} = 2\left(1.0 - \frac{[illegible]}{(12)(36)}\right) 70.7 = 102.3 \text{ psi}$$

$v_u - v_{cu} = 183.0 - 102.3 = 80.7$ psi > 50 min

FOR #7 U-STIRRUPS AT 1 LEG/FOOT

$$S = \frac{A_v f_y}{(v_u - v_c) b} \quad \text{ACI (11-13)}$$

$$S = \frac{(.60)(40{,}000)}{(80.7)(12)} = 24.78''$$

MAX SPACING $= \frac{d}{2} = \frac{31}{2} = 15.5''$

USE #7 U-STIRRUPS @ 15"

CENTRAL RADIAL WALL - HORIZONTAL SHEAR STEEL

3' THICK WALL - ANALYZE 5' PORTIONS ABOVE AND BELOW 6'x5' BEAM AS FLAT PLATES FIXED ON ALL EDGES

ANALYZE FOR 1.5 P LOADING $w = 4.717\ K/FT^2$
$w = 4.717\ K/FT$ FOR 1 FT. SECTION

USE STRIP ANALYSIS COMPATIBILITY TO DETERMINE HORIZONTAL AND VERTICAL LOAD DISTRIBUTIONS FOR 2 WAY SLAB ACTION:

DEFLECTION @ POINT A $\Delta_A(STRIP\ 1) = \Delta_A(STRIP\ 2)$

LOAD COMPATIBILITY

$w_1 + w_2 = w_T = 4.717\ K/FT$

$$\frac{w_1 \ell_1^4}{384 E_1 I_1} = \frac{w_2 \ell_2^4}{384 E_2 I_2} \qquad E_1 I_1 = E_2 I_2$$

$$w_1 = w_2 \left(\frac{\ell_2^4}{\ell_1^4}\right) = w_2 \frac{(19.83)^4}{(37.0)^4} = .0825\, w_2$$

$.0825 w_2 + w_2 = 4.717$

$w_2 = 4.35\ K/FT \quad \therefore w_1 = .36\ K/FT$

$W_1 = w_1 \ell_1 = .36(19.83) = 7.139\ K$

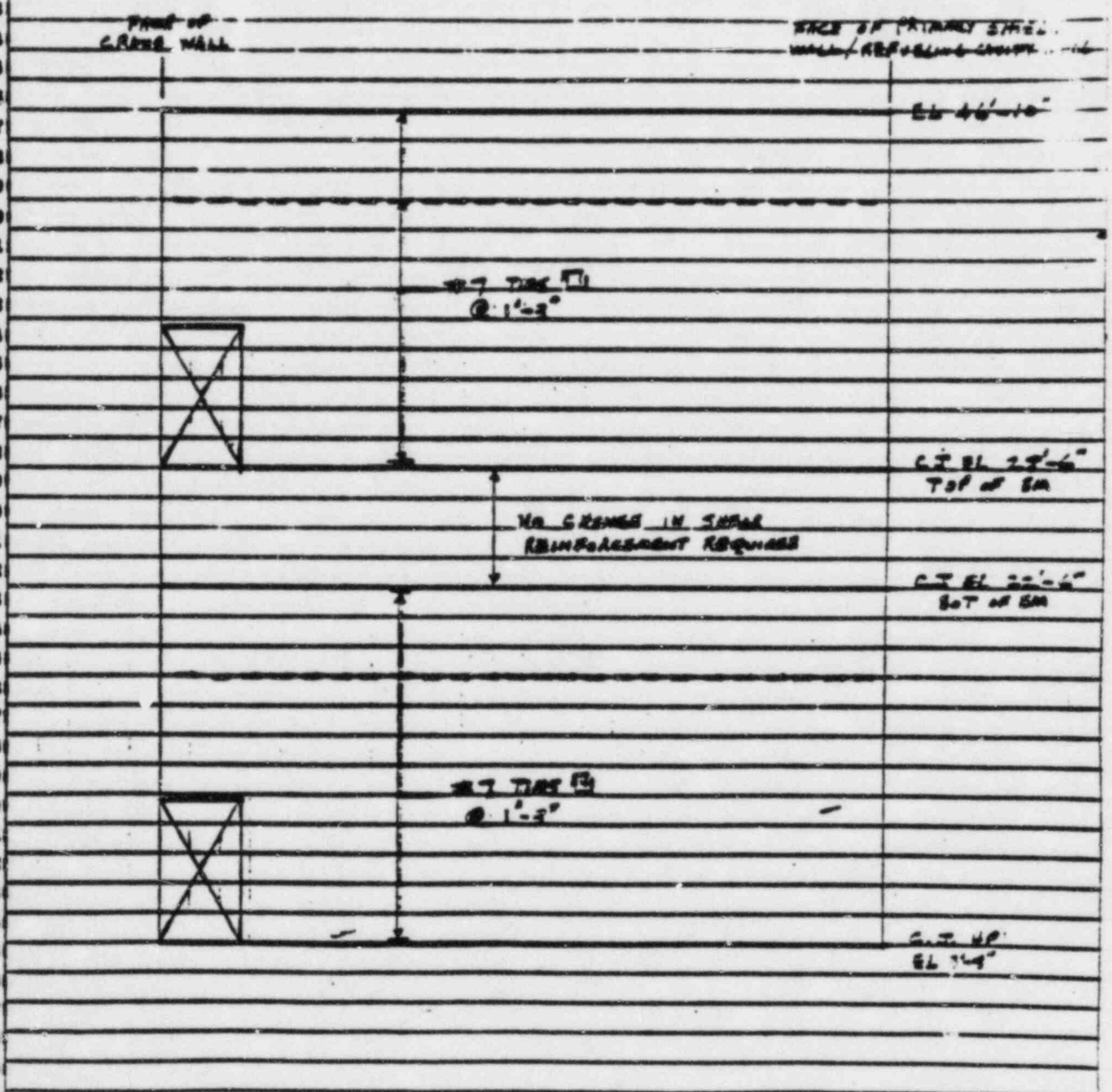
$V = \frac{W_1}{2} = 3.57\ K$

$$v_u = \frac{V}{\phi b d} = \frac{3570}{.85(12)(33.0)} = \underline{10.5\ psi}$$

THUS NO SHEAR STEEL IS REQUIRED IN HORIZONTAL DIRECTION

(NOTE: TOTAL SHEAR STEEL PROVIDED IS THUS EQUAL TO AMOUNT OF SHEAR STEEL REQUIRED IN VERTICAL DIRECTION

E AND W WALLS - REVISED SHEAR STEEL IN 3' THICK PORTION OF WALL



ITEM 26 With respect to the EGE Seismic Analysis, please assess the effect of combining 2 directional response versus that of the 3 component combination as required in the staff position. A summary of eigenvectors from the half-space model was presented, demonstrating a negigible coupling effect between the N-S and E-W direction. The issue was resolved. The Applicant will provide this response.

Response:

The seismic response analysis of the Emergency Generator Enclosure utilized 2 planar models (i.e. N-S and E-W direction), with no coupling between these two orthogonal directions. However, the planar model was subjected to a vertical as well as horizontal input motion. The resulting component responses were then absolutely summed to obtain the total response of the structure in the horizontal and vertical direction. To demonstrate the acceptability of this 2 direction response combination with respect to a 3 component combination as required by Regulatory Guide 1.92, the results of the modified half-space model (reference SEB audit notes Item No. 12) which considered all six degrees of freedom is presented. The attached Table 1 gives a summary of eigenvectors for the significant modes of vibrations for the structure. It is clear from a review of this table that no significant coupling occurs between the X and Z direction (i.e. N-S and E-W respectively). Furthermore the method used to combine the components for the horizontal and vertical response (absolute sum) is more conservative than that specified by Regulatory Guide 1.92.

TABLE I
EMERGENCY GENERATOR ENCLOSURE
SUMMARY OF MODE SHAPES FOR MODIFIED HALF-SPACE MODEL

MODE	FREQ. (HZ)	EL. (FT)	EIGENVECTORS		
			X-DISP	Y-DISP	Z-DISP
1	8.5	66'-0"	1.000	0.0	0.0
		51'-0"	0.774	0.0	0.0
		10'-0"	0.115	0.0	0.0
2	9.4	66'-0"	0.0	- 0.045	1.000
		51'-0"	0.0	- 0.021	0.765
		10'-0"	0.0	- 0.002	0.147
3	13.8	66'-0"	- 0.500	0.0	0.0
		51'-0"	1.000	0.0	0.0
		10'-0"	0.2505	0.0	0.0
4	17.0	66'-0"	0.0	0.136	-0.004
		51'-0"	0.0	0.082	0.349
		10'-0"	0.0	0.023	1.00
5	18.0	66'-0"	-0.362	0.0	0.0
		51'-0"	0.136	0.0	0.0
		10'-0"	1.000	0.0	0.0
6	22.7	66'-0"	0.0	1.000	0.091
		51'-0"	0.0	0.922	0.026
		10'-0"	0.0	0.591	- 0.056

ITEM 29 Provide the Finite Element-Frame Analysis comparisons for the Spent Fuel Pool Analysis. An example of the results of comparison was presented and the issue was resolved. The Applicant will provide the documentation.

Response:

Spent Fuel Pool Analysis

Results of space frame model were verified by the use of a finite element model. In both models, the same geometry and loadings were used.

Documentation for comparison of results of Finite Element Analysis and Space Frame Analysis for Node 276 on the East wall of the pool are provided in the attached sheets.

Page 2 - Finite element model - element and node identification numbers in circle are the member numbers in the space frame model.

Page 3 - Tabulation of stresses for the finite element model (Syy and Sxx).

Stresses due to space frame analysis are shown in the parenthesis.

Page 4 - Sign convention for finite element and space frame analysis.

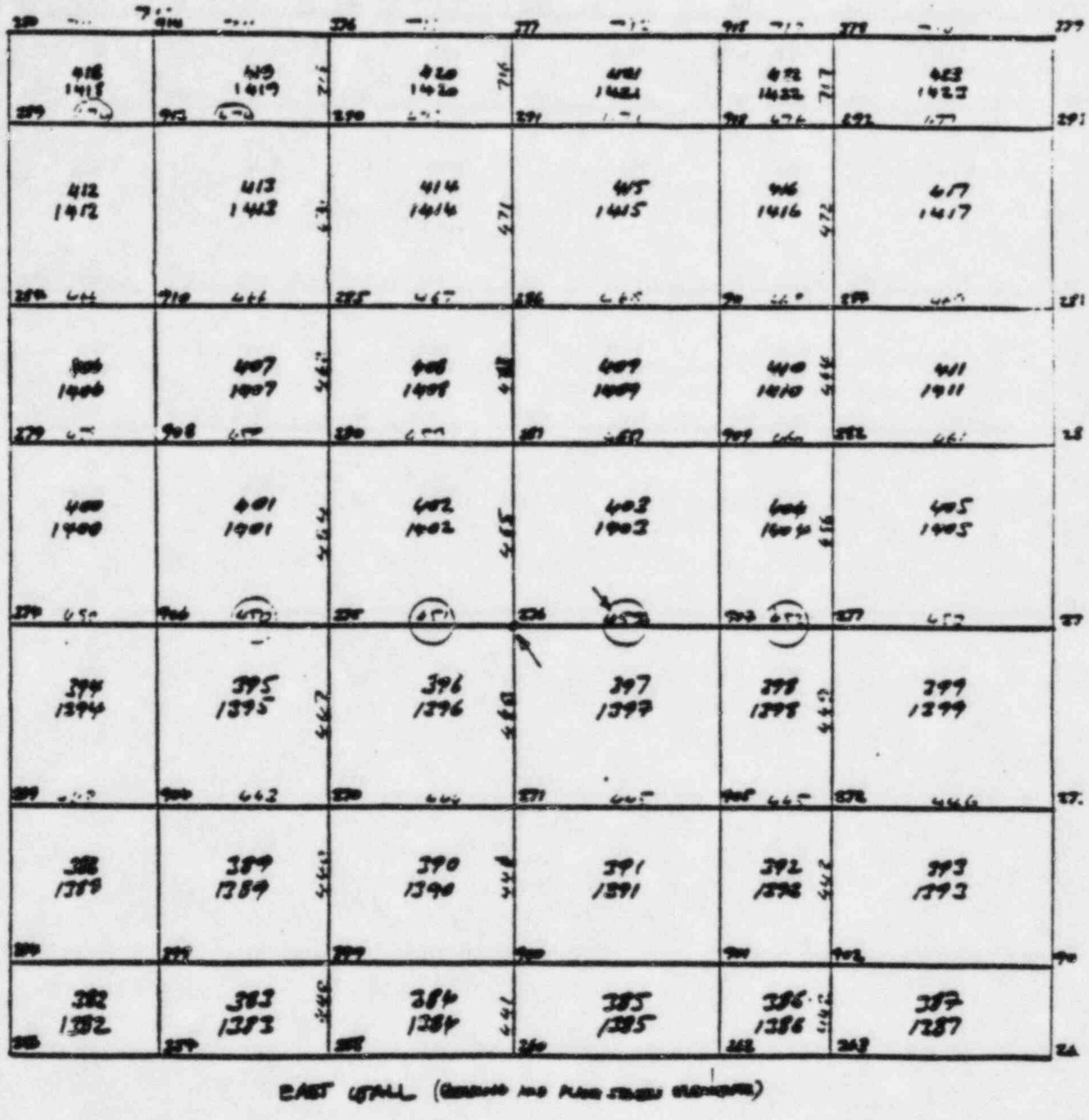
Page 5 - Graphic representation of the stresses for both methods.

Pages 6&7 - Excerpt from the computer output of the space frame analysis. Node 276 is the common joint for members 451 and 452.

Pages 8&9 - Excerpt from the computer output for the finite element analysis (stresses at Node 276 are underlined on Page ~~10~~ 9).

ITEM 29.

EAST WALL.



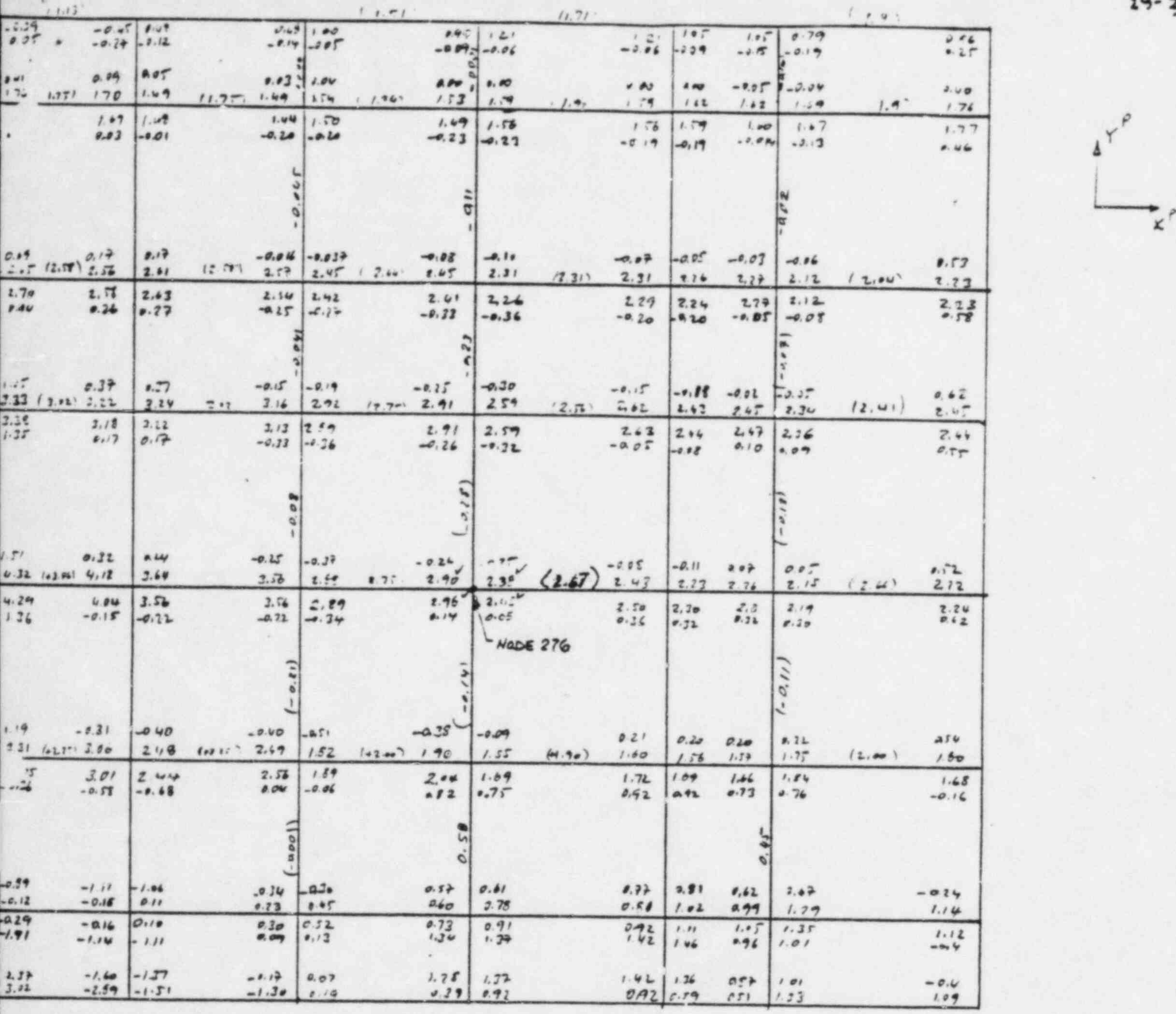
STRESS COMPARISON.. LOADING 3 (HYDROSTATIC LOAD)

FINITE ELEMENT MODEL

Vs.

SPACE FRAME MODEL.

FIGURE - 1



EAST WALL (PLANE STRESSES)

EAST WALL PLANE STRESSES - LOADING 3

FINITE ELEMENT MODEL - AVG. STRESS AT NODE 276 = $\frac{2.90 + 2.38 + 2.45 + 2.96}{4}$

$\sigma_{yy(276)} = 2.67\ ^{k}/_{ft^2}$

SPACE FRAME MODEL - 275 ___(451)___ 276 ___(452)___ 467

AVG. STRESS AT NODE 276 = $\frac{(42.92 + 44.25)\ ^1/_2}{6' \times 6'}$

$\sigma_{yy(276)} = 2.67\ ^{k}/_{ft^2}$

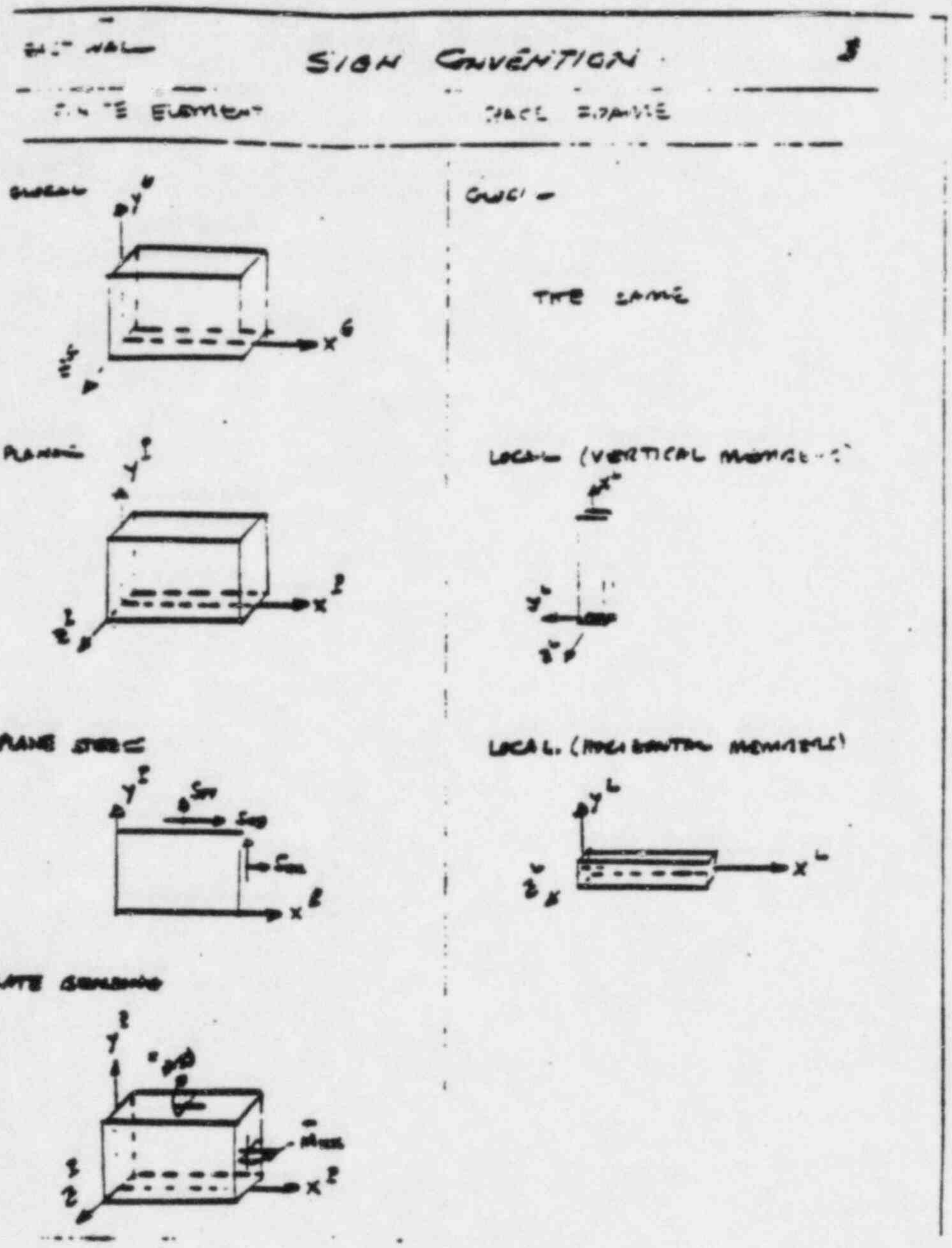
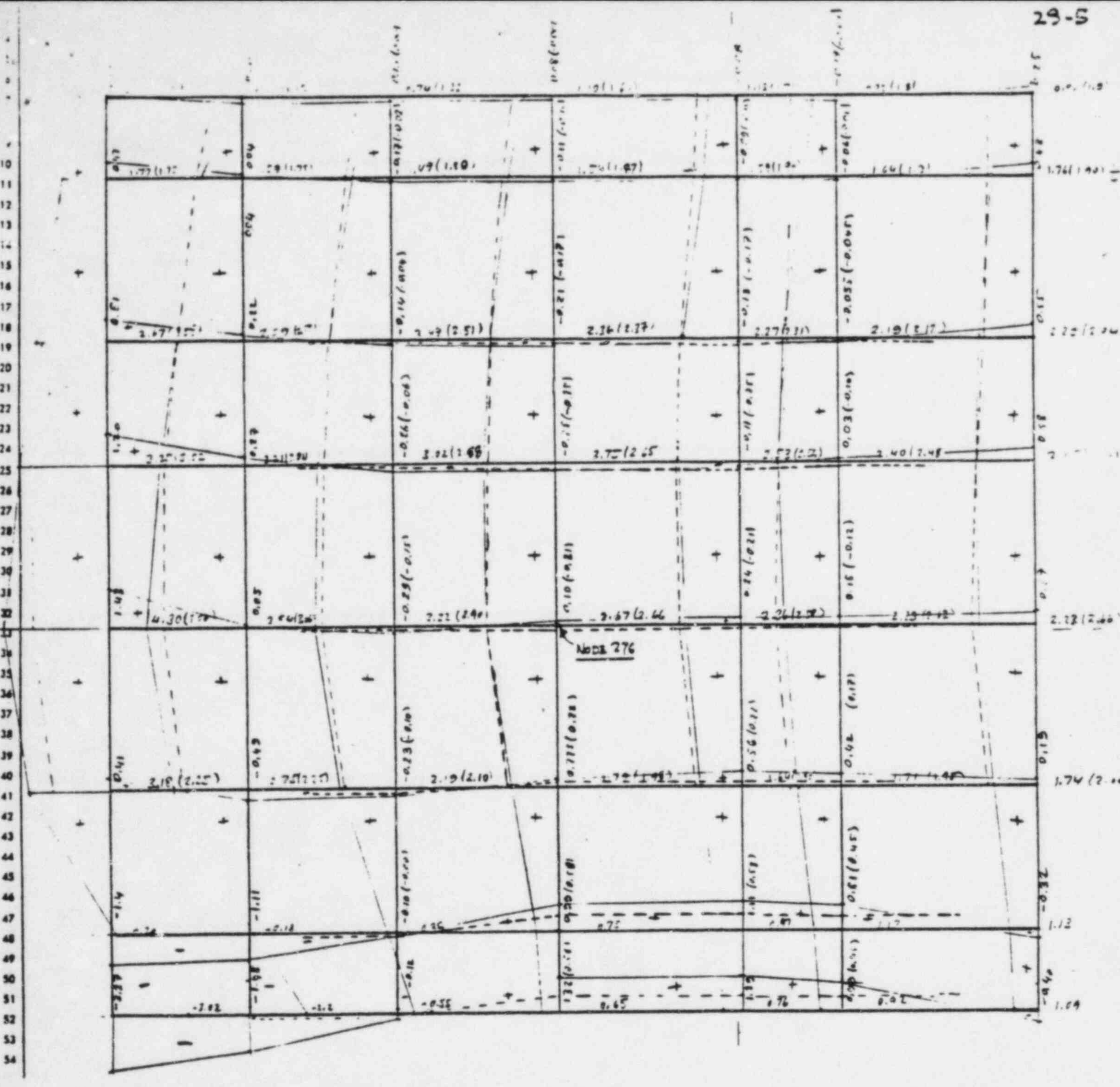


FIGURE 3



EAST WALL STRESSES — LOADING 3 (HYDROSTATIC LOAD)

—— SOLID LINES - FINITE ELEMENT MODEL

- - - - DOTTED LINES - SPACE FRAME MODEL

STRESS @ Node 276 = 2.67 k/ft²

FIGURE - 4

SPACE FRAME MODEL

LOADING - 3   UNFACTORED HYDROSTATIC FOR SPENT FUEL POOL

MEMBER FORCES

MEMBER	JOINT	FORCE AXIAL	FORCE SHEAR Y	FORCE SHEAR Z	MOMENT TORSIONAL	MOMENT BENDING Y	MOMENT BENDING Z
1	1	27.94	-52.77	4.21	0.00	30.92	-159.40
1	2	-27.94	52.77	-4.21	-0.00	-59.94	-104.45
2	2	32.31	2.64	-3.62	0.00	39.42	104.45
2	3	-32.31	-2.64	3.62	-0.00	-1.37	-79.04
3	3	20.60	22.94	-0.31	0.65	13.11	149.42
3	4	-20.60	-22.94	0.31	-0.00	-10.34	57.03
4	4	2.95	27.47	-0.39	0.00	16.43	96.25
4	5	-2.95	-27.47	0.39	-0.00	-7.04	145.12
5	5	-2.79	-34.49	-11.91	0.00	64.26	-170.42
5	6	2.79	34.49	11.91	-0.00	52.02	-194.25
6	6	-11.29	42.97	-0.93	-0.00	-16.69	163.04
6	7	11.29	-42.97	0.93	0.00	20.30	31.02
7	7	-9.59	1.72	9.20	-0.00	-35.37	-12.79
7	8	9.50	-1.72	-9.20	0.00	-29.93	23.99
8	8	-2.52	-7.61	6.14	-0.00	9.47	-23.90
8	9	2.52	7.61	-6.14	0.00	-33.05	-12.10
9	1	-43.90	26.00	-20.45	0.00	116.50	213.45
9	45	43.90	-26.00	20.45	-0.00	-9.01	-66.05
10	2	-6.03	-9.17	-4.36	-0.00	20.34	0.00
10	46	6.03	9.17	4.36	0.00	3.62	-50.44
11	3	0.29	-17.09	4.05	-0.00	-11.73	-62.07
11	47	-0.29	17.09	-4.05	0.00	-10.59	-31.94
12	4	1.00	96.45	-3.37	-0.00	-0.07	-22.39
12	48	-1.00	-96.45	3.37	0.00	10.41	540.49
13	5	-10.16	104.42	9.20	-0.00	-59.22	-11.60
13	49	10.16	-104.42	-9.20	0.00	0.10	597.20
14	6	9.02	49.01	10.36	0.00	-37.10	29.00
14	50	-9.02	-49.01	-10.36	-0.00	-19.79	239.76
15	7	10.46	30.42	-4.27	0.00	15.07	10.53
15	51	-10.46	-30.42	4.27	-0.00	6.42	201.09
16	8	-3.13	9.34	-7.07	0.00	20.26	-0.00
16	52	3.13	-9.34	7.07	-0.00	16.63	61.35
17	9	-12.42	0.60	-4.16	0.00	17.06	24.35
17	53	12.42	-0.60	4.16	-0.00	4.99	-25.02
18	45	-3.09	-12.49	14.40	-0.00	-36.47	0.00
18	46	3.09	12.49	-14.40	0.00	-35.95	-63.47
19	46	4.12	0.02	-0.63	-0.00	6.09	63.47
19	47	-4.12	-0.02	0.63	0.00	-0.50	-63.29
20	47	-0.27	6.60	-0.09	-0.00	3.39	63.29
20	48	0.27	-6.60	0.09	0.00	-2.60	-3.65
21	48	-4.26	3.03	-1.22	-0.00	6.90	3.05
21	49	4.25	-3.03	1.22	0.00	4.70	29.60
22	49	-4.01	-2.90	-7.16	0.00	37.19	-29.60
22	50	4.01	2.90	7.16	-0.00	34.54	0.71
23	50	-15.23	5.17	-4.77	-0.60	13.41	-0.71
23	51	15.23	-5.17	4.77	0.00	10.44	26.53
24	51	-12.24	-10.41	0.92	-0.00	-30.97	-26.59
24	52	12.24	10.41	-0.92	0.00	[illegible]	-41.23

445	271	-166.07	22.16	-22.40	-0.00	851.76	129.06
445	272	166.07	-22.16	22.46	0.00	615.75	100.53
446	272	-165.50	-10.77	-147.42	-0.01	415.74	15.40
446	273	[illegible]	10.77	147.62	0.01	976.42	-110.02
447	270	0.51	-17.10	-16.54	-0.01	373.51	00.37
447	275	-0.51	17.10	16.54	0.01	-740.35	-60.57
448	271	5.53	-14.12	-20.16	-0.00	541.33	-76.95
448	276	-5.53	14.12	20.15	0.00	-332.15	-42.53
449	272	4.43	-10.40	-35.96	0.00	743.41	-49.40
449	277	-4.43	10.48	35.94	-0.00	-360.35	-19.05
450	274	-110.21	7.60	123.07	-0.06	-1172.59	40.63
450	275	110.21	-7.60	-123.07	0.00	-242.73	37.46
451	275	-99.25	18.09	46.93	0.00	242.72	46.35
451	276	99.25	-18.09	-46.93	-0.00	-547.73	30.47
452	276	-92.92	7.39	-20.09	0.00	547.73	39.09
452	277	92.92	-7.39	20.09	-0.00	-320.42	38.64
453	277	-95.75	3.45	-329.90	0.00	320.41	10.09
453	278	95.75	-3.45	129.94	-0.00	906.34	16.57
454	275	3.11	-6.12	-18.40	0.00	240.15	-2.30
454	280	-3.11	6.12	18.40	-0.00	-129.96	-34.54
455	276	11.03	-7.79	-29.34	-0.00	362.15	-14.90
455	281	-11.03	7.79	29.34	0.00	-184.11	-31.70
456	277	0.17	-33.30	-33.07	-0.01	306.35	-37.57
456	282	-0.17	33.30	33.07	0.01	-165.13	-42.26
457	278	5.61	-14.32	103.03	-0.01	-265.44	-43.94
457	283	-5.61	14.32	-103.03	0.01	-337.59	-21.94
458	279	-100.05	0.43	100.13	-0.00	-1049.55	-0.73
458	280	100.05	-0.43	-100.13	0.00	-190.90	0.03
459	280	-99.25	2.14	43.82	-0.00	150.69	4.73
459	281	99.25	-2.14	-43.82	0.00	-403.71	9.14
460	281	-91.99	4.06	-24.49	0.00	403.71	10.01
460	282	91.99	-4.06	24.49	-0.00	-227.64	24.57
461	282	-86.06	7.73	-116.17	0.01	227.66	30.25
461	283	86.06	-7.73	116.17	-0.01	675.62	43.21
462	280	1.41	3.47	-14.09	0.01	129.57	21.70
462	285	-1.41	-3.47	14.09	-0.01	-45.43	-0.94
463	281	9.11	-0.51	-20.00	0.00	106.31	4.61
463	286	-9.11	0.51	20.00	-0.00	-65.85	-7.76
464	282	4.50	-0.17	23.14	-0.01	165.19	-12.60
464	287	-4.50	0.17	23.14	0.01	-46.21	-36.46
465	283	0.14	-10.78	60.30	-0.01	-175.94	-21.20
465	288	-0.14	10.78	-60.30	0.01	-274.31	-43.10
466	284	-92.92	-4.02	79.39	-0.00	-780.91	-34.42
466	286	92.92	4.02	-79.39	0.00	-125.61	-11.45
467	285	-80.15	-4.20	30.66	-0.00	129.61	-19.69
467	286	80.15	4.20	-30.66	0.00	329.60	-7.60
468	286	-81.27	0.45	19.87	0.00	379.60	-5.41
468	287	81.27	0.45	19.87	-0.00	120.95	0.19
469	287	-73.52	3.94	-92.65	0.01	120.57	19.45
469	288	73.52	-3.94	92.65	-0.01	755.20	22.99
470	285	1.79	0.25	-6.56	0.01	55.43	32.24
470	290	-1.79	-0.25	6.56	-0.01	2.76	31.09
471	285	4.26	4.15	-0.15	0.00	65.43	14.05
471	291	-4.26	-4.15	0.35	-0.00	-1.41	14.52
472	287	1.20	1.66	-4.36	-0.01	92.31	13.02
472	292	-1.20	-1.60	4.36	0.01	12.50	-1.71
473	288	-0.55	2.19	16.50	-0.00	25.20	20.11
473	293	0.55	-2.19	-16.50	0.00	-101.54	-3.34
474	289	-81.35	-7.90	41.69	0.01	431.90	00.00
474	290	81.35	7.90	-41.69	0.01	[illegible]	-9.94

29-7

Finite Element Model.

Element		Node	XX	YY	ZZ	XY	XZ	YZ
							-0.213744E 00	0.364456E 00
			[illegible]E-02	-0.351803E 00	0.151502E 00	0.205500E 00	-0.196179E 00	0.175778E 00
		932	-0.120143E 00	-0.127376E 01	-0.531013E-01	0.226747E 00	0.317237E-01	0.279741E-01
		897	-0.145083E 00	-0.106954E 01	-0.406665E 00	0.218141E 00	0.247928E-01	0.135619E 00
		894	-0.140330E 00	-0.105666E 01	-0.346316E 00	0.258385E 00	-0.177050E-01	0.276778E 00
		933	-0.121515E 00	-0.124901E 01	-0.233020E-01	0.267491E 00	-0.140731E-03	0.130372E 00
517	NODE	903	0.725220E-01	-0.713333E 00	-0.107775E-01	0.120904E-01	0.700025E-02	-0.179812E-01
		935	0.258276E 00	0.135129E 00	0.274614E 00	-0.141476E 00	0.209674E-01	-0.706751E-01
		936	-0.223547E-01	0.709083E-01	0.170692E 00	0.920015E-01	-0.340660E-01	0.271563E 00
		273	-0.187134E 00	-0.784579E 00	0.114776E-01	0.245567E 00	0.779750E-01	0.345389E 00
		938	-0.343783E 00	-0.264087E 01	-0.383984E 00	0.108817E 00	-0.510612E-01	-0.643045E-01
		933	-0.155937E 00	-0.168222E 01	-0.980564E-01	0.221158E 00	-0.370941E-01	-0.267791E-01
		331	0.322641E-01	-0.165245E 01	-0.107987E 00	0.485870E 00	-0.298771E-01	0.312459E 00
		329	-0.154759E 00	-0.259016E 01	-0.289344E 00	0.373339E 00	0.820659E-01	0.298782E 00
518	NODE	935	0.992419E-01	0.101[illegible]45E 00	0.242731E 00	0.105401E 00	-0.196180E 00	-0.706751E-01
		893	-0.500157E-01	-0.337[illegible]36E 00	-0.210725E 00	0.140744E-01	-0.213744E 00	0.355726E 00
		294	-0.150065E 00	-0.328322E 00	-0.404084E-01	-0.747914E-01	-0.150649E 00	0.463749E 00
		936	-0.505274E-01	0.452402E-01	0.165044E 00	0.167348E-01	-0.880321E-01	0.271563E 00
		933	-0.206384E 00	-0.169234E 0[illegible]	-0.108171E 00	0.184702E 00	-0.140899E-03	-0.287783E-01

Element		Node	XX	YY	ZZ	XY	XZ	YZ
		894	-0.107648E 00	-0.895441E 00	-0.313633E 00	0.160054E 00	-0.177051E-01	0.188495E 00
		325	-0.627952E-01	-0.854680E 00	-0.114406E 00	0.401167E 00	-0.822169E-01	0.296439E 00
		331	-0.211216E 00	-0.170127E 01	-0.186001E 00	0.397970E 00	-0.196472E-01	0.313459E 00
519	NODE	273	-0.242913E 00	-0.103465E 01	-0.444654E-01	0.184967E 00	0.779542E-01	0.108167E 00
		936	0.170131E 00	0.103103E 01	0.363177E 00	-0.130949E 00	-0.340660E-01	-0.334266E 00
		937	-0.483566E 00	0.871786E 00	0.633026E-01	0.515702E 00	-0.334680E 00	0.275980E 00
		278	-0.744024E 00	-0.114211E 01	-0.860240E-01	0.831617E 00	0.422177E-01	0.627198E 00
		329	-0.321648E 00	-0.342022E 01	-0.456065E 00	-0.182616E-01	0.818005E-01	0.451658E-01
		331	0.508292E-02	-0.178648E 01	-0.134924E 00	0.149790E 00	-0.301412E-01	-0.200640E 00
		308	0.336965E 00	-0.174612E 01	-0.237193E 00	0.680962E 00	-0.177092E 00	0.409606E 00
		307	0.623139E-01	-0.333002E 01	-0.299915E 00	0.493249E 00	0.199808E 00	0.564539E 00
520	NODE	936	0.141958E 00	0.102533E 01	0.387530E 00	-0.206214E 00	-0.880323E-01	-0.334263E 00
		294	-0.212469E 00	-0.634601E 00	-0.102802E 00	-0.635081E-01	-0.150646E 00	0.477627E 00
		295	0.399910E-01	-0.877714E 00	-0.264365E-02	-0.504917E 00	0.472829E 00	0.455567E 00
		937	0.348806E 00	0.103046E 01	0.230177E 00	-0.649623E 00	0.501396E 00	0.275703E 00
		331	-0.237721E 00	-0.107514E 01	-0.103505E 00	0.819399E-01	-0.194184E-01	-0.200643E 00
		325	0.103909E-01	-0.491209E 00	-0.413366E-01	0.159731E 00	-0.823634E-01	0.438396E 00
		310	0.153134E 00	-0.454312E 00	0.368594E-01	0.531316E 00	0.423855E 00	0.416324E 00
		308	-0.140683E 00	-0.108388E 01	-0.332952E 00	0.453285E 00	0.452422E 00	0.409603E 00

LOADING - 3 UNFACTORED HYDROSTATIC FOR SPENT FUEL POOL

ELEMENT STRESSES

ELEMENT		Node	SXX	SYY	SXY
1	NODE	45	-0.384225E-01	0.713823E 00	0.105043E 00
1	NODE	46	-0.100590E 00	0.317680E 00	-0.323164E-01
1	NODE	2	-0.465530E 00	0.254663E 00	-0.213842E 00
1	NODE	1	-0.399362E 00	0.652870E 00	-0.756431E-01
2	NODE	46	-0.965193E-01	0.318280E 00	0.443580E 00
2	NODE	47	-0.206950E 00	-0.342975E 00	0.320592E 00
2	NODE	3	-0.369340E [illegible]	-0.370097E 00	0.169113E 00
2	NODE	2	-0.2589[illegible] 00	0.291[illegible]46E 00	0.292101E 00
3	NODE	47	-0.201932E 00	-0.342137E 00	0.197218E 00
3	NODE	48	-0.301401E 00	-0.937760E 00	0.152154E 00
3	NODE	4	-0.383482E 00	-0.951468E 00	-0.340420E-01
3	NODE	3	-0.284013E 00	-0.358044E 00	0.902191E-02
7	NODE	49	-0.338961E 00	-0.801287E 00	-0.199307E 00
7	NODE	50	-0.246176E 00	-0.245646E 00	-0.345997E-01
7	NODE	6	-0.286752E-01	-0.209343E 00	0.926749E-01
7	NODE	5	-0.121461E 00	-0.764965E 00	-0.720320E-01
	NODE	50	-0.523461E-01	-0.213316E 00	-0.459088E 00
	NODE	51	-0.261689E-01	-0.568664E-01	-0.356142E 00
	NODE	7	0.248718E 00	-0.111612E-01	-0.284326E 00
	NODE	6	0.219541E 00	-0.167911E 00	-0.387273E 00
	NODE	51	-0.146932E-01	-0.546499E-01	-0.368715E 00
	NODE	52	0.299001E-01	0.212375E 00	-0.415024E 00
	NODE	8	-0.641818E-01	0.196663E 00	-0.320919E 00
	NODE	7	-0.108775E 00	-0.703616E-01	-0.274609E 00

385	NODE 260	SXX	0.918347E 00	SYY	0.136887E 01	SXY	-0.587764E 00
385	NODE 262	SXX	0.927219E 00	SYY	0.142199E 01	SXY	-0.595174E 00
385	NODE 901	SXX	0.917730E 00	SYY	0.142241E 01	SXY	-0.533374E 00
385	NODE 900	SXX	0.900858E 00	SYY	0.136723E 01	SXY	-0.575764E 00
386	NODE 262	SXX	0.591614E 00	SYY	0.136595E 01	SXY	0.104774E-02
386	NODE 263	SXX	0.509472E 00	SYY	0.875268E 00	SXY	0.226645E 00
386	NODE 902	SXX	0.105133E 01	SYY	0.965725E 00	SXY	0.222799E-01
386	NODE 901	SXX	0.113327E 01	SYY	0.145640E 01	SXY	-0.203320E 00
387	NODE 263	SXX	0.133202E 01	SYY	0.101260E 01	SXY	0.375787E 00
387	NODE 265	SXX	0.109601E 01	SYY	-0.400604E 00	SXY	0.394540E 00
387	NODE 903	SXX	0.111720E 01	SYY	-0.397066E 00	SXY	0.117551E 00
387	NODE 902	SXX	0.135320E 01	SYY	0.101614E 01	SXY	0.987997E-01
388	NODE 805	SXX	-0.121124E 00	SYY	-0.894952E 00	SXY	-0.163984E 01
388	NODE 898	SXX	-0.157383E 00	SYY	-0.111207E 01	SXY	-0.677552E 00
388	NODE 904	SXX	0.301713E 01	SYY	-0.581930E 00	SXY	-0.801807E 00
388	NODE 269	SXX	0.305339E 01	SYY	-0.364808E 00	SXY	-0.176410E 01
389	NODE 898	SXX	0.111111E 00	SYY	-0.104723E 01	SXY	-0.233922E 01
389	NODE 899	SXX	0.231722E 00	SYY	-0.345013E 00	SXY	-0.142038E 01
389	NODE 270	SXX	0.256341E 01	SYY	0.443784E-01	SXY	-0.110246E 01
389	NODE 904	SXX	0.244279E 01	SYY	-0.677844E 00	SXY	-0.202130E 01
390	NODE 899	SXX	0.451796E 00	SYY	-0.308260E 00	SXY	-0.194070E 01
390	NODE 900	SXX	0.599247E 00	SYY	0.574680E 00	SXY	-0.137086E 01
390	NODE 271	SXX	0.204529E 01	SYY	0.816170E 00	SXY	-0.982176E 00
390	NODE 270	SXX	0.189784E 01	SYY	-0.667711E-01	SXY	-0.155202E 01
391	NODE 900	SXX	0.701578E 00	SYY	0.605130E 00	SXY	-0.940526E 00
391	NODE 901	SXX	0.809389E 00	SYY	0.771662E 00	SXY	-0.525821E 00
391	NODE 905	SXX	0.172145E 01	SYY	0.923976E 00	SXY	-0.462283E 00
391	NODE 271	SXX	0.169363E 01	SYY	0.757943E 00	SXY	-0.876988E 00
392	NODE 901	SXX	0.102493E 01	SYY	0.807457E 00	SXY	-0.145767E 00
392	NODE 902	SXX	0.993197E 00	SYY	0.617644E 00	SXY	0.149915E-01
392	NODE 272	SXX	0.165611E 01	SYY	0.728351E 00	SXY	-0.120929E 00
392	NODE 905	SXX	0.168784E 01	SYY	0.918364E 00	SXY	-0.281687E 00
393	NODE 902	SXX	0.129507E 01	SYY	0.668057E 00	SXY	0.915113E-01
393	NODE 903	SXX	0.114230E 01	SYY	-0.246752E 00	SXY	0.371393E 00
393	NODE 273	SXX	0.168543E 01	SYY	-0.156049E 00	SXY	0.734432E-01
393	NODE 272	SXX	0.183820E 01	SYY	0.758760E 00	SXY	-0.216440E 00
394	NODE 269	SXX	0.331459E 01	SYY	0.119922E 01	SXY	-0.331082E 00
394	NODE 904	SXX	0.306275E 01	SYY	-0.368753E 00	SXY	-0.640062E-01
394	NODE 906	SXX	0.404128E 01	SYY	-0.145339E 00	SXY	-0.102240E 01
394	NODE 274	SXX	0.429311E 01	SYY	0.136263E 01	SXY	-0.128952E 01
395	NODE 904	SXX	0.248841E 01	SYY	-0.404668E 00	SXY	-0.128350E 01
395	NODE 270	SXX	0.248846E 01	SYY	-0.404364E 00	SXY	-0.900221E 00
395	NODE 275	SXX	0.356868E 01	SYY	-0.223968E 00	SXY	-0.900068E 00
395	NODE 906	SXX	0.356863E 01	SYY	-0.224272E 00	SXY	-0.128335E 01
396	NODE 270	SXX	0.182290E 01	SYY	-0.515514E 00	SXY	-0.139979E 01
396	NODE 271	SXX	0.190259E 01	SYY	-0.383497E-01	SXY	-0.971093E 00
396	NODE 276	SXX	0.296988E 01	SYY	0.139888E 00	SXY	-0.737836E 00
396	NODE 275	SXX	0.289019E 01	SYY	-0.337276E 00	SXY	-0.111650E 01

397	NODE 271	SXX	0.155093E 01	SYY	-0.970764E-01	SXY	-0.865905E 00
397	NODE 905	SXX	0.140182E 01	SYY	0.207670E 00	SXY	-0.496988E 00
397	NODE 907	SXX	0.250293E 01	SYY	0.358155E 00	SXY	-0.367861E 00
397	NODE 276	SXX	0.295204E 01	SYY	0.539084E-01	SXY	-0.736777E 00
398	NODE 905	SXX	0.156823E 01	SYY	0.202060E 00	SXY	-0.316392E 00
398	NODE 272	SXX	0.156733E 01	SYY	0.196692E 00	SXY	-0.155547E 00
398	NODE 277	SXX	0.230398E 01	SYY	0.319712E 00	SXY	-0.159800E 00
398	NODE 907	SXX	0.230487E 01	SYY	0.325079E 00	SXY	-0.320656E 00
399	NODE 272	SXX	0.174942E 01	SYY	0.227100E 00	SXY	-0.251058E 00
399	NODE 273	SXX	0.180264E 01	SYY	0.545035E 00	SXY	-0.464058E-01
399	NODE 278	SXX	0.224372E 01	SYY	0.619494E 00	SXY	0.727625E-01
399	NODE 277	SXX	0.219049E 01	SYY	0.300759E 00	SXY	-0.131891E 00
400	NODE 274	SXX	0.431733E 01	SYY	0.150766E 01	SXY	0.438315E 00
400	NODE 906	SXX	0.411977E 01	SYY	0.324672E 00	SXY	0.202200E 00
400	NODE 908	SXX	0.318439E 01	SYY	0.160963E 00	SXY	-0.610782E 00
400	NODE 279	SXX	0.338194E 01	SYY	0.135145E 01	SXY	-0.374667E 00
401	NODE 906	SXX	0.364712E 01	SYY	0.245740E 00	SXY	-0.587056E-01
401	NODE 275	SXX	0.356356E 01	SYY	-0.254620E 00	SXY	-0.200112E 00
401	NODE 280	SXX	0.313264E 01	SYY	-0.376585E 00	SXY	-0.464624E 00
401	NODE 908	SXX	0.321620E 01	SYY	0.173775E 00	SXY	-0.323217E 00
402	NODE 275	SXX	0.288507E 01	SYY	-0.367929E 00	SXY	-0.416544E 00
402	NODE 276	SXX	0.290249E 01	SYY	-0.263613E 00	SXY	-0.415587E 00
402	NODE 281	SXX	[illegible]	SYY	[illegible]	SXY	-0.359439E 00
402	NODE 280	SXX	0.289008E 01	SYY	-0.366423E 00	SXY	-0.361396E 00
403	NODE 276	SXX	0.238445E 01	SYY	-0.350092E 00	SXY	-0.412558E 00
403	NODE 907	SXX	[illegible]	SYY	[illegible]	SXY	-0.335386E 00
403	NODE 909	SXX	0.263353E 01	SYY	-0.461845E-01	SXY	-0.211743E 00
403	NODE 231	SXX	0.258846E 01	SYY	-0.316056E 00	SXY	-0.283914E 00
404	NODE 907	SXX	0.223166E 01	SYY	-0.113297E 00	SXY	-0.208181E 00

ITEM 32 Discuss how venting was considered for internal cubicle pressurization (Sec. FSAR 3.3.3). Item resolved if a sentence to reflect actual venting is included in FSAR, i.e., that all structures except for fuel building were designed for nonventing situation. The Applicant will provide this response.

Response:

Revise the MNPS-3 FSAR p. 3.3-3 as follows:

Tornado Differential Pressure Load (W_p)

For all reinforced concrete structures with the exception of the Fuel Building and the Emergency Generator Enclosure, the exterior walls and roofs were designed for nonvented conditions (full 3 psi pressure drop).

For the Fuel Building, the section of metal roof at elevation 55 ft-3 in. and between column lines 6.5 and 4 is capable of venting the building. Those sections of interior walls and floors which could be affected by this condition have been designed for the full 3 psi pressure drop. In addition, it is assumed that this roof does not vent the building and those portions of the exterior walls and roofs which would be affected are designed for the full pressure drop (3 psi).

For the Emergency Generator Enclosure, the diesel generator muffler cubicle above elevation 51 ft-0 in. is capable of venting. The portions of the interior walls and floors which could be affected by this condition are designed for the full pressure drop (3 psi). In addition, it is assumed that this cubicle does not vent and the portions of exterior walls and the roof affected are designed for the full 3 psi pressure drop.

ITEM 33 Justification of unity DLF of pressure drop provided description and results as presented. Resolved. The Applicant will provide the response.

Response:

The MNPS-3 FSAR will be revised to add the following:

A dynamic load factor of 1.0 is applied tc the pressure drop since all wall and floor panels subject to pressure drop have frequencies greater than 4 Hz as shown in Table 3.3.1. Figure 3.3.1 presents the calculated dynamic load factor curve for the pressure drop. Comparing the two it is evident that the Millstone III structural elements experience no dynamic amplification during the pressure drop condition.

TABLE 3.3.1

Panel	Size (Ft)	Thick-ness (Ft)	Fundamental Frequency (Hz)	Remarks
MSVB North Wall	36x73	2	6.5	Simple supports
Aux. Bldg Roof	49.5x63	2	4.6	Simple supports
Aux. Bldg Roof	126.5x26.5	2	9.0	Simple supported beam
Fuel Bldg Roof	59.5x66.5	2	4.0	Simple supports
Control Bldg Roof	57.5x102	2	4.2	Partial fixity

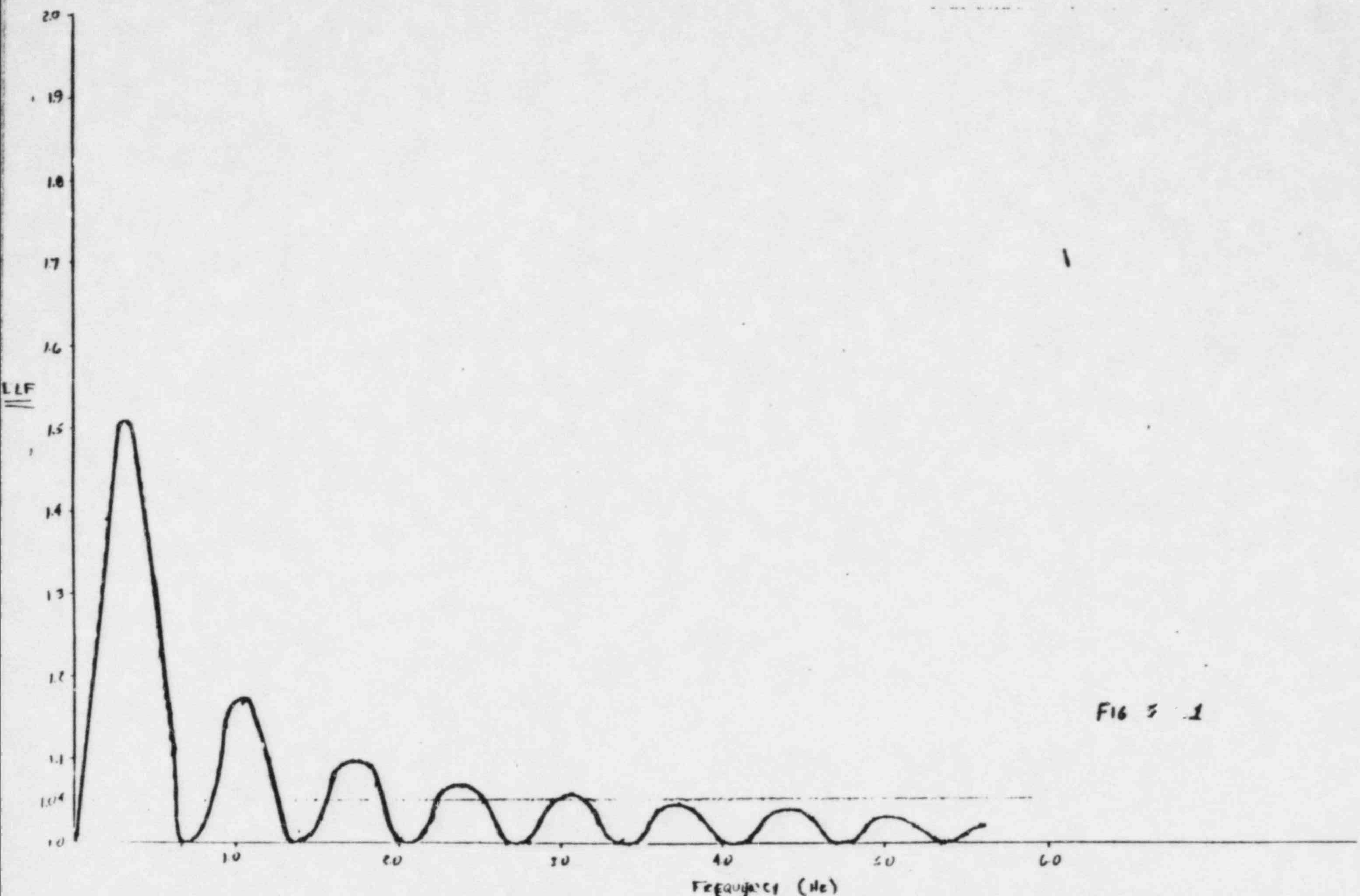

LLF
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.04
1.0
10
20
30
40
50
60
Frequency (Hz)

FIG 3.1

ITEM 39 A review of accidental torsion SEB Item 08 should be performed. A review was performed and the issue was resolved. The Applicant will provide this response.

Response:

The effects of accidental torsion have been evaluated for the fuel building, control building, containment structure internals, and containment structure shell.

Calculations performed for these buildings indicate that they are able to accommodate the 5 percent additional torsion. Reinforcing steel requirements for critical wall sections in these structures are summarized below:

Building	Wall/Elev	Reinf Required (Including 5 Percent Additional Torsion)	Reinf Provided
Fuel	G/52 ft-4 in.	2.89 in.^{2}/foot	4.16 in.^{2}/foot
Control	E-1/4 ft-6 in.	2.09 in.^{2}/foot	3.74 in.^{2}/foot
Containment Structure	Shell/(-)27 ft-3 in.	2.37 in.^{2}/foot	3.23 in.^{2}/foot
Containment Structure	Cranewall Column/ (-)27 ft-3 in.	25 - #18	28 - #18