50-498
50-499

SEP 2 1981

MEMORANDUM FOR: F. J. Miraglia, Chief, Licensing Branch No. 3, DL

FROM: D. E. Sells, Project Manager, Licensing Branch No. 3, DL

SUBJECT: Meeting Summary - Soil Structure Interaction, South Texas Project

On August 7, 1981 a meeting was held with Houston Lighting and Power (HL&P) to discuss the South Texas Project (STP) soil structure interaction analysis and two reports that were sent to NRC in late July. A list of attendees is attached as Enclosure A.

The agenda is attached as Enclosure B. HL&P presented the results of two studies that were conducted by two independent panels. One panel consisted of technical experts that had previously worked on the STP and the other panel consisted of experts that did not have previous contact with the STP. The purpose of the studies was to determine the adequacy of the use of the finite element method (FEM) versus the use of the elastic half space method (EHS). HL&P used the FEM in filing for and obtaining its construction permits for STP and have taken the position that what has been done in this area is adequate and conservative. The two study panels also concluded that the use of the FEM for STP is adequate and sufficient. Slides of HL&P presentation are enclosed as Enclosure C.

The staff, on the other hand, is not satisfied that credit should be taken for damping from the surface to the base mat. The staff offered a suggested alternative to resolve this issue and have formalized the suggestion in a memorandum dated August 21, 1981 (Enclosure D).

This branch position will be formerly transmitted to HL&P.

Donald E. Sells, Project Manager
Licensing Branch No. 3
Division of Licensing

cc: See next page.

OFFICE	DL:LB#3	DL:LB#3					
SURNAME	DESells:jb	FJMiraglia					
DATE	9/ /81	9/ /81					

MEETING SUMMARY DISTRIBUTION

Docket File
NRC PDR
Local PDR
NSIC
TERA
LB#3 Reading
H. Denton
E. Case
D. Eisenhut
R. Purple
B. J. Youngblood
A. Schwencer
F. Miraglia
J. Miller
G. Lainas
R. Vollmer
J. P. Knight
R. Bosnak
F. Schauer
R. E. Jackson
Project Manager D. Sells
Attorney, OELD
J. Lee
OIE (3)
ACRS (16)
R. Tedesco

G. Lear

S. Pawlicki
V. Benaroya
Z. Rosztoczy
W. Haass
D. Muller
R. Ballard
W. Regan
R. Mattson
P. Check
M. Srinivasan
O. Parr
F. Rosa
W. Butler
W. Kreger
R. Houston
T. Murphy
L. Rubenstein
T. Speis
W. Johnston

S. Hanauer
W. Gammill
T. Murley
F. Schroeder
D. Skovholt
M. Ernst

NRC Participants:

F. Schauer
D. Jeng
K. Shaukat
N. Chokski
A. Ibrahim
J. Ma
S. Chan
H. Graves
J. Costello

K. Kniel
G. Knighton
A. Thadani
D. Tondi
J. Kramer
D. Vassallo
P. Collins
D. Ziemann
E. Adensam

bcc: Applicant & Service List

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Mr. Cloin Robertson
Manager, Nuclear Licensing
Houston Lighting and Power Company
P. O. Box 1700
Houston, Texas 77001

ENCLOSURE A

LIST OF ATTENDEES

HL&P
J. Goldberg
C. Robertson
D. Barker
R. Hernandez

NRC
D. Sells
F. Schauer
D. Jeng
K. Shaukat
N. Chokski
A. Ibrahim
J. Ma
S. Chan
H. Graves
J. Costello

B&R
F. Muellner
F. Jordan
J. Lee

WLL
I. Idriss

Enclosure B

AGENDA

ATTENDEES:

NRC	HL&P	B&R
D. Sells	C. Robertson	J. Lee
F. Shauer	D. Barker	P. Jordan
J. Ma	R. Hernandez	F. Muellner
D. Jeng	J. Goldberg	I. Idriss (WCC)

I. INTRODUCTION, PURPOSE AND HL&P POSITION	J. Goldberg (03)
II. BACKGROUND	
A. Licensing Requirements	C. Robertson (03)
B. Technical Meetings	R. Hernandex (03)
III. VERIFICATION STUDY	J. Lee (15)
A. SIP (WCC) Verification Study Scope	
B. Conclusions	
IV. INDEPENDENT CONSULTANT REPORT	I. Idriss (15)
A. Scope of Study	
B. Conclusions	
V. IMPACT ON PROJECT TO ENVELOPE AND REDESIGN	D. Barker (03)
VI. SUMMARY	J. Goldberg (03)
VII. DISCUSSION	

Enclosure C

SOUTH TEXAS PROJECT
SOIL STRUCTURE INTERACTION CHRONOLOGY

February 13, 1975	A meeting was held between HL&P, B&R, Woodward Clyde Consultants (WCC) and the NRC to finalize the SSI criteria and analysis approach to be used on the South Texas Project. In this meeting it was established that the SSI analysis would be performed utilizing the Finite Element Method (FEM) in accorance with USNRC Standard Review Plan (SRP) Section 3.7.2.
August 1, 1975	South Texas Project Safety Evaluation Report (SER) issued with conclusion by the NRC that the FEM was acceptable (SER 3.7.2).
December 27, 1975	Construction Permit issued.
May 19, 1976	HL&P submitted response spectra curves for the South Texas Project based upon approved FEM.
April 13, 1979	NRC requests alternate comparative analysis using Elastic Half-Space Method (EHS) in FSAR Question 130.11 and 130.12.
May 10, 1979	HL&P/B&R met with the NRC to contest responding to FSAR Question. HL&P agreed to perform alternate analysis for comparison purposes only.
September 18, 1979	HL&P/B&R/WCC presented to NRC for approval the methodology under which the alternate confirmatory EHS model would be performed using Kausel's approach in considering embedment effects.
May 16, 1980	HL&P transmitted to the NRC the response to FSAR Question 130.12 entitled "Alternate Comparative Soil Structure Interaction Analysis Using the Elastic Half-Space Approach for Category 1 Structures for the South Texas Project."
July 21, 1981	HL&P transmitted to the NRC the consultants' reports documenting the review of the South Texas Project FEM analysis.

ENGINEERING IMPACT ASSESSMENT

REANALYZING TO REVISED RESPONSE CURVES WILL AFFECT THE FOLLOWING STRUCTURES.

- REACTOR CONTAINMENT BUILDING
- FUEL HANDLING BUILDING
- DIESEL GENERATOR BUILDING

SIGNIFICANT ENGINEERING ACTIVITIES WOULD INCLUDE

1. ISSUE REVISED RESPONSE SPECTRA FOR EVALUATION

2. REVISE DESIGN DOCUMENTS
   - CRITERIA DOCUMENTS
   - SPECIFICATIONS
   - CALCULATIONS

3. REANALYSIS OF NSSS SUPPLIED PIPING

4. EDS REANALYSIS OF NON NSSS PIPING (CONTAINMENT)

5. EVALUATE PROPOSED MODIFICATIONS
   - PIPING LAYOUT
   - PIPING HANGARS/RESTRAINT

6. EVALUATE STRUCTURES AND SYSTEMS

7. EVALUATE EQUIPMENT/MATERIAL MANUFACTURER RECOMMENDATION.

8. ISSUED REVISED DESIGN DRAWINGS.

9. SUPPORT PROCUREMENT INTERFACE.

10. SUPPORT CONSTRUCTION SCHEDULE REVISION.

PURCHASING IMPACT ASSESSMENT

1. REISSUE REVISED SPECIFICATIONS.

2. REVISE PURCHASE ORDERS.

3. REISSUE INQUIRIES IF REQUIRED.

4. REQUEST PRICE/SCHEDULE IMPACT ASSESSMENT.

5. EVALUATE MANUFACTURER'S/FABRICATOR'S RESPONSE FOR

   - REANALYSIS
   - REQUALIFICATION
   - MODIFICATION

6. NEGOTIATE COST INCREASE.

7. NEGOTIATE CANCELLATION COST IF REQUIRED.

PURCHASING IMPACT ASSESSMENT

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   - REANALYSIS
   - REQUALIFICATION
   - MODIFICATION
6. NEGOTIATE COST INCREASE.
7. NEGOTIATE CANCELLATION COST IF REQUIRED.

CONSTRUCTION IMPACT ASSESSMENT

REVISE CONSTRUCTION SCHEDULE TO ACCOMODATE:

- NEW ARRIVAL DATES FOR EQUIPMENT/MATERIAL
- RELEASE OF REVISED ENGINEERING DRAWINGS
- ASSESS NEED FOR HOLDS, BLOCKOUTS, WORK AROUNDS
- REMOVAL OF EQUIPMENT FOR HARDWARE MODIFICATION
- FIELD MODIFICATION

CONSTRUCTION SCHEDULE IMPACT 2.5 YEARS

SUMMARY

- SIGNIFICANT ENGINEERING IMPACT
- SIGNIFICANT PROCUREMENT IMPACT
- SIGNIFICANT CONSTRUCTION IMPACT

OVERALL SCHEDULE DELAY IS AT LEAST 2.5 YEARS ESTIMATED

COST IMPACT IS 1 BILLION.

REVIEW OF SOIL-STRUCTURE INTERACTION AND SEISMIC ANALYSIS OF CATEGORY I STRUCTURES SOUTH TEXAS PROJECT UNITS 1 & 2

by

PROJECT TEAM

WOODWARD-CLYDE CONSULTANTS

C.-Y. Chang

I. M. Idriss

BROWN & ROOT, INC.

James P. Lee

PROJECT CONSULTANTS

Eduardo Kausel
Associate Professor of Civil Engineering, MIT

John Lysmer
Professor of Civil Engineering, University of California, Berkeley

H. Bolton Seed
Professor of Civil Engineering, University of California, Berkeley

May 5, 1981

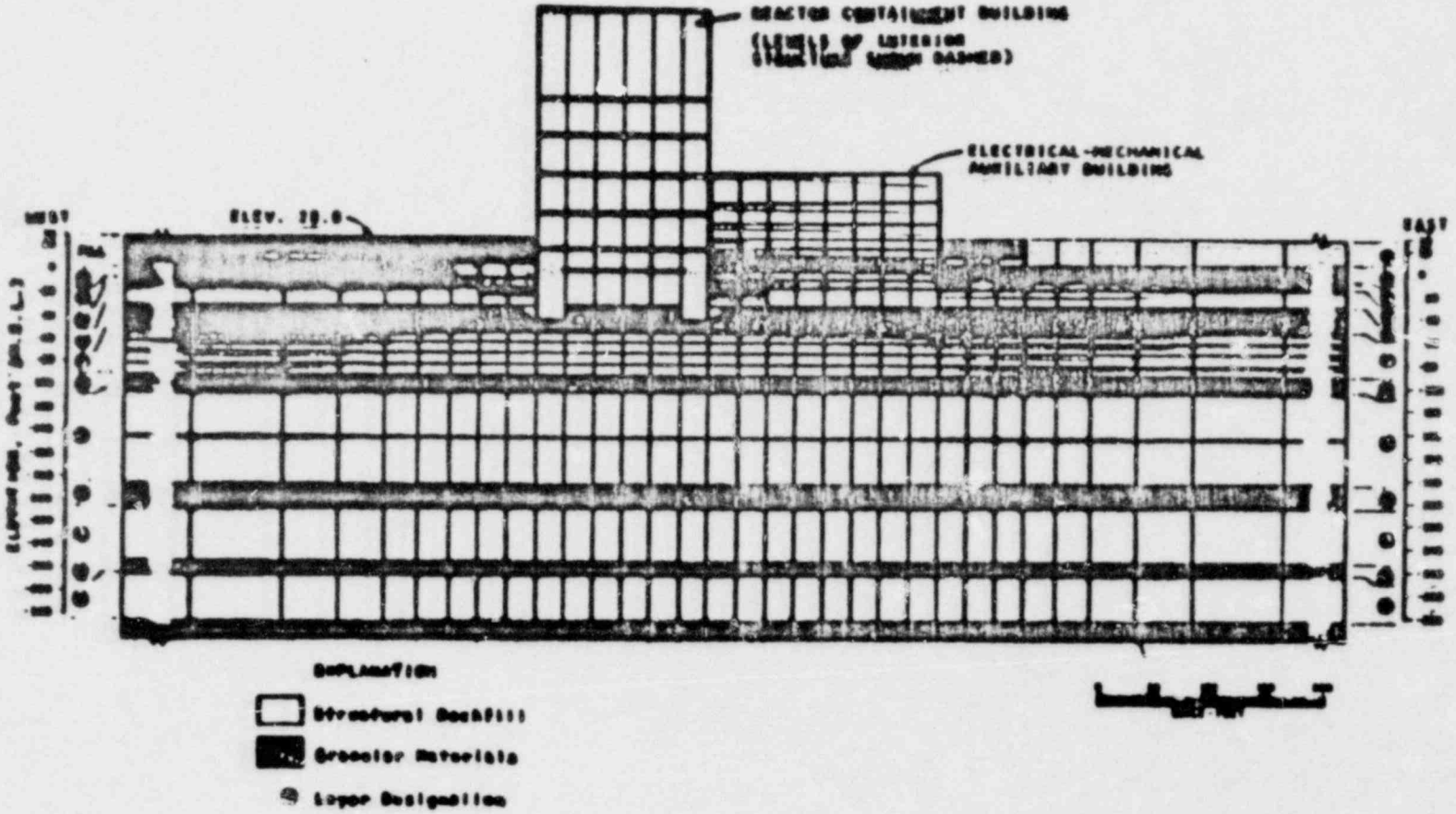
January 1981
2 copies

PURPOSE:

- To review soil structure interaction finite-element analyses specifically used for the South Texas Project site and to prepare a report summarizing comments and conclusions based on this review.

SCOPE OF REVIEWS:

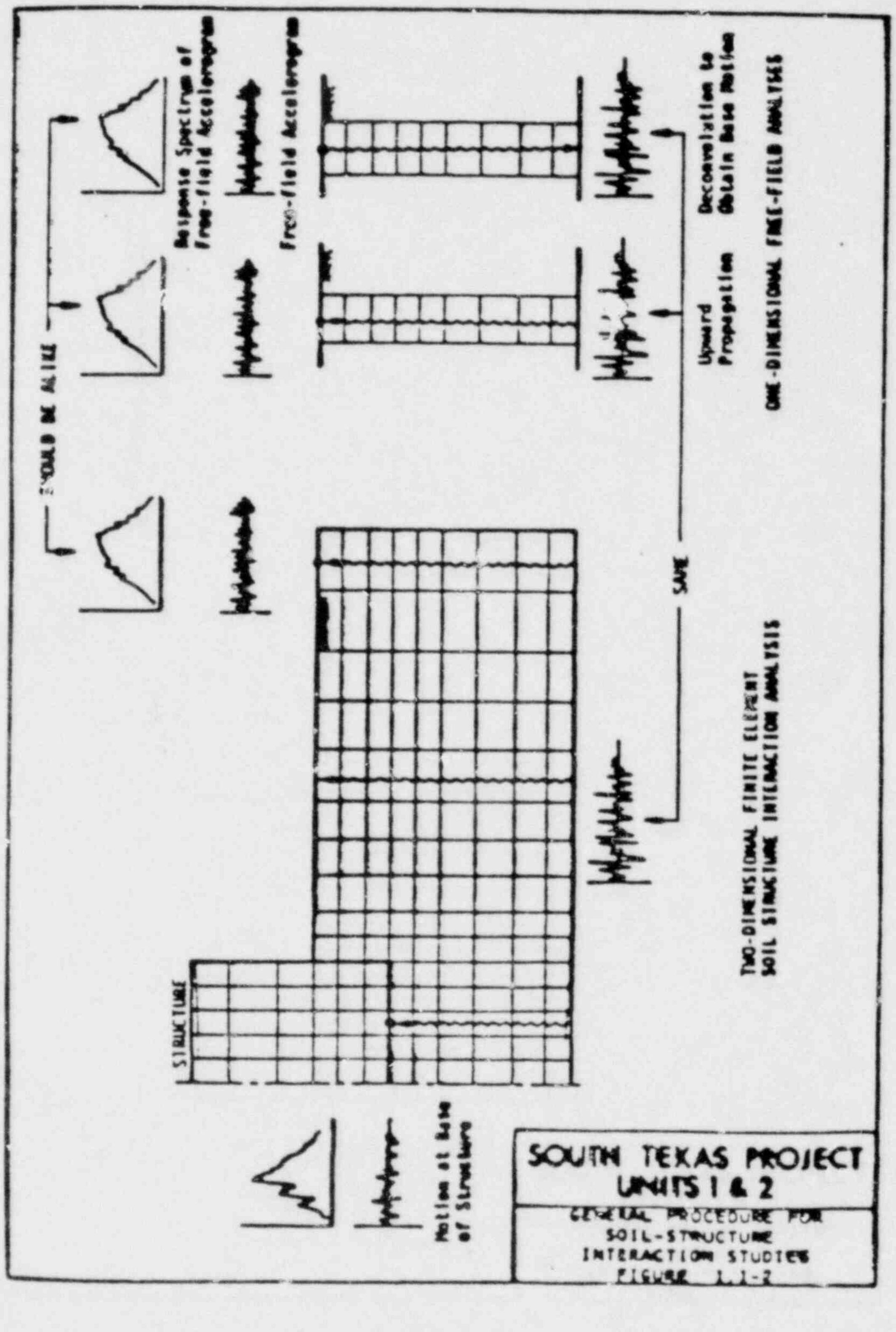
- Conservatism of input motion
- Applicability of the FEM to the STP site
- Applicability of procedures used for the seismic analysis of Category I structures
- Sources of conservatism
- Conservatism of results



(From Fig. 7-1 of Ref. 14a)

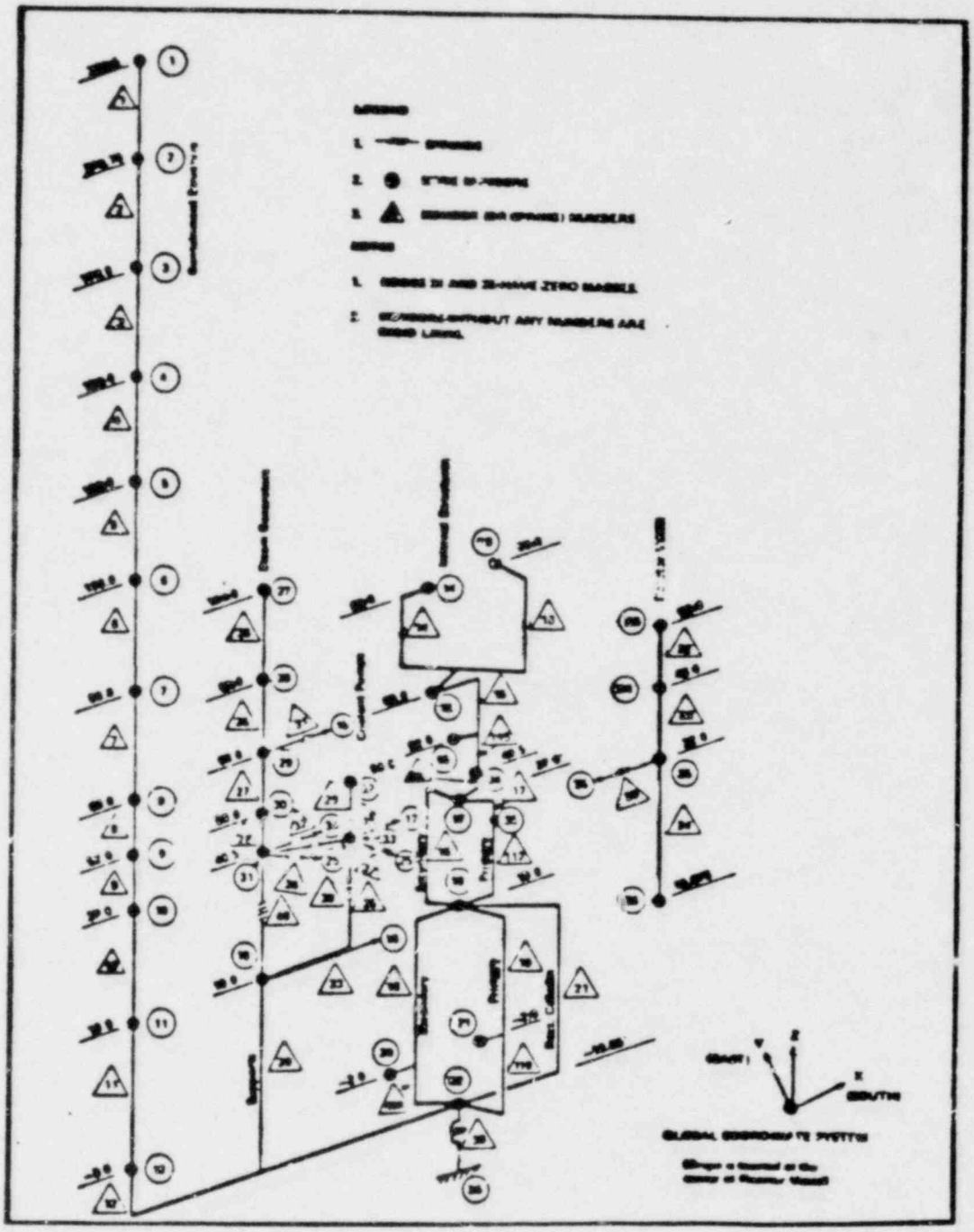
SOUTH TEXAS PROJECT
UNITS 1 & 2
FINITE ELEMENT MESH
CROSS SECTION 1
FIGURE 4.3-4

1. Layered site
2. Embedment



SOUTH TEXAS PROJECT
UNITS 1 & 2

GENERAL PROCEDURE FOR
SOIL-STRUCTURE
INTERACTION STUDIES
FIGURE 1.1-2



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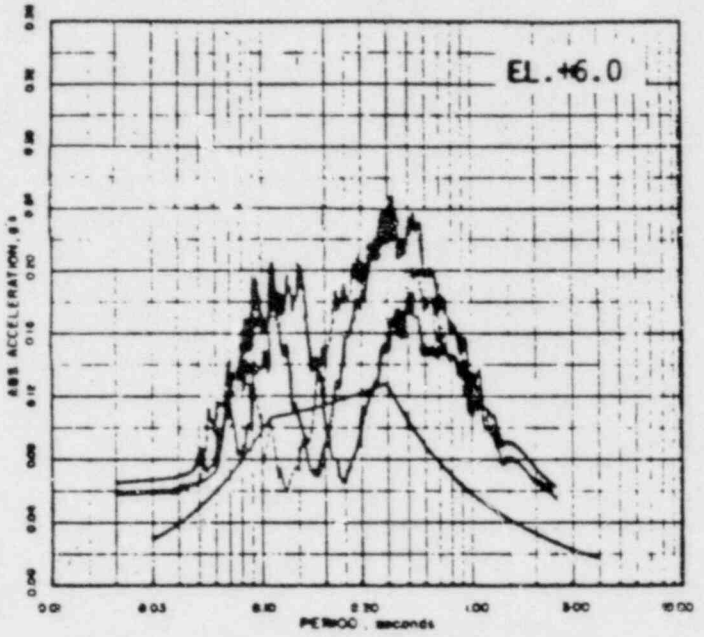
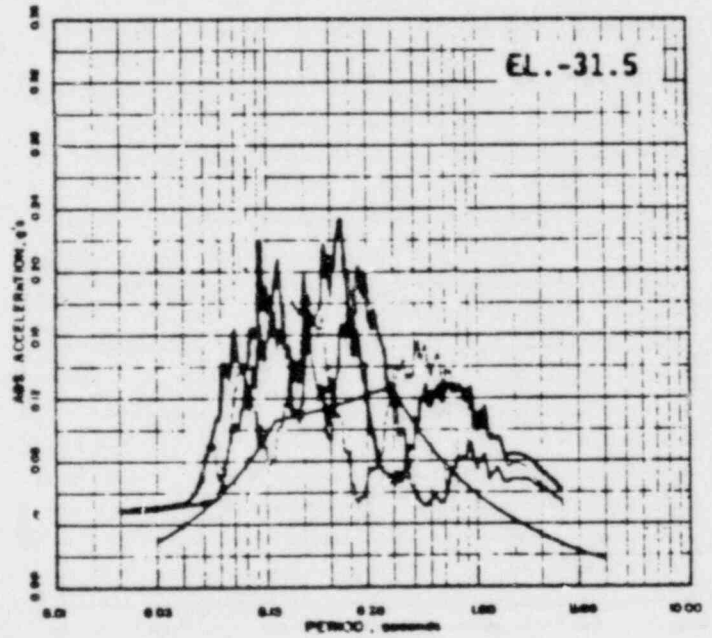




LEGEND:

——— AVERAGE

- - - - - - UPPER-BOUND

——— LOWER-BOUND

SPECTRAL DAMPING = 2%

SOUTH TEXAS PROJECT
UNITS 1 & 2

COMPARISON OF FOUNDATION-LEVEL MOTION RESPONSE SPECTRA WITH NRC CRITERIA, HORIZONTAL OBE

FIGURE 9.6-2

TABLE 3.7-1

DAMPING VALUES[1]

(Percent of Critical Damping)

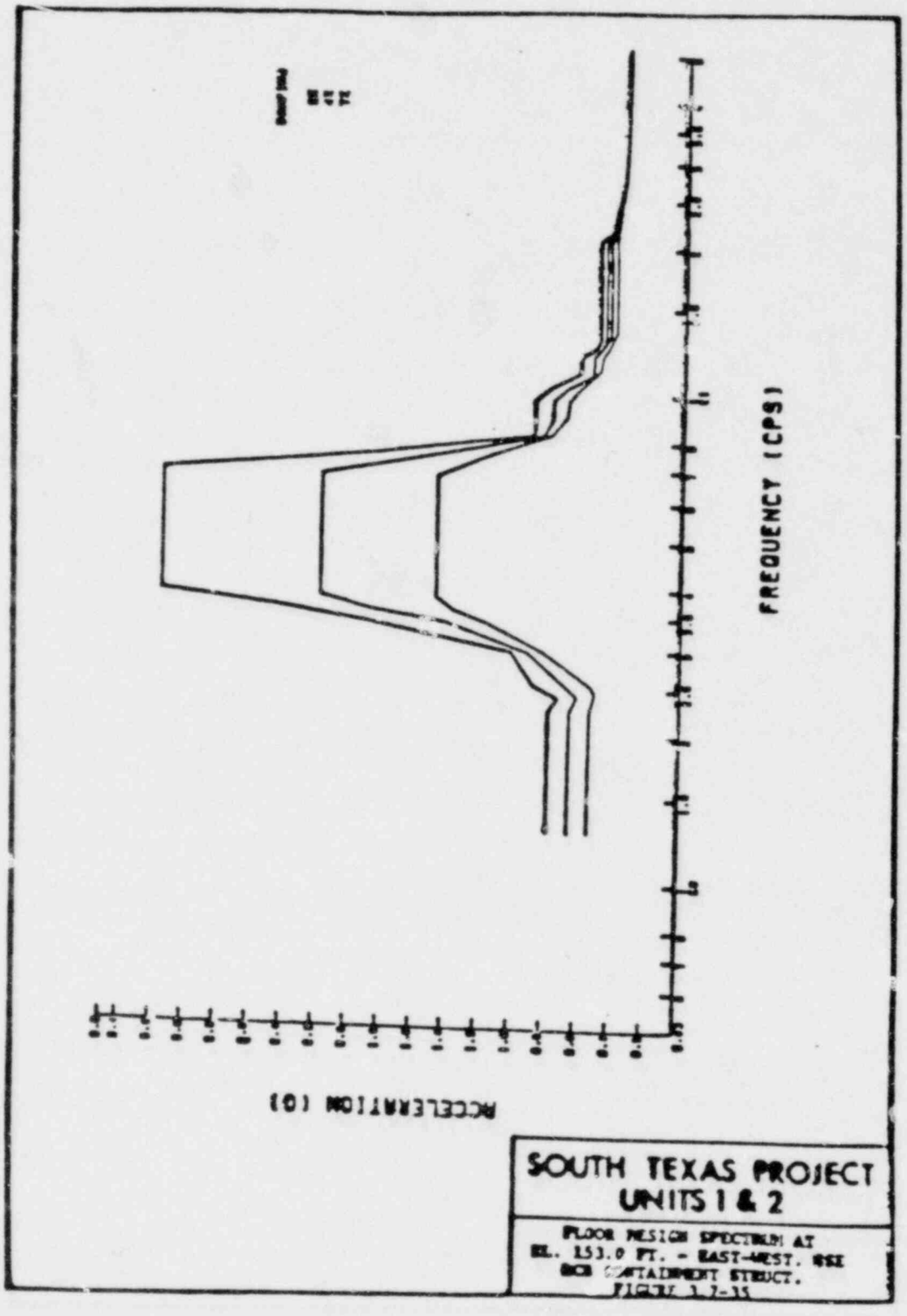
Structure or Component	Operating Basis Earthquake[2]	Safe Shutdown Earthquake
Equipment and large-diameter piping systems,[3] pipe diameter greater than 12 in.	2	3
Small-diameter piping system, diameter equal to or less than 12 in.	1	2
Welded steel structures	2	4
Bolted steel structures	4	7
Prestressed concrete structures	2	5
Reinforced concrete structures	4	7

Note: Table 3.7-1 is derived from the recommendations given in Reference 3.7.1-1 and complies with RG 1.61, October 1973.

[1]These damping values are for non-NSSS equipment. See Table 3.7-7 for damping values of NSSS equipment.

[2]In the dynamic analysis of active components as defined in RG 1.48, these values should also be used for SSE.

[3]Includes both material and structural damping. If the piping system consists of only one or two spans with little structural damping, use values for small-diameter piping.



AREAS OF CONSERVATISM

- Peak Ground Acceleration of 0.1G for SSE (SF = 1.43)
- Peak Acceleration of 0.1G at Foundation Level (SF = 1.3)
- Synthetic Time History (SF = 1.0—1.2)
- Used 0.07G for OBE In the E-W Direction for DGB and FHB (SF = 1.4 +)
- Wide Ranges of Soil Properties
- 3-D Model Introduced Conservatism

AREAS OF CONSERVATISM (Cont'd)

- Combination of Co-directional Responses
- Combination of Dynamic and Static Loads
- Wave Passage Effect
- Inelastic Effect
- Design for Dynamic Lateral Soil Pressures
- Usage of Response Envelopes in Piping Analysis

APPLICABILITY OF FEM TO STP SITE

- Layered Foundation Materials
- Deeply Embedded Structures
- Close Proximity of Structures
- Control Motion at Finished Grade
- Parametric Studies on Soil Properties
- Enveloped 60% Design Response Spectra at Foundation Level

APPLICABILITY OF FEM TO STP SITE

- Layered Foundation Materials
- Deeply Embedded Structures
- Close Proximity of Structures
- Control Motion at Finished Grade
- Parametric Studies on Soil Properties
- Enveloped 60% Design Response Spectra at Foundation Level

APPLICABILITY OF PROCEDURES FOR THE SEISMIC ANALYSIS OF CATEGORY 1 STRUCTURES

- Time History Analysis
- Torsional Spring Eccentricity Between CG & CR were Incorporated in the 3-D Lumped Mass Model
- Major EQ was Included in the Model
- Damping Valves were Obtained from RG 1:61
- Development of FRS Follows R.G. 1.122
- Peaks of FRS were Widened

CONCLUSIONS

"The finite element method used in the analysis of soil-structure interaction is an applicable and appropriate method for assessing soil-structure interaction effects at the STP."

"Based on examinations of various sources of conservatism, it is concluded that the results of the SSI analysis and the seismic structural analysis are very conservative for the design of the Category I structures and the subsystems at the STP site."

To: Dr. Jim P. Lee
Brown & Root
Rm. 03-9060

From C.Y. Chang
Woodward-Clyde
STP-SSI Review
144618-1000

1 4068

PANEL OF INDEPENDENT CONSULTANTS
CONDUCTING THE EVALUATION

DR. ANIL K. CHOPRA

DR. JOSE M. ROESSET

DR. ROBERT V. WHITMAN - CHAIRMAN

SCOPE OF EVALUATION

1. REVIEW FINITE ELEMENT SOIL-STRUCTURE INTERACTION AND SEISMIC RESPONSE ANALYSES SPECIFICALLY USED FOR THE STP SITE

2. PREPARE A REPORT SUMMARIZING COMMENTS AND CONCLUSIONS BASED ON THIS REVIEW, INCLUDING THE FOLLOWING ITEMS:

   - APPLICABILITY OF THE FINITE ELEMENT METHOD FOR SOIL-STRUCTURE INTERACTION ANALYSES TO THE STP SITE
   - APPLICABILITY OF PROCEDURES USED FOR THE SEISMIC ANALYSIS OF CATEGORY I STRUCTURES
   - SOURCES OF CONSERVATISM INCLUDING THE INPUT MOTION
   - CONSERVATISM OF RESULTS

EVALUATION PROCEDURES

- REVIEW SEVEN PERTINENT DOCUMENTS RELATED TO SOIL-STRUCTURE INTERACTION AND SEISMIC ANALYSIS OF CATEGORY I STRUCTURES OF STP
- GENERATE QUESTIONS AND REQUESTS FOR CLARIFICATION
- DISCUSS WITH THE PROJECT TEAM

GENERAL APPROACH FOLLOWED IN EVALUATION

- DEVELOPING A THOROUGH UNDERSTANDING OF THE ASSUMPTIONS MADE AND THE PROCEDURES USED AT VARIOUS STAGES OF THE ANALYSES
- STUDYING SELECTED RESULTS FOR CONSISTENCY AND REASONABLENESS, EMPLOYING A FEW APPROXIMATE HAND CALCULATIONS TO CHECK SOME ASPECTS OF THE COMPUTED RESPONSES
- REVIEWING SELECTED RESULTS IN THE LIGHT OF THE EXPERIENCE OF THE CONSULTANTS

APPLICABILITY OF THE FINITE ELEMENT METHOD FOR SOIL-STRUCTURE INTERACTION ANALYSIS

- GREAT CARE WAS TAKEN IN THE DEVELOPMENT OF THE MODEL FOR THE SOIL PROFILE AND OF THE FINITE ELEMENT REPRESENTATION, AND IN THE SELECTION OF THE PARAMETERS FOR THE MODEL

- ALL OF THE REGULATORY REQUIREMENTS CONCERNING UNCERTAINTY IN SOIL PROPERTIES AND THE VARIATIONS OF GROUND MOTIONS WITH DEPTH WERE SATISFIED

- THE RESULTS OF THE F.E. ANALYSIS PROCEDURES, USED WITH PROPER ENGINEERING JUDGMENT AND CONSERVATISM, ARE SATISFACTORY FOR SOIL-STRUCTURE INTERACTION ANALYSES OF THE STP SITE

- IF THIS PROJECT WERE STARTING UP FRESH TODAY, THE CONSULTANTS WOULD ACCEPT ESSENTIALLY THE SAME TYPES OF ANALYSIS AS THAT COMPLETED

APPLICABILITY OF PROCEDURES USED FOR THE SEISMIC ANALYSIS OF CATEGORY I STRUCTURES

- THE PROCEDURE OF USING THE BASEMAT MOTIONS COMPUTED FROM THE F.E. ANALYSIS AS INPUT MOTIONS TO SEISMIC ANALYSES OF STRUCTURES IS A REASONABLE AND RATIONAL PROCEDURE

- REGULATORY REQUIREMENTS CONCERNING BROADENING OF FLOOR RESPONSE SPECTRA PEAKS AND THE COMBINING OF DIFFERENT MOTIONS WERE SATISFIED

CONCLUSIONS FROM INDEPENDENT CONSULTANTS REPORT

TAKING ALL CONSIDERATIONS INTO ACCOUNT, THE CONSULTANTS BELIEVE THAT THE PROCEDURE USED FOR ANALYSIS OF SOIL-STRUCTURE INTERACTION AND DYNAMIC ANALYSIS ARE APPROPRIATE FOR THE STP, AND, IF IMPLEMENTED PROPERLY OR CONSERVATIVELY, SHOULD LEAD TO FORCES AND FLOOR RESPONSE SPECTRA WHICH ARE CONSERVATIVE FOR USE IN DESIGN. WHERE COMPUTED RESULTS WERE EXAMINED IN DETAIL, THEY APPEARED TO BE EITHER CORRECT OR CONSERVATIVE, SUGGESTING APPROPRIATE IMPLEMENTATION FOR AT LEAST THOSE PARTS OF THE ANALYSIS.