

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.

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

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May 5, 1981

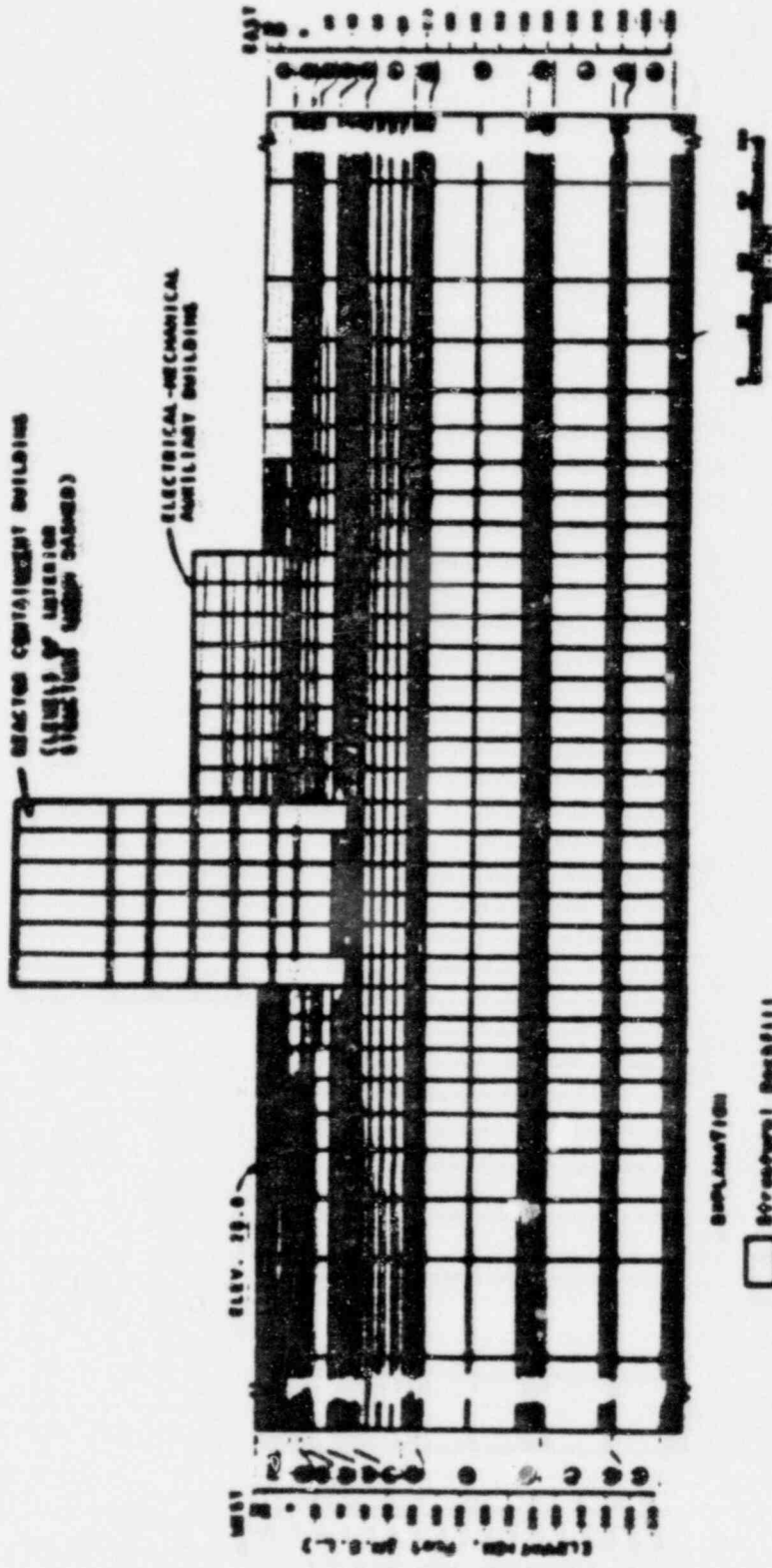
January 1981
2 comments

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:

- Conservation 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
- Conservation of results

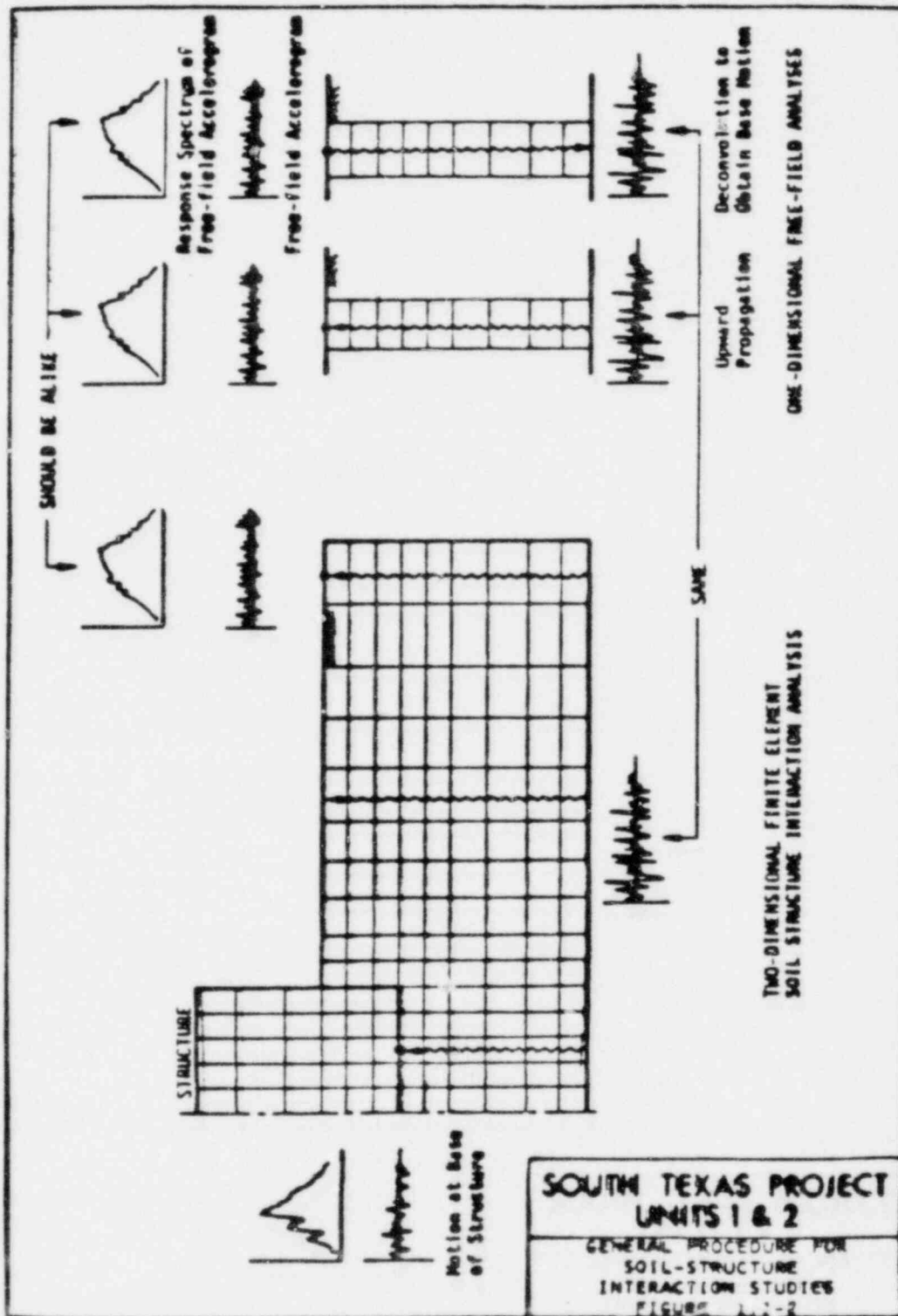


- EXPLANATION
- Structural Details
 - Greater Materials
 - Layer Designation

SOUTH TEXAS PROJECT
UNITS 1 & 2
 VERTICAL ELEVATION
 CROSS SECTION 1
 PROPOSED 4.3-4

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

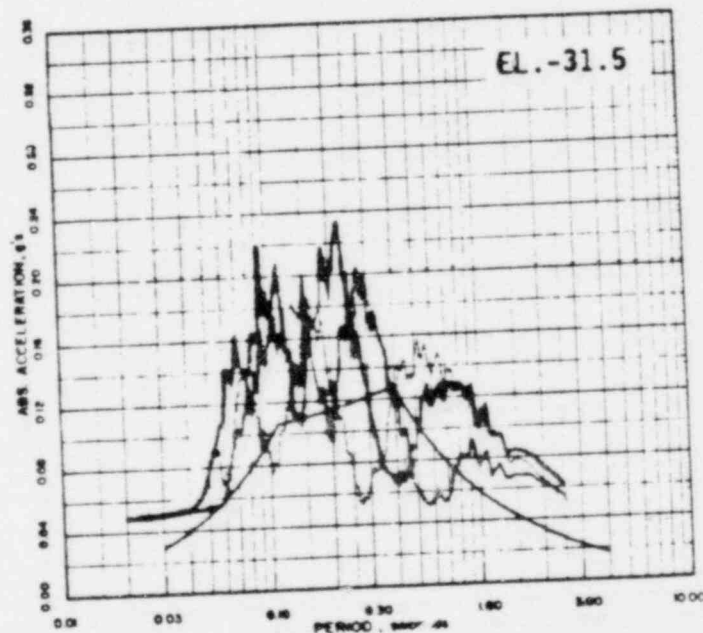
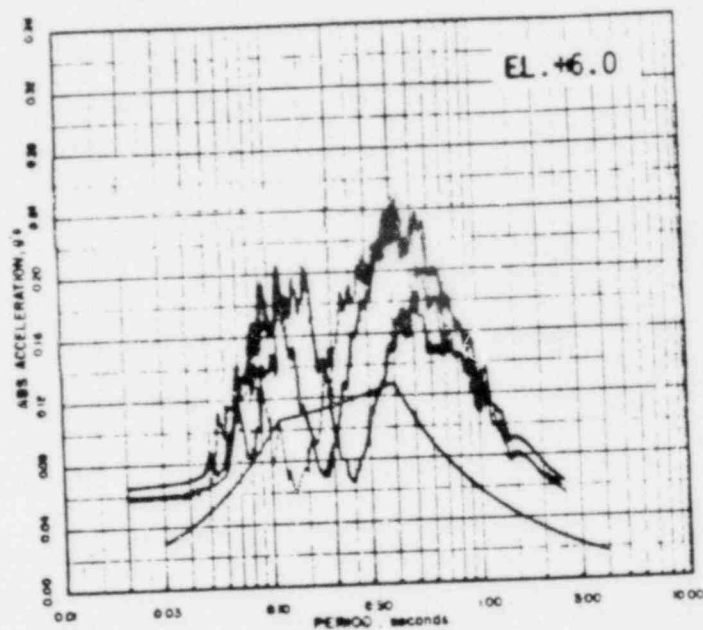
1. Layered site
2. Embedded at



**SOUTH TEXAS PROJECT
UNITS 1 & 2**
GENERAL PROCEDURE FOR
SOIL-STRUCTURE
INTERACTION STUDIES
FIGURE 2.2-2

Revised 10/10/78





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

SOP PSAR

TABLE 3.7-1

DAMPING VALUES¹

(Percent of Critical Damping)

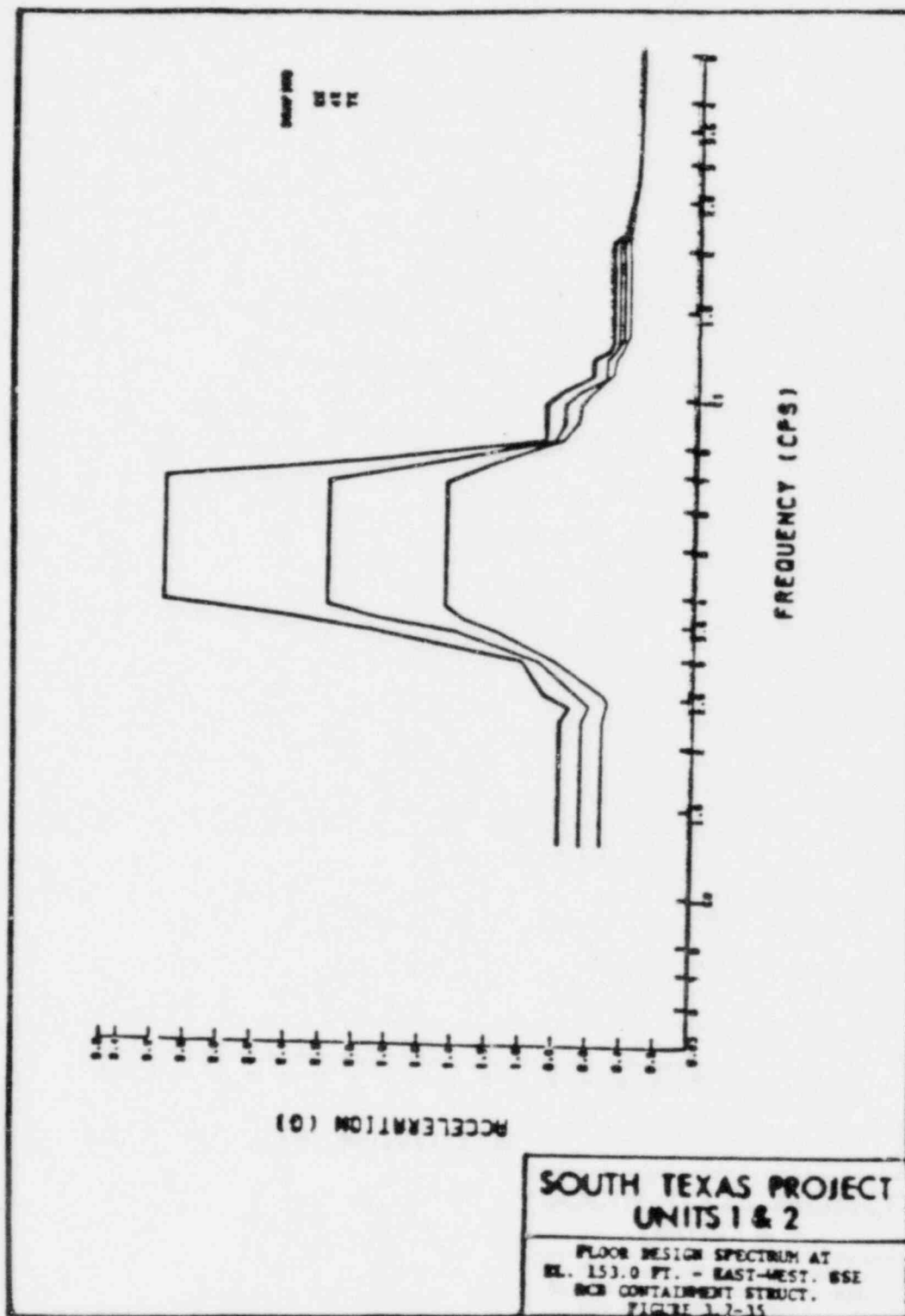
<u>Structure or Component</u>	<u>Operating Basis Earthquake²</u>	<u>Safe Shutdown Earthquake</u>
Equipment and large-diameter piping systems, ³ pipe diameter greater than 12 in.	2	3
Small-diameter piping system, diameter equal to or less than 12 in.	1	2
Welded steel structures	2	4
Bolted steel structures	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 RC 1.61, October 1973.

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

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

³Includes 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 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 Values were Obtained from R.G. 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."

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From C.Y. Chang
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PANEL OF INDEPENDENT CONSULTANTS
CONDUCTING THE EVALUATION

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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 COM-
BINING OF DIFFERENT MOTIONS WERE SATISFIED
-

CONSERVATISM IN THE ANALYSIS

- THE CHOICE OF 0.10G FOR THE SSE AND 0.05G FOR THE OBE APPEARS TO BE QUITE CONSERVATIVE FOR THE LOCATION OF THE STP
- THE TIME SERIES OF ACCELERATION USED FOR THE SSI ANALYSES HAVE RESPONSE SPECTRA WHICH ARE AT OR ABOVE THE TARGET SPECTRA IN THE COMPLETE RANGE OF FREQUENCIES OF INTEREST, FOR ALL VALUES OF DAMPING
- ADDITIONAL CONSERVATISM IN THE INPUT MOTIONS WAS INTRODUCED IN ORDER TO COMPLY WITH CERTAIN REQUIREMENTS ON THE FREE-FIELD PEAK ACCELERATION AT THE FOUNDATION OF THE DEEPEST BUILDING AND UPON THE RESPONSE SPECTRA AT THIS ELEVATION
- THE PROCEDURE FOR ASSIGNING BASE MOTIONS TO THE DIESEL GENERATOR BUILDING AND FUEL HANDLING BUILDING IS DEFINITELY CONSERVATIVE
- THE ANALYSIS PROCEDURE USED RESULTS IN CONSERVATIVE FLOOR RESPONSE SPECTRA
- THE SPECTRAL PEAKS FOR VERTICAL INPUT MOTION DUE TO THE VERTICAL OBE ARE CONSERVATIVELY HIGH

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.