TENTATIVE PLAN FOR THE SEISMIC REANALYSIS OF THE CRITICAL STRUCTURAL SYSTEMS OF OYSTER CREEK NUCLEAR POWER STATION UNIT 1

S. M. Ma
EGG
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1. INTRODUCTION

Presented herein are the tentative plans for reanalyzing the critical (seismic Class 1) structures of Oyster Creek Nuclear Power Station Unit 1. The object of the reanalysis is to demonstrate whether or not the seismic loads and criteria previously used for the design of these structures are indeed conservative as evaluated by the available current analytical tools. The selected approach is to come up with new seismic loads (shears and moments) by first employing simple conservative models. If any of the seismic loads obtained from these models significantly exceed the design loads, the second step will be to use more refined models, hopefully, reduced seismic loads would be obtained. For example, in the area of soil-structure interaction analysis, the half-space or lumped parameter approach will be used first; if seismic load results are too high, a suitable finite element approach will be utilized next. The detailed analysis plan for each critical structure will be addressed separately in the report. The previous analysis technique used for the design of each structure will also be described briefly.

2. CRITICAL STRUCTURES TO BE ANALYZED

The major critical structures concerned herein are the reactor building, the turbine building/control room, the ventilation stack, the condensate storage tank and buried piping (14" diameter emergency service water lines).

3. ANALYSIS GUIDES

NUREG/CR-0098, "Development of Criteria for Seismic Review of Selected Nuclear Power Plants" by Newmark and Hall will be used as the primary guide. Additional guides mainly in the area of soil structure interaction analysis, buried lifeline analysis, and above ground vertical storage tank analysis are cited in the text and listed in References.

4. SEISMIC INPUT

As the site-specific input is not available, for the time being the SSE input defined by the Regulatory Guide 1.60 design spectra will be used. In this phase of analysis, the emphasis is more on establishing suitable analysis models. Once this is accomplished, reanalysis for various seismic loadings will only require input changes.

5. COMPUTER PROGRAMS

For the contemplated linear analyses, the general-purpose linear elastic SAP program is available on both LLL and LBL systems. For nonlinear soil-structure interaction analysis, the FLUSH program is also available on these two systems. In half-space soil-structure interaction analysis, the use of concentrated viscous dampers at structure foundation is required. Presently there are no damper elements available in either LLL SAP or LBL SAP program. A program modification is therefore necessary. Alternatively, ANSYS program on Boeing Computer Systems can be used through EG&G/San Ramon's computer terminal.

6. GENERATION OF FLOOR SPECTRA

Floor response spectra for equipment/piping design are generally generated by time history analysis of the building structures. Various methods of generating floor spectra without going through a time history analysis have also been developed and shall be considered. The modeling of the structure (i.e., location of the mass points), shall be made such that the response information at or close to major equipment piping support points can be easily retrieved.

7. VARIATION IN PARAMETERS

Sensitivity of seismic response to variation in important parameters shall be studied. The list includes soil properties. concrete modulus, shear areas, damping values, modeling techniques, etc.

8. ANALYSIS OF VENTILATION STACK

8.1 Previous Analysis by J. A. Blume ... ck Design

The analysis is reported in Ref. ... ne stacks (two stacks, similar in structure) were modeled as cant... ms with lumped masses (stick model). Rocking around the foun... analyzed and found to be negligible in contributing seismic l... ver, no documentation was available to confirm this statement.

8.2 Reanalysis Plan

A stick model is deemed sufficient to represent the stack dynamic response, and the modification is to incorporate additional soil springs and dampers given by Richart, Hall and Woods (3) see Figure 1. The

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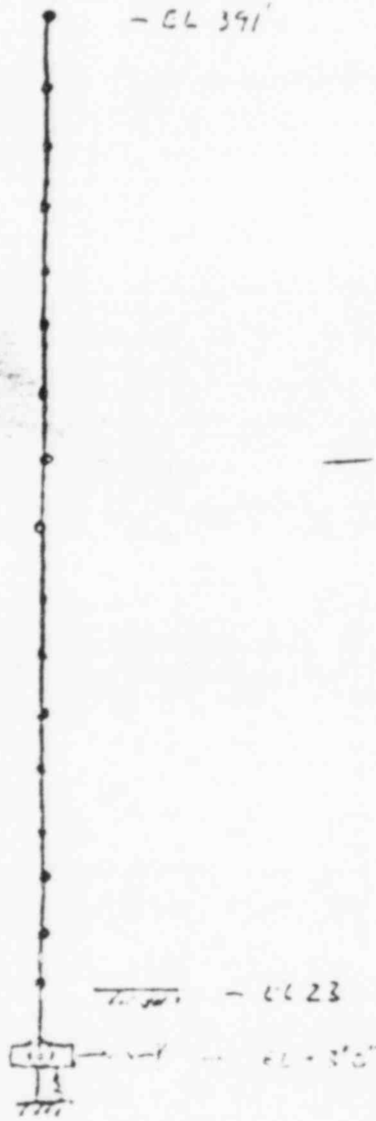

VENTILATION STACK MODEL

Fig 1.

general analysis steps are listed below

(a) Verify model section and mass data from drawings, make corrections if any.

(b) Calculate rocking, lateral and vertical soil spring constant from soil data.

(c) Make response spectrum analysis of the model by inputing the R.G. 1.60 response spectrum. Use a 10% damping as per NUREG/CR-0098 for all modes. Make one for the horizontal direction and another for the vertical direction.

(d) Check and compare the results with Blume's results.

(e) If the results are significantly greater than Blume's results, incorporate soil viscous dampers (in lateral, rocking and vertical directions as determined by Ref. 2) into the model. Run a direct time integration time history analysis.

9. ANALYSIS OF REACTOR BUILDING

9.1 Previous Analysis by J. A. Blume for Reactor Building Design

A stick model was used to represent the reactor building, and the rocking of the building around the foundation was analyzed separately using a damping ratio of 0.10 and an elastic soil modulus of 800 tons per square foot (Sh. 27 and 28, ref. 3). The building material frequencies were found to be above 37.6 rad/sec (5.987 cps) and the rocking period is 1.57 sec (0.637 cps).

9.2 Reanalysis Plan

A stick model representation for the reactor building is deemed acceptable. This building is a short, massive reinforced concrete box structure with a concrete shield at the center to provide shielding for the reactor pressure vessel. The transmission of inertia forces from top to bottom is most likely through the exterior shear wall and the center shield.

The analysis model shall include the reactor building as well as the steel containment (dry well), the reactor pressure vessel, and its supports. The model diagram is shown in Fig. 2.

A 3D response spectrum analysis will be performed using R.G. 1.60 spectra, and 10% damping for all modes.

It is expected that the RPV and drywell will experience greater seismic loads that previously determined by Blume, since the foundation rocking and coupling of the drywell, RPV, and reactor building were not considered in Blume's analysis.

If needed, a less conservative estimation of seismic loads due to soil structure interaction will be conducted. It is suggested to proceed with more refined analyses as follows:

(1) Time history analysis using soil viscous dampers;

(2) Use a refined soil model for the deep embedment case, i.e., the Hall-Kissenpfenning model, ref. 4, p. 25;

(3) Use FLUSH analysis (recommended).

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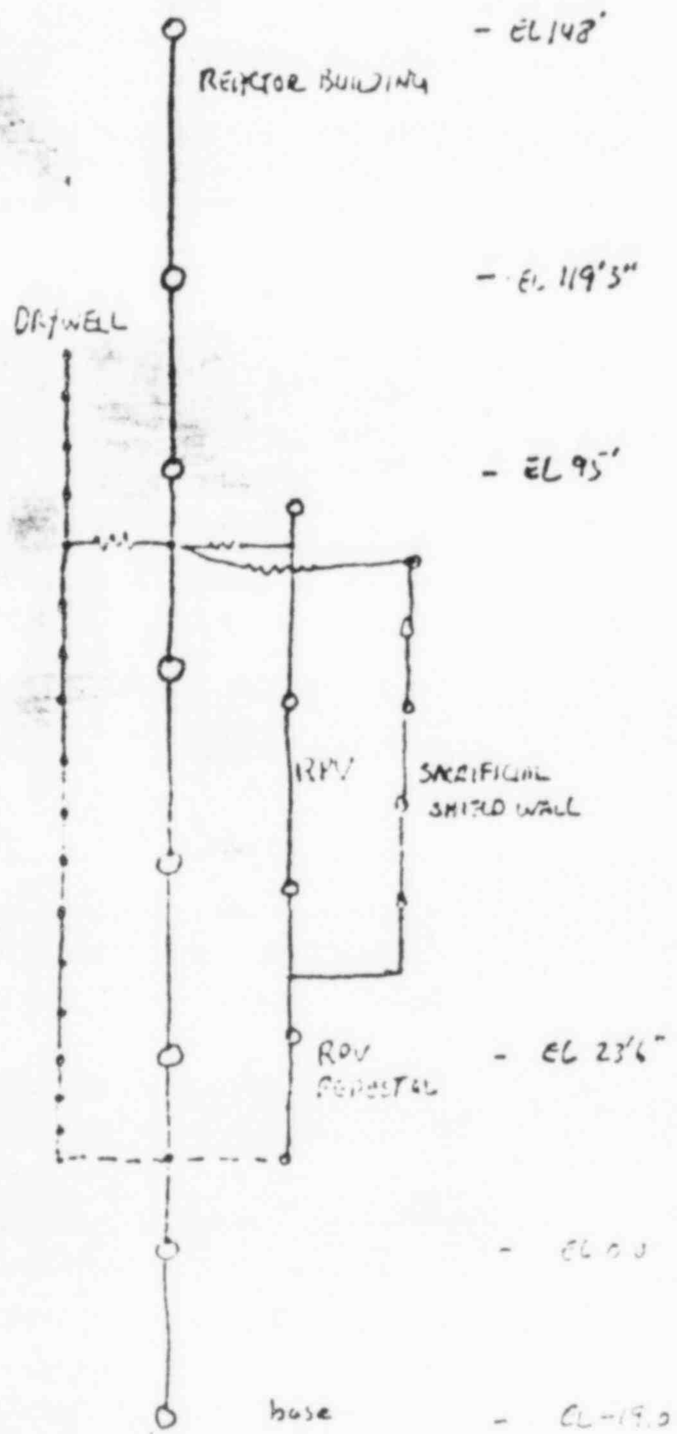

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FIG 2 REACTOR BUILDING MODEL

10. ANALYSIS OF TURBINE BUILDING/CONTROL ROOM

10.1 Previous Analysis by J. A. Blume for Turbine Building/Control Room Design

The building was represented by a two mass stick model. A time history analysis using El Centro earthquake of May, 1940 N-S component normalized to 0.11 g (5).

10.2 Reanalysis Plan

Since the turbine building is a seismic class (category) 2 structure, the main concern is the response of seismic class 1 facilities/equipment in this building. These are the control room on the N-E corner of the operating floor, C battery room and switchgear room on the S-W corner of the mezzanine floor. The turbine building is a short rectangular based reinforced concrete building stiffened laterally by shear walls in both the N-S and E-W directions. A stick model representation is deemed adequate. The separate control room enclosure as shown in Fig. 1-4-10, FSAR shall be modeled separately to evaluate its seismic integrity. The proposed model including the usual soil springs are shown in Fig. 3.

Note that separate stick models of the turbine, its pedestal, and overhead crane frame above the operating floor are included in the model to take account of all possible dynamic interaction effects.

It is expected that soil-structure effects will dominate the seismic response. The analysis procedure for the turbine building will be similar to that of the reactor building described in Section 9.2.

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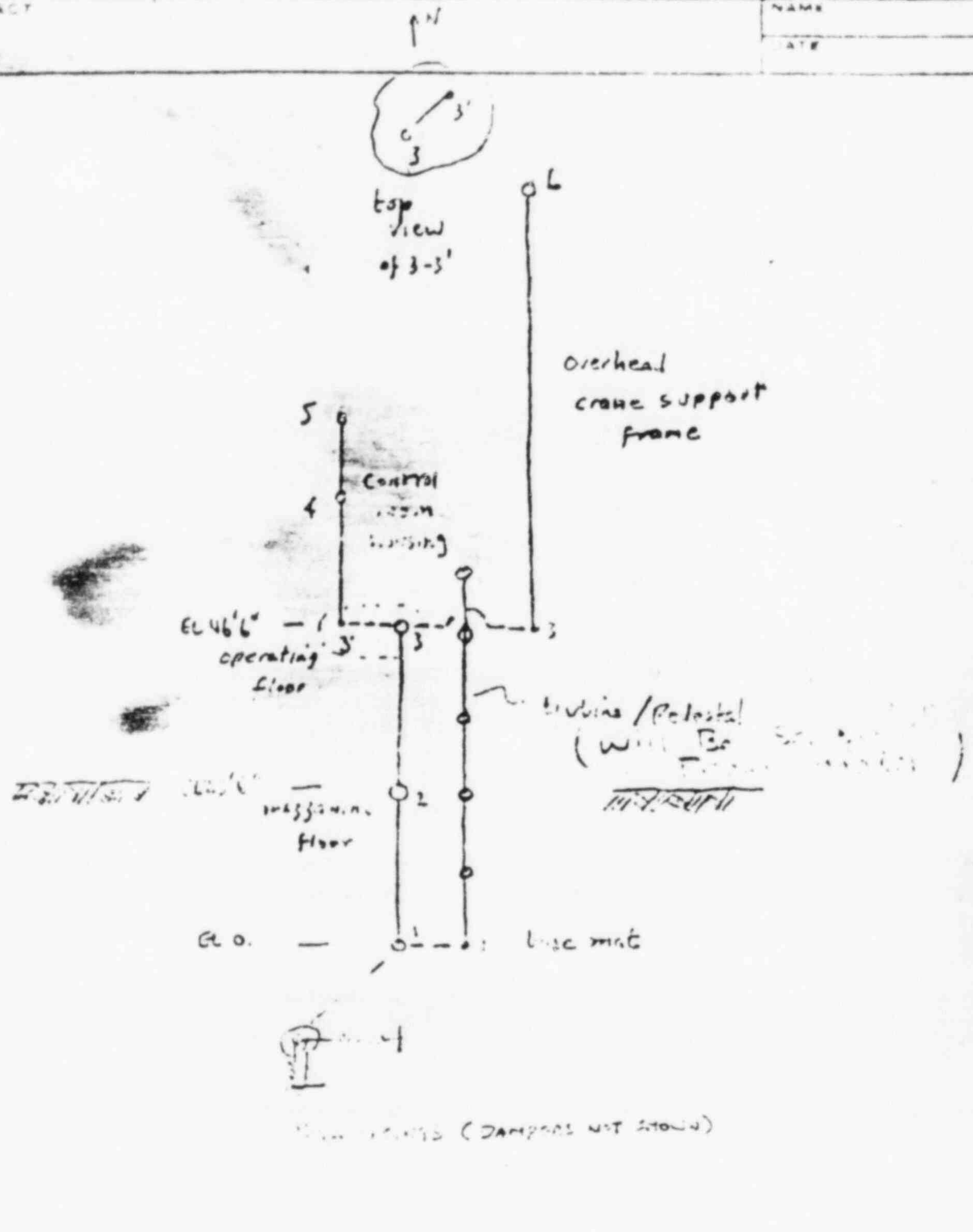

FIG. 3

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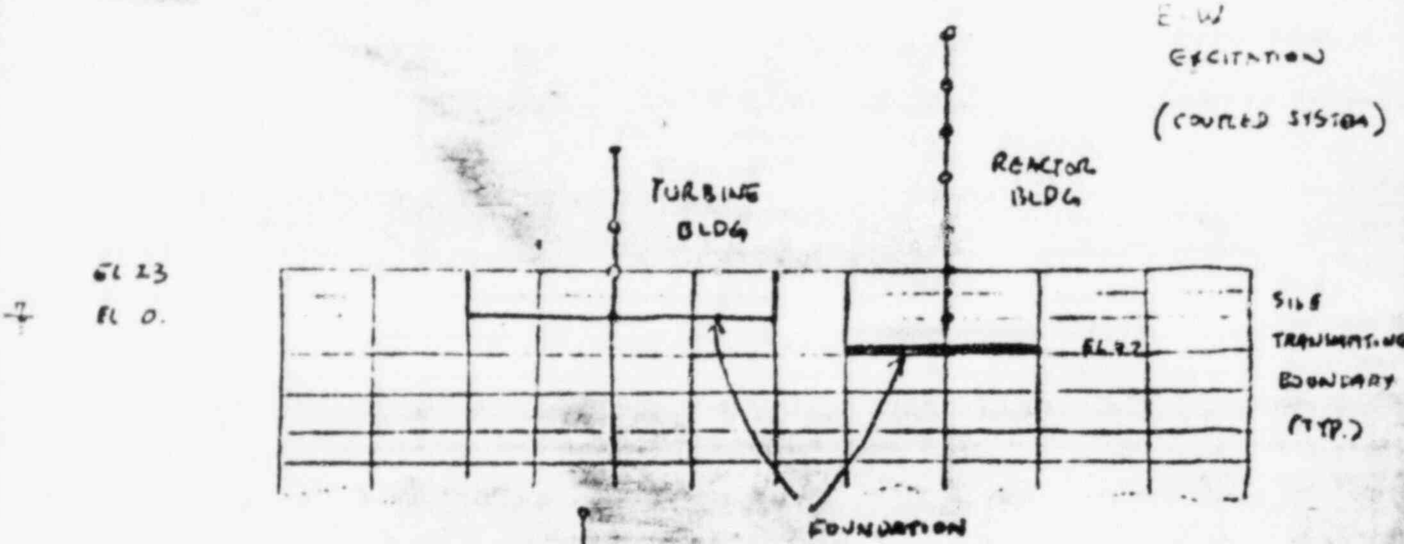

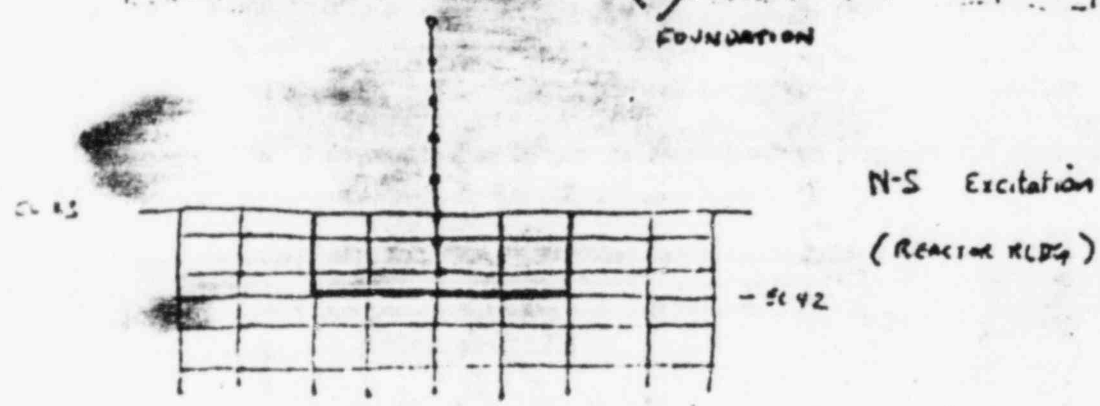

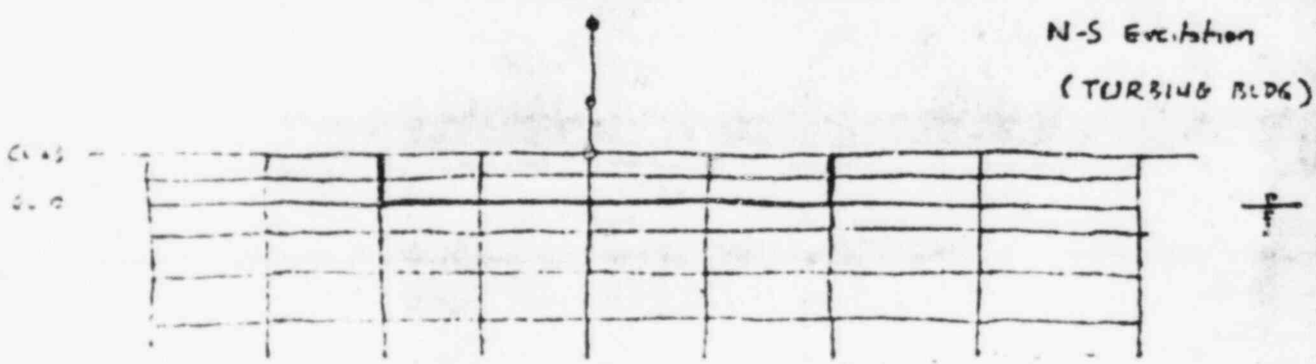

F.E. MODELS
SOIL-STRUCTURE INTERACTION

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To determine accurate seismic soil-structure interaction effects, the FLUSH program may be eventually employed. In this case both the turbine building and the reactor building and its internals shall be modeled together in the soil-structure system due to their proximity (the structure to structure interaction effect will hence be considered, see Figure 4).

11 ANALYSIS OF CONDENSATE STORAGE TANK

11.1 Previous analysis for the Tank Design

The seismic analysis procedure is described on pages 5-10 and 5-11 of Am. 38 to O.C. FSAR. The tank and the contained liquid (assumed to be 43.5 feet high versus a tank height of 45 feet) were assumed to be rigidly coupled to the ground through the tank wall undergoing a maximum horizontal acceleration equal to that of the ground. The forces from convective water pressures were also calculated presumably from ref. 6, TID-7024 "Nuclear Reactors and Earthquakes" 1963 guidelines.

The moment and shear forces were then determined for the design of the base support structures.

11.2 Reanalysis Plan

More modern analytical techniques for analyzing vertical storage tanks will be utilized on the basis of the development of Ref's 7 to 9.

12 ANALYSIS OF BURIED EMERGENCY SERVICE WATER LINES

12.1 Previous Analysis for the Buried Water Lines

The analysis is reported in Ref. 10 by J. A. Blume Associates in November, 1967. Only the bending stresses were calculated and no calculations were made to determine axial stresses due to passage of seismic waves.

12.1 Reanalysis Plan

The reanalysis of buried pipeline will follow the guidelines given in NUREG/CR-0098, Sect. 8.3 and those given in Ref's 11 to 15. A similar summary of more modern analysis formulas is given in Bechtel Topic Report BC-TOP-4A, Rev. 3, Sept. 1974, Chapter 6.

Information is needed on the exact layout (routing) of the buried emergency service water lines, its connection details to the intake and turbine buildings. Critical areas are then to be identified and appropriate formula will be used to check pipe axial, bending stresses due to passage of seismic waves and building displacements.

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(3) Earthquake Analysis: Reactor Building, Jersey Central Reactor Project, June 18, 1965, by J. A. Blume Associates.

(4) Analytical Procedures in Soil Dynamics, UCB/CERC-78/29 Dec. 1978 College of Engineering, U.C. Berkeley by John Lysmer.

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(15)Sakurai, A., and Takahashi, T., "Dynamic Stresses of Underground Pipe Lines During Earthquakes," Proceedings of the Fourth World Conference on Earthquake Engineering, Santiago, Chile, 1969.