# MINUTES OF THE ACRS SUBCOMMITTEE ON EXTREME EXTERNAL PHENOMENA LOS ANGELES, CA NOVEMBER 15-16, 1979

The ACRS Subcommittee on Extreme External Phenomena held an open meeting on November 15-16, 1979 at the Best Western Airport Park Motel, Los Angeles, CA. The purpose of this meeting was to continue the Subcommittee review of matters related to the NRC sponsored research on extreme external phenomena. The Seismic Safety Margins Research Program (SSMRP) was of particular interest. Notice of this meeting was published in the Federal Register on October 31, 1979. A copy of this notice is included as Attachment A. A list of attendees is included as Attachment B. The schedule for the meeting is included as Attachment C. Selected portions of the handouts are included as Attachment D. A complete set of handouts have been included in the ACRS files. No written statements of requests to give oral statements were received from members of the public.

The meeting was attended by Dr. D. Okrent, Subcommittee chairman, Dr. M. Carbon, Dr. J. C. Mark, and Mr. W. Mathis, Subcommittee members; Dr. R. Savio and Dr. T. G. McCreless, ACRS Staff. The ACRS consultants present were. Dr. G. Thompson, Dr. S. Philbrick, Dr. S. Saunders, Dr. Z. Zudans, Dr. M. White, Dr. T. Pickel, Dr. M. Trifunac, and Dr. J. Maxwell.

Dr. R. Savio was the Designated Federal Employee. The meeting was opened at 8:30 am on November 15 with a short executive session. The open portion of the meeting on this day extended to 5:30 pm. A closed session was held between 5:30 pm and 6:30 pm to discuss matters pertaining to the FY 1981 budget. The subcommittee was reconvened at 8:30 am on November 16 and was adjourned at 6:00 on that day. The discussions of November 16 were held entirely in open session.

-2-

EP

INTRODUCTION - L. SHAO, NRC-RES

Dr. Shao summarized the scope of the presentations which would be given by the Lawrence Livermore Laboratory and NRC personnel over the next two days. In addition, he indicated that discussions were schedule with Dr. Newmark and Dr. Cornell of the SSMRP Senior Review Group. Mr. Richardson gave a brief review of the status of the SSMRP program and the progress that had been made since the NRC last met with the ACRS Subcommittee. Mr. Richardson indicated that a computational technique for the SSMRP risk evaluation had been selected and that a systems analysis program had been developed. The load combinations work project had been initiated and the initial subcontractor work on the event trees for the Zion Plant had been completed. He also noted that a panel of fragility experts had been formed and that they had an applied statistics Steering Group formed. Work on the best estimate/evaluation model (BEEM) had also been started.

Mr. Richardson indicated that the goals for the short-term (next six months) were to perform some best estimate analyses and to identify and quantify the uncertainties which would be associated with the SSMRP process. It was the project's intention to evaluate the state-of-the-art on soil structure interaction response models, and to establish suitable structural and mechanical response models for the SSMRP evaluation. The projects also intends to establish the statistical methods and to determine the adequacy of the existing fragility data. Mr. Richardson noted that the project's resources for dealing with any inadequacy (if it exists) in the fragility data bases are limited. Some small experimental programs may be initiated. The project, however, will depend, to the largest extent, on the use of existing data.

The intermediate goals (6-9 months) are to establish system models, to perform sensitivity studies, and to establish research priorities based upon these studies. It also intended to develop a program plan for the SSMRP Phase II work and to provide intermediate recommendations on the adequacy of the methods presently in use were raised as to the adequacy of this approach. It was suggested that it would be better to establish bounds on the uncertainties to the different inputs into the system model prior to establishing of systems model. Opinions were expressed that if the process was carried out in this fashion a better systems model and a higher degree of confidence as to the adequacy of the treatment of the phenomena could be established.

Long term goals are to estimate the conservatisms (or lack of conservatisms) in the seismic safety requirements, to develop improved seismic methodology as appropriate, and to define quantitatively the seismic contribution to the overall risks associated with the operation of nuclear reactors. Recommendations for changes to the standard review plan into regulatory guides would be developed as a result of this program. Mr. Richardson indicated that it may be difficult to quantify the seismic risk in Phase I because of the uncertainties which are expected to be associated with the evaluation process. The Subcommittee noted that this program had been ongoing since July 1978 and that the project's best estimate as to the seismic contribution to the overall risks should be made availa' le as soon as possible.

Mr. Richardson noted that there were areas within the process in which the project expected to encounter unusual difficulties. These were in the treatment of the seismic hazard, soil structure interaction, structural dampening, fragility, and design/construction errors. The Subcommittee noted that evaluation of potential system degradation would, in all likelihood, present the area of greatest difficulty in the evaluation process. It was additionally noted by the Subcommittee that the study should address the role of the reactor operator and the interaction of safety grade with non-safety grade equipment.

SEISMIC SAFETY MARGINS RESEARCH PROGRAM OVERVIEW - P. D. SMITH, LLL

Mr. Smith summarized the scope of the SSMRP program. He noted that the work was divided into three phases. In Phase I, the methodology, is to be developed which will be used to perform sensitivity studies to gain insights into the seismic safety requirements. Some sensitivity studies will be performed and estimates will be made of the probability of failures and the probability of radioactive releases over range of earthquake levels. It is intended that some recommendations for changes in the licensing process should result from Phase I. In Phase II, the methodology from Phase I will be used to estimate the conservatism of the standard review plan safety requirements. Research will be initiated to develop improved methodology if a need for this is indicated by the Phase I studies. This improved methodology will be used to refine the estimates of conservatism and to refine the seismic contribution to reactor risk. In Phase III, the improved methodology from Phase II will be used to develop recommendations as to changes in the standard review plan deterministic safety requirements.

Mr. Smith indicated that the work performed to date has identified in some areas in which the NRC methods are clearly conservative and have produced estimates of some of these conservatisms. The use of the Regulatory Guide 1.60 synthetic response spectra has been compared to the use of real-time histories, using one dimensional and three dimensional analyses. It was concluded that the Regulatory Guide 160 said that spectrum would be conservative in an overall sense. Mr. Smith stated that for model plant study the probability of damage at the SSE of 0.1g was of the order of $10^{-5}$. Increasing the SSE to 0.2g, yielded about a 10% increase in reliability. It was noted that only the resistance of the plant to the seismic event was considered in computing the reliability. Other effects which might reduce reliability such as the increased probability of failure due to thermal cycling were not inlcuded.

SSMRP PROJECT 2-SEISMIC INPUT - D. L. BERNREUTER, LLL

The objective of Project 2 was to quantify the earthquake hazard at the Zion Nuclear Power Plant site. The Zion site was used in the Lawrence Livermore studies as a plant model. The studies linking earthquake hazard model/studies were reviewed in this phase of the work. The major sources of uncertainty which were identified were the uncertainty in the knowledge of the local structure near the site, the incompleteness of the available data, and possible systematic differences which might exist when information obtained from studies of the western earthquakes is applied to earthquakes in the Eastern U. S. The special treatment of the input would cause uncertainties in the treatment of soil structure interaction.

A survey of expert opinions will be used to help evaluate the uncertainties in the process. The members on this panel are listed on page 1 of Attachment D.

A correlation describing the earthquake hazard at the site has been developed and a description of the method used is given on page 2 of Attachment D. It is noted that the model intermixes data obtained from a few earthquakes from the tectonic region containing the Zion site, and correlations obtained from intermixing measurement made in the Western and Eastern United States.

In attempt to address these problems as well as the overall relationship between the earthquake source parameters and ground motion, the project will attempt to model the basic earthquake mechanics. The most ambitious of these models will account for dynamic and static stress drop, the length and width of the rupture, the rupture velocity, the depth of focus, and the structures surrounding the break. Site correction factors are obtained through SHAKE type analysis, from data obtained from measurements at similar sites, from computer models, and from data obtained in the underground nuclear tests. LLL is currently reviewing the results of their expert opinion survey. A sampling of the results is given on page 3 of Attachment D.

SSMRP PROJECT 7 - SYSTEMS ANALYSIS COMPUTATIONAL PROCEDURE - G. WELLS, LLL

Mr. Wells described the computational procedure used in their systems analysis code (SEISIM). The procedure is intended to provide a flexible computational procedure capable of estimating the relative importance of the various contributions to reactor seismic safety. The key elements to the computational approach are outlined on page 4 of Attachment D.

The treatment of the transfer function/dynamic analysis in seismic was a major decision point in setting up this computational procedure. Two methods were considered: (1) to use transfer functions as input to SEISIM and to perform a dynamic analysis in SEISIM and (2) to use response input to SEISIM and not to perform any dynamic analysis within SEISIM. Values and disadvantages to both approaches are discussed on pages 5-10 of Attachment D. The response approach was selected over the transfer function approach. In making this decision, a great deal of weight was given to the capability of the response function approach to handle non-linear analysis. The overview of the SEISIM calculational procedure is given on pages 11-16 of Attachment D.

SSMRP PROJECT 7 - SYSTEMS ANALYSIS OUTPUT MODEL AND SENSITIVITY ANALYSIS - L. GEORGE, LLL

Mr. George discussed the output model and sensitivity analysis segments of the systems analysis procedure. The sensitivity of the various accident sequences to the input parameters will be obtained by perturbing the input valves of about the nominal valves in obtaining sensitivity relationship. It was noted that this technique does not provide a basis for extrapolation very far beyond the range in which the calculations performed and that the process was somewhat time consuming and expensive. The results from the sensitivity will be used to establish priorities for the SSMRP Phase II work.

SMRP PROJECT 3-5 OVERVIEW OF THE RESPONSE COMPUTATIONS - . JOHNSON, LLL

Mr. Johnson gave an overview of the calculations of the response factors which are input into the SEISIM code. Mr. Johnson noted that in the work performed to date, all dynamic analysis was of the linear type. Non-linear behavior will be treated in future calculations. Time history analysis has and will be used to maximum extent. This allows the inclusion of the major sources of uncertainty directed in the calculations rather than masking it by the use of other methods.

The programs being developed will perform calculations which will obtain responses from free field time histories. Soil structure interaction, structural response, and subsystem response will be calculated. Effective uncertainty will be treated by generating random variations in time histories, soil structure interaction parameters, structural response, and subsystem response. The methodology will be applied to the Zion studies but will not be unique to this particular application and will be applicable to a general class of plants. The code will include the capability of using the CLASSI-type analysis for the soil structure interaction and major structural response. The code will also have the capability of modeling the structures and supporting soil in three dimensions and representing the soil by horizontal layers of viscoelastic materials. It is expected that in this work comparisons will be made between CLASSI, FLUSH, and non-linear soil structures interaction analysis techniques. The first set of systems selected for analysis using these techniques are the auxiliary feedwater, service water, residual heat removal, safety injection, component cooling water, containment spray, and main steam and main feedwater systems.

DELETION

SSMRP - PROJECT 6 - COMPONENT AND STRUCTURAL FRAGILITIES - R. G. DONG, LLL

Mr. Dong summarized the scope of the work dealing with component and structural fragilities. A work plan is summarized on page 17 of Attachment D. The work is directed towards gathering fragility data and analyzing it in a systematic fashion. Expert opinion will be utilized to provide what is expected to be a highly judgmental evaluation. A panel of experts has been assembled and the members of this panel are listed on page 18 of Attachment D. Some preliminary work has been done on the application of the Zion plant. A summary of some of this work is given on pages 19-25 of Attachment D. An increased data base of fragility related information is being developed. The NRC's data gathering system, literature searches, military and foreign data banks, and information obtained from participants in the expert opinion pool have been utilized.

Earthquake damage surveillance reports are also being analyzed. The events to be studied are the Japan, June 1978 earthquake, the San Fernando, February 9, 1971 earthquake, the Santa Barbara, August 21, 1978 earthquake, the Alaska, March 27, 1964 earthquake, and the Managua, Nicaragua 1972 earthquake. Examples of the type of information being reviewed are given on pages 26-27 of Attachment D.

About 10 percent of the SSMRP effort will be devoted to this activity. The resources of the SSMRP work will be such as to severely limit any experimental work. It was noted by the Subcommittee that the LLL work should at the minimum able to evaluate the body of information that is available and to provide limits on its usefulness and guidance to where the data base might be improved by future work.

PRESENTATION BY THE SENIOR REVIEW GROUP - W. NEWMARK AND D. CORNELL

Dr. Newmark and Dr. Cornell addressed the Subcommittee and gave their views on various aspects of the SSMRP. Dr. Newmark stated that it was important that SSMRP address the adequacy of the degree of redundancy used in critical systems and the effectiveness of the application of the redundancy to the particular challenge. He also noted that in the SSMRP we would have to deal with uncertainties which could be understood by utilizing calculation techniques and others which could only be dealt with by measurement and empirical methods. Dr. Newmark felt that many of the empirical techniques should be examined and replaced, when possible, by more rational techniques. In cases where fragility cannot be well quantified, Dr. Newmark recommended qualification to sufficiently high levels to assure equipment integrity. Dr. Newmark urged a systematic search for weakness in the design procedure. He also urged more attention to the design margins required by seismic considerations relative to the normal operating loads and endorsed the consideration of an earthquake beyond the design basis and operator response as the Japanese have done. He also urged the use of as much in situ testing and qualification and large scale testing as is practical.

Dr. Cornell indicated that he believed that the SSMRP was making very satisfactory progress. Dr. Cornell believes that the ability of the project to utilize expert opinion is becoming of increasing importance and that the project is utilizing the correct approach. He indicated that pressures for the redirection of the Phase 1 work should be kept to a minimum.

SUBJECTIVE INPUTS FOR THE SSMRP - R. MENSING, LLL

Mr. Mensing summarized LLL's effort to make a systematic selection use of expert opinion. The approach taken is summarized on pages 28-30 of Attachment D. The process appeared to place a good deal of emphasis on consensus and peer review.

SSMRP PROJECT 7 - SYSTEMS ANALYSIS EVENT TREES/FAULT TREE ANALYSIS G.E. CUMMINGS, LLL

Mr. Cummings discussed the event/fault tree development for the Zion analysis. Initiating events were selected and event and fault trees developed. The event and fault trees will be input to the computational procedures in SEISM. Event trees selected are summarized on pages 31-32 of Attachment D. These event trees include pressure vessel rupture and a range of LOCA, and ATWS transients. On the basis of the preliminary analysi the systems are judged to contribute the most to the overall risk from the Zion plant subjected to a seismic event were auxiliary feedwater, emergency AC power system, service water systems, ECCS, residual heat removal system, containment spray injection system, containment fan cooling system, and the component cooling water system. The basis/specific failures leading to the conclusions summarized on pages 33 and 34 of Attachment D. Mr. Cummings indicated that dependencies between fault trees/event trees are accounted for when identified and judged to be important. Bounding studies (such as, assuming that redundant components failed simultaneously) would be performed in the future.

SSMRP SOIL STRUCTURE INTERACTION - J. JOHNSON, LLL

Mr. Johnson indicated that objective of this part of the program was to develop transfer function relating to the free field motion to basemat and in structure response utilizing the state-of-the-art analysis methods. The adequacy of the linear and non-linear and substructure and direct method approaches would be assessed. The establishment of benchmark and linkup in test programs will be part of this work. Sensitivity studies will be performed using the Zion site model. The effect of soil configuration and materials properties, the effect of structure interactions, and the effect of wave passage and direction will be among the topics addressed. State-of-the-art description of special variations of ground motion will be used to assess the effect of wave passage on structural response.

SSMRP STRUCTURAL BUILDING RESPONSE - J. JOHNSON, LLL

Mr. Johnson indicated that the state-of-the-art analysis techniques for major structural response is being reviewed. The modeling of structures and dynamic response methods will be evaluated and the sources of uncertainty will be identified and an estimation made of their effects on the end product. The work should lead to recommendation of appropriate techniques for modeling of structures to be used in the Phase 1 work. Sargent and Lundy and EBASCO Services have been awarded contracts for performing this work. The effects of dampening and impact between structures will be included in this evaluation. The Zion plant will be used as the model and the reactor containment shell (prestressed concrete), the reactor building internal structure (reinforced concrete), and the auxiliary-fuel-turbine building complex (reinforced concrete/steel frame) will be analyzed.

SSMRP MODELS FOR STRUCTURAL RESPONSE COMPUTATIONS AND SENSITIVITY STUDIES - T. Y. LO, LLL

Mr. Lo summarized the scope of this work and indicated that the reactor building, the crib house, and the auxiliary-fuel-turbine building complex at the Zion plant would be used in this study. Modeling considerations and structural sites would be evaluated in the sensitivity analysis. Samples of the models used for the various building/structures are given on pages 35-37 of Attachment D. The beam-type/lump-mass model will be used for the containment structure and the finite element approach will be used to develop the dynamic analysis models for the internal structure of the containment and auxiliary-fuel-turbine building complex.

SSMRP - SUBSYSTEM RESPONSE - J. JOHNSON, LLL

Mr. Johnson indicated that the scope of this work was to develop response input parameters for the equipment within the main structures which could be treated as being decoupled from the main structures. This work will include a review of the existing methods and assessment of their adequacy for use in the SSMRP analysis. ADAC and NSC/QUQDREX have been awarded contracts for the review of the current state-of-the-art. The work is nearing completion and draft reports have been received and are currently being reviewed by LLL. The methodology will be applied to the Zion plant and fragilities will be assigned to the subsystems which are consistent with the response to which these subsytems are subjected. The pilot study will treat the main feedwater piping between the containment and the steam generator and will include a detailed modeling of the pipe support system and will treat non-linear behavior of the support system. Fragility parameters will be allowed to vary with expectation level.

SSMRP PROJECT 5 SUBSYSTEM RESPONSE - SAFETY RELATED PIPING SYSTEMS-T. Y. CHUANG, LLL

Mr. Chuang indicated that the Zion analysis auxiliary feedwater, service water, residual heat removal, safety injection, coolant component water, containment spray. main steam and main feedwater, and reactor coolant piping had been selected for analysis. The sensitivity of the results to model and fragility input will be evaluated.

For additional details, a complete transcript of the meeting is available in the Nuclear Regulatory Commission Public Document Room, 1717 H Street, N. W., Washington, D. C. 20555, or from Ace Federal Report, Inc., 444 North Capitol Street, N. W., Washington, D. C.

ments and discussions. Written
ments may be submitted before or
each session.
ditional information concerning
meeting may be obtained through
ommittee's Executive Director, Mr.
W. Connolly, whose mailing
ess is: National Advisory
mittee on Oceans and Atmosphere,
Whitehaven Street NW. (Suite 438,
Building No. 1), Washington, D.C.,
5. The telephone number is (202)
-8418.

ted: October 29, 1979.

W. Connolly,

*cutive Director.*

[FR Doc. 79-33886 Filed 10-30-79; 8:45 am]

BILLING CODE 3410-12-M

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## TIONAL COMMISSION ON THE TERNATIONAL YEAR OF THE ILD, 1979

### eeting

ENCY: National Commission on the ternational Year of the Child, 1979.

TION: Notice of meeting.

UMMARY: This notice announces the orthcoming meeting of the National ommission on the International Year of Child, 1979. The meeting is being to discuss substantive issues, ..ding to the development of ecommendations to be included in the eport to the President. This document is ntended to notify the general public of ts opportunity to attend:

DATES: November 12–13, 1979.

ADDRESS: Wingspread Conference Center, Racine, Wisconsin.

FOR FURTHER INFORMATION CONTACT: James B. Roberts, Executive Officer, 600 "E" Street, N.W., Suite 505, Washington, D.C. 20471, (202) 376–2435.

Since conference facilities are in great demand, we must know the number of general public who plan to attend in order to allocate adequate space for the meeting. Notice of persons from the general public who plan to attend must be in writing and be received by the Executive Officer of the National Commission (at the above address) by *close of business November 5, 1979.* Such notice of intent to attend should include the address and telephone number of the person.

**James B. Roberts,**

*Executive Officer, National Commission on the International Year of the Child.*

[FR Doc. 79-33881 Filed 10-30-79; 8:45 am]

BILLING CODE 6820-40-M

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## NUCLEAR REGULATORY COMMISSION

### Advisory Committee on Reactor Safeguards, Subcommittee on Extreme External Phenomena; Meeting

The ACRS Subcommittee on Extreme External Phenomena will hold a meeting on November 15–16, 1979 at the Best Western Airport Park Hotel, 600 Avenue of Champions, Inglewood, CA to discuss the NRC-sponsored General Reactor Safety Research Programs with the emphasis on the Seismic Safety Margins Research Program. Notice of this meeting was published October 18, 1979 (44 FR 60178).

In accordance with the procedures outlined in the Federal Register on October 1, 1979 (44 FR 56408), oral or written statements may be presented by members of the public, recordings will be permitted only during those portions of the meeting when a transcript is being kept, and questions may be asked only by members of the Subcommittee, its consultants, and Staff. Persons desiring to make oral statements should notify the Designated Federal Employee as far in advance as practicable so that appropriate arrangements can be made to allow the necessary time during the meeting for such statements.

The agenda for subject meeting shall be as follows: *Thursday and Friday, November 15 and 16, 1979, 8:30 a.m. until the conclusion of business each day.*

The Subcommittee may meet in Executive Session, with any of its consultants who may be present, to explore and exchange their preliminary opinions regarding matters which should be considered during the meeting and to formulate a report and recommendations to the full Committee.

At the conclusion of the Executive Session, the Subcommittee will hear presentations by and hold discussions with representatives of the NRC Staff, and their consultants, pertinent to the above topics.

The Subcommittee will be considering portions of the budget and program of the Office of Nuclear Regulatory Research. Since the NRC budget proposals are now part of the President's budget—not yet submitted to Congress—public disclosure of budgetary information is not permitted. See OMB Circular #A–10. The ACRS, however, is required by Section 5 of the 1978 NRC Authorization Act to review the NRC research program and budget and report the results of the review to Congress. in order to perform this review, the ACRS must be able to engage in frank discussion with members of the NRC Staff. For the reason just stated, a discussion would not be possible if held in public session.

I have determined, therefore, that it is necessary to close portions of this meeting to prevent frustration of this aspect of the ACRS' statutory responsibilities, in accordance with Exemption 9(b) to the Government in the Sunshine Act (552b(c)(9)(B)).

Further information regarding topics to be discussed, whether the meeting has been cancelled or rescheduled, the Chairman's ruling on requests for the opportunity to present oral statements and the time allotted therefore can be obtained by a prepaid telephone call to the Designated Federal Employee for this meeting, Dr. Richard P. Savio (telephone 202/634–3267) between 8:15 a.m. and 5:00 p.m., EST.

Dated: October 25, 1979.

**John C. Hoyle,**

*Advisory Committee Management Officer.*

[FR Doc. 79-33870 Filed 10-30-79; 8:45 am]

BILLING CODE 7590-01-M

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### Financial Protection Requirements and Indemnity Agreements; Determination of Extraordinary Nuclear Occurrence

The Commission recently extended the period for its "extraordinary nuclear occurrence" (ENO) determination in regard to the accident at Three Mile Island until January 31, 1980. The period is hereby extended to February 15, 1980.

Dated at Washington, D.C. this 24th day of October, 1979.

For the Commission.

**Samuel J. Chilk,**

*Secretary of the Commission.*

[FR Doc. 79-33888 Filed 10-30-79; 8:45 am]

BILLING CODE 7590-01-M

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[Docket No. 50-155]

### Consumers Power Co.; Issuance of Amendment to Facility Operating License

The U.S. Nuclear Regulatory Commission (the Commission) has issued Amendment No. 29 to Facility Operating License No. DPR-6, issued to Consumers Power Company (the licensee), which revised Technical Specifications for operation of the Big Rock Point Plant (the facility) located in Charlevoix County, Michigan. The amendment is effective as of its date of issuance.

The amendment modifies the technical Specifications to incorporate a procedure for reactor startup in the event neutron source strength is below that which provides the currently

ATTACHMENT A

# ATTENDEES LIST

## ACRS Members

D. Okrent, Chairman
M. Carbon
J. C. Mark
W. Mathis

## ACRS Staff

R. Savio, Designated Federal Employee
T. G. McCreless

## ACRS Consultants

G. Thompson
S. Philbrick
S. Saunders
Z. Zudans
M. White
T. Pickel
M. Trifunac
J. Maxwell

## Lawrence Livermore Labs

D. Arthur
C. K. Chou
J. J. Johnson
G. L. Goudreau
T. Y. Lo
T. Y. Chuang
B. Benda
F. M. Gilman
R. G. Dong
G. E. Cummings
L. George
J. Wells
D. Bernreuter
R. W. Mensing
F. J. Tokarz
R. J. Wasley

## NRC Staff

L. L. Beratan, OSD
S. Brocoom, OSD
F. Schauer, DSS
J. Knight, DSS
G. Bachgi, RES
C. P. Tan, DSS
J. Richardson, RES
L. Shao → J. Harbour

## Miscellaneous

J. Malthan, Agbabian Associates
S. Simonian, J. H. Wiggins
T. K. Hasselman, J. H. Wiggins

ATTACHMENT B

SCHEDULE FOR NOVEMBER 15-16, 1979

EXTREME EXTERNAL PHENOMENA SUBCOMMITTEE
LOS ANGELES, CA

THURSDAY, NOVEMBER 15, 1979

| | | |
|---|---|---|
| 8:30 - 8:45 | Executive Session | 15 min |
| 8:45 - 9:00 | Introduction - J. Richardson | 15 min |
| 9:00 - 9:30 | Overview - P. Smith | 30 min |
| 9:30 - 10:30 | NRC Goals, Short Term and Long Term J. Richardson | 1 hour |
| 10:30 - 11:30 | Relative Importance of the Various Contributions to Seismic Risk | 1 hour |
| 11:30 - 12:00 | Project I, Plant/Site Selection - C. Chou | 30 min |
| 12:00 - 1:00 | Lunch | |
| 1:00 - 2:30 | Project II, Seismic Input - D. Bernreuter | 1½ hours |
| 2:30 - 4:00 | Project III, Soil Structure/Interaction J. Johnson | 1½ hours |
| 4:00 - 5:30 | Project IV, Structural Building Response T. Y. Lo | 1½ hours |
| 5:30 - 7:00 | Status of GRSR Programs ((CLOSED SESSION, Exemption 9) - L. Shao | 1½ hours |

FRIDAY, NOVEMBER 16, 1979

| | | |
|---|---|---|
| 8:30 - 9:00 | Executive Session | 30 min |
| 9:00 - 11:00 | Discussions with the Senior Review Group | 2 hours |
| 11: 00 - 12:30 | Project V, Subsystem Response - J. Johnson | 1½ hours |
| 12:30 - 1:30 | Lunch | |
| 1:30 - 2:30 | Project VI- Fragility - R. Dong | 1 hour |
| 2:30 - 5:00 | System Analysis - G. Cummings | 2½ hours |
| 5:00 - 5:30 | Summary - P/ Smith & J. Richardson | 30 min |
| 5:30 - 6:30 | Follow-up from January SSMRP meeting and concluding discussion with ACRS Subcommittee and ACRS Summary | 1 hour |

ATTACHMENT C

ATTACHMENT D

OUR FIRST PANEL DEALING WITH THE OVERALL HAZARD MODEL FOR CENTRAL AND NORTHEASTERN US HAS THE FOLLOWING MEMBERS:

PROFESSOR GILBERT A. BOLLINGER
DR. EDWARD CHIBURIS
DR. MICHAEL A. CHINNERY
PROFESSOR ROBERT B. HERRMANN
DR. RICHARD J. HOLT
PROFESSOR OTTO NUTTLI
PROFESSOR PAUL W. POMEROY
PROFESSOR RONALD STREET
PROFESSOR MARC SBAR
PROFESSOR NAFI TOKSOZ

LAWRENCE LIVERMORE LABORATORY

TO DEVELOP A RELATION BETWEEN EARTHQUAKE MAGNITUDE AND DISTANCE WE FOUND FROM THE DATA FROM THE 1968 EARTHQUAKE IN CENTRAL ILLINOIS:

$$I_s - I_o = 0.4 - 0.005\, r - 0.7 \log r$$

$I_s$ => intensity at the site, $I_o$ => at the origin

WE COMBINED THIS WITH A RELATION BETWEEN ACCELERATION, SITE INTENSITY AND DISTANCE BASED ON WESTERN US DATA:

$$\ln a = 1.8 + 0.6\, I_s - 0.3 \ln r$$

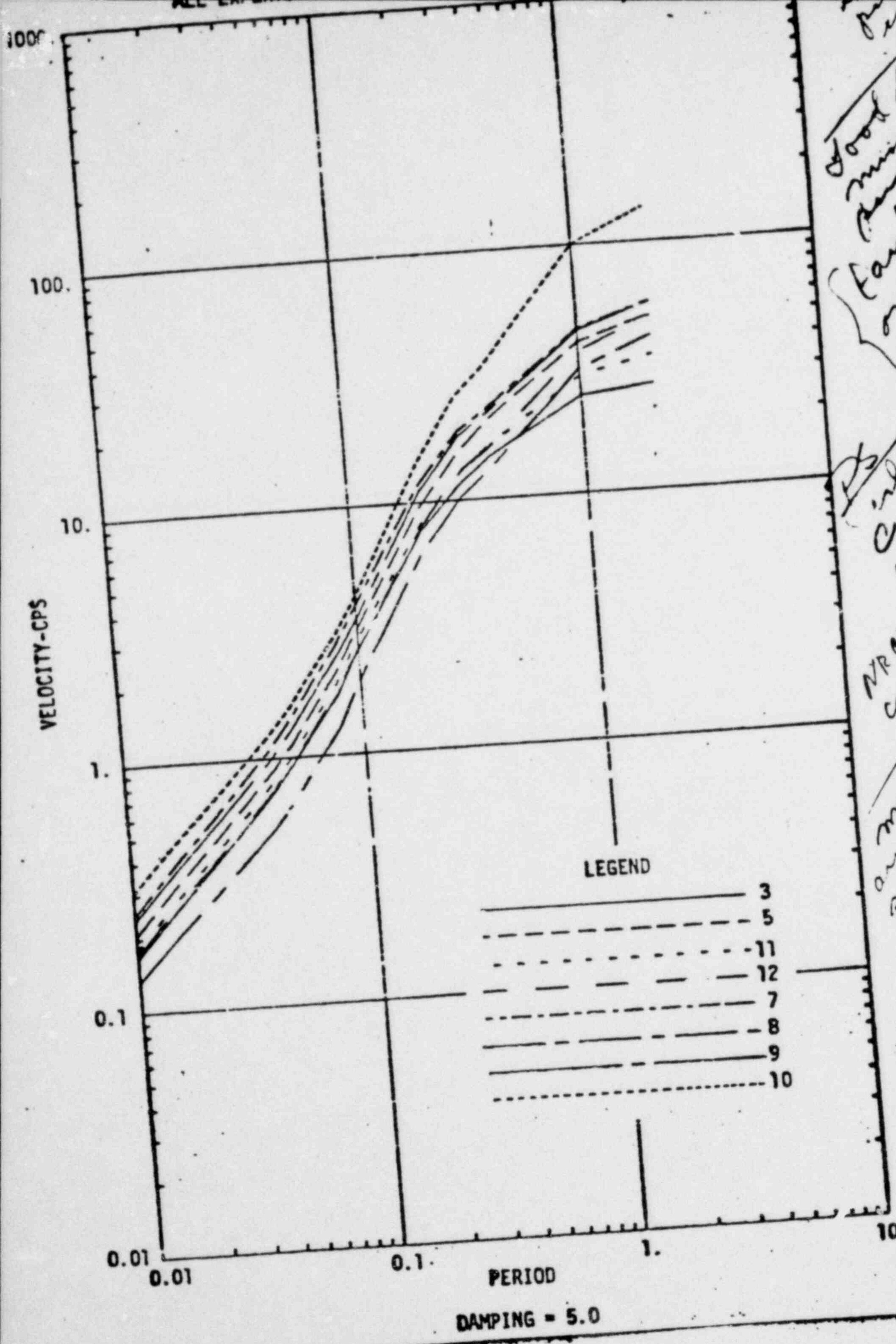
AND FROM NUTTLI'S WORK IN THE CENTRAL US

$$\ln I_o = 2\, m_b - 3.5$$

TO GET

$$\ln a = 0.009 + 1.15\, m_b - 0.003\, r - 0.5 \ln r$$

LAWRENCE LIVERMORE LABORATORY
University of California


VELOCITY-CPS
1000.
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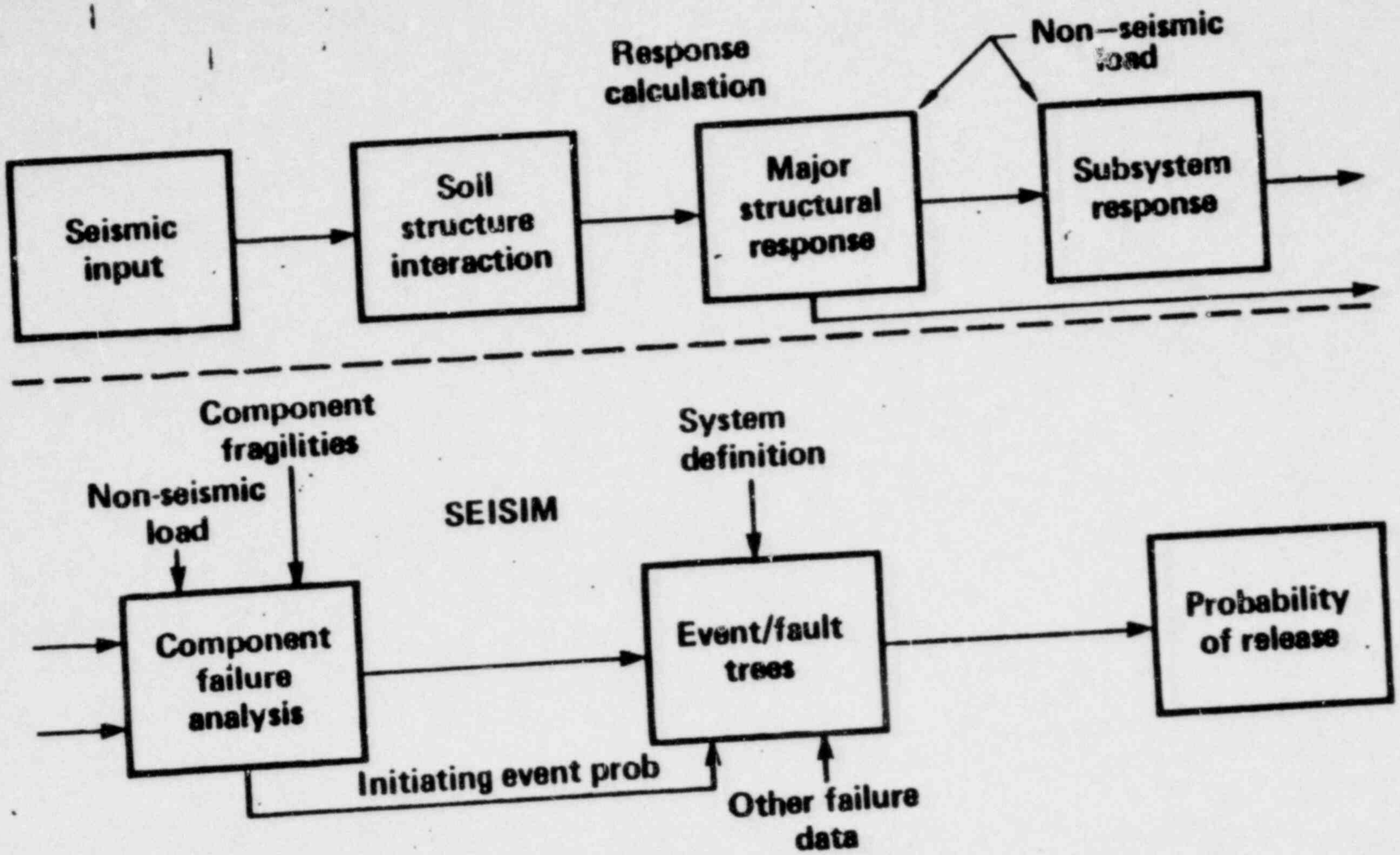
DAMPING = 5.0

4

## KEY ELEMENTS OF THE COMPUTATIONAL APPROACH

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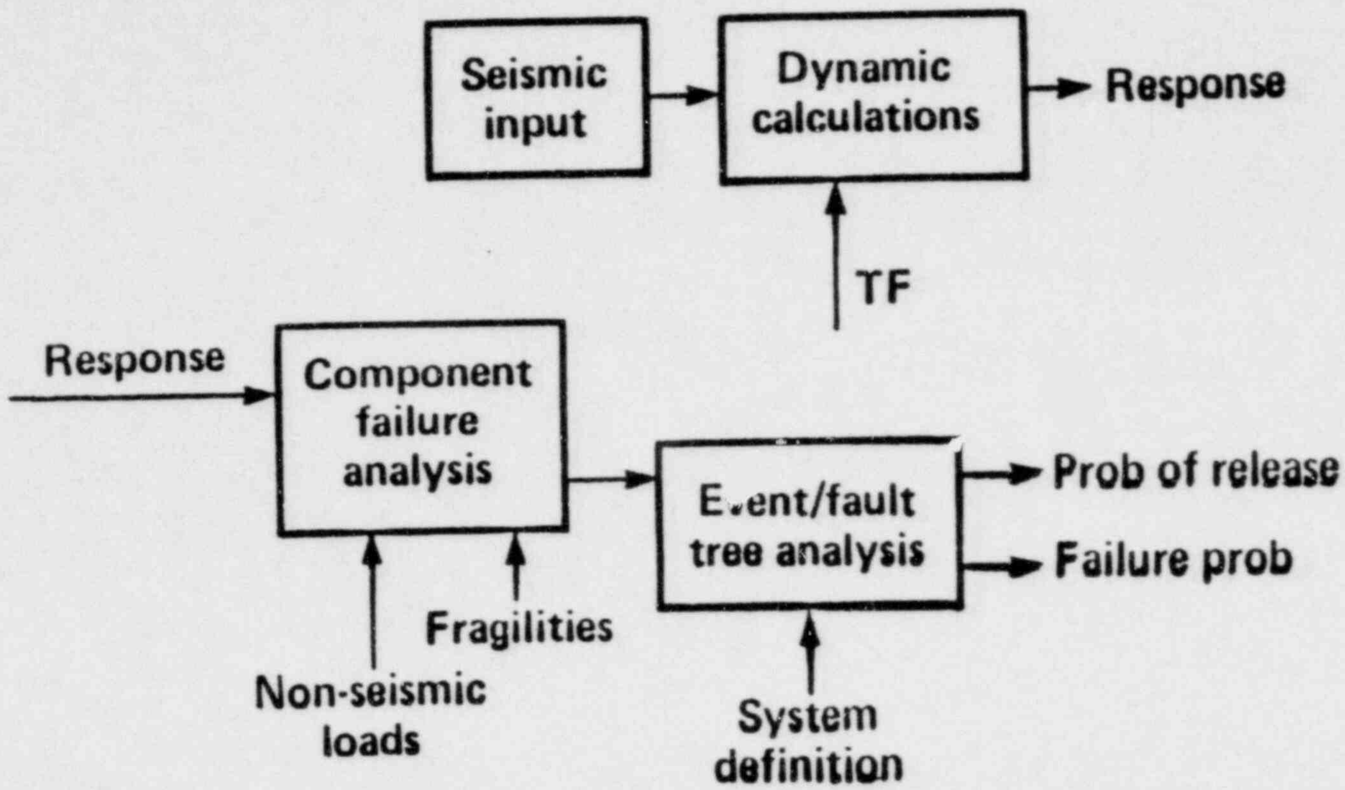
## INPUT TRANSFER FUNCTIONS

Carry out dynamic analysis within overall computational procedure

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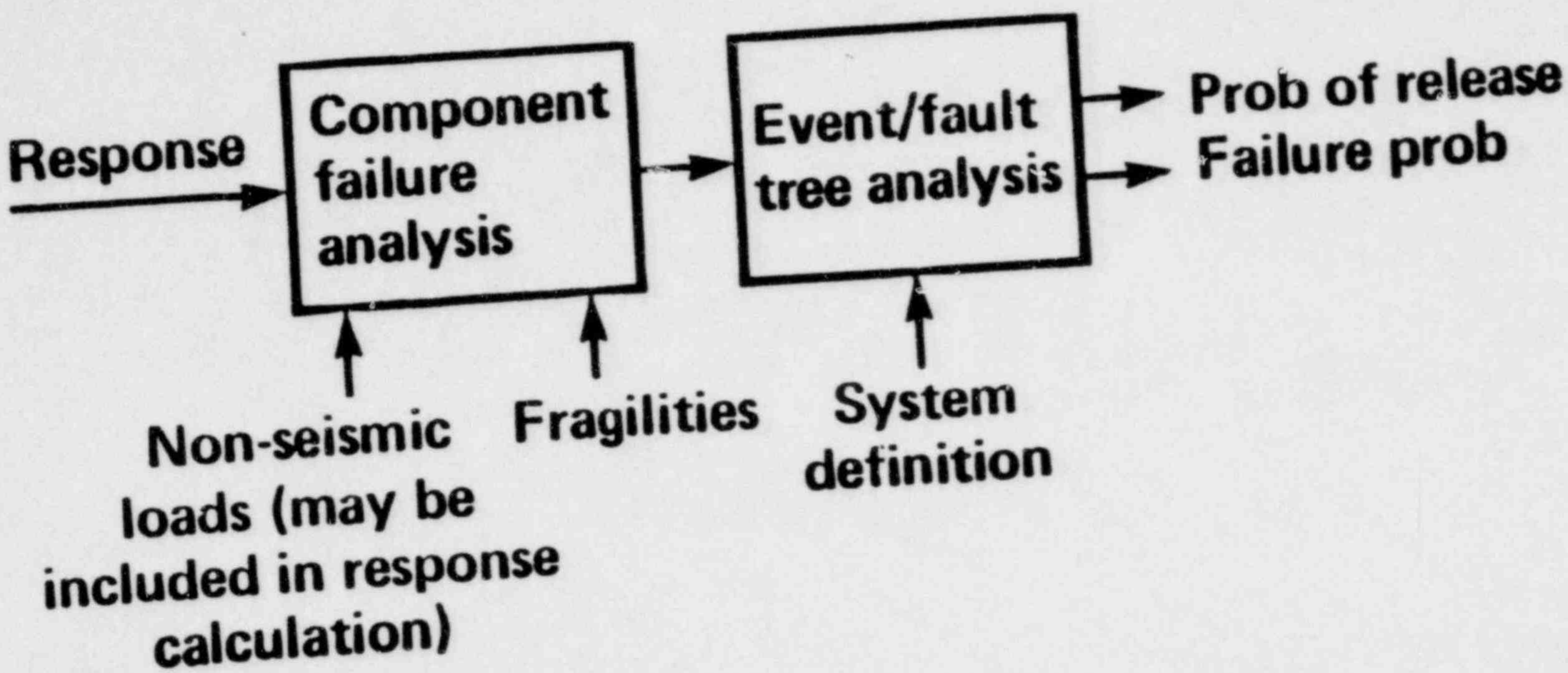
## INPUT RESPONSES

No dynamic analysis carried out within overall computational procedure



# TRANSFER FUNCTIONS INPUT TO SEISIM DYNAMIC ANALYSIS IN SEISIM

Advantages

- Tracking random and modeling uncertainties may be easier
- Transfer functions can be developed in parallel
- Sensitivity studies may be simpler since all inputs and outputs are contained in SEISIM

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# TRANSFER FUNCTIONS INPUT TO SEISIM DYNAMIC ANALYSIS IN SEISIM (Cont'd)

Disadvantages

- Form of transfer functions unclear so that development of SEISIM may be hindered
- Level of dynamic analysis (simple or complex) cannot be varied from response point to response point independent of running times of SEISIM
- Transfer functions imply linear, elastic analysis. Therefore SEISIM would not be applicable to subsequent phases of SSMRP.
- More coordination may be required between projects. Systems analysts would have to become very familiar with various dynamic response calculations.

# RESPONSES INPUT TO SEISIM
# NO DYNAMIC ANALYSIS IN SEISIM

**Advantages**

- SEISIM can be developed independent of type of seismic analysis and would be more general
- Partial results of seismic analysis would be available prior to completion of SEISIM. These would be valuable to NRR.
- Can do detailed or simple dynamic analysis independent of SEISIM
- More program effort will be expended on calculations familiar to industry and more program results will be of direct use to NRR

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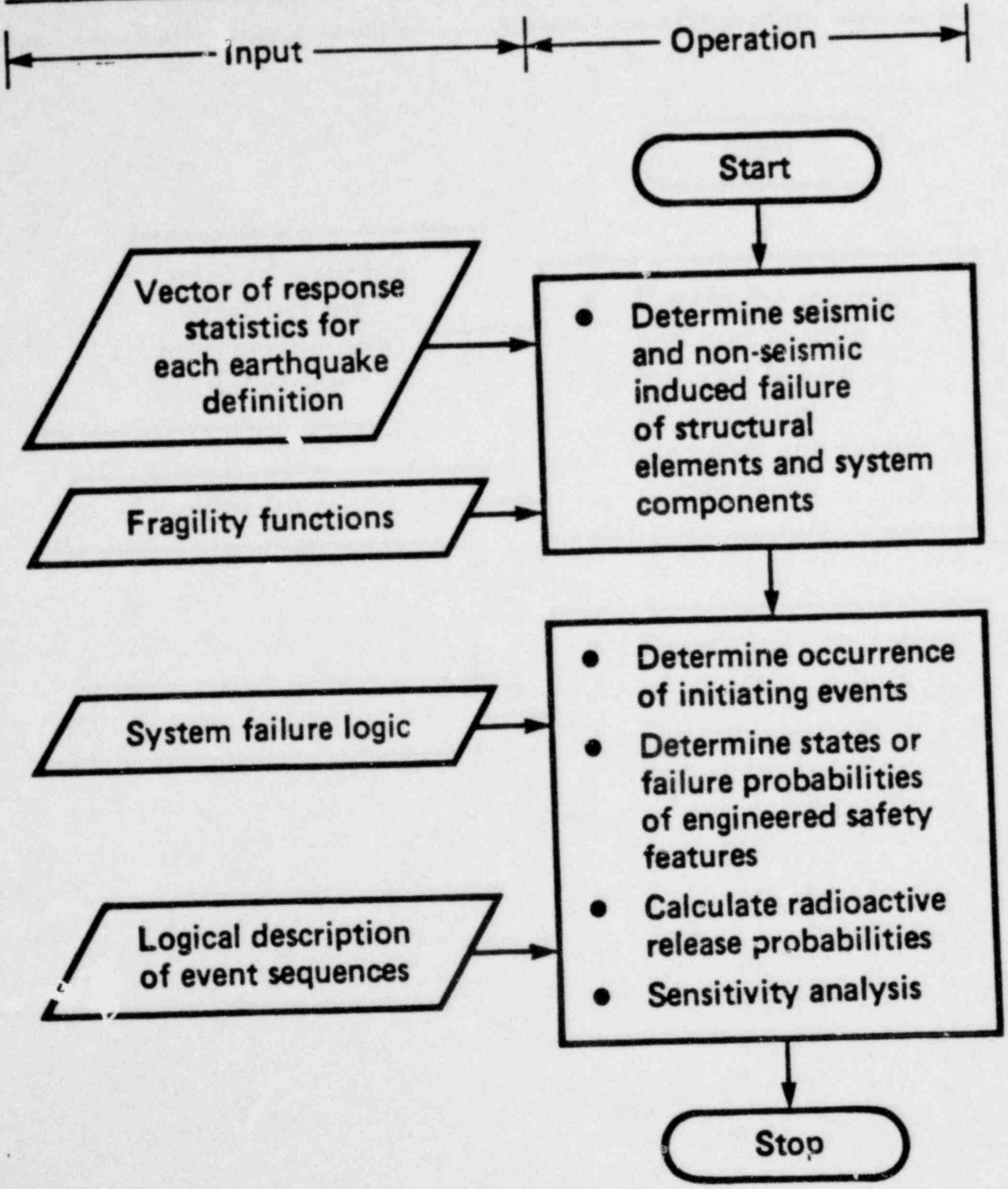
## RESPONSES INPUT TO SEISIM
## NO DYNAMIC ANALYSIS IN SEISIM (Cont'd)

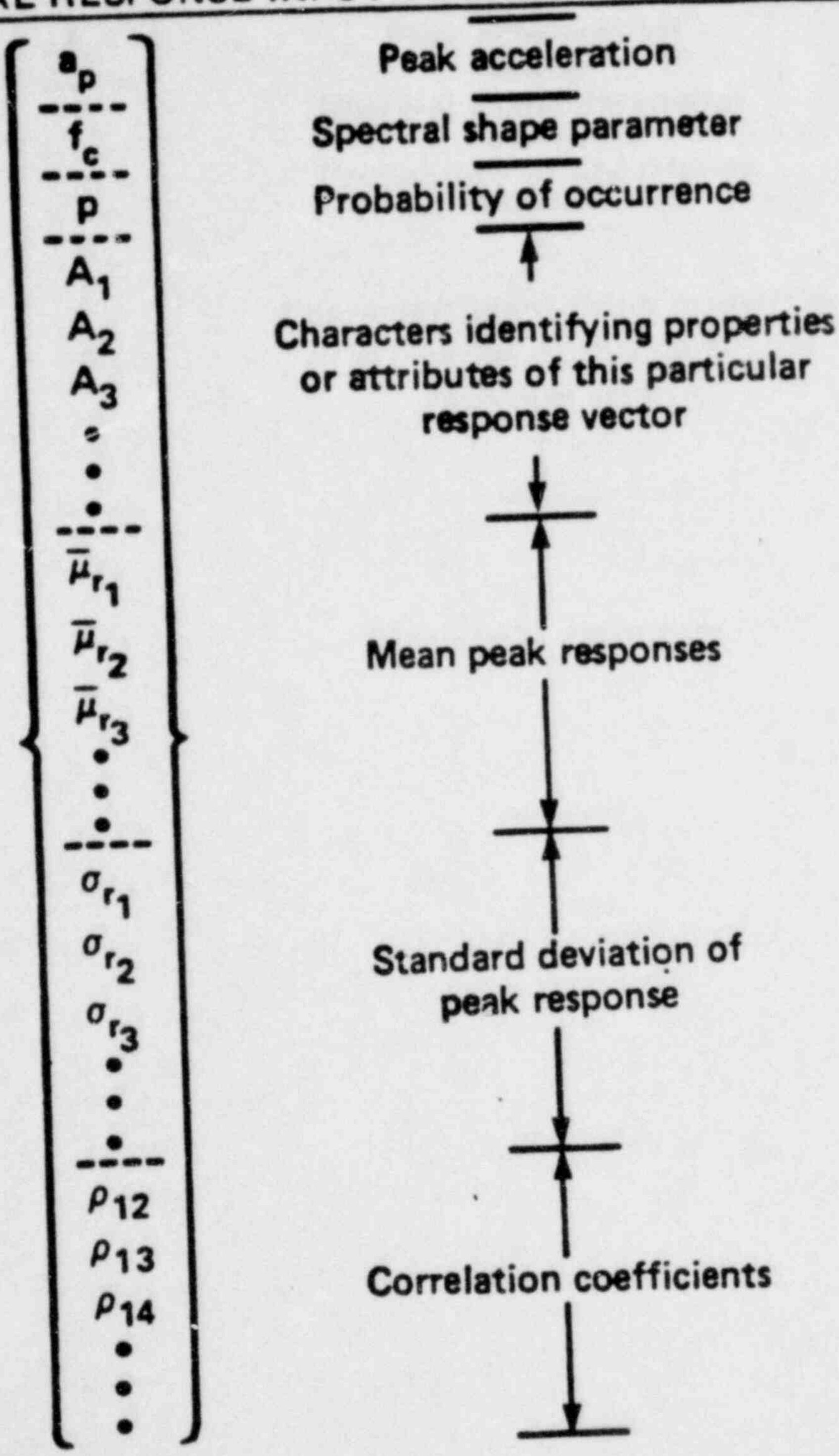
Disadvantages

- Handling of modeling uncertainty, except in fragilities and seismic input may be more difficult
- Correlation relationships and input data identification are needed with response inputs
- A number of response data sets will be needed to study the effect of modeling and input variable uncertainties
- Calculations have to be carried out sequentially

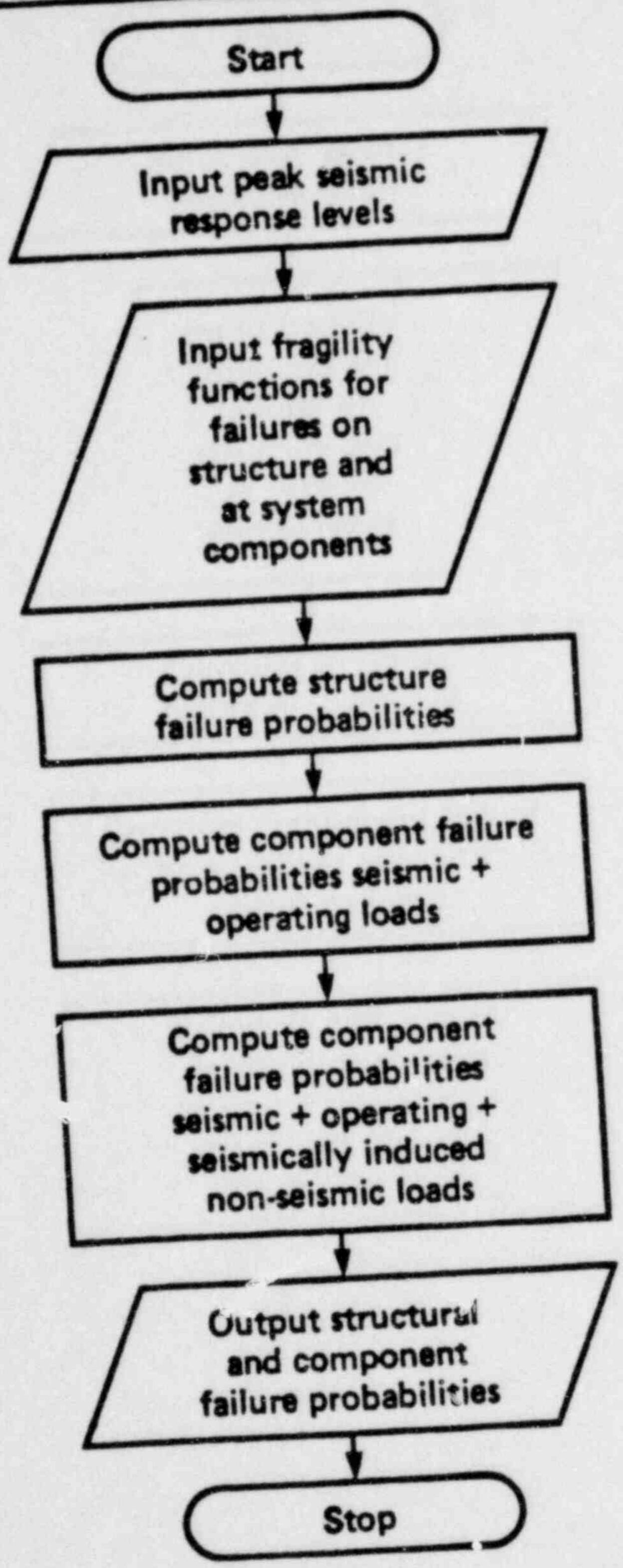
# SEISIM OVERVIEW



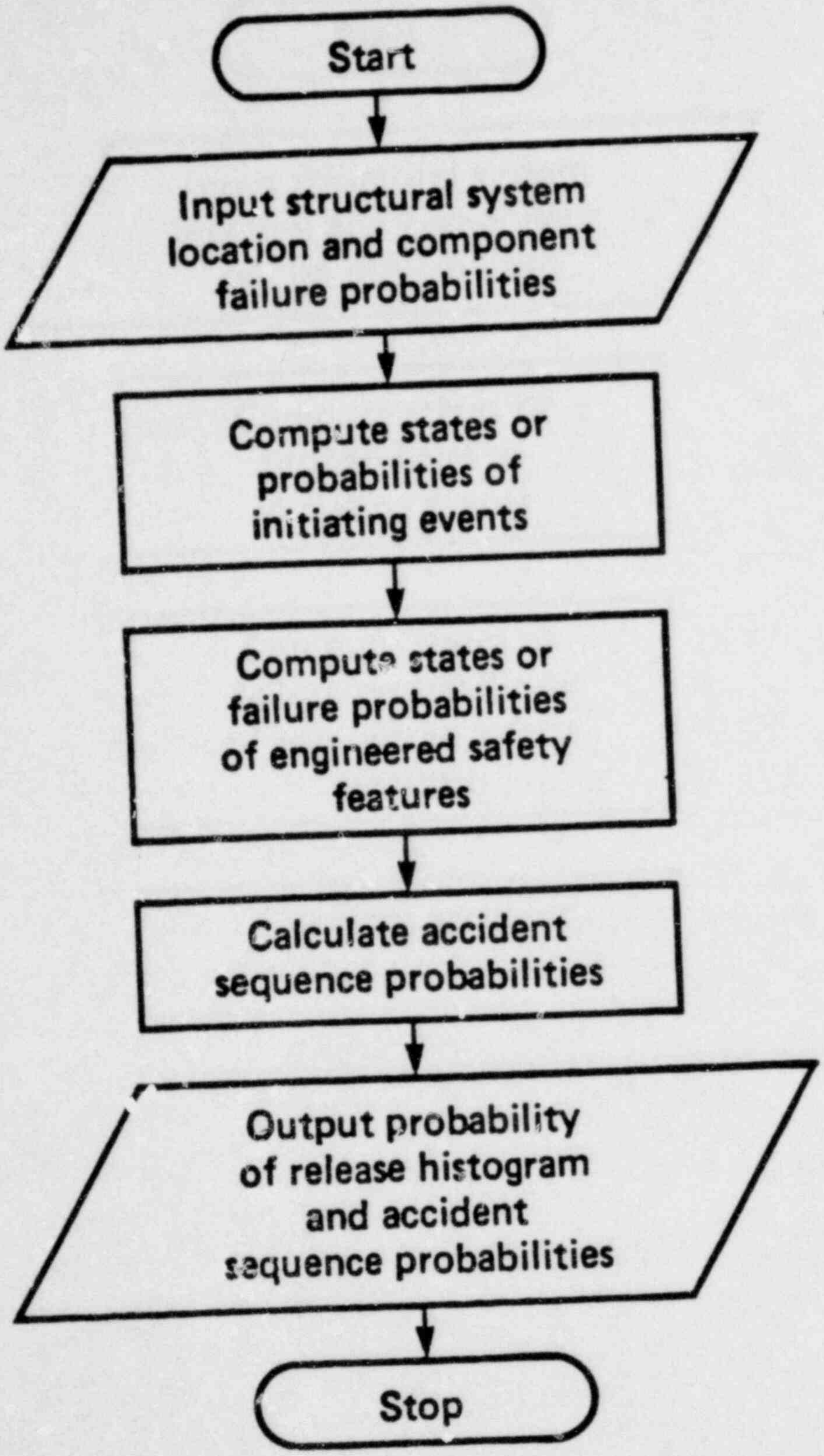
## TYPICAL RESPONSE INPUT VECTOR



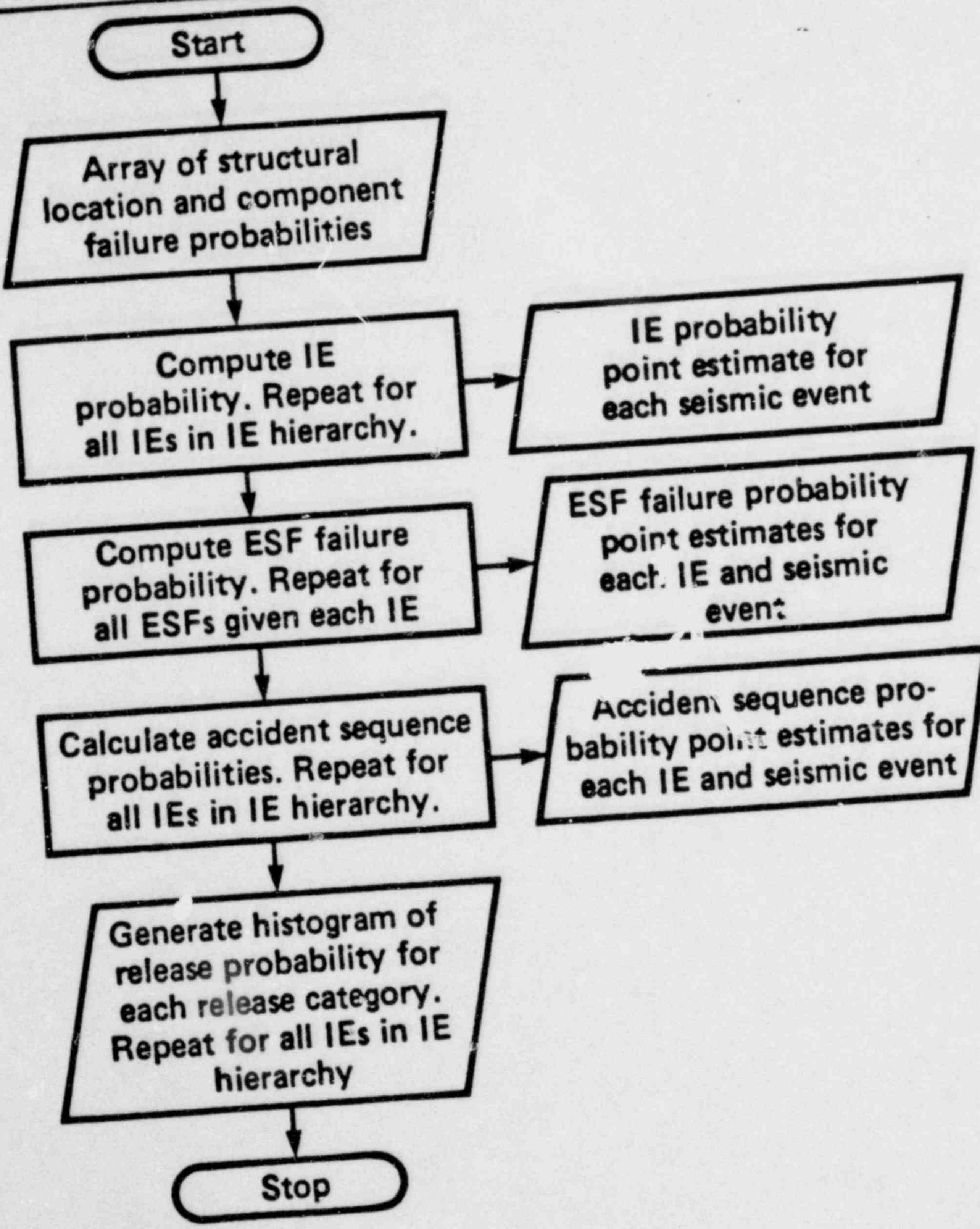
# COMPONENT/STRUCTURAL FAILURE COMPUTATIONAL OVERVIEW



## ACCIDENT SEQUENCE COMPUTATION OVERVIEW



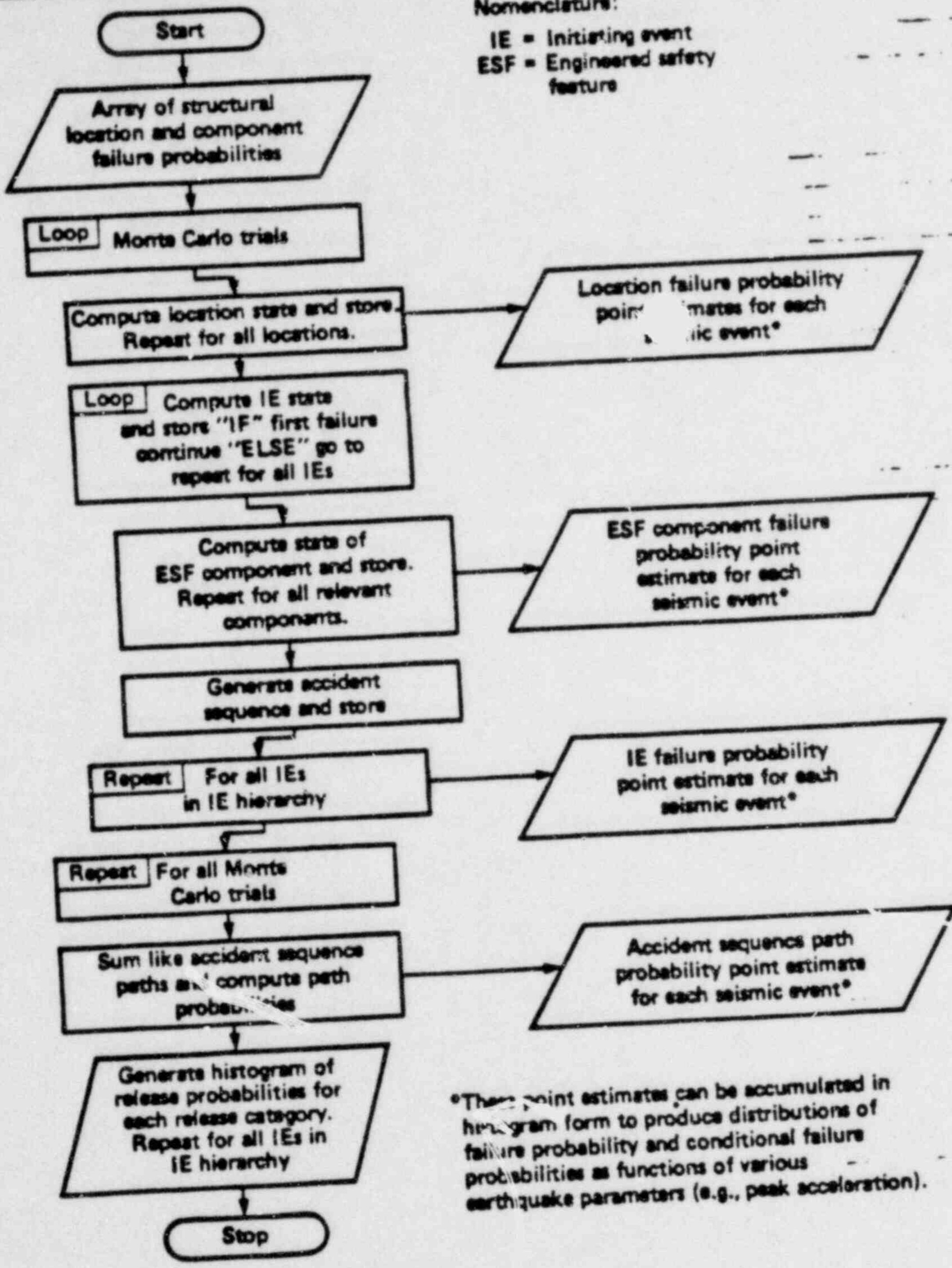
## SIMPLIFIED ACCIDENT SEQUENCE COMPUTATIONS (PROBABILISTIC MODEL)



# SIMPLIFIED ACCIDENT SEQUENCE COMPUTATIONS (BINARY MODEL)

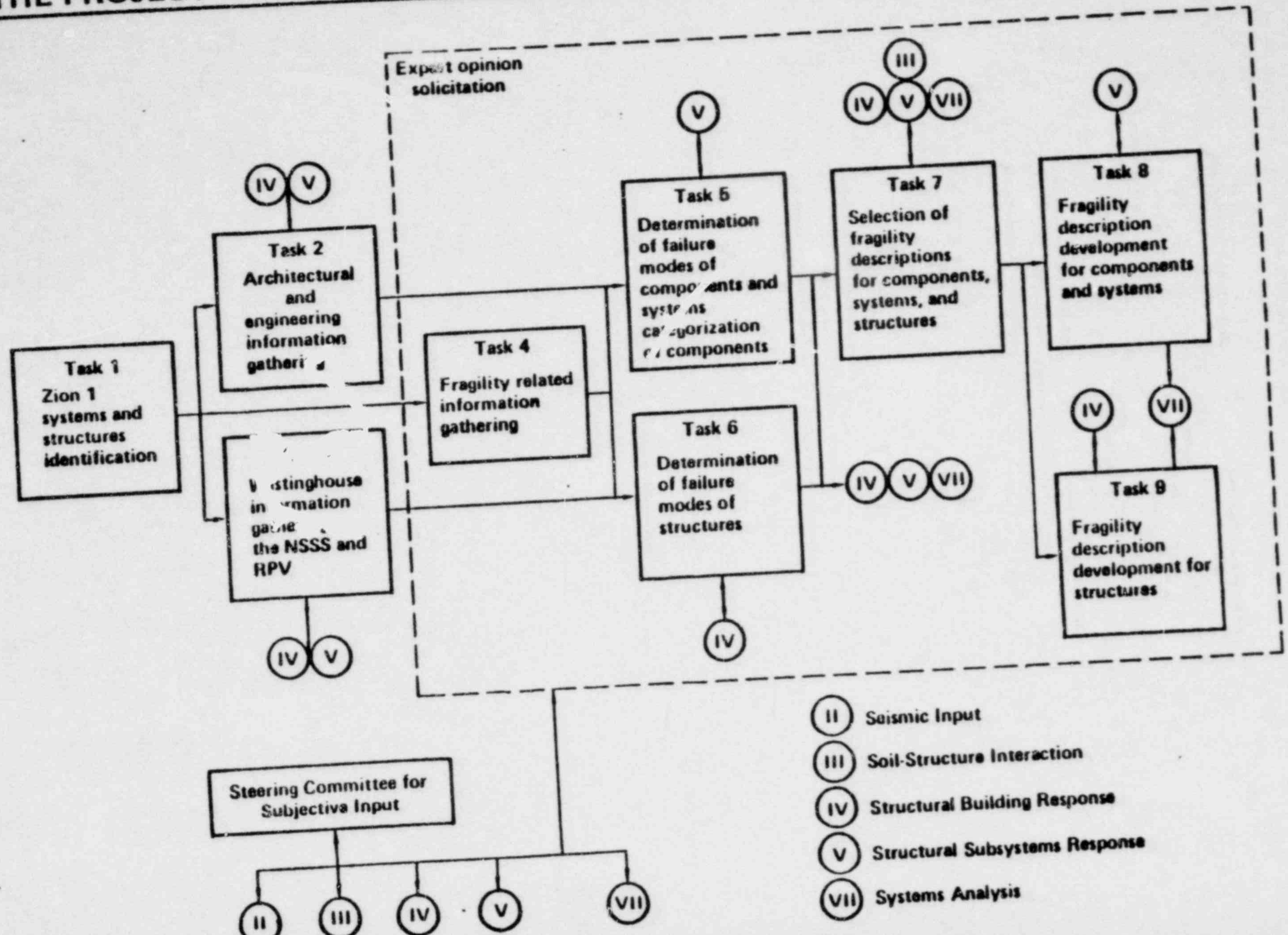
Nomenclature:

IE = Initiating event
ESF = Engineered safety feature




*These point estimates can be accumulated in histogram form to produce distributions of failure probability and conditional failure probabilities as functions of various earthquake parameters (e.g., peak acceleration).

# THE PROJECT CONSISTS OF NINE TASKS

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18.

# WE HAVE ESTABLISHED A PANEL TO ASSIST IN THE DETERMINATION OF FRAGILITIES

| | | |
|---|---|---|
| Spencer H. Bush | : | Battelle Pacific Northwest Lab. |
| Robert P. Kennedy | : | Engineering Decision Analysis Corp. |
| George D. Shipway | : | Wyle Laboratories |
| John D. Stevenson | : | Woodward-Clyde Consultants |
| Jerrell M. Thomas | : | Failure Analysis Associates |
| Peter P. Zemanick | : | Westinghouse Electric Corp. |

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# PRELIMINARY FAILURE MODES FOR COMPONENTS

| Generic component or subsystem | Location in plant | Function | Governing * code or standard | Seismic qualification method | Size/shape of equipment | Primary failure mode | Secondary failure mode | Tertiary failure mode |
|---|---|---|---|---|---|---|---|---|
| Reactor core assembly including core supports, fuel and control rod assemblies | Containment building | Heat power source | NSSS criteria<br>ASME sec. III for support, NSSS criteria for fuel and control rods | Analysis plus test of fuel assemblies | Cylindrical assembly of fuel rods and control rods surrounded by core support structure | Crushing of fuel pin grid spacers. L | Binding of control rod drives d | Core support structure fasteners σ |
| Reactor coolant system vessels (RPV,SG and pressurizer) | Containment building | Containment of coolant | ASME sec. III | Analysis | Large, vertical, cylindrical, heavy wall | Nozzle/pipe weld in presence of flaw L | Vessel supports L | Nozzle with flaws d |
| Primary coolant system piping | Containment | Coolant boundary | ANSI B31.1<br>ASME sec. III | Analysis | Continuous 3D beam | Component supports L | Butt welds in presence of flaws L | Elbow collapse L |
| Large diameter piping, 8 in. and greater | Containment, auxiliary and turbine bldg. | Coolant boundary | ANSI B31.1<br>ASME sec. III | Analysis | Continuous 3D beam | Component supports L | Butt welds in presence of flaws L | Elbow collapse L |
| Intermediate diameter piping 2 1/2 - 8 in. | Containment and auxiliary building | Coolant boundary | ANSI B31.1<br>ASME sec. III | Analysis | Continuous 3D beam | Fabricated branch connections L | Component supports (welded to piping) L | Butt welds in presence of flaws L |
| Small diameter piping, 2 in. and less | Containment and auxiliary building | Coolant boundary | ANSI B31.1<br>ASME sec. III | Analysis | Continuous 3D beam | Socket welds L | Fabricated branch connections L | Component supports (welded to piping) L |

* Upper box: Assumed applicable to Zion
Lower box: Current codes

**Preliminary Opinion on Fragility Parameters**

- σ Stress
- L Load
- a Acceleration
- d Displacement

# PRELIMINARY FAILURE MODES FOR COMPONENTS

| Generic component or subsystem | Location in plant | Function | Governing code or standard | Seismic qualification method | Size/shape of equipment | Primary failure mode | Secondary failure mode | Tertiary failure mode |
|---|---|---|---|---|---|---|---|---|
| DC power (batteries and static chargers) | Auxiliary building | Emergency DC power source | None<br>IEEE 323 and 344 | Test | Rack-mounted units | Rack/building interface L | Electrical connection d | Battery or charger failure a |
| Switch gear | Auxiliary building | Emergency AC power control to ESF systems | None<br>IEEE 323 and 344 | Analysis and test | Transformers, relays, breakers, etc., mounted in racks or consoles | Equipment supports L | Transformers a | Miscellaneous electrical equipment failure a |
| Miscellaneous motor control centers, instrument racks, H and V and AC controls, aux. relay cabinets, breaker panels, local instruments | All buildings except crib house | Elect. control and instrumentation for ESF systems | None<br>IEEE 323 and 344 | Analysis and test | Primarily rack mounted electrical equipment | Failure of electrical function a | Rack failure (local or at rack/building interface) L | Electrical connections a & d |
| Invertors | Auxiliary building | AC-DC power conversion | None<br>IEEE 323 and 344 | Test | Compact rigid | Internal supports L | External support L | Electrical connections a & d |
| Cable trays | All buildings | Support of power and instrument cables | AISC<br>AISC | Analysis | Beam-like structures | Local supports L | Miscellaneous steel L | Cable damage due to excessive motion d |
| Ducting | Containment, auxiliary and turbine bldgs | Channel vital ventilation and cooling air | AISC<br>AISC | Analysis | Beam-like structures with thin walls | Joint leakage d | Support failure L | Joint severance d |

# PRELIMINARY FAILURE MODES FOR COMPONENTS

| Generic component or subsystem | Location in plant | Function | Governing code or standard | Seismic qualification method | Size/shape of equipment | Primary failure mode | Secondary failure mode | Tertiary failure mode |
|---|---|---|---|---|---|---|---|---|
| Vertical diesel driven centrifugal pumps | Crib house | Fire pump | ASME sec. VIII<br>ASME sec. III | Analysis | Veritcal, cylindrical, slender | Distortion induced vibration a or d | Diesel ancillary equipment a | Nozzle/pipe joint L |
| Horizontal motor, turbine and diesel driven pumps and compressors all sizes | All buildings | Pump coolant and compressed air | ASME sec. VIII<br>ASME section III and VIII | Analysis | Compact, heavy | Supports<br>Flexible L<br>Rigid a | Distortion induced vibrations a or d | Nozzle/pipe joint L |
| Large motor operated valves | Containment, auxillary and turbine bldgs. | Flow isolation and control | USAS B16.9<br>ASME sec. III | Analysis | Rigid body with extended operator | Binding from yoke/stem deformation a or d | Operator failure a | Pipe/valve nozzle L |
| Large relief and check valves > 8 in. | Containment, auxillary and turbine bldgs. | Flow isolation and over-pressure protection | USAS B16.9<br>ASME sec. III | Analysis | Rigid body with or without operator | Operator failure if power actuated a | Binding due to permanent deformation a or d | Pipe/valve nozzle L |
| Miscellaneous small valves, < 8 in. | Containment, auxillary and turbine bldgs. | Flow isolation, control and over-pressure protection | USAS B16.9<br>ASME sec. III | Analysis and test | Rigid body with various operators | Binding of MOV a or d | Operator failure, MOV most critical a | Pneumatic and hydraulic control system failures a or d |
| Large cooling fans, motor generators and electric motors | Containment, auxillary and turbine bldgs. | Rotary power drive, DC power generation | None<br>IEEE 323 and 344 | Test and analysis | Compact and rigid | Distortion and vibration with eventual winding damage a or d | Supports L | Bearing seizure L |
| Emergency AC power units (diesel generators) | Auxillary building | Generate Ac power | None<br>IEEE 323 and 344 | Test and analysis | Skid-mounted assembly of rigid and flexible components | Ancillary equip. (brackets, fuel lines elect. connec., etc.) a or d | Day tank component supports L | Distortion, misalignment, vibration and ultimate alternator failure a or d |

# PRELIMINARY FAILURE MODES FOR COMPONENTS

| Generic component or subsystem | Location in plant | Function | Governing code or standard | Seismic qualification method | Size/shape of equipment | Primary failure mode | Secondary failure mode | Tertiary failure mode |
|---|---|---|---|---|---|---|---|---|
| Large vertical storage vessels with formed heads | Containment and auxiliary building | Coolant pressure boundary | ASME sec. VIII<br>ASME sec. III | Analysis | Vertical, cylindrical, thin wall | Tank supports L | Nonintegral reinforced or nonreinforced nozzles L | Pipe/nozzle joint L |
| Large vertical flat bottom storage tanks | Outdoors by turbine building | Water storage | ASME sec. VIII<br>ASME sec. III | Analysis | Cylindrical, flat bottom, thin wall | Hold down bolt failure induces tank wall failure L | Roof damage L | Nozzle failure at nonintegral or nonreinforced nozzle L |
| Large horizontal vessels | Auxiliary building | Coolant pressure boundry, diesel oil storage | ASME sec. VIII<br>ASME sec. III | Analysis | Horizontal, cylindrical, thin wall, low pressure | Tank supports L | Nonintegral reinforced or nonreinforced nozzels L | Pipe/nozzle joint L |
| Refueling water storage tanks | Between auxiliary and containment bldgs. | Coolant storage | ACI-318<br>ACI-349-76 | Analysis | Triangular shaped, concrete wall, steel lined | Bottom-side wall intersection L | Intersection of sides L | Nozzles L |
| Small-medium vessels and heat exchangers | Auxiliary building | Coolant pressure boundary | ASME sec. VIII<br>ASME sec. III | Analysis | Horizontal and vertical cylindrical | Tank supports<br>Flexible L<br>Ridgid a | Nonintegral reinforced or nonreinforced nozzles L | Pipe/nozzle joint L |
| Buried pipe | Crib house to turbine and auxilary bldg. | Pressure boundary | ANSI B31.1<br>ASME sec. III | Analysis | 3D beam-like structure | Pipe branch connections L | Pipe/equipment interface L | Pipe butt welds at reducer L |
| Main coolant pumps | Containment building | Primary collant pump | ASME sec. VIII<br>ASME sec. III | Analysis | Vertical, cylindrical, slender | Cooling or lubrication system a | Pump supports L | Distortion induced vibration a or d |
| Large vertical centrifugal pumps with motor drive | Crib house | Service water and fire pumps | ASME sec. VIII<br>ASME sec. III | Analysis | Vertical, cylindrical, slender | Distortion induced vibration a or d | Drive motor a | Nozzle/pipe joint L |

## ELEVEN FAILURE MODES ARE IDENTIFIED FOR THE TURBINE–AUXILIARY BUILDING

1. Failure of turbine building roof bracing system (element, gusset plate, or bolt failure) – transfer of inertial loads to out-of-plane wall
2. Yielding or buckling of columns between the turbine and auxiliary building – collapse of roof
3. Loss of the turbine building vertical braced frame systems (element, gusset plate, or bolt failure) – column bucking and collapse
4. Column anchor bolt failure under combined shear and tension – loss of lateral load transfer capacity
5. Auxiliary building concrete slab roof diaphragm failure (shear failure of the slab or failure of shear transfer to collector beams)
6. Auxiliary building roof truss failure (shear failure of bolts, member, or gusset plate failure)
7. Failure of composite wall between turbine and auxiliary building (failure of shear studs or crushing of concrete) – transfer of load to braced frame
8. Auxiliary building shear wall failures (shear failure across a construction joint, shear failure across a plastic hinge joint, flexural failure) – transfer of load to braced frame
9. Auxiliary building vertical braced frame failure (shear failure of bolts, gusset plate failure, element frailure) – loss of lateral support and eventual collapse
10. Plastic hinge of roof girder – partial collapse of roof
11. Out-of-plane bending and collapse of one foot thick walls around control room and other critical equipment

## TWELVE FAILURE MODES ARE IDENTIFIED FOR THE CONTAINMENT BUILDING

1. Shear and diagonal tension cracks in the containment vessel
2. Crushing and spalling of concrete in the vessel wall
3. Yielding and failure of the reinforcing steel and loss of prestress
4. Gross shear failure due to loss of dowel action and aggregate interlock
5. Axial shear failure along buttress plates
6. Buckling of vessel wall
7. Shear failure in the foundation slab due to uplift
8. Failure of a tendon gallery wall and collapse of gallery
9. Shear failure of concrete internal structure anchor bolts at liner interface
10. Shear failure of internal structure ring and shield walls
11. Failure of the concrete structure enclosing the pressurizer
12. Failure resulting from impact of adjacent structures or equipment

# NINE FAILURE MODES ARE IDENTIFIED FOR THE INTAKE STRUCTURE (CRIB HOUSE)

1. Longitudinal guide wall failure from shear failure, flexural failure, or concrete crushing from out-of-plane response
2. Operating floor diaphragm failure from shear failure of slab initiating from cut-outs or failure of shear transfer to walls
3. Service water pump enclosure failure from loss of roof diaphragm due to shear failure at roof-shear wall junction or initiating from cut-outs — flexural failure and collapse of out-of-plane walls
4. Failure of north and south shear walls — loss of lateral support — flexural failure and collapse of out-of-plane walls
5. Failure of concrete walls at the intake end of the structure due to out-of-plane bending — partial flow blockage
6. Failure of concrete strut in open area from combined axial compression and biaxial bending — loss of north and south foundation walls from excess lateral soil pressure
7. Tensile, shear, or buckling failure of underground pipes due to relative motion of structure
8. Failure of masonry block walls due to rigid body rocking and collapse
9. Collapse of roof top trolley frame due to lack of E-W lateral bracing

# EARTHQUAKE DAMAGE SURVEILLANCE REPORTS

| Component | Event | Design basis ZPA and specs | Experience: Maximum ZPA (freefield) | Experience: Max Sa | Experience: Failure percent | Experience: Failure modes | Comments |
|---|---|---|---|---|---|---|---|
| DC power (batteries, chargers, etc.) | a) San Fernando Feb. 9, 1971 | UBC (0.2g, static) | 0.35g | ? | Significant | Rack & interface failure | Telephone company SCE substation etc. (1) |
| | b) Santa Barbara | UBC | 0.4g | ? | Significant | Racks | UCSB (4) |
| Switch gear | a) San Fernando Feb. 9, 1971 | UBC | ~0.35g | | Significant | Racks, interface | Telephone co. SCE substation, etc. (1) |
| | b) Santa Barbara | UBC | ~0.4g | | | Racks, interface | Substation equipment |
| | c) Miyagi-Ken-Oki | ? | 0.25g | | | Racks, interface | Substation equipment |
| Control centers wall mounted (3[illegible] x 18" x 24") | a) San Fernando | UBC | ~0.35g | | 0 | | Telephone co. SCE substation |
| | b) Santa Barbara | | ~0.4g | | 0 | | UCSB buildings |
| Floor mounted (36" x 18" x 24") | | | | | | | |
| Emergency diesel generators | | | | | | | |
| Substation equipment | a) San Fernando | 0.2g static | 0.15 to 0.4g | ? | Several types and modes | Anchors, racks relays, tripping, etc. | Several substation failures |
| | b) Miyagi-Ken-Oki | ? | 0.25g | | Several types and modes | Anchors, racks relays, tripping, etc. | Several substations failures |

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# EARTHQUAKE DAMAGE SURVEILLANCE REPORTS

| Component | Event | Design basis ZPA and specs | Maximum ZPA (freefield) | Experience | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | | Max Sa | Failure percent | Failure modes | |
| Reactor internals, control rod drive mechanism | a) San Fernando Earthquake of Feb. 9, 1971 | 1) UBC, Zone 3 | 0.01 to 0.2g | | 0 | | 1) Research and test reactors (1) |
| | | 2) 0.5g, dynamic tests and analysis; requalified to 0.67g | 0.01 to 0.02g | ~0.1g | 0 | | 2) SONGS-1 (2, 3) |
| | b) Miyagi-Ken-Oki Earthquake of June 12, 1978 | 1) 0.5g dynamic analysis (Japan) | 0.2g | | | | 1) Fukushima Plants (4) total of 6, (5 oper and 1 construction) |
| NSSS equipment - Reactor Vessel (RV), Steam Generator (SG), Reactor Coolant Pump (Pu) Pressurizer (Pr) | a) San Fernando Earthquake of Feb. 9, 1971 | 1) 0.5g dynamic analysis requalified to 0.67g (1975) | 0.01 to 0.02g | (0.13g spikes) ~0.2g | 0 | | 1) SONGS-1 (3, 5) |
| | b) Miyagi-Ken-Oki | 1) 0.5g, dynamic analysis | ~0.2g | | 0 | | 1) Fukushima Plants (4) |
| Primary coolant and ECCS piping | a) San Fernando, Feb. 9, 1971 | 1) Primary loop - 0.5g dynamic analysis; ECCS - 0.5g pseudo-dynamic | 0.01 to 0.02g | 0.1g | 0 | | 1) SONGS-1 (3, 4, 5) |
| | b) Miyagi-Ken-Oki | 1) 0.5g, dynamic | ~0.2g | | 0 | | 1) Fukushima |

# APPROACH TAKEN BY THE SSMRP WITH REGARD TO THE USE OF SUBJECTIVE INPUTS

1. JOINT WITH NRC, COMMITTEE FORMED TO GUIDE THE SSMRP IN USE OF SUBJECTIVE INPUTS (SCSI)
   - RECOMMENDATIONS TO THE SSMRP

2. USE THE SERVICES OF SEVERAL CONSULTANTS TO ASSIST THE SSMRP IN ELICITATION, EVALUATION, USE AND VALIDATION OF EXPERT OPINIONS

3. INVESTIGATE ALTERNATIVE APPROACHES TO ELICITING, EVALUATING, WEIGHTING, AGGREGATING, ETC. EXPERT OPINIONS

4. ENCOURAGE FURTHER RESEARCH

# STEERING COMMITTEE ON SUBJECTIVE INPUTS FOR THE SSMRP

MEMBERS: R. MENSING, LLL, CHAIRMAN
D. CHUNG, LLL, SECRETARY
P. SMITH, LLL
L. ABRAMSON, NRC
R. BRAZEE, NRC
J. BURNS, NRC
B. VESELEY, NRC

CONSULTANTS: DR. T. FINE, CORNELL UNIVERSITY
DR. R. KEENEY, WOODWARD-CLYDE
DR. P. MORRIS, APPLIED DECISION ANALYSIS
DR. A. MURPHY, OREGON STATE UNIVERSITY
D. RUBINSTEIN, NRC
DR. D. VENEZIANO, M.I.T.

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## Some conclusions

1. Usf of expert opinions is ^ complex issue
2. There does not seem to be any 'best' method for eliciting, evaluating, etc. of expert opinions.
3. Consensus may not always be the best. Diversity of opinions should be retained.
4. Small group elicitations usually realize better quality opinions
5. A study of the sensitivity of the outputs to the methods used and to the diversity of opinions between experts is important
6. Research on the topic should continue

# MINIMUM LIST OF EVENT TREE INITIATING EVENTS RECOMMENDED FOR SSMRP ANALYSIS OF ZION

1. Reactor vessel rupture (R)
   - A vessel rupture large enough to negate the effectiveness of the ECCS systems required to prevent core melt
2. Large LOCA (A)
   - Rupture of primary coolant piping equivalent to break of a single pipe whose diameter is $> 6''$, i.e., a break of one or more primary system pipes whose total cross-sectional area is $> 28.3$ square inches
3. Medium LOCA (M)
   - Rupture of primary coolant piping equivalent to the break of a single pipe whose diameter is $\leq 6''$ but $> 3''$

## MINIMUM LIST OF EVENT TREE INITIATING EVENTS RECOMMENDED FOR SSMRP ANALYSIS OF ZION (Cont'd)

4. Small LOCA (S1)
   - Rupture of primary coolant piping equivalent to the break of a single pipe whose diameter is ≤3" but > (~) 1.5"

5. Small-small LOCA (S2)
   - Rupture of primary coolant piping equivalent to the break of a single pipe whose diameter is ≤(~) 1.5" but > 0.5"

6. Transient ($T_1$)
   - A transient with PCS event is defined as any abnormal condition in the plant which (a) requires that the plant be shut down, (b) does not directly affect the operability of the PCS, and (c) does not qualify as a LOCA or vessel rupture

7. Transient ($T_2$)
   - A transient without PCS event is defined as any abnormal condition in the plant which (a) requires that the plant be shut down, (b) causes the PCS to become inoperative, and (c) does not qualify as a LOCA or vessel rupture

# IDENTIFICATION OF ZION UNIT 1 SYSTEMS CONSIDERED LIKELY TO BE MAJOR CONTRIBUTORS TO PLANT RISK IN THE SSMRP ANALYSIS (ORDER NOT IMPORTANT)

1. Auxiliary feedwater system

   Basis: a. A 40-foot section of the line from the secondary water (condensate) storage tank appears vulnerable to failure of the turbine building. All AFWS pumps require emergency power to operate for extended time.

2. Emergency AC power (diesel generator) system

   Basis: a. The air start system on each diesel is not completely redundant. Two tanks feed into one unsupported line.

   b. There may be a possibility of the swing diesel being locked-out due to a relay race situation under certain failure conditions

   c. A steam pipe tunnel is located in the vicinity of the diesel fuel tanks

## IDENTIFICATION OF ZION UNIT 1 SYSTEMS CONSIDERED LIKELY TO BE MAJOR CONTRIBUTORS TO PLANT RISK IN THE SSMRP ANALYSIS (ORDER NOT IMPORTANT) (Cont'd)

3. Component cooling water system

   Basis: a. Many manually operated valves in the system

   b. System is generally located in one place in the auxiliary building

   c. System heat exchangers are apparently bolted directly to the floor and have no seismic restraints

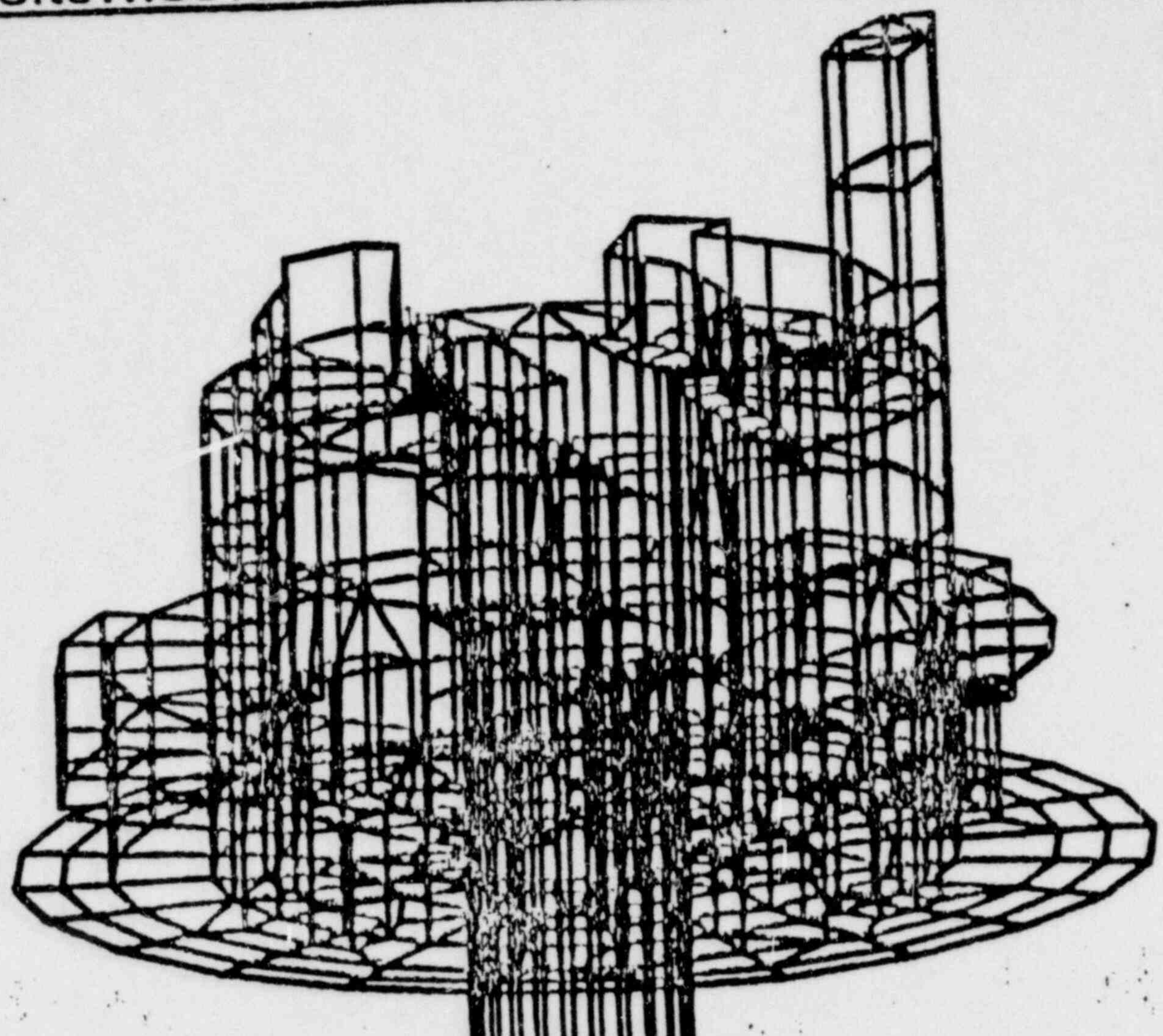
4. Service water system

   Basis: a. Common header for six service water pumps. Although the system is described as consisting of two headers with a crosstie, the crosstie is apparently normally open.

5. Containment spray injection system

   Basis: a. All three supply lines to the sparger rings in the containment dome are located with in a 90° sector (approximately) of the containment

## WE HAVE CONSTRUCTED A FEM FOR INTERNAL STRUCTURE



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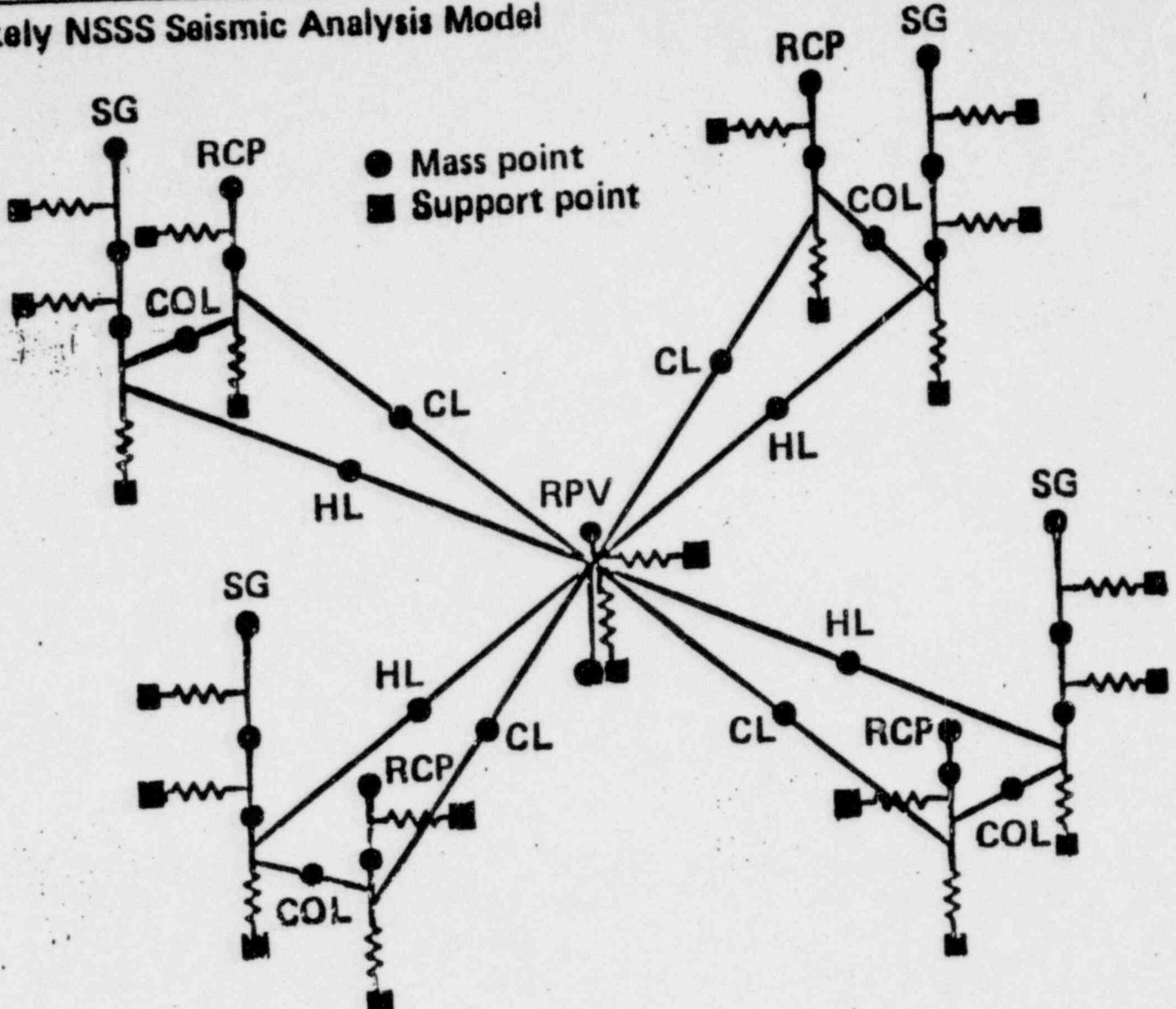
## COUPLING BETWEEN NSSS AND INTERNAL STRUCTURE IS CONSIDERED BY MODELING THE NSSS WITH THE STRUCTURE

**Most likely NSSS Seismic Analysis Model**

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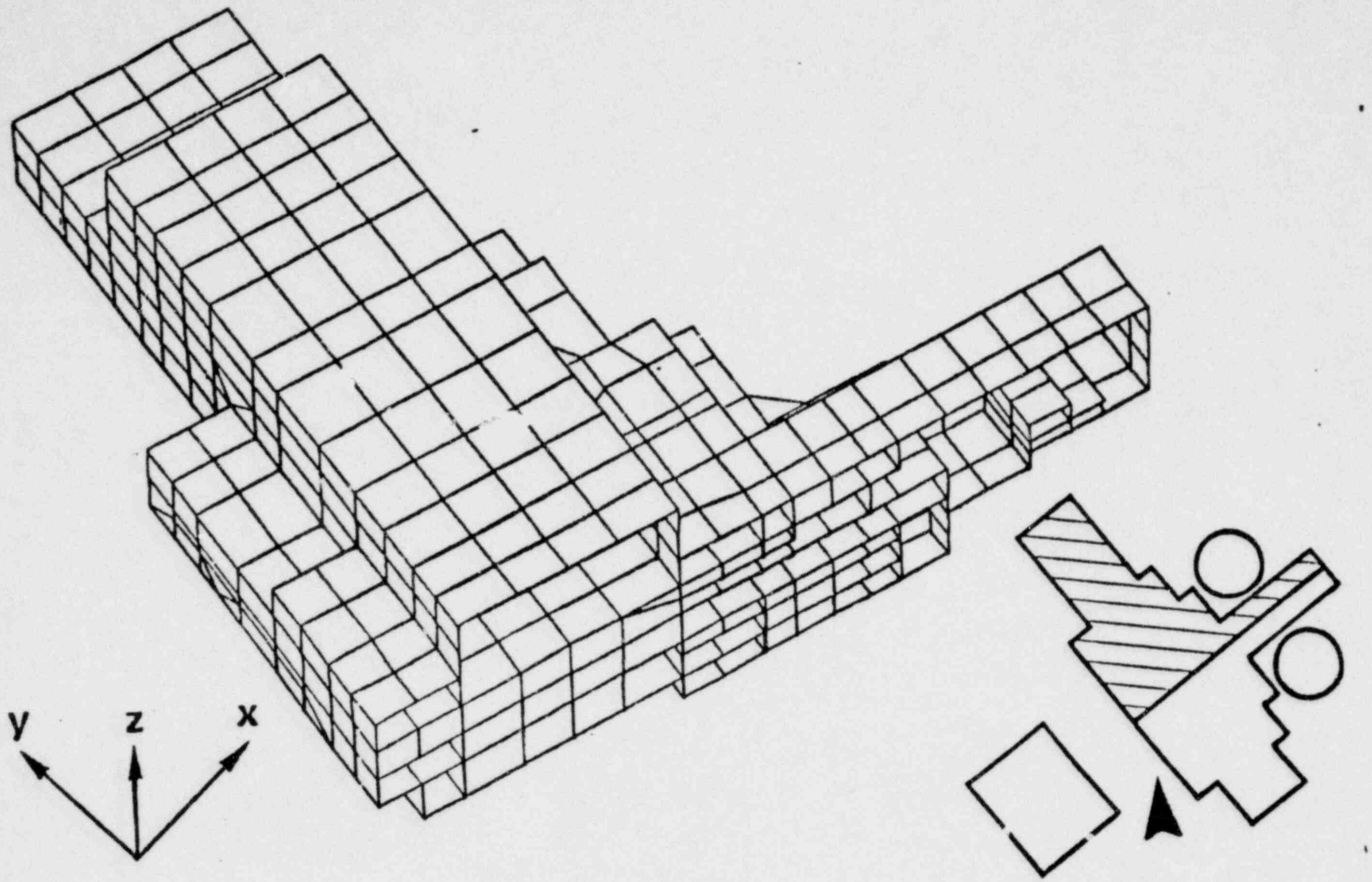
## A FINITE ELEMENT MODEL (FEM) WAS CONSTRUCTED FOR AUXILIARY-FUEL-TURBINE BUILDING COMPLEX





ATTACHMENT E

Attachment E (Response to comments on the NRC SRB Budget and the Budget Estimate Sheets) has been deleted involving predescisional information.

DELETION 6