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ACRS CLINCH RIVER BREEDER REACTOR (CRBR) SUBCOMMITTEE MEETING
MEETING MINUTES
JUNE 1, 1982
WASHINGTON, DC

PURPOSE

The purpose of the meeting was to discuss the seismicity and seismic design for the CRBR.

ATTENDEES: Principal attendees of the meeting are noted below:

ACRS

M. Carbon, Chairman
H. Etherington, Member
C. Mark, Member
J. Ray, Member
W. Lipinski, Consultant
P. Pomeroy, Consultant
M. Trifunac, Consultant
Z. Zudans, Consultant
P. Boehnert, Staff*
A. Bice, Fellow
*Designated Federal Employee

NRC

P. Check
R. Stark
J. Knight

CRBR PROJECT

J. Longenecker, DOE
D. Ujifusa, DOE
P. Dickson, W
R. Mallett, W
W. Brusey, Burns & Roe
A. Dajani, Burns & Roe
A. Morrone, W
G. Krauter, W
T. Pitterle, W
R. Mallett, W

A complete list of attendees is attached to the office copy of these minutes.

MEETING HIGHLIGHTS, AGREEMENTS AND REQUESTS

1. During opening remarks, Dr. Mark asked for the NRC's status of the CRBR seismic review. Mr. Stark replied that the site characteristics and seismology review is essentially complete while the review of the plant

seismic response is still on-going. Mr. Longenecker said DOE will attempt to show that the CRBR seismic design is appropriate and conservative, and that the licensing approach is identical to an LWR seismic review.

2. Mr. W. Brusey (Burns & Roe) discussed the geology and seismology of the CRBR site. He noted that the site is located in the Valley and Ridge geological province. The site itself is located on the Chickamunga Formation of rock strata in an area of minimum solutioning of limestone. Over 258 borings have been made at the site ranging from 100-300 feet deep.

There was discussion of possible limestone solutioning at the site. The Applicant has (and still is) investigating this possibility. In particular an area of the site is being investigated for solutioning (Figure 1). To date, preliminary results show a minimum amount of solutioning (voids no larger than 10 ft), and no foundation treatment is presently required.

Faulting investigations of the site region show no capable faults. At NRC behest, the Project investigated the possibility of injection of waste at the ORNL causing a seismic event. Mr. Brusey said the data obtained indicates it is not possible to initiate seismic activity by the ORNL activities.

The selection of the SSE and OBE for CRBR was discussed. The tectonic province approach was used by the Project. The maximum historical controlling earthquakes for design considerations are Charleston, New Madrid and Giles County. Giles County is the maximum historical earthquake for CRBR with an Intensity MM VII-VIII. The NRC recommended assumption of an MM VIII for the Giles County event. The SSE and OBE selected are thus 0.250 and 0.125g, respectively.

Dr. Pomeroy noted that there is uncertainty associated with the depth of the earthquakes in this region and that there is a lack of data on

focal depth of earthquakes. The Project agreed that shallow earthquakes are a possibility, but the prevailing scientific opinion is that the earthquakes originate in the basement rock structure. It was noted that a microsceismic network would be helpful in this regard but the Project has no plans to install one. Dr. Pomeroy asked about the seismic design capability of dams upstream of the plant. NRC noted that this question was explored for the near-by Sequoyah plant during its review, and the Staff will respond to this point at the next CRBR Subcommitttee meeting (June 24-25, 1982). Dr. Trifunac noted that the incidence of seismic activity appears higher around the plant site (Figure 2). He requested that the Project supply the Subcommittee with the appropriate information in order to estimate the number of earthquakes expected as a function of their intensity. The Project said they would provide this information. In response to Dr. Carbon, Mr. Brusey said the estimate for the return frequency of an earthquake with 0.25g acceleration value is on the order of 10^{-5} to 10^{-6}/year.

Dr. McMullen (NRC Seismologist) commented on the Staff's review of CRBR. He noted the following points:

° NRC has alot of review experience in this area (4 TVA nuclear plants). At the present time, the site appears suitable.

° NRC is in general agreement with the "thin-skin tectonics" approach used by the Project, although the Staff has requested the Project investigate further some aspects of the Giles County event. The Staff is also requesting additional data analysis concerning the uncertainty associated with earthquake focal depths.

° NRC said there should be a longer return period for the CRBR SSE vis-a-vis the Sequoyah SSE (the Sequoyah SSE is lower than the CRBR SSE).

3. Mr. A. Dajani (Burns & Roe) discussed the plant seismic design. He noted that 2 of the 3 Seismic Category I structures are founded on

rock. The seismic design response spectra was developed per Regulatory Guide 1.60 recommendations and was anchored at 0.25g. The method of analysis used for the nuclear island was a lumped mass model calculated with finite element analysis. Dr. Trifunac asked if there is any concern about possible focusing of incident seismic waves by the inclined rock stata present (Figure 1). Mr. Dajani said that the conservatisms in calculation of earthquake input and plant response should allay such concern. Mr. Dajani noted that in general the nuclear island seismic loads are controlled by the OBE. Also, for many structural components other loads (DBA's, shielding, and TMBDB) are controlling.

Dr. Zudans asked a number of questions, focusing on the details of the seismic mathematical model used. He noted that for many components the buckling load is the controlling load. He requested that at the next Subcommittee meeting the Project provide a detailed presentation on the determination of buckling. In response to Dr. Pomeroy, Mr. Dajani estimated that the amount of plant structural margin is substantial such that the plant would remain standing given an earthquake load of 0.50g. Mr. Ebberington noted that some of the margin noted above will be offset by the inevitable defects seen in large plant structures and components.

4. Mr. A. Morrone (W) discussed the details of the seismic design analysis of plant systems and components. He said that for Seismic Category I & II systems and components a detailed dynamic anlaysis is performed using response spectrum and time history methods. He also noted that Seismic Category I, Class IE equipment is subjected to testing at both multiple frequencies as well as single frequency resonance.

The details of the development of the structural and component design response spectra were provided. The Project believes their approach to development of these spectra is conservative (Figure 3). Dr. Zudans questioned the details of the treatment of the rotational response

spectrum in the structural analysis. Further discussion failed to satisfy his concerns and he requested that this item be discused at a future meeting, in particular a meeting of the CRBR Working Group on Structures and Materials.

The methodology applied in the seismic testing of Class 1E components was also detailed. W uses the sine beat test procedure (Figure 4). Drs. Trifunac and Zudans noted that the upper resonance test frequency search is limited to 33 Hz. Mr. Morrone noted the equipment excited at frequencies above 33 Hz will see little acceleration compared with the design values. He also said that the test response spectra accelerations always envelope the required response spectra (Figures 5-6).

5. Mr. G. Krauter (W) detailed the progress of seismic qualification testing for CRBR Class IE Plant Protection System electrical equipment in accordance with IEEE-344 requirements. The qualification method used is type, or proof, testing. In response to a question from Dr. Carbon, Mr. Krauter said the equipment is tested to design limits, not to destruction. All equipment tested to date has functioned satisfactorily, both during and after testing.

   Dr. Lipinski raised a concern of determining the margin-to-failure for relays in vital PPS equipment. Further discussion pointed out that this parameter is not established for any electrical equipment relays. Dr. Lipinski noted that this concern is generic to all plants and NRC should investigate this on such a basis. The Staff agreed and said they would look into it.

6. The seismic/dynamic test program for the control rod drive system was reviewed by Mr. T. Pitterle (W). A series of dynamic/seismic tests have been conducted to date on both the primary control rod drive system (CRDS) and the scram valve used in the secondary CRDS. A preliminary check of the analysis used to calculate the scram system response to seismic/dynamic events shows good agreement with the data. Additional tests are planned to verify the primary and secondary scram system seismic capability.

Dr. Kastenberg asked if there is any concern with core deformation during a seismic event and the related possibility of the control rods being blocked or misaligned such that they could not enter the core. Mr. Pitterle said the core assemblies are designed with a margin to resist movement. Dr. Kastenberg requested that discussion of this item be expanded at a future meeting on the topic of core restraint design.

7. Mr. R. Mallett (W) discussed the seismic design of the heat transport system (HTS) components. He made the following points during his presentation.

   - The HTS seismic design problems are essentially the same as LWR design problems except for the higher temperature and lower system pressure.

   - The CRBR plant seismic design methods and criteria include conventional conservatisms.

   - There is an inherent seismic margin capability in the HTS design similar to any other structure with a similar level of design.

   - Since other design considerations (CDA, etc.) are controlling and the hot piping is quite flexible, a sudden gross piping failure is not credible given a seismic event.

   - A program of testing and verification is underway to confirm the HTS design and assure against any oversights.

   There were questions raised concerning the snubber system planned for CRBR. Dr. Trifunac asked if out-of-phase seismic loadings are a concern. Mr. Mallett said studies have shown this is not a problem. In response to Dr. Kastenberg, the Project said the planned PRA study should pinpoint any weak links in the HTS resulting from seismic loads. CRBR will use mechanical snubbers which the Project believes are less prone to problems than hydraulic snubbers.

8. Mr. J. Knight commented on the status of the NRC seismic design review for CRBR. He said EG&G is aiding the review, particularly in the area of high temperature Code case considerations. A draft SER should be complete by mid-July 1982. In response to Dr. Mark, Mr. Knight said the Project's SSE and OBE values appear acceptable; the Staff has some questions outstanding - basically of a confirmatory nature. Dr. Kastenberg asked how earthquakes beyond the SSE are considered. Mr. Knight said for this case the reliance is on the seismic margin inherent in the plant design. Futher responding to Dr. Kastenberg, Mr. Knight said the Staff will look into the degree of seismic margin available for this plant to assure comparibility with an LWR, but no specific detailed study of the CRBR seismic margin is planned. Dr. Kastenberg indicated that the Staff needs to face this issue head-on, sooner or later.

   In response to Mr. Etherington, Mr. Knight said data is lacking on the phenomenon of low cycle fatigue of austenitic steels at high temperature conditions.

9. The meeting was adjourned at 5:30 p.m.

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A transcript of the open portion of the meeting is available in the NRC Public Document Room at 1717 H Street, N.W., Washington, D.C., or can be obtained at cost from Alderson Reporting, 400 Virginia Avenue, S.W., Washington, D.C. 202/554-2345.

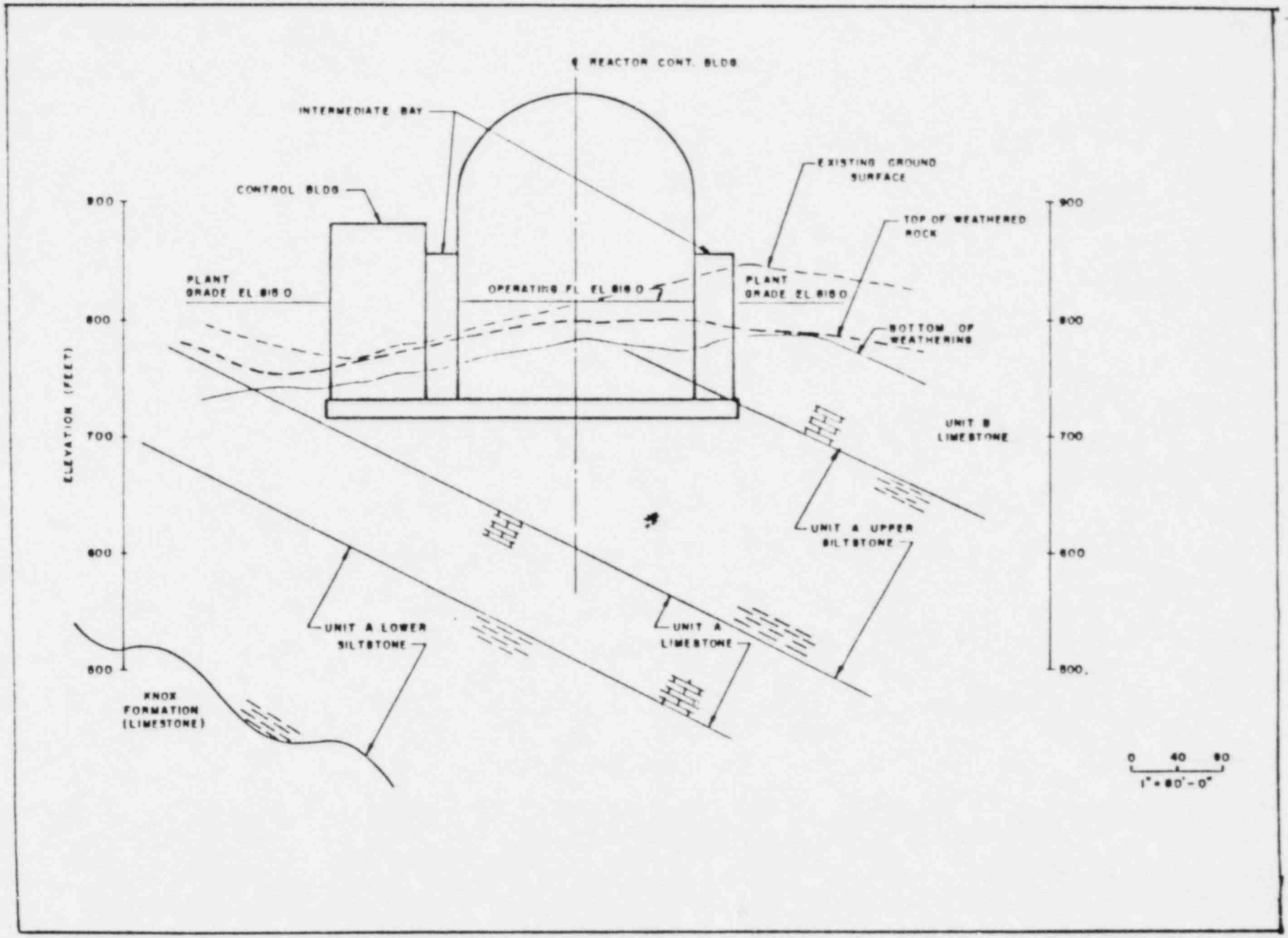
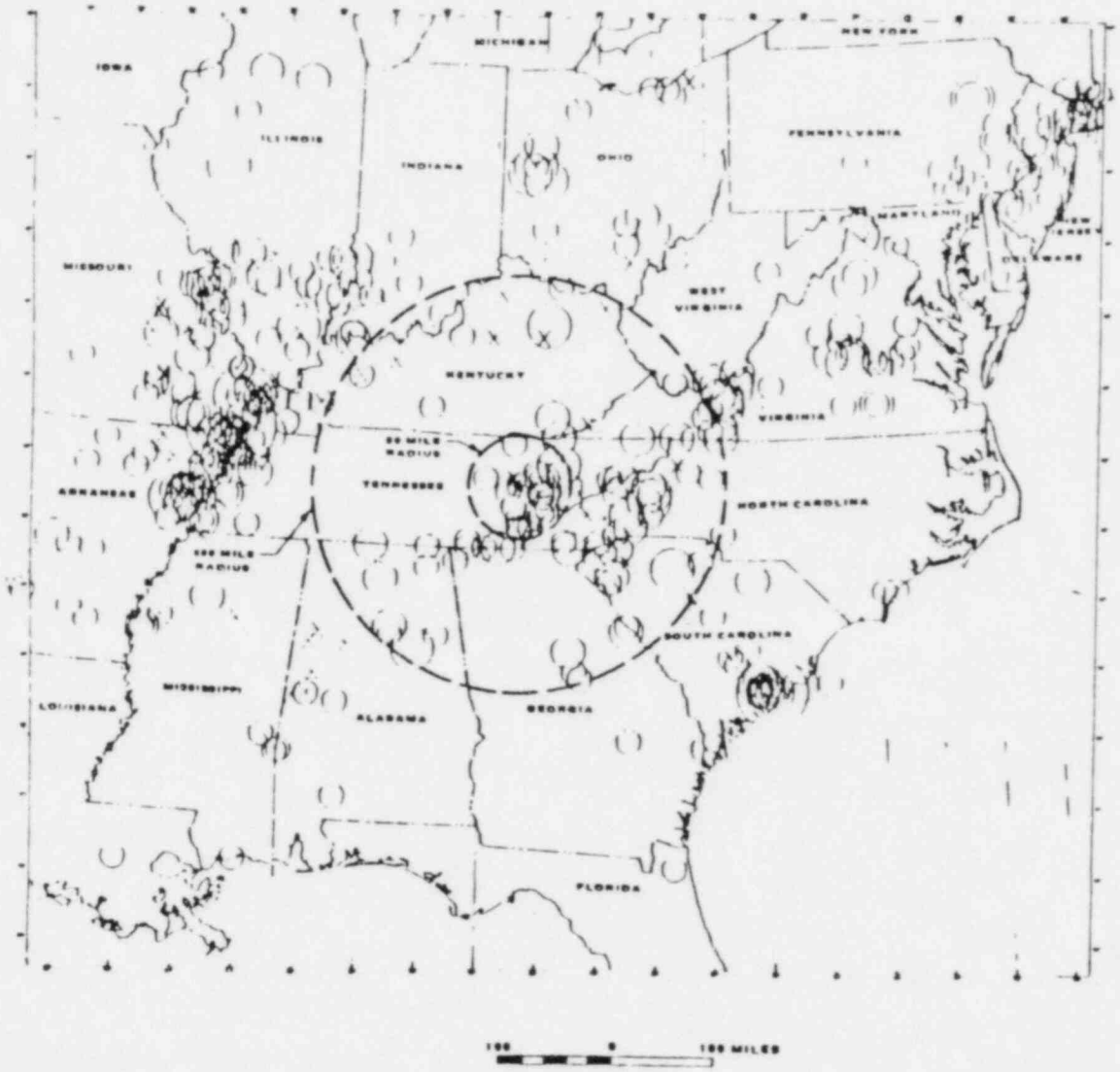


FIG. 1

CROSS SECTION — NUCLEAR ISLAND



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LEGEND.

- IV - V / V INTENSITY
- V - VI / VI INTENSITY
- VI - VII / VII INTENSITY
- VII - VIII / VIII INTENSITY
- VIII - IX / IX INTENSITY
- IX - X / X INTENSITY
- XI - XII / XII INTENSITY

X 1 SIGNIFICANT EARLY HISTORICAL EARTHQUAKES WITH UNREPORTED MAGNITUDE AND INTENSITY

OR

2 EARTHQUAKES WITH MAGNITUDE GREATER THAN OR EQUAL TO 5.0 AND MAXIMUM INTENSITY IV MM OR LESS

REGIONAL EARTHQUAKES WITH MAXIMUM INTENSITY EXCEEDING IV MM

FIG. 2

DESIGN SPECTRA

- Envelop upper and lower bounds of soil moduli
- Peaks widened for uncertainties
- Spectra smoothed to eliminate valleys and spectral fluctuations
- Results in conservative design spectra

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FIG. 3

BASIC SEISMIC TEST PROCEDURE

Single Frequency Sine Beat Tests

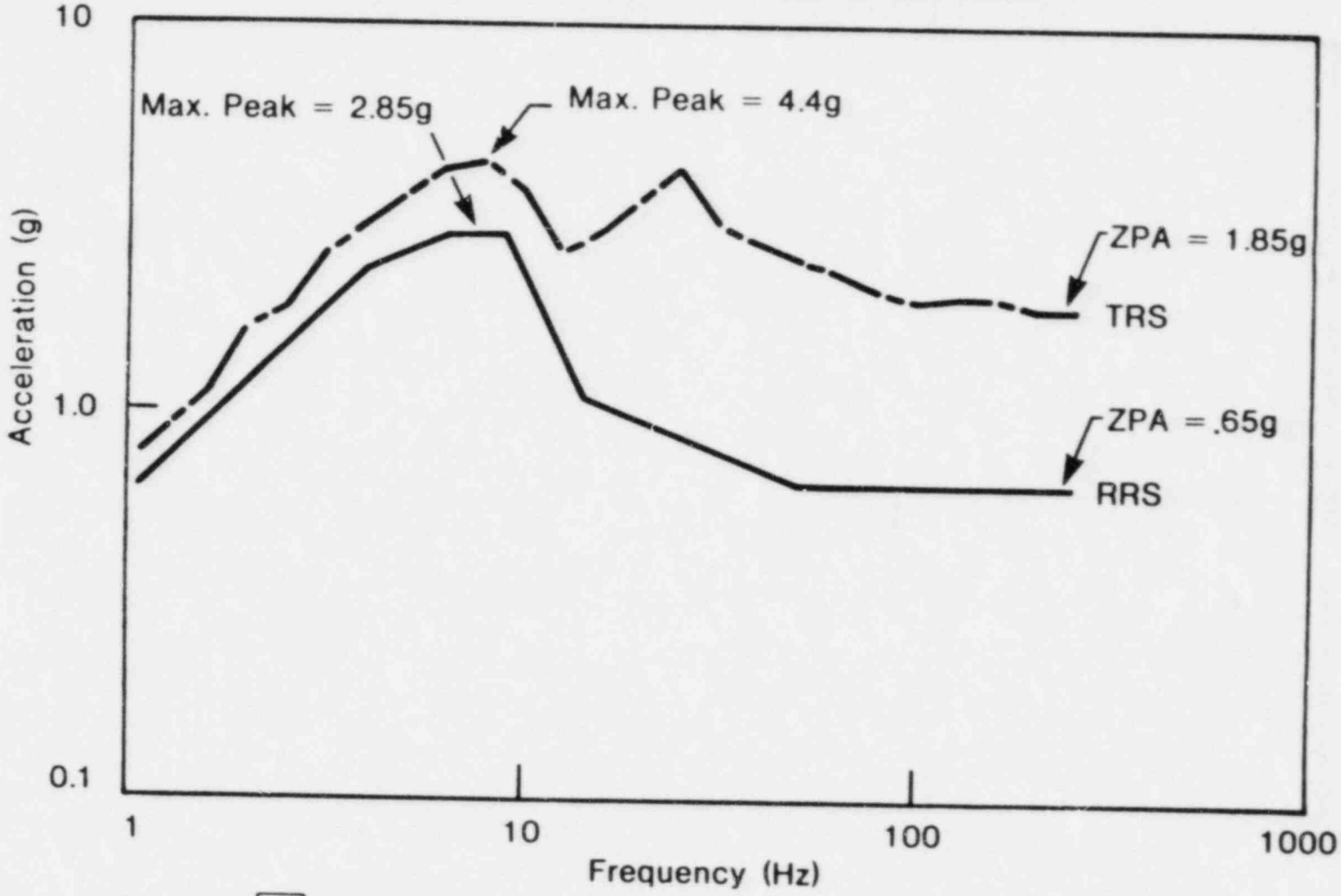
- Frequency search from 1-33 Hz
- SSE sine beat tests at natural frequencies and 1/2 octave intervals
- Five beats motion with 10 cycles/beat
- Shake table motion maximum acceleration equal to ZPA of RRS
- TRS maximum response acceleration greater than RRS
- One OBE test preceding SSE test at each frequency
- Independent direction input

Multiple Frequency Tests

- IEEE std. 344-1975
- Five OBE and one SSE
- Random motion
- Biaxial direction input
- Envelop RRS with TRS

FIG. 4

PRIMARY REACTOR SHUTDOWN SYSTEM COMPARATOR/BUFFER CABINET AND LOGIC CABINET ASSEMBLIES



Damping 5%

SSE - Horizontal

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FIG. 5

PRIMARY REACTOR SHUTDOWN SYSTEM COMPARATOR/BUFFER CABINET AND LOGIC CABINET ASSEMBLIES

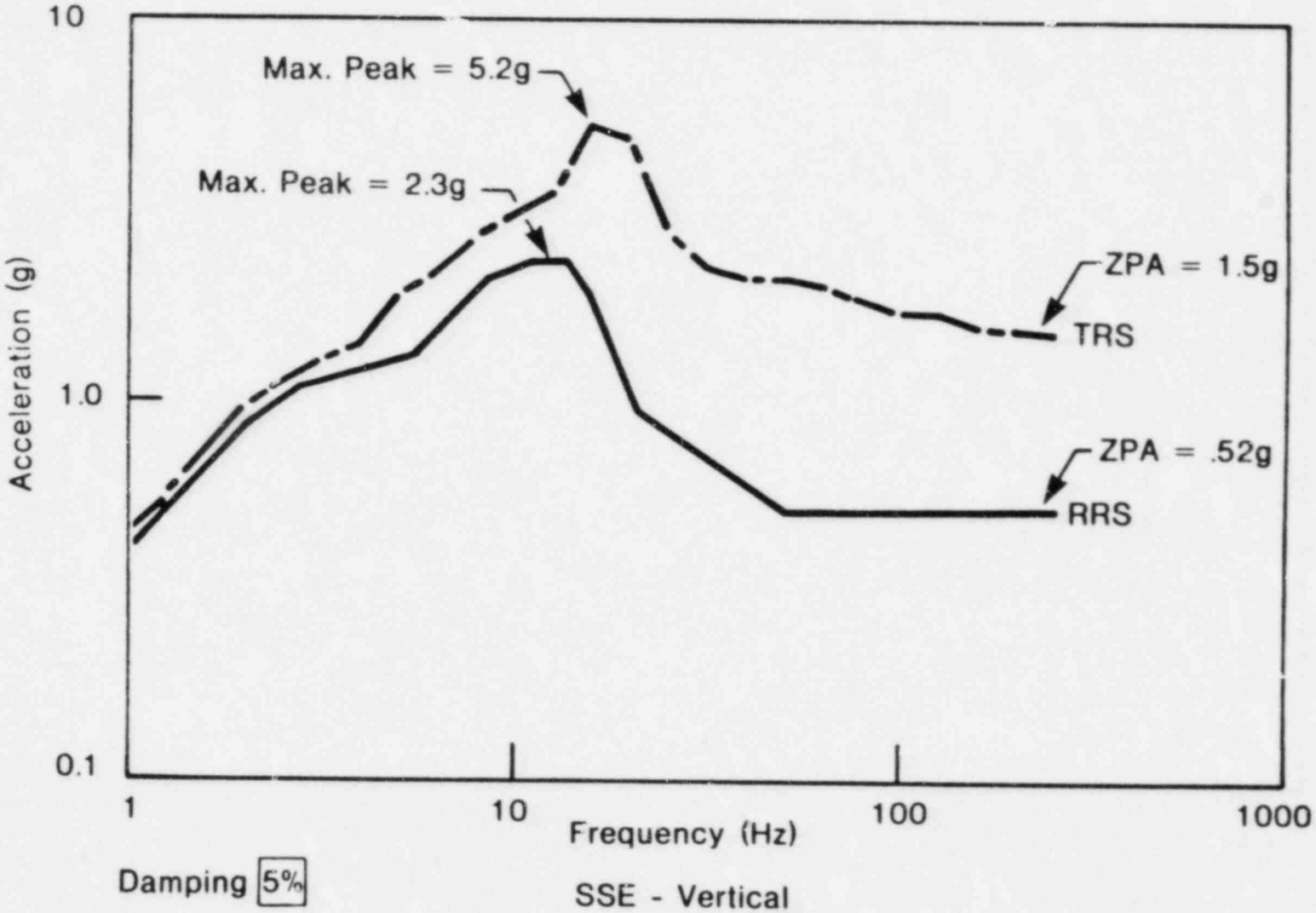

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FIG. 9