

ORIGINAL

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the matter of:

MEETING ON RECALCULATION OF
SEISMIC RESPONSE SPECTRA:
COMANCHE PEAK

Docket No.

Location: Bethesda, Maryland
Date: Tuesday, June 18, 1985

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2 NUCLEAR REGULATORY COMMISSION
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4 MEETING ON RECALCULATION OF SEISMIC RESPONSE SPECTRA:
5 COMANCHE PEAK

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8 Room P-422
9 Phillips Building
10 7920 Norfolk Avenue
11 Bethesda, Maryland
12 Tuesday, June 18, 1985
13

14 The meeting in the above-entitled matter convened,
15 pursuant to notice, at 9:10 a.m., Mr. Spottswood B. Burwell
16 presiding.

17 ATTENDEES:

18	S. Burwell	NRC/NRR/DL/LB
19	L. Shao	NRC
20	B. Bosnak	NRC
21	A. Vietti	NRC/NRR/DL
22	V. Noonan	NRC/NRR/DL
23	D. Terao	NRC/NRR/DL
24	D. Jeng	NRC/NRR/DL
25	F. Rinaldi	NRC/NRR/SGEB

1 ATTENDEES: (continued)

2	R. Lipinski	NRC/NRR/DL
3	C. Hofmayer	BNL
4	D. Enos	Teledyne/NRC Consultant
5	D. Landers	Teledyne/NRC Consultant
6	J. George	TUGCO
7	R. Cloud	RLCA
8	P. Rizzo	Gibbs/Hill/Rizzo Assoc.
9	K. Scheppele	Gibbs & Hill
10	C. Jan	Gibbs & Hill
11	M. Holley, Jr.	HH&B/TUGCO
12	J. Redding	TUGCO

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P R O C E E D I N G S

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MR. BURWELL: Good morning. My name is Spottswood Burwell. I am with the NRC. I am one of the project managers on the Comanche Peak project.

We are gathered here this morning to discuss the recalculation of the seismic response spectra for Comanche Peak. We have gone around the room and made introductions. At this point in time I would like to ask the Applicant to give us an overview.

I assume that you have prepared some type of presentation?

MR. GEORGE: Yes, Spotts, that is correct.

If I might again, I am Joe George, Vice President, E&C, for the Comanche Project. We appreciate this opportunity to brief you on the status of the reanalysis we have done on our 1974 model response spectra and in light of 1985 technology.

We will be giving you a detailed status, and we will be making an official submittal on our docket of the results of this reanalysis soon.

The purpose this morning is to brief you and solicit your input to the results thus far. I would propose to proceed this morning. I would like to reintroduce Mr. Ken Scheppele, who is the senior Gibbs & Hill Vice President who has been associated with the Comanche Project for a number of

1 years, and Dr. Cloud with R.L. Cloud Associates is a
2 consultant to TUGCO on this matter as well as other CPRT
3 matters.

4 MR. NOONAN: I wonder if I can interrupt you. I
5 would like to know about background before you start out. Tell
6 me why we need to do this. Where do you plan to use it? I'm
7 looking for impact on your program.

8 MR. GEORGE: Vince, the program -- the way we
9 proceed will, I think, move right into that detail. I would
10 really defer to Mr. Scheppele. This entire program, by the
11 way, will only take about an hour for the presentation. We
12 have slides. It is in very much detail, and I would like to
13 let Ken proceed, with Dr. Rizzo, and then I would like to
14 close at the end and then maybe give you some detail.

15 MR. SHAD: Eventually we want you to address whether
16 you are going to change the FSAR. We want to know whether we
17 need to change the FSAR.

18 MR. GEORGE: It is our view that we will need an
19 amendment for the FSAR, and I would expect to have that in
20 hand soon.

21 This program has been going on for a number of
22 months. As a matter of fact, it has been going for quite some
23 time as far as revisiting our response spectra, going back
24 quite some time, and there has been a lot of work done as far
25 as rigorous analysis on this particular issue.

1 MR. SHAD: Before you go into detail, another thing
2 we want to address is suppose you have to make an amendment to
3 the FSAR. Do you still meet the Standard Review Plan?

4 MR. GEORGE: Yes.

5 MR. TRAMMELL: I have to make a brief administrative
6 announcement. I'm sorry. I am the one who arranged for the
7 recordings in this part of the building, so one of the things
8 we are supposed to caution you is this is a non-secured area
9 of the building. It is not like the public meeting rooms that
10 you see downstairs on the first floor. There is a recording
11 device in this room which is only allowed by special
12 permission, security. The intervenors may be showing up with
13 a recording device also. I am supposed to announce that that
14 is what we have here. You are not supposed to discuss
15 safeguards information, proprietary information or, you know,
16 the other stuff in SA -- what is that called? Nuclear
17 material, the other stuff, in this room.

18 With that I will close. Thanks.

19 MR. NOONAN: Where I am coming from -- when we were
20 down at Dallas last week, Ed Siskin in the piping and piping
21 support analysis said he was going to use the present FSAR
22 methods.

23 MR. GEORGE: That is a matter of timing, Vince. We
24 would like very much to use our view response spectra, and
25 I proposed to use that at risk of it not being acceptable to

1 NRR, but the final conclusion on that matter was that the
2 reanalysis of the 300 problems on Unit 1 would at least start
3 with the existing response spectra. But we would propose --
4 when I say "soon" on the submittal, I have a status meeting
5 with Ken Scheppele and the folks in New York next Tuesday, and
6 I hope to come away from that meeting with a first draft of
7 that submittal.

8 MR. SHAD: One area I want you to address today is
9 has this methodology been used in any other plant or is it
10 first of a kind?

11 MR. GEORGE: They will be prepared technically.

12 MR. TRAMMELL: Do you have time to wait through?
13 You are going to get the whole program now unless you ask for
14 an abbreviation.

15 MR. NOONAN: Go ahead and go.

16 MR. GEORGE: I think if you get 30 or 40 minutes
17 into it, you will appreciate it.

18 MR. SCHEPPELE: I am standing not because of
19 formality but I figure this will be the last time I will be
20 able to stand for an hour or so, so that's why I'm on my feet.

21 First of all, we appreciate, as Joe said, this
22 opportunity of meeting with you gentlemen this morning. I had
23 planned on introducing some of my colleagues in our contingent
24 this morning. They have introduced themselves, but let me just
25 reinforce that. Jerry Jan is our chief structural engineer

1 from Gibbs & Hill, Paul Rizzo is President of Paul Rizzo
2 Associates, and Chris Holley is from MIT and is a consultant.

3 I will explain in a few moments the role of each of
4 these individuals in our program of developing in-structure
5 response spectra based on 1985 technology, but first let me
6 put in perspective our program for you.

7 At the time of our licensing Comanche Peak in 1973
8 and 1974, Gibbs & Hill was the architect engineer working
9 directly with Dames & Moore, who had been selected by TUGCO as
10 the seismology soils consultant for the Comanche Peak PSAR.
11 With Dames & Moore, we established the soil/structure
12 interface for our structural seismic models.

13 These seismic models and the criteria for the
14 structural seismic analyses themselves, including the
15 in-structure response spectra, were developed based on the
16 technology available at that time in 1973 and 1974, and that
17 information was incorporated into the licensing documents
18 culminating in the granting of a licensing of a construction
19 permit in December of 1974.

20 Dr. Jerry Jan, who was our chief structural
21 engineer, led that work in 1973 and 1974, just as he has led
22 the work today on this same subject matter.

23 Now, when TUGCO authorized us to proceed with the
24 development of in-structure response spectra based on the
25 latest technology available in 1985, we selected Dr. Paul

1 Rizzo as our consultant in seismology and soils because of the
2 close working relationship that we developed with Dr. Rizzo
3 over the years. Our Gibbs & Hill staff and Dr. Rizzo have
4 worked together on nine previous nuclear installations, three
5 here in the United States, three nuclear power plants in
6 Spain, two in Italy, one in Brazil, and I personally worked
7 with Dr. Rizzo in the advancement of the concept of the
8 floating barge-mounted nuclear facility.

9 Now, to provide an independent review of the
10 methodology and approach and using 1985 technology and
11 developing in-structure response spectra, TUGCO selected
12 several additional well-known consultants in the field of
13 soil/structure interaction and also structural seismic
14 analysis.

15 We met with these consultants bi-weekly to receive
16 their comments and suggestions on the work as it progressed.
17 These are Professor Holley, here this morning, Professor Mel
18 Biggs, Professor Edward Castle, all of MIT. Also Dr. Chris
19 Margot of Terra Corporation, and Jean Lieu Shmieu of Purdue
20 University.

21 As a result of their review, our final report will
22 have the endorsement of these consultants.

23 For our meeting today, as Joe indicated, the purpose
24 of the presentation is to provide you with the approach that
25 we have taken in the development of in-structure response

1 spectra based on 1985 technology and to share with you some of
2 the preliminary findings that we have produced to date.

3 MR. SHAD: What do you mean by 1985 technology? Do
4 you mean brand new? Nobody has ever used it?

5 MR. SCHEPPELE: I think what we are doing, as will
6 be evident by the presentation, is we are, in effect, updating
7 the state of the art to today's technology as opposed to that
8 which was apparent to us in 1973 and 1974, and I think that
9 will be apparent from the presentation.

10 MR. SHAD: When you say 1985 technology, it bothers
11 me.

12 MR. SCHEPPELE: Let's say this. Let's use different
13 terms and let's say most recent technology by our judgment,
14 and this will be spelled out in the presentation. Our
15 approach and findings will, of course, be submitted in a
16 report which will come to you folks within a few weeks.

17 Now, for the technical presentation today I have
18 asked Paul Rizzo to make this presentation, primarily because
19 the refinements which have been made in the in-structure
20 response spectra relate primarily to the soil/structure
21 interaction. At the conclusion of the presentation, certainly
22 Dr. Jan or Dr. Rizzo will respond to any questions or
23 clarification which you may wish to make, and I can fully
24 appreciate the fact that this is the first time that you, of
25 course, are aware of our approach, and obviously you want to

1 study this matter further. But if you care to make any
2 comments or clarifications which you request from us,
3 certainly we will do our best to provide these for you today.

4 [Slide]

5 MR. BURWELL: This is a small series, 35 millimeter
6 slides. Are you prepared to give us copie of these?

7 MR. RIZZO: Yes.

8 [Slide]

9 MR. RIZZO: We are going to discuss today the status
10 of our reanalysis of the rock-structure interaction. We do
11 have rock at the site as opposed to soil, so the terminology
12 is rock-structure interaction throughout the presentation. AS
13 that relates to the in-structure floor response spectra
14 development. I will mix the terms "in-structure" and "floor
15 response spectra," and this means the dynamic response of the
16 floors to input. And you will see from the presentation that
17 what we are talking about is the impact of rock-structure
18 interaction on the floor response spectra.

19 Ken mentioned that we are going to discuss 1985
20 versus 1974 technology. Mr. Shao raised a comment on that,
21 and let me speak to that for a moment. What you are going to
22 see really is changes that have occurred over the past decade
23 in rock-structure interaction analysis. You will see
24 references in here back as early as 1973 and 1974. I would
25 think that it would be better characterized by saying that we

1 are looking at improvements in the technology that have
2 occurred since the FSAR was developed in the early 1970s.

3 I don't think anybody in the room would be surprised
4 at the changes that we are talking about. We are speaking
5 state of the practice, not state of the art. In applying
6 these changes in the technology in the past year to our
7 rock-structure interaction analysis, we have, of course, by
8 way of passing incorporated minor changes in our structures to
9 the models. It is not the prime purpose of our effort, but it
10 has been done as we are going along.

11 We will cite these a little bit today in our report
12 where they have occurred.

13 MR. SHAD: What is the shear velocity of the rock?

14 MR. RIZZO: The shear velocity of our rock -- I will
15 get to that in a moment, but it varies basically from about
16 4000 to 6000 feet per second. It could be very well classified
17 as a rock site where fixed base motion is appropriate. We
18 have not taken that path primarily because the profession has
19 not always agreed on when you can use fixed base, although
20 rock site certainly are commonplace.

21 We have incorporated rock-structure interaction into
22 our analysis, and as you can well expect, the effect of
23 rock-structure interaction is not that great on the overall
24 response of the structure. You will see that as we go through
25 it. But nevertheless, we include it in our analysis, and you

1 can do that as a conservative step or, technically speaking,
2 the best way to go about it.

3 [Slide]

4 This presentation has four segments to it. The
5 first two are relatively brief. They are simply to bring you
6 up to date or reupdate you on our basic seismic design
7 criteria and a very quick review of our site conditions so
8 we are all talking the same terminology, we all see the same
9 conditions in what we are dealing with.

10 The meat of the talk is dealing with the major steps
11 of the reanalysis. We go into a lot of detail here on a
12 step-by-step basis of what we have done this past spring in
13 reanalyzing the rock-structure interaction and its impact on
14 floor response analysis. Once we get through the reanalysis,
15 I'm going to show you some typical results. Of course, we are
16 doing this for all of our Category I buildings, and I have
17 simply chosen the aux building as typical examples of what we
18 are getting as far as response, the kind of margin we are
19 seeing in our calculations as compared to what we had in the
20 past.

21 [Slide]

22 The next slide is basically a summary of the
23 fundamental criteria, all of which are seen in the FSAR. We
24 have a .12 g SSE in the aux building, a .06 g, a relatively
25 low seismic area based on historic seismicity. Our response

1 spectra for the horizontal direction satisfies Reg Guide
2 1.60. Our vertical satisfies Newmark's vertical for 1973.
3 This is about the time when we were making this submittal tht
4 the Reg Guide 1.60 was just being published. Our structural
5 damping satisfies 1.61, and again, it was in the same time
6 frame.

7 MR. SHAD: You say the vertical and the horizontal
8 use a different spectra?

9 MR. RIZZO: The vertical is Newmark, the basis under
10 which 1.60 was developed. The difference is at the tail end
11 of the response data.

12 MR. SHAD: What was the reason for using a different
13 spectra for the vertical?

14 MR. RIZZO: In 1973-74, there was no Reg Guide
15 1.60. We only had it in the Newmark Report paper, and the
16 NUREG backed it up. When we made the application, this is
17 what we used. We have never changed it.

18 Does that ring a bell? That is going back 12
19 years. That is what happened. The only difference in vertical
20 is between 33 and 50 hertz. It tails off the high frequency
21 end. Everywhere else is the same as Reg Guide 1.60. We have
22 an artificial time history that we used to generate our floor
23 response spectra. The artifical time history that we use is
24 the same as in the FSAR. It envelopes the design response
25 spectra at all points, a little bit difference than what the

1 Standard Review Plan would allow today. It is 10 second
2 duration. Our control motion location is at the foundation
3 elevation. The ground motion was specified at the surface. We
4 have not taken any credit for attenuation or frequency shift
5 at the foundation elevations. It is the same as the site
6 grade.

7 MR. JENG: You mentioned the only difference is in
8 the 33 to 50 hertz. It is 3.5 hertz.

9 MR. RIZZD: It is a minor shift.

10 MR. JENG: You should be more precise in your
11 statement.

12 MR. RIZZD: The most significant part is the tail
13 end I did not pay much attention. We envelope our response
14 spectra for the artificial time history. Our rock-structure
15 interaction approach then was a lumped parameter. It is now
16 lumped parameter again. The terminology shifted in the last
17 ten years to substructure. The name changed. It is more
18 sophisticated but it is the same thing.

19 The final note is that in the analysis we are
20 discussing today, we have introduced no changes in any of
21 these basic parameters using all of these same parameters in
22 the analysis that we are discussing today.

23 MR. LANDERS: Does that mean you have used the same
24 time history?

25 MR. RIZZD: Yes, the same time history. We are

1 looking at the time history a little bit because it is
2 enveloping everywhere and there is deservedly some review of
3 that requirement. Today the results we are showing you, we
4 are using the same one as in the FSAR.

5 The next group of slides gives you an appreciation
6 of our actual site conditions, a very generalized plant layout
7 or plant view is here, with the two containments.

8 [Slide]

9 These are all individual buildings on individual
10 mats. This is a singular building with a singular mat.
11 Auxiliary electrical. It is two functions but it is a
12 singular building on one mat, structurally tied throughout
13 this point here, and it is one mat at the foundation level. I
14 put it in color because that is the one I am using for an
15 example later on. I want to give you an idea of where that is
16 located with respect to the other buildings.

17 I mentioned earlier we have a rock site. This is an
18 artist's sketch, basically, of describing showing you how our
19 buildings are situated. This happens to be through Unit 2 on
20 the left side of the previous figure, the fuel building being
21 on the right side here. This formation is the Glen Rose
22 limestone, highly competent limestone that you will see in
23 other slides. It overlays on this scale between mountainous
24 formation, which is a sandstone. These beige layers shown
25 interspersed are clay stone lenses that are part of a marine

1 deposits, part of the Glen Rose limestone.

2 We point these out because we do factor the layers
3 one by one into our analysis as we generate the rock-structure
4 interaction parameters. The grade at this site on the slide
5 was about here before we took off the overburden
6 [indicating]. This is an elevation of about 805 to 810 at the
7 site, and this is about 793. This is about 769. That is 40
8 feet. We have taken off 40 or 50 feet of overburden, and we
9 are basically on rock. We have taken off rock, which you will
10 see on a subsequent slide all of the overburden has been
11 removed.

12 [Slide]

13 The next four slides are photographs of the site
14 during the excavation stage. I show these because it is ten
15 years or a few years since that work has been done. For those
16 who did not see it when the work was being done, you really do
17 not have an appreciation for the foundation conditions. You
18 can see that the rock has been basically carved out to receive
19 the foundations or these plants, these units.

20 This is the 793 that I referred to down in here,
21 769. You can see the rock right in this area exposed. That
22 is the uppermost limestone [indicating]. This is also a
23 cutback of the weather overburden rock.

24 [Slide]

25 The rock has been excavated by drilling and

1 shooting, loading out with front end loaders, and the banding
2 through here that you see in this particular face is the clay
3 stone layers that I mentioned earlier. Of course, the rock
4 stands very vertically. You can see in this closeup view that
5 the clay stone, while being a little bit softer than the
6 limestone, is not that much different than the rock itself.

7 [Slide]

8 Before proceeding with a step-by-step analysis of
9 what we have done, I want to clarify some terms and compare a
10 little bit what we are doing now with what we did in 1973-74
11 time frame. We are using a substructure in our lumped
12 parameter for all of our buildings. We account for embedment
13 effects. We have 6 degrees of freedom, 3 shown here, 3 in the
14 other direction.

15 I point out to you that MF is mass of foundation,
16 and in parentheses, we have the mass of the soil that had
17 traditionally been considered in this kind of an analysis.

18 [Slide]

19 The reanalysis. One of the first areas we got into
20 which represents a change in technology was exclusion of the
21 soil mass from the addition to the foundation mass for lumped
22 parameter analysis. It was included earlier. It is now
23 excluded in our analysis, and that is clearly a change in
24 technology that occurred early on in the past decade.

25 The FSAR. We used a uniform modulus value that was

1 representative of the entire formation. The reanalysis is a
2 little more sophisticated. We have looked at the actual
3 layered system itself and accounted for layers, the effect of
4 layering on the damping as well as the stiffness coefficients
5 for the analysis.

6 Damping as a whole. In the FSAR the rock-structure
7 interaction damping was taken as 10 percent translation and 5
8 percent for rotation. This was hysteretic-type damping. The
9 analysis accounts for damping as it should be in the analysis
10 and also material damping of hysteretic nature. The material
11 damping throughout our reanalysis has been taken as 2 percent,
12 geometric damping being a function of geometry that is
13 different for each building.

14 The embedment effects were included in our previous
15 analysis. Since that time there has been a fair amount of
16 work done on embedment effects. We have incorporated that
17 improvement information, updated information in our
18 reanalysis.

19 In the FSAR we varied our stiffness parameters
20 basically around a best estimate value by taking 25 percent of
21 it and 200 percent of the K values in each situation. In our
22 reanalysis we have looked at each building and then looked at
23 the embedment effects, how they might range. We have looked
24 at the rock properties that were already measured,
25 incorporated that into a variation analysis. That leads to a

1 range of variation between 65 and 150 percent. That is
2 building dependent. You will not find this range in every
3 building. This is the outermost range that you will see in our
4 results.

5 In some of our buildings this tightens up to around
6 75 percent on the lower side, maybe 130 percent on the upper
7 side. It is building dependent on geometry of the building,
8 specifically the bevin effects and the rock properties
9 measured at the site. I will get to it later. We have looked
10 at that on a special study effort at each building itself.

11 [Slide]

12 Now, the main part of this presentation is a
13 step-by-step description of our reanalysis. I am going to
14 show this slide seven times, so you need to try to memorize
15 the whole thing as you go through it.

16 The first step is simply to define for our analysis
17 the profile under each building and the specific dynamic rock
18 properties that apply to that building. We do this for each
19 building specifically using the borings that are closest to
20 that building or immediately beneath that, and we use the
21 laboratory tests that were conducted in those same borings
22 under those same samples. The site is highly uniform when you
23 look at the gross cross-sections across the site.

24 We have chosen to be as detailed and as refined as
25 we possibly can in our analysis, and therefore we look at the

1 specific borings beneath each building. I point out to you a
2 little cross-hatched area referred to as May 1985 program
3 area. I will refer back to that.

4 MR. NOONAN: You said you wanted to look at -- you
5 are taking each one of these borings and using that in a
6 detailed sense, not just generically applying --

7 MR. RIZZO: For example, the aux building sits in
8 here.

9 MR. NOONAN: Why are you doing that? That's a lot
10 of complexity you are putting into this.

11 MR. RIZZO: We are using computer codes that accept
12 the detail readily, so why not? It's not a problem for us.

13 [Slide]

14 A typical analysis profile. This happens to be
15 beneath the aux and electrical building. The gray is the
16 limestone. This whole formation, of course, is the Glen Rose
17 limestone. The beige are the interbedded clay lenses. The
18 yellow here is the Twin Mountains formation.

19 This column is derived from shear wave velocity
20 measurements, as are the ratio of values which come from
21 laboratory tests. We have adopted a material damping of 2
22 percent for our entire -- for all of our rock layers. We
23 believe that that is a relatively low value. It is one of the
24 primary purposes of the May 1985 program mentioned on an
25 earlier slide.

1 We are going back and obtaining new samples for
2 laboratory testing to measure the material damping of the
3 rock, which we expect to be more in the range of 5 percent,
4 and we are also measuring some new shear wave velocities at
5 the site.

6 [Slide]

7 The next step in our analysis is to define the
8 foundation geometry. It is usually relatively
9 straightforward, and it is not unusual at this site either.
10 We have a couple of foundations, and this is by way of an
11 example. The aux electrical building is stepped at
12 mid-mat. The structure is tied at the superelevations and
13 across here [indicating].

14 We account for this step geometry in our analysis
15 for a number of reasons, not the least of which is that we
16 recall in the artist's rendering of the rock there are clay
17 stone layers high up in the formation which must be accounted
18 for, and the stepping, because those layers are horizontal,
19 the stepping is through here. The layering is considered in
20 our analysis.

21 The safeguards building has three basic elevations
22 to it, and again, we account for that in the stepping in the
23 foundation mat in our analysis in this particular step.

24 [Slide]

25 Step 3. After having obtained the rock properties

1 and the analysis profile beneath each building and looked at
2 the geometry of each foundation mat, now we get into the meat
3 of the analysis of determining the stiffness and damping
4 parameters for the six modes of freedom, six degrees of
5 freedom.

6 We are looking at rigid mats on elastic layered
7 systems. We are using a substructure approach, which I
8 illustrate on this slide to show you how we are doing it
9 versus how some other people might view typical substructure
10 approaches. The upper half is taken from a recent NUREG. It
11 is a common slide. It shows the approach to substructuring
12 using impedance analysis. Basically the free-field motion is
13 subjected to analysis with the elevation of the foundation.
14 Impedances are calculated for the mass of the foundation. The
15 structural model is done independently. They are married and
16 you use the altered ground motion with the total structure for
17 the impedance function, which is frequency dependent.

18 Our reanalysis uses the free-field motion directly
19 as input motion. We do not reduce it or change frequency
20 content with the depth of our embedded foundations.

21 We generate stiffness and damping values in two
22 approaches. First we do it as a typical half-space calculation
23 using the layered half-space theory for stiffness
24 calculations, work that has been done since 1974 basically
25 on half-space theory. It is frequency independent.

1 We also generate impedance. The functions for the
2 same geometry and the same rock, again considering the
3 layering. This, of course, is frequency dependent. We
4 compare the two and then adopt a frequency independent
5 stiffness set of stiffness parameters and damping parameters
6 for use in a lumped parameter model. The structural model, a
7 finite element model that has been condensed onto a lumped
8 parameter model which is married into a three-dimensional time
9 history analysis.

10 MR. JENG: In this substructuring procedure you are
11 presenting there, in your opinion, where is the earthquake
12 motion applied?

13 MR. RIZZO: Right here [indicating].

14 MR. JENG: On the top picture. This is the
15 embedment.

16 MR. RIZZO: It is accounting for embedment, yes.

17 MR. JENG: In your FSAR commitment, you are supposed
18 to apply the motion in the free field at the foundation level
19 by using the substructure procedure. Because you are using the
20 geometric relationship, there may be a reduction in the motion
21 at the surface level, reduction to the bottom line.

22 MR. RIZZO: From here to here.

23 MR. JENG: Yes, and you have not addressed that.

24 MR. RIZZO: We are not doing that. We are using the
25 full motion.

1 MR. JENG: I want you to show some information in
2 your submittal which indicates the motions that indeed apply
3 at the foundation level in the free field.

4 MR. RIZZO: Yes, up here.

5 MR. JENG: Yes.

6 MR. RIZZO: Do we agree that the motions here are
7 less than here [indicating]? We do not have any serious
8 non-linear problems. I can do that, David, but understand, do
9 we agree that doing what we are doing is -

10 MR. CLOUD: I think there is some -- what you said
11 is that we apply the free-field motion at its full exactly as
12 it is at the base of the foundation, and I think all you asked
13 was that we document that in the submittal.

14 MR. JENG: At the lower reaches. You don't mean at
15 the surface level, right?

16 MR. RIZZO: We apply the same motion to surface at
17 the foundation level.

18 MR. JENG: This has raised quite a few items of
19 contention, so we would like you to address this one.

20 MR. RIZZO: Sure.

21 MR. SHAO: What is the original FSAR? Is it as the
22 free field?

23 MR. JENG: The free field at the foundation level.

24 MR. CLOUD: That is what we are doing.

25 MR. JAN: The upper part is for comparison. We are

1 doing the lower part.

2 MR. JENG: Then why did he say earlier that the
3 embedment effect was not accounted for?

4 MR. RIZZO: That is separate.

5 MR. JENG: How did you account for it? This
6 procedure the way I know is based on the ring conception. You
7 take different rings, embedment depths to account for the
8 stiffness resistance.

9 MR. RIZZO: I will show you in a few minutes how we
10 take care of embedment.

11 Now, I have two choices, basically, David. You are
12 obviously very familiar with the subject. I can use the same
13 motion, the free field at depth, and counteract change by
14 damping values for embedment, or I can take the reduced motion
15 at elevation and take a lesser effect of embedment on my
16 spring.

17 MR. JENG: Can you address that issue, the second
18 point? I thought you should mention this one. What is the
19 objective of the reanalysis? The earlier analysis was no
20 good, or in your opinion it was good enough and had too much
21 safety margin? You wanted to improve the safety margin to
22 reflect more closely and provide a safe response? If it is the
23 latter, I want you to show.

24 MR. RIZZO: It is the latter. I am going to show you
25 in our example that we have excess safety, excess seismic

1 margin in our floor response spectra.

2 MR. SHAD: There can be lots of implications. You
3 have margins that are all frequencies or certain frequencies?
4 Maybe this method may go higher? Are you going to requalify
5 all of the equipment?

6 MR. RIZZO: We will have, we believe at this point,
7 and we are not finished yet, Larry, but we believe that we are
8 going to have floor response spectra at the same level or
9 lower than at all frequencies than we have done previously,
10 than we had in the previously one.

11 MR. SHAD: Suppose the certain frequency, you have
12 to requalify all of the equipment?

13 MR. RIZZO: We understand the implications of what
14 we are doing very well.

15 MR. SHAD: Are you going to apply this throughout
16 the plant, that everything will meet the new analysis?

17 MR. RIZZO: You're talking to the wrong guy. My
18 area is structure interaction.

19 MR. SHAD: But when you ask for this, there are lots
20 of implications involved.

21 MR. GEORGE: We have not seen any excursions as far
22 as the response spectra are concerned that would require
23 requalifying the equipment. We have not identified any
24 excursions that require equipment requalification.

25 MR. DENTON: Watch out, for any elevation, any

1 spectra for certain frequencies can be higher than the
2 original spectra. Then you have to requalify.

3 MR. GEORGE: Yes. When you see the curves, the
4 examples, it might be a good time to discuss that.

5 MR. RIZZO: We understand your concern. That was
6 one of ours at the very beginning.

7 MR. DENTON: I don't know whether the management at
8 TUGCo realizes what they are getting into. I'm trying to warn
9 them ahead of time. There may be cases, certain areas where
10 the spectra may be lower at certain frequencies, and then it
11 wasn't designed right.

12 MR. RIZZO: A new frequency, a new response spectra
13 may be higher than the old.

14 MR. DENTON: I cannot believe you would have a
15 frequency as high at all elevations, at all frequencies. I
16 don't think you can envelope everything. There will be
17 certain areas that would be lower than the original curve.

18 MR. LANDERS: If that's what falls out, that's what
19 falls out. And they are aware that they have to look at that.

20 MR. TRAMMELL: We'll get there.

21 MR. JENG: Do you expect that the new analysis would
22 show generally lower than what you had before, most
23 frequencies?

24 MR. RIZZO: Yes.

25 MR. JENG: The reason it is lower comes from several

1 parameters. One is removing the soil mass?

2 MR. RIZZO: That is one of them. That is not the
3 most important, but it is certainly one of them.

4 MR. JENG: And a second is to try to redesign a
5 higher material damping from 2 to 5?

6 MR. RIZZO: We're using 2 percent. Everything here
7 is 2 percent.

8 MR. JENG: But you mentioned earlier to change the
9 5.

10 MR. RIZZO: That is a possibility. We are not
11 committing to do that. The results we are showing today are 2
12 percent.

13 MR. JENG: And the third approach is to use --

14 MR. RIZZO: To improve the substructuring method.
15 Then you have higher damping values, geometric damping.

16 MR. JENG: All of these have to be justified. I
17 feel that your presentation is just to run through quickly,
18 okay.

19 MR. SHAO: We're not proving anything today. We're
20 just listening.

21 MR. JENG: Go ahead.

22 MR. RIZZO: We're giving you the status of where we
23 are.

24 MR. GEORGE: This is a briefing on the status, and
25 we solicit your input, as you desire. We will be making a

1 detailed, formal submittal on our docket to justify everything
2 that we will be modifying.

3 MR. RIZZO: Don't hesitate to tell us our comments.

4 MR. JENG: To my knowledge, this procedure does not
5 account for the so-called stepping in the mat that you
6 mentioned, that you mentioned was accounted for.

7 Can you explain how?

8 MR. RIZZO: It is not that difficult to do. You
9 analyze the building --

10 MR. JENG: By what?

11 MR. RIZZO: By CLASSI, the elastic computer model or
12 the WIDGEMOD program, which I'm going to describe in a
13 moment, at two different elevations. The higher elevation --
14 the higher and the lower elevation, you proportion the
15 stiffness for the moment of inertia, depending on rocking or
16 translation. You marry the two together and come up with
17 basically an equivalent stiffness value for that mat. You
18 have to account for the layering up at the top.

19 MR. JENG: I am talking about the mat covering the
20 auxiliary building and the control building. You mentioned it
21 was accounted for. I did not follow how you did it.

22 MR. RIZZO: First, I placed the entire mat at the
23 higher elevation. Then I did a reanalysis of the mat at a
24 lower elevation, and then I proportioned the stiffness of the
25 two areas in proportion to the area of the foundation.

1 MR. JENG: Stiffness of what? That's a general
2 term. You're throwing it up and down. What stiffness are you
3 talking about?

4 MR. RIZZO: I have two foundations. At one
5 foundation, two elevations. I take the entire mat, assume
6 that it is at the upper elevation --

7 MR. JENG: Even though there is a void at the lower
8 level?

9 MR. RIZZO: No void. Run the layers on through.
10 You calculate the stiffness, both frequency-dependent and
11 frequency-independent. Two different approaches. And then
12 take the entire foundation, assume it is the lower elevation
13 with the same horizontal layering of the soils. Regenerate
14 the stiffness again, and now the stiffness is proportional to
15 the area in the case of the translation of each of those
16 two.

17 In the case of rocking or torsion, it is in
18 proportion to the moments of inertia -- proportion the two
19 stiffnesses to get one stiffness, a combined stiffness.

20 MR. JENG: The question is, is there a need for such
21 a refinement, given all of the assumptions factored into the
22 analysis? And your answer is yes?

23 MR. RIZZO: This is the most refined approach
24 practical for this site. And rather than being accused of
25 being unrefined, we have taken a refined approach.

1 MR. CLOUD: Excuse me. You asked a question: Is
2 there a need for? And it's not so much an issue of need, it
3 is just that Paul is trying to do a good job all the way
4 through, using consistent technology. The different features
5 that are included in the analysis are not done in response to
6 any specific need.

7 MR. JENG: I'm not saying that being more detailed,
8 more refined, does not lead to more -- or a better solution.
9 This point, you may want to address.

10 MR. RIZZO: Engineers have to make some judgments,
11 especially in this field, and the better the analytical tools
12 you have, the more detailed your analysis. You are able to
13 refine your judgments.

14 MR. JENG: There are some cases, if you are having
15 basic assumptions, it does not make common sense. You may end
16 up with garbage.

17 MR. RIZZO: Yes. Garbage in, garbage out. Your
18 basis assumptions have to be refined to start with. We agree.

19 MR. HOLLEY: As I hear from the back of the room, I
20 think you would like to know to what extent that refinement
21 was a significant contribution to the difference. If you had
22 done it by a single elevation approach, would it have made an
23 enormous difference in the results?

24 MR. RIZZO: Not an enormous difference, no.

25 MR. JENG: That's what I suspected. We are talking

1 technically. The current Standard Review Plan asks for a
2 foundation of this type. I believe you said 6000 feet.

3 MR. RIZZO: 4000 to 6000.

4 MR. JENG: Now the SRP only requires a fixed base
5 analysis. We will not stop you from doing this, if this helps
6 you reach your goal. But I want TUGCo management to
7 understand that the fixed base analysis could have been
8 considered to be adequate. It is up to you, as I said. So
9 the refinement is fine, but do not, you know, go beyond what
10 is considered to be good judgment.

11 MR. RIZZO: I'd like to spend a little time with you
12 at another time discussing how we would pursue that.

13 MR. JENG: There is a reduction of motion that has
14 to be addressed. We would not like to see a reduction without
15 justification for the basis, especially what we are working
16 with, having a strong belief that what we are doing is just
17 right, is safe.

18 MR. RIZZO: Yes. One comment, and then I will go
19 on.

20 We have not reduced our ground motion. We have used
21 the field, the free-field ground motion.

22 [Slide.]

23 The next two slides describe in a flowchart method
24 the two procedures that we used to generate the
25 frequency-independent stiffness and damping values and the

1 frequency-dependent damping values and stiffness values.

2 The first slide deals with the calculation of the
3 frequency-independent parameters. We used here work that was
4 done by Christiano, et al., reported in 1974, for assessing
5 the stiffness and damping for a layered system,
6 frequency-independent parameters. Basically it is using the
7 half-space theoretical solutions, calculating the strain
8 energy in each layer, proportioning the modulus in that area,
9 and proportioning the energy stored in that layer, computing
10 the external work done, and then deriving a stiffness
11 parameter for each mode based on the stress field, the strain
12 energy associated with that layered system.

13 We then generate a back equivalent shear modulus,
14 use that to generate a damping effect, damping values
15 corresponding to the half-space, correct it for embedment, and
16 then in a subsequent slide, we will see -- we compare those
17 results with the real part and the imaginary parts of the
18 impedance analysis.

19 Going through this flowchart results in a set of
20 rock stiffness and rock damping values corresponding to a
21 layered system, assuming the parameters are
22 frequency-independent, which is a typical -- has been the
23 typical substructure or lump parameter approach for rock
24 structure interactions.

25 The next slide --

1 [Slide.]

2 MR. JENG: The particular methodology you presented
3 in the earlier slides, and as Ken said, the 1985 technology.
4 What you have here, as far as we know, they were already
5 publicly known in the '70s. So when you say refinement, '85
6 technology, we need to know more specifically, are you
7 applying some particular specific techniques of the 1974
8 methodology?

9 For instance, you say you're going to change the
10 10 percent material damping to 5 percent. Are you going to
11 actually do some boring of the comparative levels or low
12 strain level measurements to justify your five percent? What
13 are you doing in specifics which are new from 1975, the
14 methodology presented here?

15 MR. RIZZO: All right. There are two parts to your
16 question.

17 [Slide.]

18 This paper, this work, as you well know, was
19 originally published in 1974. In the timeframe from '74 until
20 about '80, that was put into a code and refined several
21 times. It is called the WIDGEMOD code. Those are only minor
22 refinements that were published originally in 1974. It is an
23 old Boston Institute paper.

24 MR. JENG: So there were a couple of changes in the
25 computer codes.

1 MR. RIZZO: But we did not use this in the 1974 FSAR
2 submittal.

3 MR. JENG: I'm more interested in since that time.
4 Besides changing the computer codes on paper, has any observed
5 response of a similar type of structure shown that such a
6 methodology indeed predicts better the observed response in
7 the earthquake situation? Observed data, not just a couple of
8 high technology computer program changes here and there in the
9 computer code.

10 MR. TRAMMELL: I'm going to have to break in here.
11 Vince and Annette have limited time. We can get to these
12 questions afterward.

13 Either that, or we can -- can you summarize, and can
14 we continue? These two people have to leave, and I want them
15 to get the benefit of some frank discussion on why these
16 changes are necessary and other factors that are not as
17 technical as this.

18 MR. GEORGE: We will be available to follow up.

19 MR. TRAMMELL: Can we proceed, then? You're about
20 ready to finish anyway, aren't you?

21 MR. RIZZO: No.

22 [Laughter.]

23 MR. TRAMMELL: You said originally you needed 45
24 minutes, and we are over an hour now.

25 MR. RIZZO: If you want me to zip along, I will.

1 How much time do you want me to zip through?

2 MR. TRAMMELL: I don't want to rush you. I'm trying
3 to calibrate the problem. We don't have time for unlimited
4 back-and-forth like you're doing now.

5 [Slide.]

6 MR. RIZZO: The other method for generating the
7 stiffness and damping was the frequency-dependent analysis.
8 We use here the CLASSI computer program developed by Luko and
9 Long. It accounts for the geometry and plan view. It also
10 accounts for the layering effects. It generates impedance
11 values or functions for stiffness and damping, which we
12 separate into real or imaginary parts, and in this slide
13 compare the two types of -- in this case, we're talking about
14 the three horizontal or three translation stiffness -- K_x , K_y ,
15 and K_z . The horizontal lines represent frequency-independent,
16 derived from the first procedure that we discussed.

17 These are the frequency-dependence stiffness and
18 parameters generated from the CLASSI program.

19 I have four slides, and then let me show you very
20 quickly, they are for stiffness, two for stiffness and two for
21 damping.

22 You will find when you review our work that these
23 functions are very well-behaved, as you would expect for a
24 rock site with non-linear behavior. We do not see large peaks
25 and valleys in these functions in our frequency range of

1 interest. We do not see any of the stiffness or real terms
2 going negative, as you often do.

3 These analyses are very comparable to what has been
4 done in half a dozen or so NUREGs by Lawrence Livermore on
5 design studies, part of the safety margins program.

6 We conclude from our series of slides that we are
7 using very acceptable frequency-independent parameters,
8 checked and verified by frequency-dependent analysis.

9 I will just skim through these quickly.

10 [Slide.]

11 These are the rocking. For example, the rocking at
12 the X axis, rocking at the Z axis, and the torsion. I would
13 point out, in our analysis, X and Z are in a horizontal
14 plane. Y is vertical.

15 [Slide.]

16 The next two slides are damping, geometric damping.
17 This happens to be the coefficients, not percentages.

18 [Slide.]

19 [Slide.]

20 The next step, having generated the stiffness
21 parameters for both frequency-independent and
22 frequency-dependent analyses, we correct for embedment. We
23 follow the lead of several investigators over the past ten
24 years, where basically you take the unembedded foundation,
25 develop a correction factor for it, and basically upgrade the

1 stiffness and damping values to account for the embedment
2 effects.

3 We use three different investigators for our
4 stiffness, and they do not vary that much. Our best-estimate
5 stiffness parameters, we use basically a mean value. When we
6 vary our stiffness parameters, we take the lower bound for the
7 lower-bound estimate and the upper bound for the upper-bound
8 estimate.

9 The most significant effect on embedment is in the
10 torsional mode in this particular building. It varies with
11 the building, of course.

12 These values are indicative of the correction
13 factors applied to the unembedded damping values. And of
14 course the percentage beta values are lower than these, are
15 marked up lower than this when you go to the accounting for
16 embedment effects on the percentage damping, because of the
17 stiffness term as the denominator.

18 [Slide.]

19 Step 5, we take the springs that we developed for
20 the singular mass on the elastic foundation, and in the case,
21 for example, of the auxiliary building and the safeguards
22 building, we distribute those springs to the locations in
23 those structures where the structural model is compatible with
24 it. This is a simple mathematical distribution of a rigid
25 body, showing two springs that assure geometric compatibility

1 and statics. Nothing more than that.

2 In this case it is three different locations.

3 [Slide]

4 The next step, we take the rock-structure
5 interaction parameters that we talked about in the first five
6 steps and marry those with a structural model for the building
7 which has been derived from a three-dimensional analysis and
8 condensed down to a lumped parameter model. It has 6 degrees
9 of freedom. At each node point we used three-directional
10 input motions, three motions. We develop a modal damping. We
11 have a value in our analysis, and we vary our rock properties,
12 embedment effects. I mentioned earlier that we took a lower
13 bound and an upper bound estimate of our stiffness and repeat
14 the analysis. After we repeat the analysis, we envelope and
15 peak broaden.

16 Here is a specific flow chart, the first five
17 steps. This is the model. This is basically the same as
18 reported in the FSAR, generates the value, computes the modal
19 damping values, participation factors, repeat and compute the
20 time histories in each mode, three directions of input.
21 Typical modal position analysis.

22 We have a series of time histories for output. We
23 compute the floor response spectra at the center of gravity.
24 In this point here we go look at the floor geometry. We go to
25 the edge of the slab, accounting for the rotation of the slab

1 about at the center of gravity.

2 We combine the response into the three directions of
3 input by the sum of the squares, and we repeat the analysis
4 for the lower bound and upper bound springs, put them on a
5 plot, envelope the results totally, and then peak broaden
6 beyond those another 10 percent up and down.

7 MR. NOONAN: Have you combined those?

8 MR. RIZZO: These are enveloped. The square root of
9 the sum of the squares. SRSS.

10 [Slide]

11 I would point out to you a change in the FSAR. In
12 the FSAR we had only hysteretic damping, 5 and 10 percent for
13 the translation mode and rocky modes. When we moved to the
14 inclusion of viscous or geometric damping, we change our
15 calculation of modal damping, and basically we use the Biggs
16 and Roesset equation to estimate, calculate the damping that
17 should be applied to each particular mode.

18 We are in the process of this, as you can see from
19 the earlier slides. We are coming up with viscous damping
20 values that are somewhat higher, and we are considering the
21 impact of these higher damping values, and this equation on
22 modal position analysis as part of our work.

23 [Slide]

24 The final step of this is to show you some results.
25 I am going to show you floor response spectra for the

1 auxiliary building. These are meant to be typical
2 results. This building, as I mentioned earlier, is a singular
3 large structure. It is structurally tied at the common walls
4 here, and it is structurally tied at the mat.

5 Here is a side view of it showing the
6 interconnections. This is an elevator shaft.

7 [Slide]

8 The model for this is very simply -- and this sketch
9 is for talking purposes only. The two buildings, the mat tied
10 across the structural length. The springs that I mentioned
11 earlier. The coordinate system in the plant is xz, and then
12 the vertical is y.

13 [Slide]

14 This is a summary table of the spring constants we
15 are using for this building, or the best estimate upper
16 bound. I am going to show you a slide that compares them with
17 the FSAR values in a moment. These all account for the
18 layering embedment effects.

19 This particular building, I would point out the
20 range, for example, in the vertical worked out to be about 75,
21 78 percent of the best estimate for the lower bound. The upper
22 bound may be 130 percent. That range varies from building to
23 building. It can be as much as 65 to 150. Typically it is in
24 this range, 72 to 130.

25 [Slide]

1 Now, here is a comparison of the spring constants
2 used in the auxiliary building from the FSAR versus our
3 reanalysis. This is after the springs have been distributed.
4 You can actually find these in the FSAR if you go dig into the
5 tables. You will see throughout our analysis, not only for
6 this building but for all of our buildings, that our
7 translation springs, these three, the horizontal and the
8 vertical are softer than what we reported in the FSAR. Our
9 rocking springs and torsion springs are stiffer than what was
10 reported in the FSAR.

11 Sometimes -- in this case, for example, it is three
12 times. Other times it is as much as ten. The main difference
13 is geometry considerations, layering effects, and the
14 embedment effects. They all come into play in changing these
15 numbers. We are softer in the translation, much stiffer on
16 the rocking and torsion. Here is a factor of 10 on about 1
17 axis. This is primarily a geometry consideration.

18 [Slide]

19 Damping values. These are the geometric damping
20 values that we are using in our analysis for this particular
21 building. They have been reduced to account for layering and
22 embedment effects using the two procedures described
23 earlier. They also have been checked by frequency-dependent
24 and frequency-independent analysis, and therefore we feel
25 strongly that we have got a handle on those and they are

1 highly competent in their values.

2 The material damping, we are using 2 percent, which
3 we believe to be a conservatively low number. We are going
4 back in the field and doing new borings, taking new tests, and
5 we will subject samples to strain-dependent analysis to verify
6 that number or a more appropriate higher number, in my
7 opinion.

8 [Slide]

9 I mentioned earlier that these equations, these
10 terms, then, are those beta values that appear in the Biggs
11 and Roesset equation for viscous damping. They are probably
12 viewed by many in the profession as relatively high numbers.
13 They certainly impact on response of the building. They
14 certainly impact on a modal damping value, and as a
15 consequence, we are considering the impact of those kinds of
16 values on our overall analysis procedure. They are the
17 numbers that result from impedance analysis of the type
18 described in the NUREGs done by Lawrence Livermore, and also
19 the numbers generated from the half-space theory.

20 MR. NOONAN: Those numbers are very high, aren't
21 they?

22 MR. RIZZO: They are not very high. They are
23 numbers that can be high depending on the structure, but not
24 this particular case, but they can be substantially higher,
25 particularly the translation modes. These are geometric

1 damping values, not hysteretic damping values.

2 MR. BURWELL: Could I caution you to refer to, when
3 you point to different columns, to use the title of the
4 column. If you just say "this" or "that," the transcript
5 becomes very confusing.

6 MR. RIZZO: Yes.

7 One comment, Mr. Noonan. Damping is clearly the
8 significant parameter that affects our response. There are
9 several, but damping is clearly the most -- has the most
10 serious impact. Typical results. I have nine slides for the
11 aux building, three corresponding to each of three
12 directions. This happens to be the AX. There is a high point
13 in the building. I am going to show you X direction, high,
14 medium foundation level, Z, high, medium and foundation, and
15 then a vertical high, medium and foundation.

16 The line on this plot, the response spectra
17 previously defined from the FSAR is the solid line. The dashed
18 line is the results of this reanalysis. Comparing the peaks,
19 for example, is an indication of the margin that exists from
20 the analysis. This number basically is about 5.6 versus 3.7,
21 3.8 reduction in peak motion.

22 Now, in response to Larry Shao's comment earlier,
23 you can see that across this particular elevation, this
24 particular direction, we are below our previous response
25 spectra at all points except here [indicating], at about 1.8

1 hertz.

2 [Slide]

3 Here is a mid-elevation again in the X
4 direction. These are all 2 percent damping. A reduction in
5 peak from about 4.2 to 3. We are everywhere except out in
6 this range of 1.5 to 1.8 hertz.

7 MR. NOONAN: What is the number at 7 hertz?"

8 MR. RIZZO: If you take that as the peak, it is
9 about 3.7. Here it is maybe 2.8, about a g.

10 [Slide]

11 The foundation level. It is not much different,
12 quite frankly. Frequency shift is evident from here to here,
13 but other than that, we are basically having the same motion
14 in the foundation level as we had before. None of that is to
15 scale because we are blocking it. Much reduced motion.

16 Here the frequency shift occurs. We have a slight
17 overage on the response spectra.

18 [Slide]

19 The other direction, the Z direction, the trend is
20 the same. Reduction in peak, general reduction in the high
21 frequency side.

22 I would remind you that this is after running three
23 cases, lower bound, best estimate, upper bounding. It is also
24 after peak broadening, so we have an apples to apples
25 comparison.

1 [Slide]

2 Mid-elevation, again at the foundation elevation.

3 [Slide]

4 Again you see the slight frequency shift. Vertical
5 direction. The results are somewhat more dramatic. This is a
6 attributed primarily to the much higher damping in the
7 vertical mode that you saw in the previous slide, and if you
8 are of the school of thought, as many people in the profession
9 are, that foundation should move the same or less than the
10 ground motion, you see that this is much more indicative of
11 what you should expect under real life behavior under an
12 earthquake at that site.

13 [Slide]

14 Those slides are typical of what we are finding for
15 all of our buildings. Substantial reduction in peak, portion
16 of reduction across the other frequency ranges. We are in the
17 process -- we have done that for about, I guess, four or five
18 of the six buildings we have there. The results are typically
19 the same throughout.

20 MR. JENG: Would you please rank the parameters of
21 what contributed such a drastic drop in the high level of
22 springs?

23 MR. RIZZO: It is dependent upon the building. It is
24 dependent upon the frequency, but the primary contributor to
25 the reduced response is damping, geometric damping. In some

1 cases it is the treatment of the layering in the rock, but not
2 so much, because the stiffness parameters did not change very
3 much, and the somewhat consideration of the embedment effects.

4 MR. JENG: How about the effect that you are finding
5 the rocking and torsion increase by ten times? Would that be
6 a major contributor in the reduction of the upper level
7 response?

8 MR. RIZZO: The 10 is a rocking.

9 MR. JENG: To me rocking is a major contributor.

10 MR. RIZZO: That is a geometry calculation.

11 MR. JENG: The bottom line is to make sure of the
12 way that you have reduced the movement for the foundation was
13 proper. I would like you to articulate that point. That is a
14 main contributor besides the damping.

15 MR. RIZZO: Fine.

16 MR. RINALDI: I have two short questions. One, you
17 refer to peak broadening. You use plus and minus 10 percent.
18 I want to caution you that the new requirement is 15 percent
19 unless you can prove otherwise. Just a comment.

20 The other thing is a question basically on the
21 spectra you showed for 2 percent damping. Can you comment on
22 5 percent damping? Is there significant change from what you
23 show?

24 MR. RIZZO: The changes we have shown are amplified
25 at 2 percent because of the damping. It is not as

1 important. It is reduced effect. But the trend is the same.
2 It is just more dramatic at 2 percent than everything else.

3 We would like to spend one minute on the peak
4 broadening issue, if you don't mind. I want to check the
5 thought processes on that with you folks. I do not want to
6 belabor the issue, but I think that we ought to spend two
7 minutes on it if we can.

8 MR. NOONAN: Let me suggest something here. I would
9 like to call for a short break. I have to go off to another
10 meeting pretty soon. Let me take a short break. And one
11 thing I would like you to do, I would like you to continue the
12 discussion you were having with David before we cut it off to
13 get through your presentation. I would like to get on the
14 record some of the things David was talking about. Okay?

15 Let's take about a ten-minute break.

16 [Recess.]

17 MR. BURWELL: Back on the record.

18 MR. CLOUD: On the issue of the peak broadening, I
19 guess we have felt that the Standard Review Plan was slightly
20 different than you stated it. We felt that it called for 15
21 percent, but that 10 percent would be acceptable, provided it
22 was justified with additional studies.

23 MR. RIZZO: It is on the first slide.

24 MR. JENG: Let me comment. What he says is
25 correct. The Standard Review Plan calls for 15 percent

1 boring, if you do not do any specific justification. However,
2 if you are justifying in any other way, the 10 percent can be
3 used.

4 MR. CLOUD: We feel that it is justified, and Paul
5 is going to present it.

6 MR. RIZZO: We do not need to present it, as long as
7 we have that from David Jeng.

8 MR. TRAMMELL: We have the groundrules for this
9 thing.

10 MR. RIZZO: First we have to have the groundrules
11 straightened out.

12 [Slide.]

13 The top part of the text is the Standard Review Plan
14 wording, and if you go back and look at Reg Guide 1.122, the
15 Reg Guide is substantially the same wording. And basically it
16 says, the first sentence says that you have to peak broaden
17 after you account for variations in structural properties,
18 damping, and so on and the soil structure interaction, and any
19 reasonable method for determining the amount of peak widening
20 can be used, but in no case should it be less than 10 percent.

21 If no special study is performed for this purpose,
22 the peak width should be increased by a minimum of 15 percent,
23 plus or minus.

24 For our site, we have first a rock site. And for
25 those of us who helped participate in the development of that

1 kind of wording, there was an immense concern about non-linear
2 behavior of soils. We do not have a non-linear situation. We
3 have a linear rock, and therefore a good deal of the concern
4 about soil structure interaction, in fact, is taken away once
5 you go to the linear analysis.

6 Be that as it may, we are using --

7 MR. SHAD: A lot of concern on the structure
8 stiffness. The concrete may crack or not crack. What kind of
9 structure stiffness are you using?

10 MR. JAN: It is based on uncracked, except the
11 containment. It is a cracked and uncracked model, subject to
12 --

13 MR. SHAD: When you develop the spectra, you use the
14 --

15 MR. JAN: We used the upper bound and lower bound,
16 the best estimate. We have six different models, and we
17 envelope.

18 MR. SHAD: But that is only for the containment
19 building. What about other buildings? What do you use?

20 MR. JAN: Uncracked.

21 MR. SHAD: Suppose the structure does crack? What
22 would be the spectra?

23 MR. JAN: It is not subject to pressure. We
24 recognize concrete has to crack in order to develop the action
25 of the reinforced concrete function.

1 MR. SHAD: We have studied this, that it can happen
2 six or seven times on the shear wall. We went the 15 percent
3 for that reason.

4 MR. CLOUD: Isn't it true, however, that the
5 containment building, by virtue of its greater height, has
6 higher, much higher response than the other buildings, and
7 that is the basis for -- doesn't that provide a basis for
8 studying them separately from the other buildings?

9 MR. JAN: Because of the pressure.

10 MR. SHAD: If you want to justify it, it is not easy
11 to justify it. There are all kinds of things that people
12 worry about.

13 MR. GEORGE: We would expect to justify this on our
14 submittal.

15 MR. JAN: In the existing FSAR, it is 10 percent.

16 MR. SHAD: But you want to reopen the box? It may
17 have been reviewed by a different staff at that time. As far
18 as we are concerned, it was closed, but if you want to reopen
19 it, the whole thing is reopened.

20 MR. RIZZO: Our response is that we are doing a
21 specific study, have done a specific study on a
22 building-by-building basis, specific to rock properties, the
23 embedment effects on the stiffness parameters. And from the
24 analysis, basically lower-bound, best-estimate, upper-bound,
25 and envelope those results and then peak broaden an additional

1 10 percent.

2 In our view, that satisfies this approach
3 (indicating). Any reasonable method for determining the
4 amount of peak widening, and we add 10 percent on top of
5 that. It says "plus or minus." We take 10 percent on top of
6 the widening.

7 MR. LANDERS: That was the question that I had
8 earlier when broadening was first brought up. I understood
9 what you said. You were doing lower bound, upper bound, best
10 estimate. You were enveloping those, and obviously those were
11 the shift frequencies. And you envelope that and then broaden
12 it 10 percent. The best estimate, you could come into us and
13 say that on the average, we may be plus or minus 17 percent or
14 something like that. I think that is an important point that
15 you should make in your submittal.

16 MR. RIZZO: Fine. That is what we can do.

17 MR. HOLLEY: This probably is a larger effect. It
18 probably tends to mask the structural flexibility question you
19 are asking about, other than in containment, where, for
20 obvious reasons, you have to go to a fully cracked situation.
21 These kinds of aux building structures, for example, the
22 earthquake levels we are talking about, you never get a,
23 quote, "fully cracked" situation. You only get approximate.

24 I think the kind of thing you are doing by taking
25 the upper, lower, and enveloping it in, plus or minus 10, is

1 pretty conservative.

2 MR. LANDERS: It might be meaningful to give the
3 number of -- that number of peak broadening of the best
4 estimate.

5 MR. RIZZO: I'm going to draw a plot of the
6 acceleration on the coordinant and the frequency on the
7 abscissa, and you saw that it looks something like this.

8 Now if I go over here, I get one that looks like
9 this (indicating) with the lower bound, and then the upper
10 bound looks like this. We're doing this, and then we're
11 going like this (indicating).

12 MR. LANDERS: What I am suggesting you do, instead
13 of rigidly sticking to the plus or minus 10 percent, is tell
14 us how you are broadening the best estimate.

15 MR. GEORGE: We will have that in our submittal.
16 This, again, is a briefing, and we will be making an official
17 submittal on this soon to justify these type issues to your
18 satisfaction, or we're going to change it.

19 MR. JENG: One was supposed to apply, going to 10
20 percent or 15 percent. Is that your understanding with the
21 SRP? You have three curves. Before you come to the
22 application of broadening, you are supposed to apply from a
23 line of 10 or 15 percent. That is the way you are supposed to
24 do it.

25 MR. RIZZO: Right.

1 MR. JENG: What is the best justification for going
2 10 percent and not 15 percent?

3 MR. RIZZO: It is that we looked at the specific
4 building on a building-by-building basis. We accounted for
5 variation in embedment, for variation in rock properties, and
6 we have linear behaving rock.

7 MR. JENG: That is the point of deviant behaving
8 rock.

9 I have a question to ask you. The property of the
10 soils damping modulus was primarily established on the cross
11 bore test, low strain, am i correct?

12 MR. RIZZO: Yes.

13 MR. JENG: The strain is 10 percent, and when actual
14 SSE hit, could the strain be much higher, to the extent that
15 some of the soil in the high-stressed zone could be going into
16 the nonlinear or the nonlinear range? I would ask you to
17 qualify that statement.

18 MR. RIZZO: We have estimated the strain behaviors
19 for the SSE under the rock. It is not exceeding -- I will
20 recall this now from memory -- about 10 to the -3, 10 to the
21 -4 percent.

22 MR. JENG: SSE, if you are anywhere in the range of
23 10 to the -2, if you look at the curves, which you have seen
24 many, you may have to think about it and talk about it. I am
25 saying that you have the behaving rock, and the SSE range may

1 not be correct or quite accurate. I would like you to reserve
2 that.

3 MR. RIZZO: We will substantiate that we are in a
4 linear range where the strain dependency is on the modulus and
5 the damping. We have checked that already and have convinced
6 ourselves that we are all right.

7 MR. JENG: I presume you are going to have an
8 organized line-by-line justification for why you are going to
9 10 percent in your submittal.

10 MR. RIZZO: Yes.

11 MR. JENG: Anything else on this one?

12 MR. LANDERS: If I can go back to the presentation,
13 for the boring you talked about an '85 study. One of the
14 questions that I had was, you said you had relative
15 uniformity. One of the questions that I had was, for example,
16 what is the difference between a P-12 and a P-4?

17 It looks to me like you are going to do your '85
18 work -- and you have to, obviously -- outside of the
19 foundations, and you're going to use that and maybe increase
20 your material damping.

21 I think if you're going to do that, we need to know
22 the kind of comparisons you are getting between P-12, P-34,
23 and the borings that are actually under the foundation.

24 MR. RIZZO: We have shear wave velocity measurements
25 up in here, which are the basis for our analysis. And that

1 is, you look at all of that data for the shear wave velocity,
2 and you see that the numbers we are using are typical for the
3 Glen Rose limestone, the claystone, and Twin Mountains
4 formation.

5 Now what we don't have from the FSAR are
6 strain-dependent dampings for that particular formation. We
7 are using 2 percent. We are going down into the plant where
8 we have access, obtaining core from that formation, down to
9 500 feet in fact. We extract cores, and then we test cores of
10 that formation for that property.

11 Now it is a sedimentary deposit, relatively
12 uniform. We do not expect any significant deviations in shear
13 wave velocity or material damping across that site. We do
14 expect changes in thicknesses, and that is why we look at each
15 building on a case-by-case basis. Some places the claystone
16 may be five feet thick; in other cases it may be four feet
17 thick, and we account for that in our analysis. That is the
18 main purpose.

19 MR. LANDERS: I understand the purpose. I'm just
20 telling you that in doing that, just verify what you said.

21 MR. CLOUD: The key thing is the limestone itself
22 will have the same properties, regardless of what it is, and
23 the claystone will, the other borings, so the trick is just to
24 be sure to account for how much of which there is.

25 MR. TRAMMELL: I would like to ask a couple of

1 licensing questions when the technical thing has run its
2 course.

3 Are we through with that?

4 MR. JENG: With the technical?

5 MR. LANDERS: I have one more question. In making
6 all of the changes that you made, just as a matter of
7 interest, why is it that you did not pick up the Reg Guide?

8 MR. RIZZO: I have one answer, you have a different
9 answer. Do you want to give yours first?

10 We did not want to change basic seismic input.
11 That's what we did not want to change. We thought that would
12 be subject to more concern on your part than if we just
13 changed our analysis procedures.

14 MR. TRAMMELL: How is it that you can reach the Reg
15 Guide --

16 MR. JAN: When we submitted the PSAR for this
17 project, it was in early '73. And then I think I remember in
18 March or April at the San Francisco conference the Newmark
19 paper was presented. And at that time, I guess, everyone
20 attending the seminar realized the curves to be used in the
21 future, so I guess quickly we changed our input in the PSAR
22 based on that paper. And then towards the end of that year, I
23 think the Reg Guide 1.60 was published, and the Reg Guide 1.60
24 Revision 0 was somewhat different from the original paper.

25 But we already submitted the curves based on the

1 paper. We did not both to change because the difference was
2 rather small.

3 MR. LANDERS: But here we are now in '85, and I'm
4 wondering why you did not change that. And what I heard was,
5 you did not want to change the basis for seismic analysis,
6 when in fact you have done that. You have changed input which
7 has an impact on that.

8 MR. JAN: But the difference is rather minor.

9 MR. LANDERS: But one of the differences is the high
10 frequency range, and the high frequency range can be a
11 concern with respect to operating equipment.

12 MR. SHAD: But the minute you reopen this,
13 everything is subject to review, all of the assumptions.

14 MR. RIZZO: That is a rather broad comment.

15 MR. SHAD: The whole subject relating to the
16 spectra, the soil structure interaction analysis. If you
17 change that portion of it, you change the whole thing.

18 MR. TRAMMELL: You're opening up the box here. This
19 was all reviewed and accepted back in 19-- -- whenever it was
20 you got your construction permit. You're opening it up, and
21 who knows what is in that box. You're going to find, who
22 knows?

23 Do you want to do this?

24 Let me ask a couple of other questions. You want to
25 update yourself to 1985, yet you are sticking to your old --

1 Reg Guild 1.60 for horizontal and not Reg Guide 1.6 for
2 vertical. The point is, at what point do we go back and amend
3 the construction permit? And that is my licensing question.

4 You have a construction permit which is tied to what
5 we have already accepted, and we are going to need a
6 discussion from you on why it is that you do not need an
7 amendment to your construction permit.

8 This is pretty major, seeing accelerations going
9 from 5 gs down to 3 and that kind of thing. It is of
10 substantial benefit to you. But I think you are going to have
11 to face that issue.

12 MR. CLOUD: Why would it be necessary to amend the
13 construction permit?

14 MR. TRAMMELL: Put the shoe on the other foot. Why
15 isn't it necessary? You're making substantial reductions to
16 the safety margins in the structure.

17 MR. CLOUD: I would say on the face of it, the
18 reason that it is not necessary is because we have changed
19 none of the fundamental design-basis parameters.

20 MR. TRAMMELL: Just discuss it when you make the
21 submittal and see how it comes out. It certainly raises that
22 question.

23 MR. GEORGE: Could I speak to your question and
24 Mr. Bosnak's question before he left as to really why we are
25 doing this?

1 MR. TRAMMELL: I would like to hear why. This is
2 not just research and development.

3 MR. GEORGE: Could we start with the Comanche Peak
4 piping system and the electrical system, the supports for the
5 piping systems as well as the supports for our -- the supports
6 for the conduit in the raceway as well as the piping?

7 The capability of these supports to behave under the
8 seismic events and carry the loads they are subjected to, of
9 course, has been called into question.

10 Now if you go into the prerequisites of all of the
11 design process to design for these forces, to decide what
12 loads they should be able to carry, we feel, from an
13 engineering point of view -- and it is based on pilot studies
14 -- that certainly there is conservatism, that in a number of
15 the prerequisites -- and the response spectra, of course,
16 being one -- we think that there is conservatism there, that
17 by reevaluating and by reanalyzing this spectra, certainly
18 there could be some insurance down the line when the Comanche
19 Peak response team, whom you have heard last Thursday and
20 Friday, are responding to the NRC technical review team
21 issues, and they told you down there that they would be using
22 the existing parameters, the existing response spectra, with
23 Stone & Webster in their analysis.

24 And Mr. Bosnak was questioning me on that at the
25 break. There seemed to be a conflict there. And I stated --

1 and the project would like to make this submittal -- we feel
2 that the reanalysis of this CPRT, using the existing
3 parameters, that we can satisfy all parties, if they are okay
4 with possibly some modifications.

5 We view this down the line as insurance, because if
6 the Staff does accept what we submit -- and certainly we are
7 aware that there are a lot of aspects involved here with
8 equipment qualifications and the things you raise -- we do not
9 take this lightly -- and in the submittal that we make, we
10 would expect it to be documented and self-supporting to your
11 satisfaction.

12 That is an attempt on my part to summarize why we
13 are doing it. It has been under way, really, for a long, long
14 time as far as reviewing the response spectra over in the
15 engineering area. There has been considerable rigorous
16 analysis put into it in the last several months as to where we
17 need an amendment to the construction permit. Certainly we
18 will evaluate that, and I will get John Beck and the licensing
19 folks involved. And again, the purpose of meeting here today,
20 I feel, has been very successful in meeting our objectives, in
21 meeting your response to the status of our analysis at this
22 point in time.

23 I told you earlier we were expecting to make a
24 formalized, well-documented submittal on this matter soon and
25 would appreciate your timely response to it.

1 MR. SHAD: One other question I have. Can you
2 mention some other plants in the United States that have used
3 this particular methodology?

4 MR. RIZZO: Every plant that is using the lumped
5 parameter analysis is doing the same thing. The use of the
6 impedance analysis is a verification of our
7 frequency-dependent parameters. There is nothing unusual.
8 Other rock sites, like Diablo, are fixed base.

9 MR. CLOUD: Yes and no. Ultimately it turned out to
10 be fixed base.

11 MR. SHAD: You propose to meet the Standard Review
12 Plan?

13 MR. RIZZO: Yes. Does anybody want to challenge
14 that? I don't think there is any issue with that. Frank, you
15 seem to know it fairly well.

16 MR. JENG: There is some concern as to whether you
17 actually met commitment to motions that it is applied in the
18 free field at the foundation level because of the way that the
19 substructuring approach is done. There could be a Classi
20 factor in the reaction of the motion. That is the point I
21 mentioned earlier. If you would stress in your submittal why
22 you think that is not the case.

23 Coming up to Larry's point, some specific
24 quotatation of other licensing plants which use the specific
25 thing as a basis for the interaction.

1 MR. RIZZO: Eduardo Cossell reviewed it.

2 MR. JENG: You could call it another name, but this
3 particular substructuring of any other plant which you know of
4 has used this one as a licensing basis, he wants you to quote
5 it. That's the point.

6 MR. RIZZO: All of the work that Lawrence Livermore
7 has done, Classi runs.

8 MR. JENG: This is a good point for me to point to
9 you --

10 MR. SHAD: I am familiar with the Lawrence Livermore
11 work. I was in charge of it. But the actual application of
12 plants I want you to cite if there are any plants. I am
13 talking about actual application.

14 MR. RIZZO: You understand the use of Classi
15 and that computer method for the frequency-dependent analysis.

16 MR. JENG: The point is that you mentioned earlier
17 the NUREG report such and such here does not consider
18 different than the NUREG.

19 MR. RIZZO: I know. I have published NUREGs too.

20 MR. SHAD: You have mentioned that Lawrence
21 Livermore -- this is all research. The Regulatory Staff has
22 not adopted a position. My point is if you can cite any plant
23 that has used this, maybe two or three or whatever you have.

24 MR. RIZZO: We both have to appreciate that the
25 amount of soil-structure interaction analysis that has been

1 done in licensing in the last few years has been minimal.
2 There have only been a couple of plants. And here you have an
3 advancement of the state of the practice; not the state of the
4 art, the state of the practice, and you should not penalize us
5 for trying to do a refining and as technical a job as
6 possible.

7 MR. JENG: We are not doing that.

8 MR. RIZZO: Then fine.

9 MR. SHAO: But then why aren't the other plants
10 using it?

11 MR. TRAMMELL: This is a construction permit issue.
12 That's why there has not been any traffic in this area, and
13 that gets back to my first question. Is this one of the
14 principal engineering and architectural criteria for this
15 plant? And if it is, we need an amendment to your
16 construction permit.

17 MR. CLOUD: I would say it is not.

18 MR. TRAMMELL: That's fine. I will not debate it
19 with you. But I would leave you with a question. This is a
20 CP issue, basically.

21 MR. CLOUD: I understand.

22 Larry, in response to your question, I think the
23 method -- in our submittal what we can do is identify the
24 differences between the work that Paul has described and all
25 of the other -- what I would like to call the regular lumped

1 parameter approach, but most of the plants in this country
2 were licensed on the basis of a lumped parameter analysis, and
3 I think the work that you describe differs very little, if at
4 all, from all of the other lumped parameter analyses presented
5 in the past.

6 MR. SHAD: There is a difference.

7 MR. JENG: You mentioned in your opinion there are
8 very small or insignificant differences between the other
9 methods versus this method.

10 MR. CLOUD: I said we would identify the
11 differences.

12 MR. JENG: Let me turn it around and ask a
13 question. Would you find it more useful to use a regular
14 fixed-base and still find that it serves the purpose which you
15 mentioned? A simple fixed-base model, which would have been
16 much easier with the -- my question is, can you do that? Would
17 that help you enough? I would like to know. That would be
18 much easier and less at issue if you used that one, and then
19 you are entitled because of the rock foundation there, and the
20 SRP says you can use fixed-base analysis.

21 MR. RIZZO: You agree we are clearly rock. Are you
22 alone or do you have universal support for that position,
23 David? If you do --

24 MR. GEORGE: We started out on this several months
25 ago. In fact, that was our objective, to go with the

1 fixed-base model, but when we got into the issue of the
2 layering, we were trying to go the extra mile, and we are
3 aware that this is taking us more time. If we had gone
4 fixed-base, I guess we would have been in here two or three
5 months ago. But we have done all of this. I have tests going
6 on site just right away, redoing the cross-hole measurements
7 and the shear wave velocity, all of this layering.

8 So we have been trying to go the extra mile to make
9 sure we are doing the right thing.

10 MR. JENG: Is that because if you were doing that
11 method you had proposed here, the outcome, the preliminary
12 outcome would have shown lower than that you would obtain from
13 a simple fixed-base method? That's not the case?

14 MR. RIZZO: No. The shear wave velocity is between
15 4000 and 6000. The 4000, the lower number, is the equivalent
16 shear wave velocity for the entire formation. The Glenrose.
17 But the those interbedded claystones in there, they can be as
18 low as 3000 or 2300 feet per second. When you put it all
19 together, you get 4000. The limestone itself may be 5000.
20 That's the real problem, by your definition. Clearly I have
21 to shoot it to get it out. You begin to look at the clay.
22 You are going to question, if they come in with a fixed-base
23 analysis, if it is, in fact, the same.

24 MR. CLOUD: That is exactly what we were concerned
25 about.

1 MR. TRAMMELL: We will have to talk one at a time.

2 MR. JENG: If you are talking the 4000 to 6000, I
3 really have difficulty arguing of treating that as a soil. We
4 commend you trying to do the best job, but if you are going to
5 do this particular type of approach, it may be more of a
6 detailed review on the part of the Staff because of not being
7 quite often used in the past compared to other generally
8 practiced approaches.

9 I could quote you 30 or 40 plants using the fixed
10 base. I think you can find plenty of cases where your type of
11 rock can support the simple fixed-base model.

12 MR. RIZZO: My concern with that problem is that
13 when you rewrote the Standard Review Plan between 1975 and
14 1981, you took out the criteria for what is a rock site. The
15 1975 Standard Review Plan says -- 3500. In '81 there is no
16 mention of that.

17 MR. JENG: But you can quote the precedents. The
18 point is can you do this particular fixed base model and
19 serve your purpose? If the answer is yes, I would suggest
20 that you consider that approach to meet the least resistance
21 and more efficient, but if you cannot achieve what you intend
22 to achieve, then that is a different story.

23 MR. RIZZO: Give me a criteria under which I can
24 tell you that I have a rock site or not. If you can give me a
25 criteria, then we will decide whether we are going to take

1 that approach. Right now we are lacking a criteria.

2 MR. JENG: I'm not here to say anything, but if you
3 ask what are the rock materials you have there, essentially
4 what is shown in the past, there are no changes or not even a
5 mention on your part, then we will consider it.

6 MR. SHAO: The minimum shear velocity is 4000?

7 MR. RIZZO: We have in those claystones the same
8 bands that I showed I showed you on that one slide. Shear
9 wave velocity could be as low as 2300. Now, those are 5 feet,
10 6 feet, 3 feet thick.

11 MR. JENG: Out of how many?

12 MR. RIZZO: Out of 400 feet.

13 MR. JENG: As competent engineers, is such a
14 refinement really in the best interest of this analysis? You
15 should think about it. Five or six hundred feet. You have
16 ten lenses of five to ten feet interspersed somewhere.

17 [Slide]

18 MR. RIZZO: Beneath the aux building, there are two
19 layers here, one here and one here.

20 MR. JENG: That is to scale.

21 MR. RIZZO: The foundation, 784.6. This is 776.9.
22 That is eight feet. I have a couple of feet of limestone, I
23 have 3 feet more claystone. Here is 5 feet of claystone.
24 Here is 10 feet of claystone.

25 MR. JENG: In the order of 3000 -- 2300. We are

1 remeasuring it, though.

2 MR. RIZZO: 2300, maybe 3000.

3 MR. JENG: Why can't you apply the weighting
4 approach that you did on the other stepped mat? To me --

5 MR. RIZZO: When you weight it you get 4000.

6 MR. JENG: Many people have done that. I am
7 wondering why you did not feel that could be there.

8 MR. RIZZO: We would be very happy to do that,
9 David, if you accept it as a criteria.

10 MR. JAN: Is 4000 acceptable?

11 MR. JENG: Unofficially, subject to upper management
12 approval. I think it is a --

13 MR. LANDERS: We have accepted 35.

14 MR. JENG: Maybe you would reassess the situation.

15 MR. HOFMAYER: Perhaps one consideration would be if
16 you had comparisons for fixed-base versus the method. They do
17 not substantially differ. Then you have justified that it is a
18 fixed-base site.

19 MR. GEORGE: The pilot studies were done on
20 fixed-base. I hired consultants to do pilot studies a number
21 of months ago. The results are probably even more significant
22 than this.

23 MR. RIZZO: For some frequencies we see a more
24 dramatic reduction.

25 MR. HOFMAYER: But that establishes whether or not

1 there is a fixed-base site. After all of this refinement, the
2 results are not substantially different.

3 MR. GEORGE: We did not want to come in here and say
4 we have a fixed-based site and we have shear wave velocities
5 that we are going to be discredited for. Again, we were
6 trying to overdo it.

7 MR. HOFMAYER: You could reverse it. If you came in
8 with a fixed-base site, people would ask you a whole lot of
9 questions.

10 [Laughter]

11 Maybe you are home now and you could meld the two
12 arguments together.

13 MR. JAN: It is more or less in line with what we
14 have in the FSAR.

15 MR. JENG: Let me take a summary of what I would
16 like to say, and then I will pass it on to other people. You
17 have presented a procedure which I feel there are these
18 following weaknesses. Number one, you should articulate more
19 as to why you are doing this reanalysis. The question could
20 be asked, given the environment we are operating under, what
21 is wrong with the earlier one? And please answer the
22 question. That question is very important.

23 Secondly, I think Don Landers has a good point, and
24 Larry mentioned this earlier. You should strongly consider
25 the use of Reg Guide 1.60, although I agree they are not much

1 different. If they are not much different, then why -- make
2 it easier. You should consider it using the 1.60, but that is
3 subject to Charley's point, whether this would be a major
4 change that would require the CP revision.

5 Now, let me go to several points I mentioned. If
6 you are right to persist to use this approach, the Staff in
7 the past have encountered some concerns, and that concern --
8 I'm not saying it is unsurpassable, but it is a concern you
9 have addressed in more detail, and the point is the three or
10 four. And then in the next one, I would like to say --

11 MR. SHAD: The three or four plants that --

12 MR. JENG: The three or four parameters of
13 concern. The potential reduction of the motion from the upper
14 to the foundation level, and how did you account for the
15 embedment as you indicated you did? And also, how are the
16 material damping justified to be changed from 2 to 5 percent
17 potentially? It may not be the finite. And also, the spectra
18 has dropped so much from before and after, and there would be
19 some questions asked as to why. Is it the right thing to do?
20 Did we do wrong things before? And that you should articulate
21 and do your best to defend or justify.

22 In regard to the submittal, if you are going to use
23 this method, fine. One question would be how does it compare
24 with down to earth fixed-base with the damping model? Would
25 the result differ too much or are they about the same? If

1 they are about the same, what is wrong? In regard to that,
2 you talk about your concern about the rock or soil. I think
3 unofficially we feel that if you were talking 4000, on the
4 average, on the weighted basis, I think that we are quite
5 confident it will rock.

6 MR. CLOUD: What if it were 3500 on a weighted
7 average basis?

8 MR. JENG: I still maintain you could quote the
9 precedence of earlier licensing actions, and Larry mentioned
10 that there are 31 positions there. Based on that position,
11 many plants have been licensed, and that makes a good
12 argument, in my opinion.

13 MR. SHAD: There are lots based on -- anything more
14 than 3500 is a rock site.

15 MR. JENG: You know and we know that anything above
16 2500 -- and Newmark was quoted many times to me. The response
17 does not differ so much. It does not show up.

18 The increase of ten times in the rocking. That is
19 one of the main considerations of the reduction in the peak.

20 MR. RIZZO: On that building.

21 MR. JENG: Yes. If you are having that result on
22 other buildings with active or more thorough --

23 MR. RIZZO: Only on that building do we have that
24 dramatic change.

25 MR. JENG: The last point, Don Landers' point. You

1 are going to do a simple boring outside of the plant area. I
2 think one can conclude that the system within the plant
3 complex will be identical. It is made with some variation in
4 the thickness, and if you're going to prove nonlinear
5 behavior, you may prove it; otherwise I see no point in doing
6 it, unless you want to prove some nonlinear behavior of the
7 material to prove it is 5 percent rather than 2 percent. For
8 that purpose, I can see it. But one may not be enough.

9 MR. RIZZO: We're doing three borings. One area,
10 three borings.

11 MR. JENG: I don't think that is variable. That's
12 an opinion of mine.

13 MR. RIZZO: Before we leave that, --

14 MR. JENG: What do you want to know?

15 MR. RIZZO: If I can show the shear wave velocity
16 equivalent is higher than 3500 -- and we think that we can
17 justify a fixed base -- that is important.

18 MR. JENG: Don't you know that as shown in the
19 earlier boring? You mentioned the rig. You have shown 15 or
20 20 borings.

21 MR. RIZZO: When I come in to argue with you guys
22 about whether it is 3500 or 4000 or 3300, you are going to
23 take issue with me on the data.

24 MR. RINALDI: Can I interject something? I guess
25 this review was done several years ago, right?

1 In the previous evaluation, you took this as rock.
2 You took this layering effect. Did you consider the layering?

3 MR. RIZZO: Only in equivalent value.

4 MR. RINALDI: You took it as a rock site?

5 MR. RIZZO: With a shear wave velocity of 4600,
6 something like that.

7 MR. RINALDI: Basically, I don't know if we're going
8 to be reviewing the submittal that you have in mind, but from
9 what I hear, you have two limiting conditions. You're taking
10 it as a layered site, and you're taking it as -- you've done
11 some preliminary studies to be fixed base, and you have all of
12 the information. It is just a matter of presenting it, I
13 guess, the way I see it.

14 MR. GEORGE: We have a world of information, and I
15 might point out, as Mr. Scheppele stated earlier, Professor
16 Holley and a number of other professors concurred with what we
17 were doing. They, in the early meetings, the biweekly
18 meetings, the concern with layering and the one with fixed
19 base is one of the things that led us to go the way we're
20 going. We definitely started out on verifying if the shear
21 wave velocities were such that they would be acceptable to you
22 people and used the fixed base.

23 It is certainly more straightforward and easier. We
24 will reanalyze exactly where we are at.

25 MR. RINALDI: It sounds like you have all of the

1 information. But if you have any question, I just want to
2 present a suggestion. To make a decision about the soil, you
3 might want to have the concurrence of the geoscience, the
4 geotechnical persons on the Staff, which probably would have
5 an input in determining that. I want to suggest, from the
6 structural point of view, although I have not seen all of the
7 results -- I was just given an outline -- it seems that you
8 have all of the information and the limiting cases considered
9 in your evaluation, so that the only other suggestion is that
10 you might want to get an input from the geotechnical,
11 geoscience person at that site, where you can just go the
12 shortcut and take 4000 as an average weighted value.

13 MR. JENG: One important point --

14 MR. LANDERS: If you stay with what you have -- if
15 you don't, then fine -- but if you are going to stay with what
16 you have, can you give us an idea now of why you had dramatic
17 changes in stiffness versus the old approach? Why is it that
18 the lateral stiffness reduced and the rocking stiffness
19 increased?

20 MR. RIZZO: The lateral stiffness is reduced
21 primarily because of the layering of the claystone up near the
22 top of the foundation. The vertical reduced primarily because
23 the shear wave velocity of the Twin Mountains formation is
24 a little bit lower than Glen Rose, and when the original
25 analysis was done, it was assumed that the vertical is not

1 influencing that depth. It does influence that depth, in
2 fact. The rocking is the geometry. What you saw was the most
3 dramatic effect in the aux building.

4 MR. LANDERS: Explain geometry to a layman.

5 MR. BURWELL: Can you use a slide and make some
6 reference? I think it would be easier.

7 MR. RIZZO: Sure.

8 MR. BURWELL: This is Section DD of the auxiliary
9 electrical building, an earlier slide.

10 [Slide.]

11 MR. RIZZO: I would like to go back to the previous
12 slide, the plan view of that foundation. When we did the
13 original FSAR analysis for this building, the mat, although a
14 singular mat, crosses the entire length. It was treated or
15 split to accommodate the structural model, which you recall
16 from previous slides, is two sticks coming down.

17 [Slide.]

18 At that point, the construction model has a stick
19 here and a stick here (indicating), and when the rock
20 structure interaction parameters were considered, this was
21 taken as a single mat, and this was taken as a single mat
22 (indicating), even though it is one continuous mat across
23 there.

24 So when the springs were calculated, they were
25 calculated one here and one here (indicating), while, in fact,

1 if you consider the entire mat, it is not linear. You do not
2 have the two, because it is a cubic function, and therefore if
3 you generate one stiffness with this direction, as opposed to
4 two small ones, you get a much larger rocking stiffness.

5 MR. LANDERS: You had a slide up that showed the
6 stick model that had two separate slabs, and did it not have
7 springs in each slab?

8 MR. RIZZO: You are correct.

9 MR. LANDERS: So your model, in fact, --

10 MR. RIZZO: When I went to the model, I said we
11 calculated a singular spring for the entire mat, and I said
12 that we resolved it was consistent with the model.

13 MR. LANDERS: How did you resolve that?

14 MR. RIZZO: By shearing geometric compatibility and
15 static. That, in fact, is where the big factor comes from on
16 the one spring in the geometry calculation.

17 MR. JENG: The torsion, the stiffness, you used the
18 entire mat? Do you separate the two models?

19 MR. RIZZO: When we do this analysis, we have a
20 separate torsion spring as well.

21 MR. JENG: For the determination of the rocking and
22 torsional spring for each of the mats shown there, did you use
23 separate one-half dimension of the total mat?

24 MR. RIZZO: When we calculated the spring constants
25 for this building, it was two steps. First, the spring

1 constants were determined for the entire singular mat beneath
2 that building.

3 MR. JENG: For what degree? For six degrees?

4 MR. RIZZO: Six degrees of freedom. When we applied
5 it to the structural model, which is broken into two parts, we
6 resolved this spring into two components, each one of those
7 six springs into the two components. Geometric
8 compatibility. The two verticals must equal the vertical.
9 The rockings must satisfy the rocking, including the vertical
10 components. Torsion must be satisfied by the horizontal
11 springs.

12 MR. JENG: But between the two submats, you must
13 have some point of comparing and determining, assuring
14 compatibility.

15 MR. RIZZO: It is riding statics. Some of the
16 verticals must be vertical.

17 MR. HOLLEY: At the risk of messing it up, Dave,
18 what I think Paul has done is to calculate first the six
19 springs on the basis of a single large mat. It is then said
20 that if you had that single large mat, but each of these six
21 springs was actually a pair of springs, so you had two located
22 for the separate parts, what would the properties of those
23 twelve springs have to be to be equivalent to the six? And to
24 calculate that, you use simple statics and geometric
25 compatibility on the assumption that whatever was occurring

1 was the geometry of the large mat.

2 In other words, if you simply said, I'm going to
3 take the six springs for the large mat and by statics alone,
4 break them down into two sets. That's all they did.

5 MR. JENG: But it should not be the statics
6 consideration. It should be that the behavior responds to the
7 deformation, to judge whether compatibility has been
8 attained. You are equating the two forces, that the sum
9 equals the origin of the big one. But what about the
10 behavior?

11 MR. RIZZO: That is a simplified way of saying it,
12 David. You also have to assure the rocking spring, the
13 overall rocking behavior of the foundation. I know I have two
14 springs, how the two springs are affected by the verticals.

15 MR. JENG: Do they rotate at the same angle?

16 MR. RIZZO: Yes. You assure that kind of
17 compatibility.

18 MR. JENG: What was the advantage of dividing the
19 two sticks. Why couldn't you use the six springs or the large
20 mat? What is wrong with that?

21 MR. RIZZO: Nothing is wrong with it. It is another
22 approach to doing it. This is the one that was used in the
23 FSAR.

24 MR. JENG: It is sort of unorthodox, and it is
25 arbitrary, but I don't make judgments.

1 MR. RIZZO: We have to make certain judgments. At
2 what point, do you change your FSAR, and at what point do you
3 simply change analysis procedures? This is one of those
4 borderline cases. We elected not to change this part of the
5 FSAR. It would certainly be no different if we put a single
6 mat in there with the same springs.

7 MR. JENG: The upper mass points.

8 MR. RIZZO: You get slightly different responses.

9 MR. JENG: The response is what we are interested
10 in, to make sure they are consistent and compatible.

11 MR. RIZZO: If you want to be consistent with the
12 FSAR, then you have to do this (indicating).

13 MR. JENG: I presume you have some explanation of
14 how this is done.

15 MR. RIZZO: Yes.

16 MR. TRAMMELL: Let me ask a couple of questions. Is
17 this over with?

18 Go ahead, Bob, you seem like you want to say
19 something.

20 MR. CLOUD: I don't want to contribute to this. I
21 want to come back to the issue of the fixed base. I can do
22 that when you're finished.

23 MR. TRAMMELL: Let me ask a question. We have seen
24 -- we have a response spectra meeting, and it looks like you
25 want to change the response spectra, and there are some other

1 things that have gone on in recent requests that make me think
2 that I want to see what the entire program is, if it is a
3 program, or these little piecemeal things.

4 We have been asked to approve the use of some recent
5 edition of the ASME Codes on supports, Section NF. We have
6 been asked to allow you the use of, I think it is N-397, as a
7 code case, but I'm not sure. It has to do with combining
8 modal responses or something. You know what that is, but I
9 don't.

10 We have been asked to approve the use of Code Case
11 411, which has to do with damping piping, I believe, and now
12 we have response spectra. These four things seem to be
13 related to the same subject. If you're going to go back and
14 redesign piping or conduits or cable in some cases, it would
15 be of some value to you.

16 Is there anything else? Is there going to be a
17 meeting on something else next week, or is this pretty much
18 the end of the reassessment program?

19 MR. GEORGE: As what I call the prerequisites
20 to this analysis, this is a response spectra, to my knowledge,
21 coupled with the code cases. It will be what we will have the
22 opportunity to use in any reanalysis, with your approval, of
23 course, and we are proceeding with the reanalysis, of course,
24 on our existing design basis parameters. That is the Stone &
25 Webster reevaluation of piping.

1 MR. LANDERS: For example, is there any anticipation
2 that you know of, Joe, to use higher damping for the cable
3 trays, which is not a code situation?

4 MR. GEORGE: The program on Unit-1, I don't
5 anticipate the additional damping there. That could be one
6 that I don't have the answer to here today. The response
7 spectra will impact, providing what comes through on response
8 spectra we have talked about here today, it will indeed affect
9 the loading on cable tray supports and on conduit supports and
10 more importantly on embedded bolts that attach these to our
11 steel reinforced concrete. I view this response spectra issue
12 as an opportunity in any reanalysis to add a layer of
13 insurance to the showing that this equipment is satisfactory
14 and will do its job in most cases, and hopefully with a
15 minimum of redoing the things.

16 MR. HOLLEY: I think the program that Marquette
17 discussed last Friday for the cable trays envisioned -- or he
18 actually mentioned some element tests, among others, and I
19 can imagine that these might lead to a request for local
20 damping changes.

21 MR. GEORGE: It possibly could. But as far as my
22 being able to tell you positively one way or the other, I'm
23 not in a position to do that today. We will be testing the
24 conduits more than the trays.

25 MR. SCHEPPELE: I'm not sure whether they plan on

1 esting the trays with regard to damping, but certainly then
2 it would have to be defended.

3 MR. LANDERS: We understand that, but really what
4 we're trying to do here is, faced with the ARS potential for
5 that, is to look at all of the issues that would be impacted
6 by that, and if, in fact, there is the anticipation to use
7 higher damping values on the cable trays, it would be nice to
8 know that up front.

9 MR. TRAMMELL: We want to get it all together, so we
10 have a package here, so that we know collectively what we are
11 faced with. We do not want to just pick this piece of the
12 code out of here, because we kind of like that, and say,
13 "Let's go back to the '74 code for that. That's kind of
14 neat." And by the time you put it all together, you don't
15 have the cohesion that we thought we had.

16 MR. CLOUD: Can we come back to the fixed base,
17 because Don raised a question that would help you better
18 understand exactly why we did this?

19 Could we see the soil profile again?

20 [Slide.]

21 It is kind of important, because it would have been
22 easier for us, as Joe mentioned, to go -- to come in and ask
23 for fixed base. But we wanted, if you will, to account for
24 any potential questions that would subsequently come from you
25 people, and as Don's question on how did we -- why did the

1 stiffnesses change, clearly, you know -- clearly elaborate the
2 reasons for us making the decision that we did, because
3 whereas a couple of feet of claystone here and here and here
4 would not make any difference, the placement of it is very
5 important. As you see, it is -- the thick layer of claystone
6 is right at the very top.

7 [Slide.]

8 This strongly affects -- this shows it even more
9 clearly. The thickest layers of the claystone are right at
10 the very top, which strongly affect the rocking and the other
11 close-in properties.

12 And not shown on this -- and by the way, the middle
13 one in this picture is exaggerated. It is very thin. It is
14 only a couple of feet, and then it goes down for 100 feet of
15 solid limestone, but then the entire thing is underlain with
16 the other formation, the Spring Mountain formation, which has
17 a strong effect when you consider it. So it is the placement
18 of these different things as much as the volume of them, and
19 we felt that if we do it the way that we had done it, then we
20 will more properly account for the true physical behavior of
21 the site. That's the reason we did it. Right, wrong, or
22 indifferent, that's the reason we did it.

23 MR. RIZZO: The claystone was 2300 to 3500.

24 MR. JENG: This resulted in the change of the --
25 drastically in the vertical direction?

1 MR. RIZZO: The horizontals.

2 MR. JENG: Based on my experience of reviewing
3 plants, I'm not concerned about the vertical direction; I'm
4 very much concerned about the major change of the spring,
5 which is the 80 percent contributing to the higher level of
6 response in the horizontal action, Z. I will be concerned if
7 you are proposing a procedure which would change the torsional
8 springs and rocking, which in my understanding would lead to
9 changes of 80 percent of the responses at the high level. I
10 would like to know why such a change is reasonable,
11 justifiable and supportable, and for that reason I am going to
12 add the point that he reminded me. Assume you are going to
13 continue to come up with the procedures, which you might as
14 well, though, if you so believe that is the basis for your
15 plan.

16 I would like to see any additional informations
17 which are so-called observed behaviors, observing the response
18 data of any plants as they are compared to the application.
19 Not just saying that in 1983 somebody wrote an improvement on
20 the computer of such and such and another guy wrote a
21 refinement of the computer code, and putting these together,
22 you say it is 1985 technology.

23 That is not what we are interested in. We are
24 interested in what reality has taught us since 1975 which
25 would make your procedure more supported, more believable. If

1 you have such information, we would appreciate it. Maybe to
2 try your effort to find if there is any other evidence.

3 MR. RIZZO: The best we have is Humboldt Bay, the
4 performance that -- you know the results of that.

5 MR. JENG: Since Humboldt Bay, have you observed
6 anything from a European source?

7 MR. SHAD: So far the methodology changes have been
8 analysis. The actual observed behavior experiments. Do they
9 have anything about actual incidents?

10 MR. RIZZO: We can certainly look in Europe. We
11 know there is nothing else in the States except Humboldt Bay.

12 MR. JENG: If you have a 2300 psi interspersed in
13 such a way, I consider that this is part one from the
14 engineering standpoint for the structural analysis. I believe
15 that is the case. But you have other judgments. Then I would
16 yield to that.

17 MR. RIZZO: Our first judgment was to go fixed
18 base. I would like to hear a reading from you, Don.

19 MR. LANDERS: In hindsight, it is going to be
20 substantially easier for you to sell fixed-base to the Staff
21 than the kind of analysis that you are involved in right now.

22 MR. HOLLEY: And we would never know if it would be
23 the other way around if we had gone the other way.

24 MR. LANDERS: You could have walked in here with
25 fixed-base and got hit with 900 questions the other way.

1 MR. ENOS: If you go with fixed-base, are you going
2 to try to take credit for the Twin Mountain effect where it
3 gives you such a drastic reduction in the vertical response?

4 MR. RIZZO: We don't take credit for anything if we
5 go with fixed-base. It does not give me drastic changes. It
6 just softens the vertical strain.

7 MR. ENOS: You have a real big reduction.

8 MR. RIZZO: That is damping, primarily, a big
9 vertical damping correlation coming into play. I had the
10 vertical geometric damping at 65 percent. That impacts on the
11 vertical response. But look, fellows, if your attitude is
12 fixed-base --

13 MR. CLOUD: We will reserve the option.

14 MR. LANDERS: I think one of the things that was
15 said here that maybe should be repeated is that here are no
16 geotechnical people here.

17 MR. SHAD: We had the option to look at fixed-base
18 too.

19 MR. SCHEPPELE: Can you give us further guidance on
20 things like this? I think you understand what we have tried
21 to do in good faith in this particular matter. It is a
22 situation which to a certain extent is judgment. Now, I would
23 think that you should give us in some form some guidance on
24 this, however, that you would suggest.

25 MR. SHAD: But today we are essentially exploring.

1 MR. CLOUD: I understand that.

2 MR. SCHEPPELE: We are not trying to have you commit
3 one way or another, but we have a good dialogue of what can be
4 considered. We heard the reason of what we did what we have
5 done. But in the hierarchy that you have here with regard to
6 manners in which you feel as though the licensing could be
7 expedited, which really is the heart of the matter, I would
8 think that if we could get your guidance from the viewpoint of
9 the fixed base concept in some form, however you would ask us
10 to do it, by written form or whatever, then I would think that
11 that would be something that would expedite the whole
12 situation.

13 We understand. We are not asking you for a set
14 position today. We have tried to give you as much information
15 as possible, which I know covers a broad range. That guidance
16 that I can see on that point is very critical.

17 MR. SHAD: Dave expresses the opinion, but I also
18 wanted to see if everyone agrees with the fixed-base too, from
19 the soil people.

20 MR. CLOUD: There will be soil people who look at
21 it.

22 MR. SCHEPPELE: Do you have any feel for the timing
23 it might take to get --

24 MR. SHAD: I think I would like to talk about other
25 implications -- I would like to talk about other implications

1 so that you are aware when you make the submittal how are we
2 going to review it. The minute you open this box, we are
3 going to review the whole thing. We are going to review the
4 spectra. I think Dave has questions about the modeling, the
5 past modeling. The whole issue has to be reviewed. It is not
6 just everything is right and we are going to do this.

7 MR. SCHEPPELE: I assume you don't go back to ground
8 accelerations.

9 MR. JENG: But what spectra should be the one in
10 1.60, or the Newmark spectra, which I understand you reasoned
11 in.

12 MR. JAN: Let me add the Comanche Peak project, the
13 ground response spectra are essentially based on the Newmark
14 paper, and then when we said horizontal, it is Reg Guide 1.60,
15 because Reg Guide 1.60 comes out of -- it is like the original
16 paper. And for the vertical, just somewhat different, but the
17 difference is rather small. We do not consider it as a really
18 significant effect, so we are not choosing one part of it and
19 leaving the other part out.

20 MR. SHAD: Suppose you have the whole package here.
21 This part, you want to use the latest knowledge, but the other
22 part, you also want to use the latest knowledge. That is a
23 question that would come up you are to answer and the Staff to
24 answer. The whole thing. You say everything is closed. The
25 minute you open, you open the whole box. It is not just

1 opening a portion that you want to open.

2 MR. HOLLEY: Operationally you feel it would be
3 easier, in essence.

4 MR. SHAD: Suppose they wanted to open the ground
5 acceleration, too.

6 MR. TRAMMELL: Look at load combinations, see how
7 modern that is.

8 MR. SHAD: It can also be under Staff control.

9 MR. TRAMMELL: 1.9 load factor.

10 VOICE: Are you going to commit yourself to Standard
11 Review Plan, 1981 revision all together? In other words, are
12 you going to reanalyze the structures, for example, for the --
13 using the new seismic codes, or just leave them the way they
14 are?

15 MR. SCHEPPELE: You mean with regard to the response
16 spectra we have shown here.

17 VOICE: Yes.

18 MR. SCHEPPELE: From the point of view of looking at
19 the loadings, yes.

20 VOICE: There is a new revision of Standard Review
21 Plans, July 1. Are you going to resubmit or revise the FSAR
22 according to the new release? Are you going to use the
23 analysis of containment using 1983, for example, issue of
24 ASME, the Code revision 2? At what point do you want to go
25 with this -- to what extent do you want to go to this

1 modernization of your analysis or FSAR? Where do you want to
2 stop?

3 MR. SHAD: You have to think out all of the
4 implications before you ask for a change on one part. They are
5 related. It is not just isolated.

6 MR. SCHEPPELE: If you try to get a change in this
7 criteria, in effect you are opening all aspects of licensing.

8 MR. SHAD: You may open all aspects.

9 MR. TRAMMELL: Let me ask you a question on timing,
10 Joe. How soon would you need approval of something like this
11 to be of value to you? The clock is running and you are
12 making changes. I guess you are making them in the basement.
13 That's where the changes seem to be minimal here. Is that
14 right? Are you working the problem in the low level of the
15 structure for now, on cable trays or conduit repairs or
16 whatever you are doing? There is work going on. I heard you
17 say that.

18 MR. GEORGE: Yes.

19 MR. TRAMMELL: Are you on hold now with respect to
20 this issue, with modifications to conduits or cable trays?

21 MR. GEORGE: No. Any support work under way in the
22 way of piping support will start with the reevaluation in
23 redoing any core support stability that is in issue, and
24 that does not really get into the loading of the supports so
25 much. That work will be ongoing in another week or so.

1 MR. CLOUD: The basic plan, Charley, on the
2 reanalysis for the piping is to initiate the work on the
3 current basis, and then if some piping or some support should
4 turn out to require attention, then those would be set aside,
5 and then when the new spectra come --

6 MR. TRAMMELL: So you would have to do that. How
7 soon would you need this approval to be of value? The clock
8 is running here. Time is very much of the essence.

9 MR. SHAD: Existing spectra.

10 MR. TRAMMELL: If it is going to be of value, it has
11 to be of value fairly soon, it seems to me. How soon would
12 you expect the Staff approval, other than as soon as possible?

13 MR. SHAD: You have some questions.

14 MR. TERAO: My question is relating to seismic
15 qualifications.

16 MR. SHAD: Most of the question is at the foundation
17 level.

18 MR. TERAO: Based on what you are seeing with the
19 response spectra, what do you think the extent of the impact
20 may be for the seismic qualification? Are you going to do
21 reevaluation? At this point we have almost finished our
22 review.

23 MR. CLOUD: The answer there is that we would hope
24 that this work would have no negative impact on equipment
25 qualification.

1 MR. SHAD: But not on the curve I saw.

2 MR. LANDERS: They have already stated that they
3 will look at that.

4 MR. SHAD: He says no impact.

5 MR. LANDERS: They are hoping no impact, but earlier
6 we have on the record that in fact they are going to take
7 these new amplified response spectra and look across the board
8 at all of the equipment.

9 MR. SHAD: He should know how much work is involved
10 with the seismic qualification. You have to reopen that
11 issue.

12 MR. CLOUD: Certainly we have to address that
13 issue. If these spectra have negative implications for any of
14 the equipment in the plant, it will obviously be necessary to
15 address that.

16 MR. ENOS: I have a question where you show the
17 original spectra and then the new spectra. Would you put one
18 of those slides up for the horizontal?

19 [Slide]

20 You said earlier that you were doing plus or minus
21 10 percent and then an additional 10 percent on your
22 broadening. Was that also done for the original curves?

23 MR. RIZZO: The original plot up there, the solid
24 line used the property variation of 2K plus or minus 10
25 percent on the two sides.

1 MR. JAN: The answer to your question is yes.

2 MR. ENOS: Now, the piping that Stone & Webster is
3 using is using the original response spectra, and this
4 includes the 10 percent plus or minus, correct?

5 MR. CLOUD: It would be that solid line.

6 MR. ENOS: Now, did they have to address the 15
7 percent?

8 MR. CLOUD: That is the existing design basis, the
9 solid line.

10 MR. ENOS: But you do not have to license it. The
11 plant is a 1985 plant. It is not a 1973 plant.

12 MR. SHAD: You cannot use part of the '85 and the
13 others 1975. The same question that he has. You cannot say
14 one part is '85 and the other --

15 MR. ENOS: Is the piping that Stone & Webster is
16 going to be doing, is it going to be okay to use that spectra
17 or do they have to increase?

18 MR. LANDERS: The current Stone & Webster analysis is
19 using the FSAR commitments. It is not an open issue at this
20 point with respect to what Stone & Webster is doing.

21 MR. SHAD: But the point is they may use this.

22 MR. LANDERS: If this is approved and if the
23 Applicant uses it and if Stone & Webster use it, that is
24 another issue. Currently Stone & Webster is complying with
25 licensing.

1 MR. SHAO: It is different, the piping and
2 damping. The spectra gets into other things. The damping is
3 more cleancut. If you want to increase damping values, it
4 only affects piping, but with spectra, you have the
5 structures, you have the -- I just want to say it shows the
6 whole picture very carefully before you come in with the
7 proposal.

8 MR. JENG: Can you qualify one point for me?
9 Earlier you mentioned right now the basic direction for the
10 engineering is to go ahead and use the old spectra and to see
11 if that can be qualified properly. Now, in the case of an
12 exceedance or difficulty in this effort, you would
13 automatically shift to a bunch of -- a list to be handled by
14 the spectra or after you have tried modification with
15 reasonable easiness to exhaust all of the possible reasons,
16 and then after you have some left that are unresolved, you go
17 and use this one, or automatically shift to this one.

18 MR. CLOUD: The latter. It automatically shifts
19 completely.

20 MR. JENG: So it could involve extensive uses.

21 MR. CLOUD: It would be the basis for the
22 qualification of the plant. The reason for starting now is
23 purely for expediency of getting the effort moving.

24 MR. GEORGE: It is possible, back to Charley's
25 question on timing, that we could go through the whole

1 revalidation of the plant with the old spectra and never use
2 this even if we made the submittal.

3 MR. TRAMMELL: I was thinking that this is a problem
4 subject to operations research, typical problem. The clock is
5 running, expenses are such and such for this and that, and
6 there has got to be a point in time where Staff approval of
7 this is of no value. I would think that timeline must be very
8 short.

9 MR. LANDERS: I have another technical concern I
10 would like to address, and really Dick's question led me to
11 it. It would appear to me, at least for the building that you
12 have presented, that your broadening in your new approach
13 will, in fact, be less than the FSAR.

14 MR. RIZZO: Yes, overall broadening.

15 MR. LANDERKS: That is going to be a critical issue,
16 in my opinion, and somehow or other you have got to address
17 that so that the Staff is convinced that what you are doing is
18 acceptable. And it is building-dependent, as you pointed
19 out. Some buildings will be very much less, and some will be
20 slightly less. And as I look at the slides you put up there,
21 a little more broadening puts you outside of the original
22 spectra, and therefore requires some evaluation, and having
23 seen that and recognizing this difference, it leads one to
24 recognize that there may be some concerns here.

25 MR. JENG: The broadening, is it dependent? Or is

1 one of the results of this use --

2 MR. JAN: Stiffness.

3 MR. JENG: If you were to use the simple fixed-base,
4 this may not be the case anymore.

5 MR. RIZZO: If we go to the simple fixed-base, ther
6 is no variation.

7 MR. JENG: You are saying the outcome would be about
8 the same --

9 MR. SHAD: It would have broadening --

10 MR. RIZZO: Peak broadening but no variation.

11 MR. HOLLEY: You have pointed out, you and your
12 colleagues, a number of the things that come up when you open
13 the box. Would you say a few words or outline a few words as
14 to how much less open the box is if you go fixed-base?

15 MR. SHAD: The box is open. There can be all kinds
16 of questions on different things.

17 MR. HOLLEY: But a lot of questions would go away,
18 like the peak broadening.

19 MR. SHAD: It's like if somebody questions --
20 there's no end to it.

21 MR. SCHEPPELE: I think there has to be some
22 understanding of what box is open. On the part of the
23 Applicant, I think he misunderstands, and it is part of our
24 job to try to give him an assessment of this.

25 MR. SHAD: The box does not even know. Suppose all

1 sorts of questions come from external sources?

2 MR. SCHEPPELE: Are you saying there is no answer?

3 MR. SHAD: I don't know the answer. It would be a
4 pretty messy problem later on. Plus there is the possibility
5 that there are all kinds of questions that, even without the
6 Staff's control, are possible the minute you open the box.

7 MR. BURWELL: From my point of view, I think you
8 need to be very careful about the impact of taking this course
9 of action on, shall we say, the analysis of record, the
10 design of record. Where do you intend to apply it, and where
11 do you not?

12 You need to be very clear on that interface. From
13 what Larry is saying, I think that once you start a course, it
14 will be very difficult to say, well, we will apply it to this
15 design of record and not to the structure. For example, we
16 will apply it to piping, but not structural and so on. I
17 think you'd had better think very carefully.

18 MR. GEORGE: We would be required to be consistent
19 with the application. It is a prerequisite that many of the
20 designs in the plant, any structural building supports or
21 whatever, we recognize that. We would have to be consistent.

22 MR. SHAD: What I'm worried about is, I think you
23 could do all of this, but your question, your methodology in
24 certain areas --

25 MR. CLOUD: If I could sum up the situation, the way

1 it looks to me at this time, first I think the meeting has
2 been immensely valuable to all of us.

3 Second, the box that you refer to would be opened at
4 the time the submittal were made. So the situation that we
5 find ourselves in is that we need to reevaluate our position
6 to decide either to make no submittal, to make a submittal on
7 the basis that we have described to you, or to make a
8 submittal on the basis of a fixed base model, which we will
9 do.

10 MR. BURWELL: And we have work to determine that.

11 MR. SHAD: The fixed base -- I think you should look
12 at all of the possible implications before you make a
13 submittal.

14 MR. CLOUD: That is to decide whether to make one.

15 MR. TRAMMELL: And your submittal should define
16 precisely what you are looking for, and I would think you
17 might take a little extra trouble to say it does not apply to
18 this, this, and that, and define these limits, so that when
19 the Staff starts asking you questions, you can say, "Hey, that
20 is beyond the scope of my request, and I did not intend to
21 include that."

22 It would help us a lot. The Staff will run over
23 you.

24 MR. LANDERS: Lines 5 through 8, Section 2.2.1.

25 MR. TRAMMELL: Be quite specific in what you are

1 asking for. And then you can say that we're asking questions
2 outside the scope.

3 MR. CLOUD: We will go further. It is true that we
4 will ask for the reasons that you elaborated, Charlie, that we
5 will ask for an expedited approval, and we will give you the
6 time that we would hope you would be able to respond.

7 MR. TRAMMELL: Obviously the better you define it,
8 the quicker we can review it.

9 MR. CLOUD: Fine.

10 MR. LIPINSKI: It may work the other way, too. You
11 can confine the submittal to certain aspects, but in the
12 opinion of the Staff, it may not be sufficient. You may find,
13 for example, that the revision has to go further beyond what
14 you describe.

15 MR. TRAMMELL: That is the other shoe. If it turns
16 out that we cannot approve it, that is of equal value.

17 MR. LANDERS: That is the importance of that kind of
18 a submittal. At that point, the Applicant can say, "I'm going
19 to withdraw my submittal. If it's going to broaden it, I'm
20 going to withdraw it."

21 MR. TRAMMELL: You need a yes or a no; do you not
22 need a maybe.

23 MR. MIZUNO: It is not sufficient just to define the
24 lines that you want to have open. You have to provide a basis
25 for saying why certain other things which potentially, from a

1 logical standpoint, are linked, but you do not wish to know
2 why these are excluded.

3 MR. SHAD: That is the same thing I said. A lot of
4 things are linked together. If you could change one part, the
5 question is why the other part doesn't change.

6 MR. JENG: To the extent that you propose that these
7 proposed changes are A, B, C, D, you should address whether
8 such a proposal extent would affect consideration of the
9 changes to require a CP modification or whatever. That issue
10 should be tied in, too.

11 MR. CLOUD: Thank you very much, gentlemen, and we
12 will look forward to seeing you the next time.

13 [Laughter.]

14 [Whereupon, at 12:13 o'clock, p.m., the meeting was
15 adjourned.]

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1 CERTIFICATE OF OFFICIAL REPORTER

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This is to certify that the attached proceedings
before the United States Nuclear Regulatory Commission in the
matter of:

Name of Proceeding: Meeting on Recalculation of Seismic
Response Spectra: Comanche Peak

Docket No.:

Place: Bethesda, Maryland

Date: Tuesday, June 18, 1985

were held as herein appears and that this is the original
transcript thereof for the file of the United States Nuclear
Regulatory Commission.

(Signature)

(Typed Name of Reporter) Barbara Whitlock
Barbara Whitlock

Ann Riley & Associates, Ltd.

RE-ANALYSIS
OF
ROCK-STRUCTURE INTERACTION

COMANCHE PEAK STEAM ELECTRIC PLANT
SPRING 1985

OBJECTIVE: TO ASSESS THE EXCESS SEISMIC MARGIN IN THE
IN-STRUCTURE FLOOR RESPONSE SPECTRA CONSIDERING:

- 1985 VERSUS 1974 TECHNOLOGY
- AS-BUILT CONDITIONS (MINOR CHANGES AND REFINEMENTS)

ORDER OF PRESENTATION

- BRIEF REVIEW OF BASIC SEISMIC DESIGN CRITERIA
- BRIEF REVIEW OF SITE FOUNDATION CONDITIONS
- MAJOR STEPS OF RE-ANALYSIS
- EXAMPLE RESULTS (AUXILIARY BUILDING)

BASIC SEISMIC DESIGN CRITERIA
(FSAR)

ITEM

VALUE/DEFINITION

SSE	0.12g
1/2 SSE (OBE)	0.06g

RESPONSE SPECTRA

- | | |
|---------|-----------------------|
| • HORZ. | R.G. 1.60 |
| • VERT. | NEWMARK, ET AL., 1973 |

<u>STRUCTURAL DAMPING</u>	R.G. 1.61
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ARTIFICIAL TIME HISTORY (FREE FIELD)

- | | |
|------------|--------------------------|
| • HORZ. | ENVELOPES DESIGN SPECTRA |
| • VERT. | ENVELOPES DESIGN SPECTRA |
| • DURATION | 10 SECONDS |

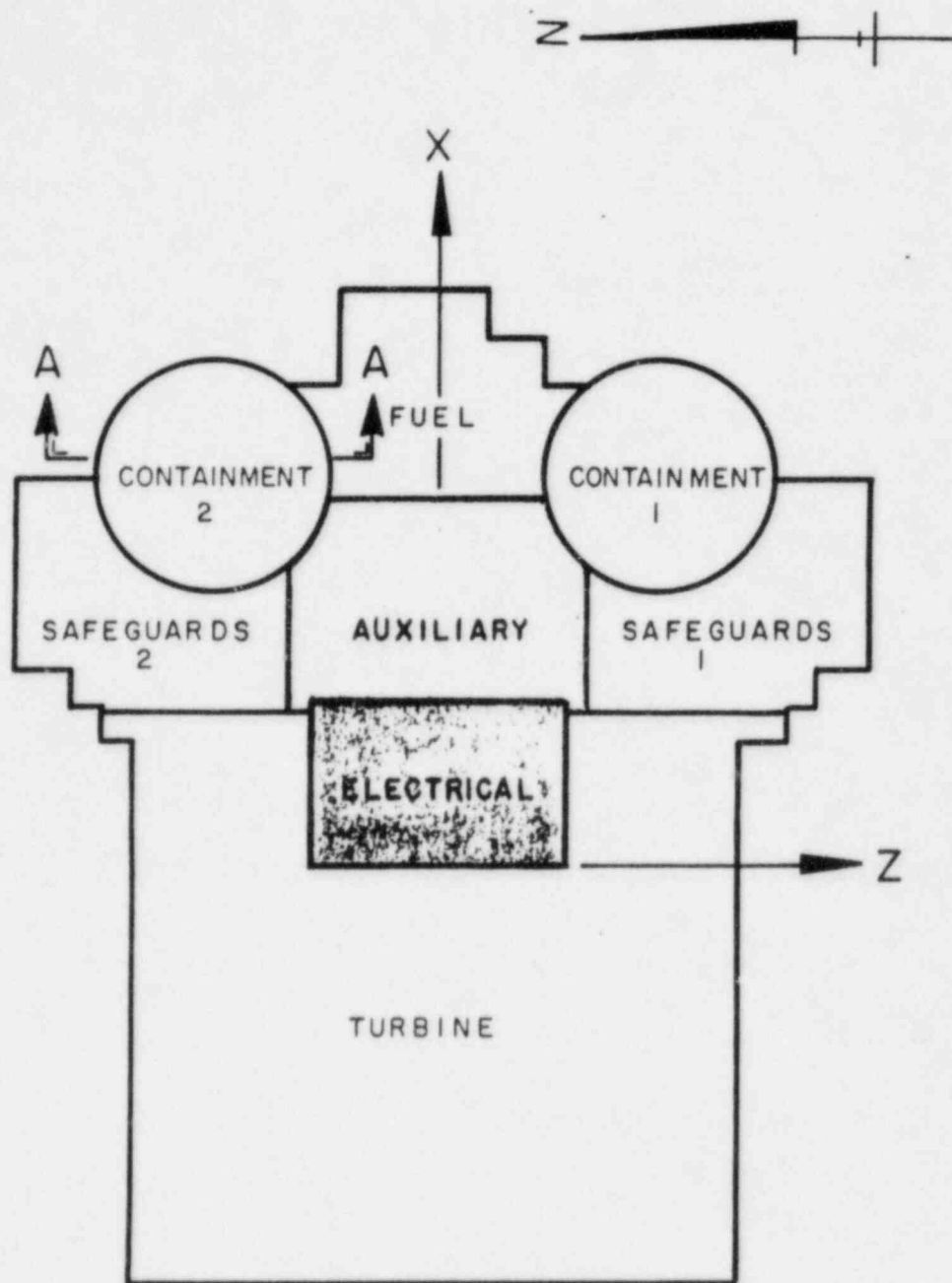
CONTROL MOTION LOCATION

FOUNDATION ELEVATION

RSI APPROACH

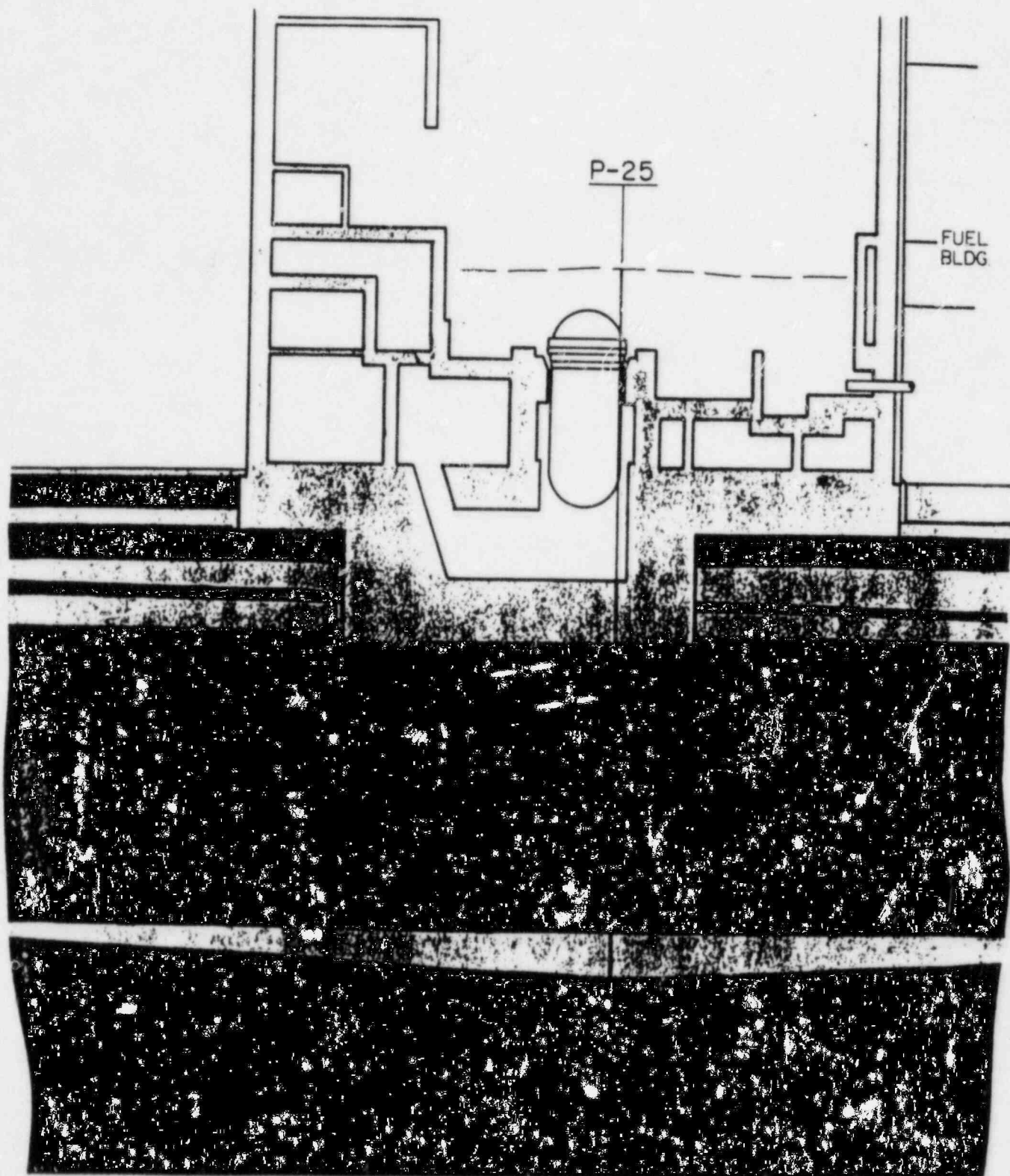
LUMPED PARAMETER
(SUB-STRUCTURING)

NOTE: FOR THE 1985 RSI RE-ANALYSIS, NO CHANGES TO THE ABOVE
HAVE BEEN INTRODUCED TO DATE.



KEY PLAN

SCALE
200 0 200 FT.



SECTION A-A

TYPICAL ROCK PROFILE

EXC SLIDE

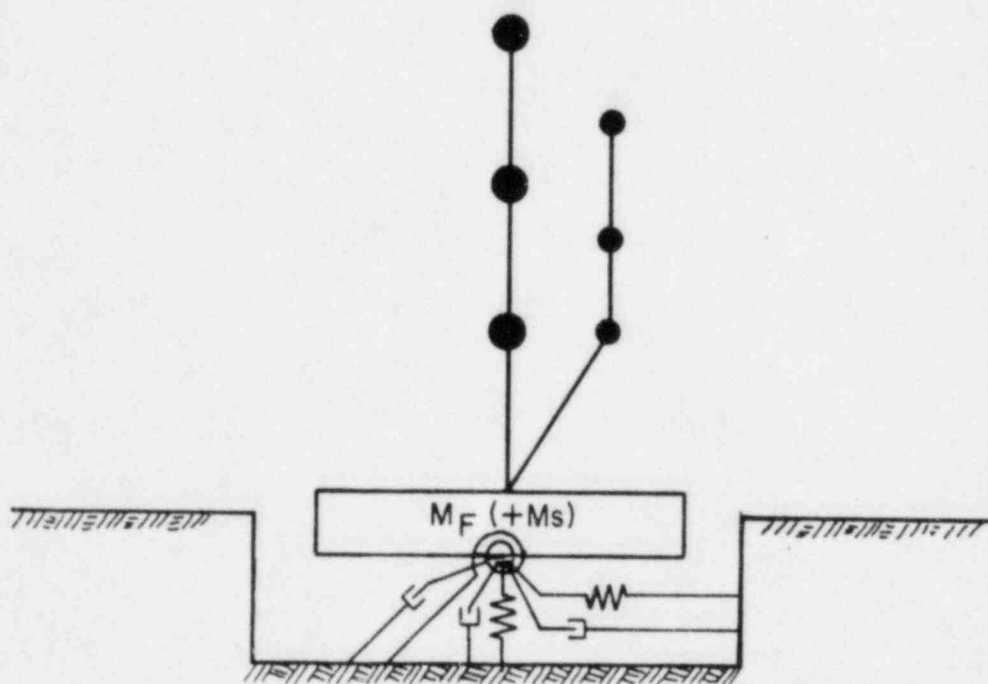
EXC SLIDE

Rock

SLIDE

Block

Slide



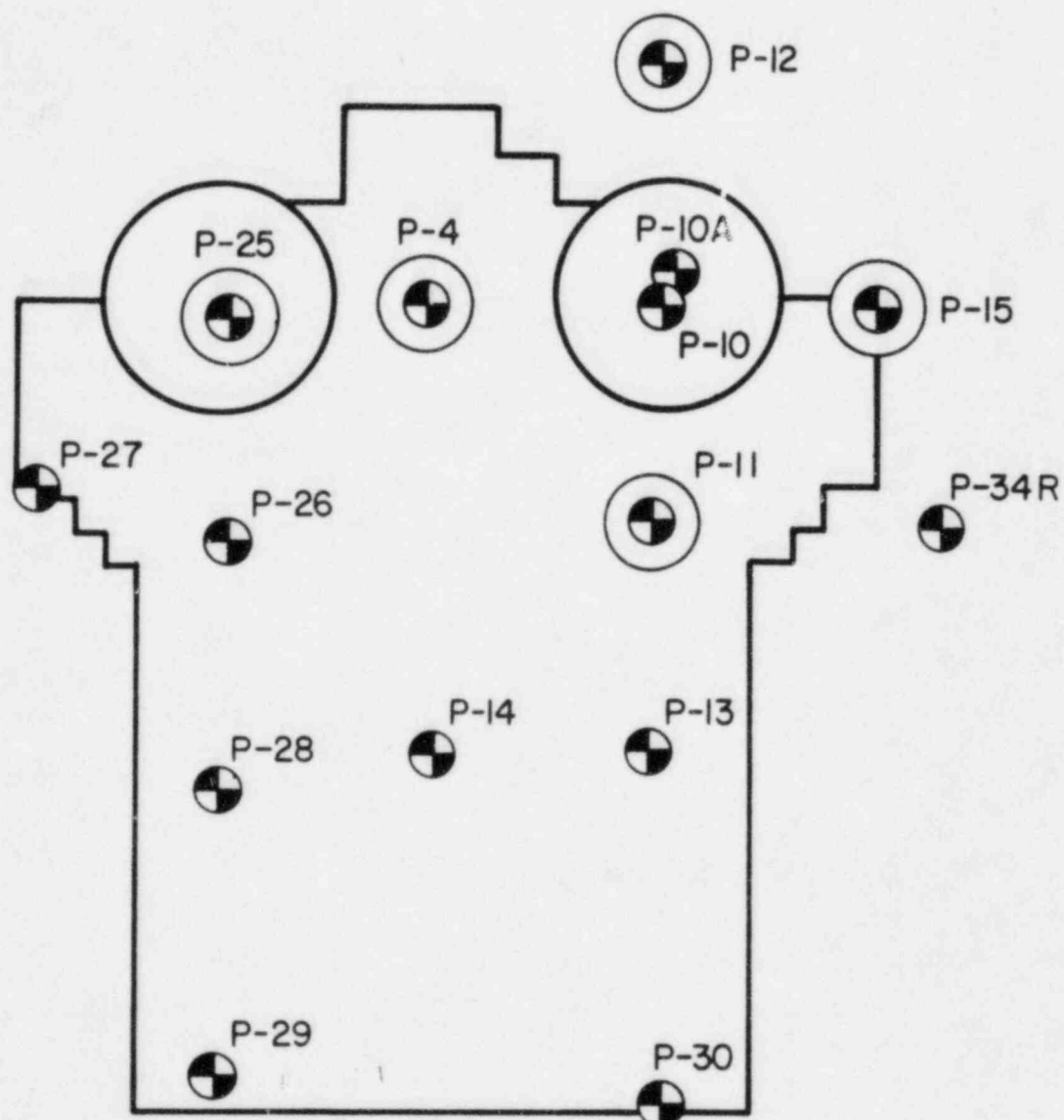
GENERIC SIMPLIFIED RSI MODEL

COMPARISON
FSAR VERSUS RSI RE-ANALYSIS
ROCK STRUCTURE INTERACTION

ITEM	FSAR	RE-ANALYSIS
(1) SOIL MASS	INCLUDED	EXCLUDED
(2) STIFFNESS	UNIFORM MODULUS VALUE ADOPTED	LAYERED SYSTEM ANALYSIS
(3) DAMPING		
• TRANSLATION	10% (HYSTERETIC)	GEOMETRIC DAMP- ING (VISCOUS). + MAT'L DAMPING (HYSTERETIC)
• ROTATION	5% (HYSTERETIC)	GEOMETRIC DAMP- ING (VISCOUS) + MAT'L DAMPING (HYSTERETIC)
(4) EMBEDMENT	INCLUDED	INCLUDED WITH UPDATED INFOR- MATION
(5) VARIATION IN STIFFNESS		
• LOWER BOUND	K/4	65% TO 150%
• BEST ESTIMATE	K	(BASED ON VARIATION
• UPPER BOUND	2K	OF INPUT PARAMETERS)

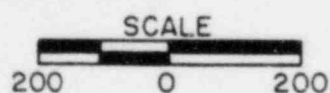
MAJOR STEPS
FOR
RSI RE-ANALYSIS

<u>STEP</u>	<u>DESCRIPTION</u>
(1)	DEFINE RSI ANALYSIS PROFILE AND DYNAMIC ROCK PROPERTIES
(2)	DEFINE FOUNDATION GEOMETRY
(3)	OBTAIN STIFFNESS & DAMPING FOR 6 MODES (RIGID MATS ON ELASTIC LAYERED SYSTEM)
(4)	CORRECT FOR EMBEDMENT
(5)	DISTRIBUTE SPRINGS COMPATIBLE WITH STRUCTURAL MODEL
(6)	PERFORM MODAL SUPERPOSITION ANALYSIS WITH ATH <ul style="list-style-type: none">• 6 DOF• 3 DIRECTIONAL INPUT MOTION (SRSS)• MODAL DAMPING• VARY ROCK PROPERTIES AND EMBEDMENT EFFECTS• PEAK BROADEN
(7)	COMPARE "OLD" AND "NEW" RSI PARAMETERS AND FLOOR RESPONSE SPECTRA

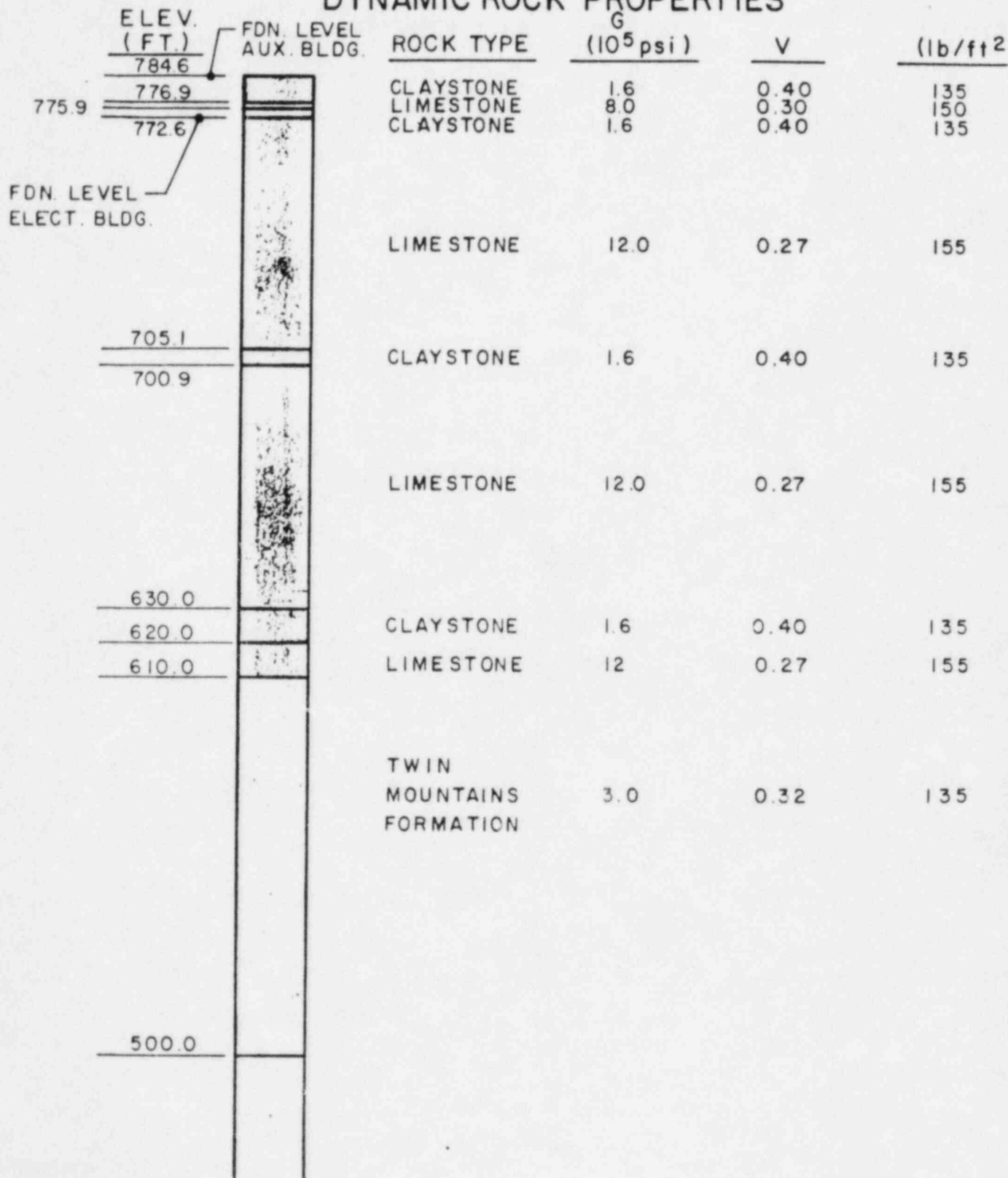


MAY 85
PROGRAM AREA

BORING PLAN

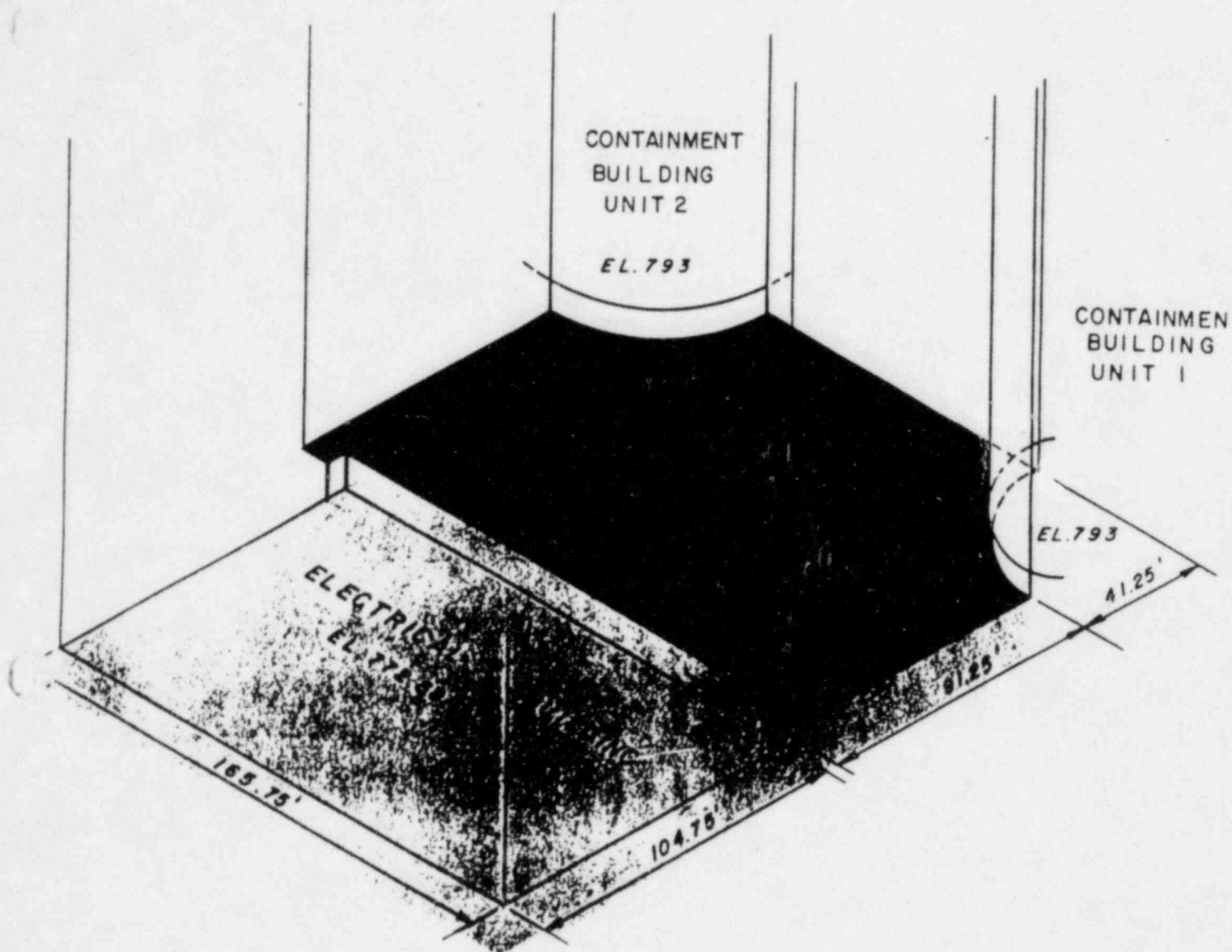


AUXILIARY/ELECTRICAL BUILDING ANALYSIS PROFILE AND DYNAMIC ROCK PROPERTIES

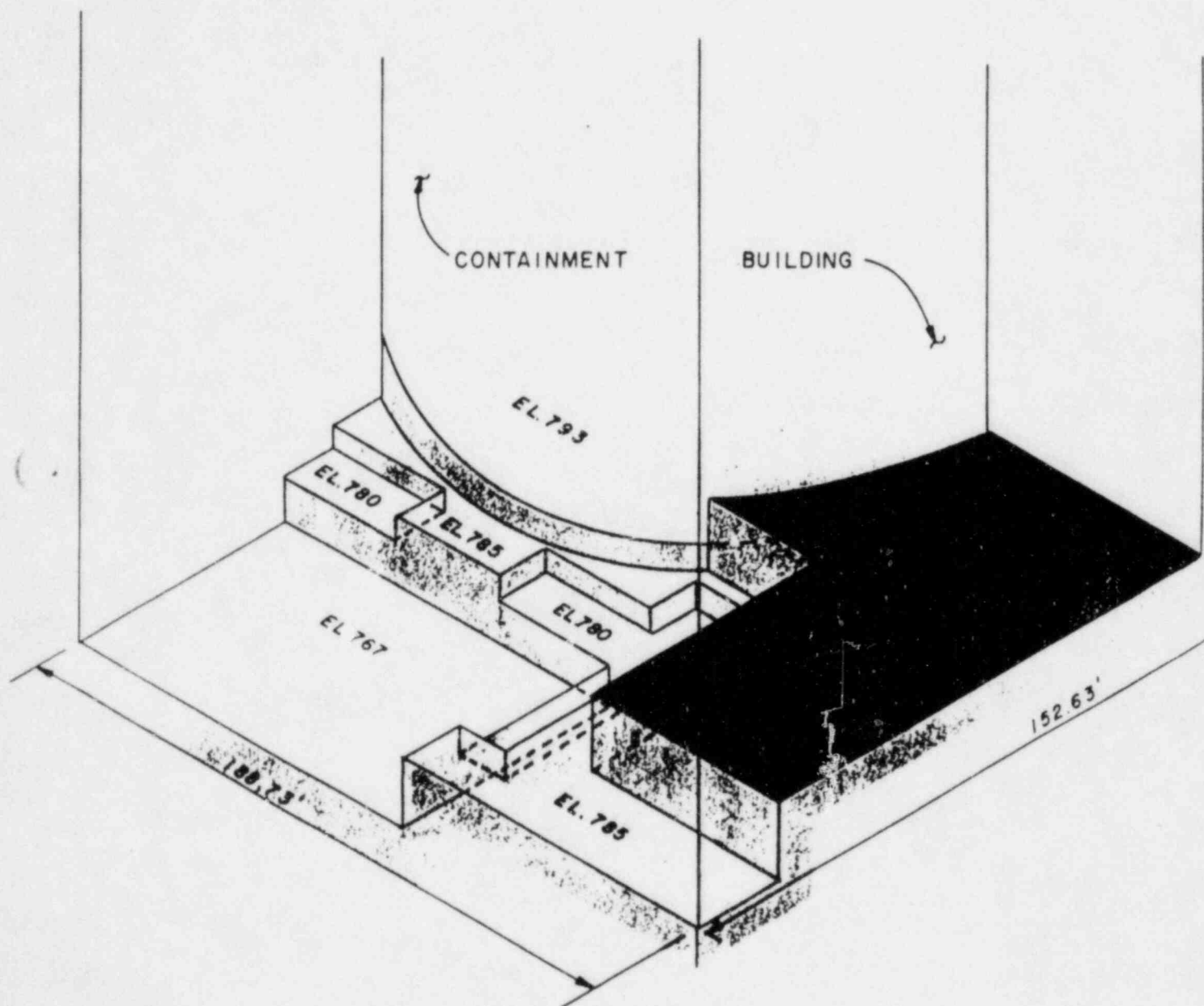


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FOR
RSI RE-ANALYSIS

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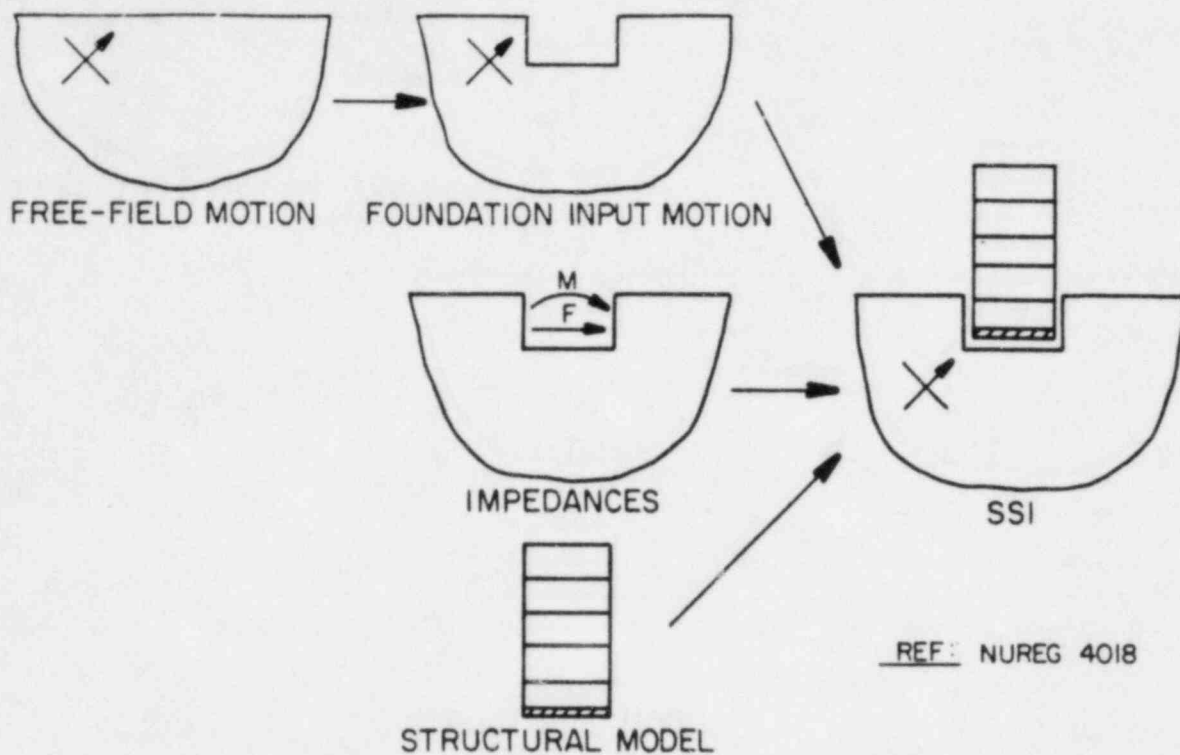
AUXILIARY / ELECTRICAL BUILDING



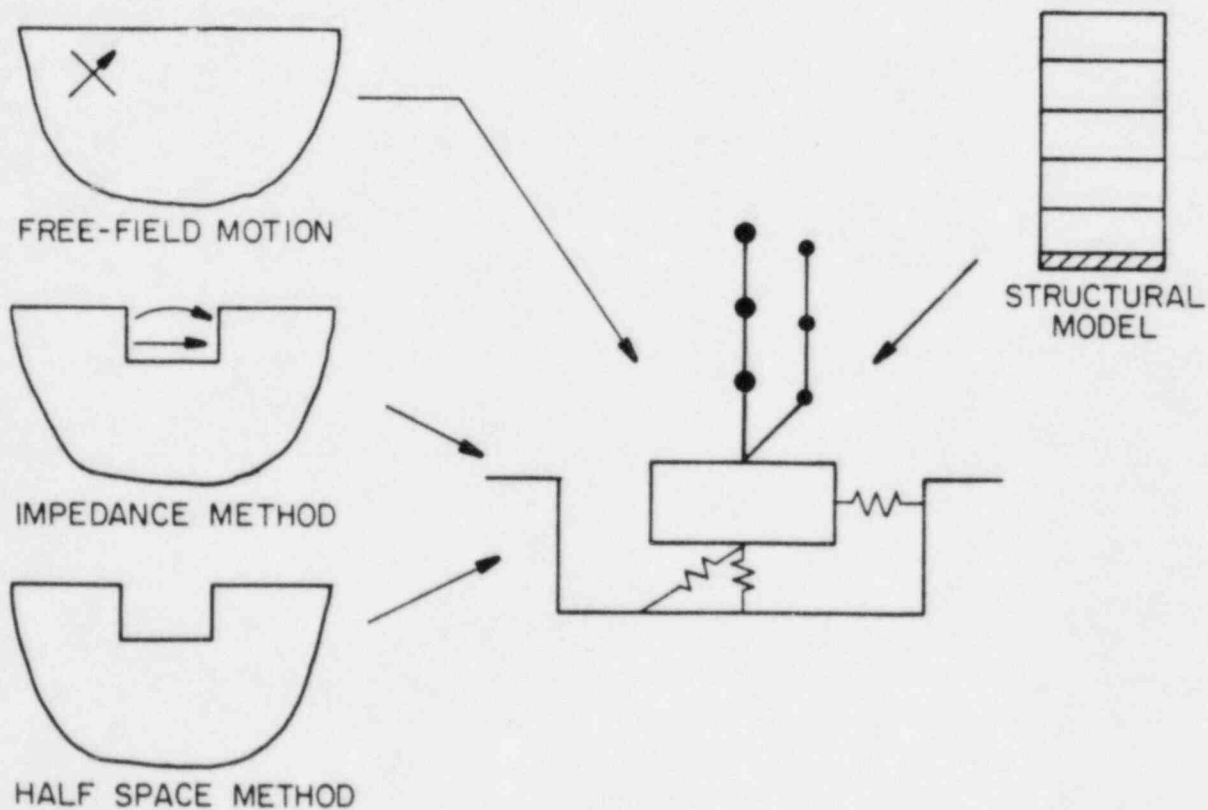
SAFEGUARDS (UNIT 1) BUILDING FOUNDATION

MAJOR STEPS
FOR
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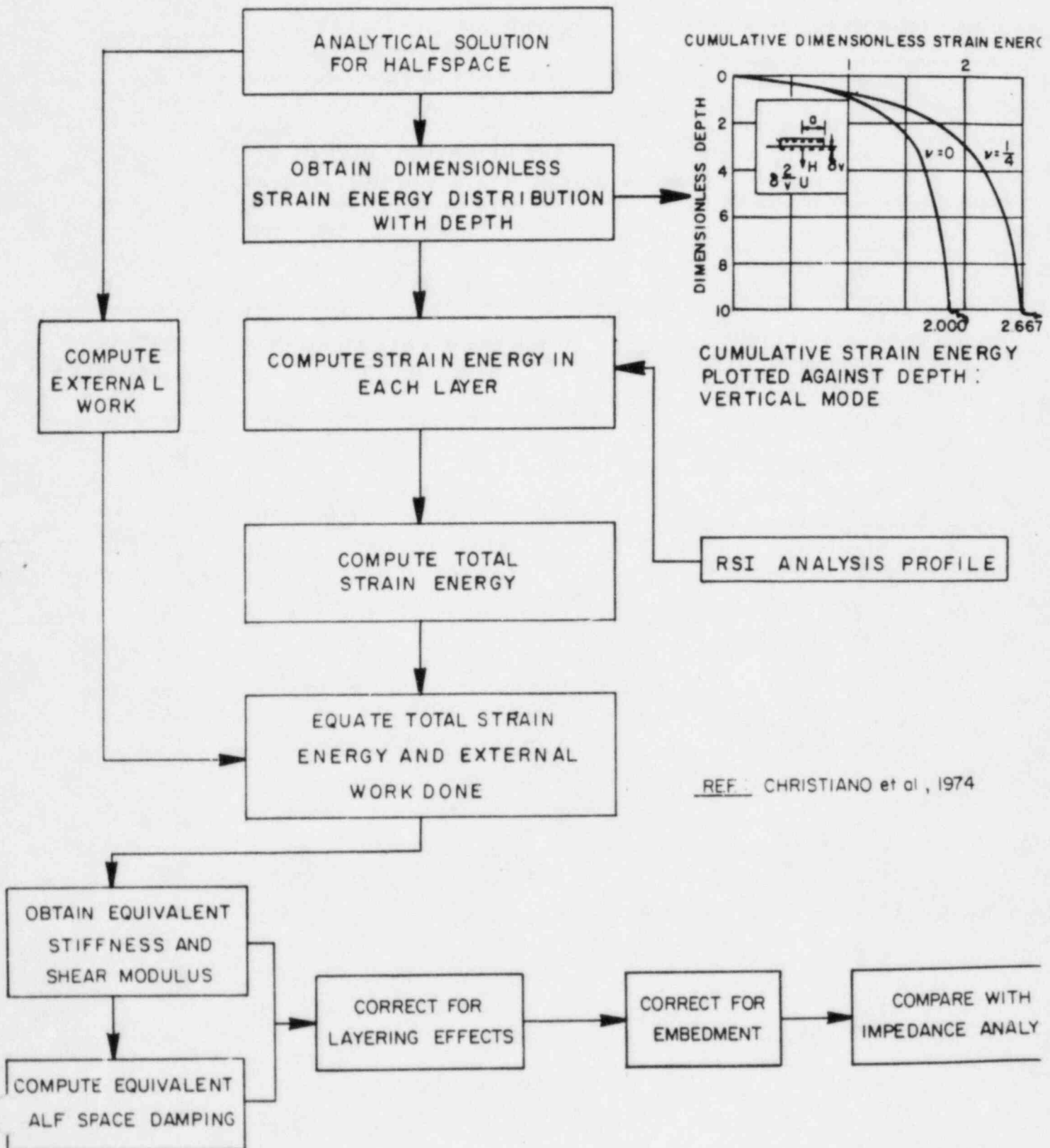
TYPICAL SUBSTRUCTURE APPROACH



CPSES APPROACH

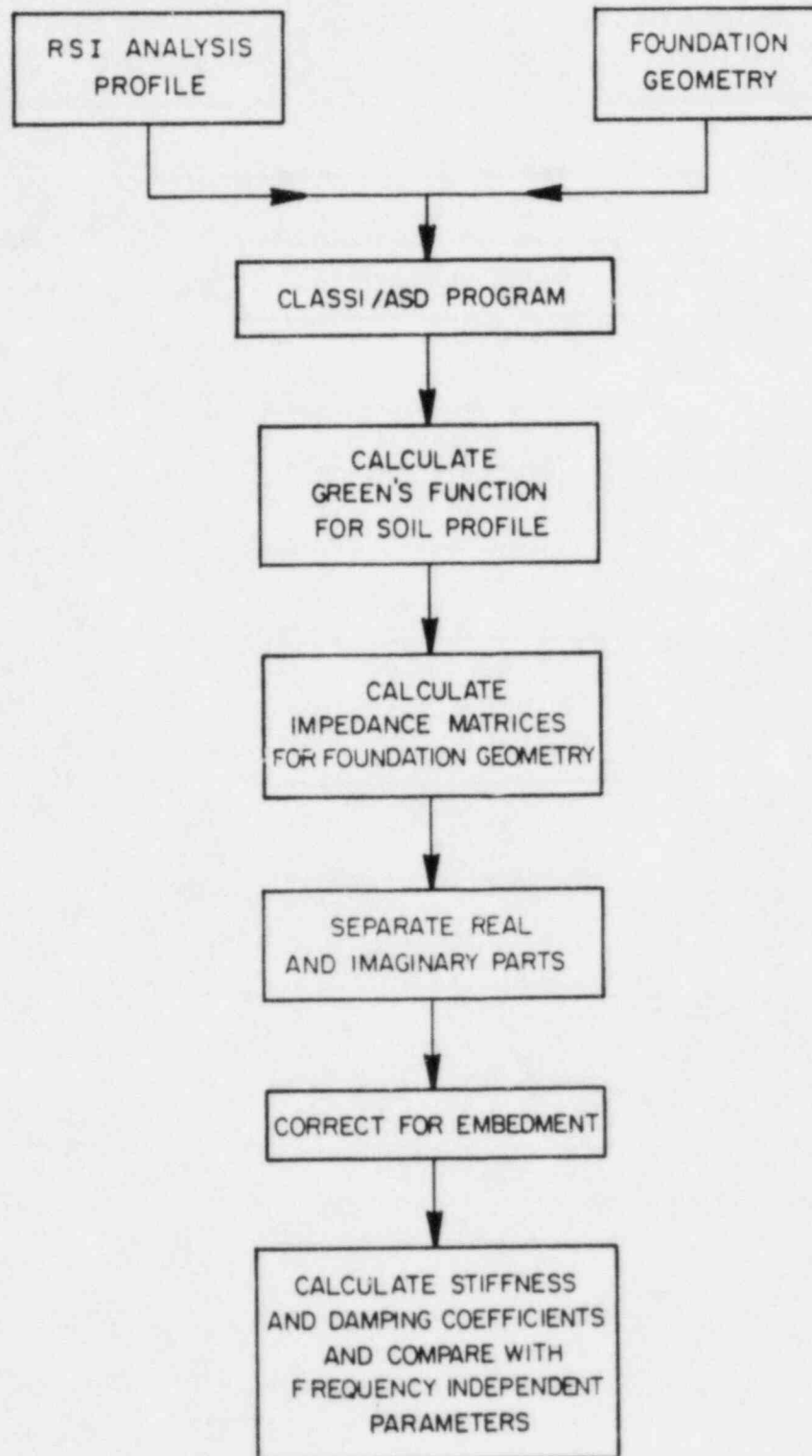
LAYERED SYSTEM ANALYSIS

(FREQUENCY INDEPENDENT)

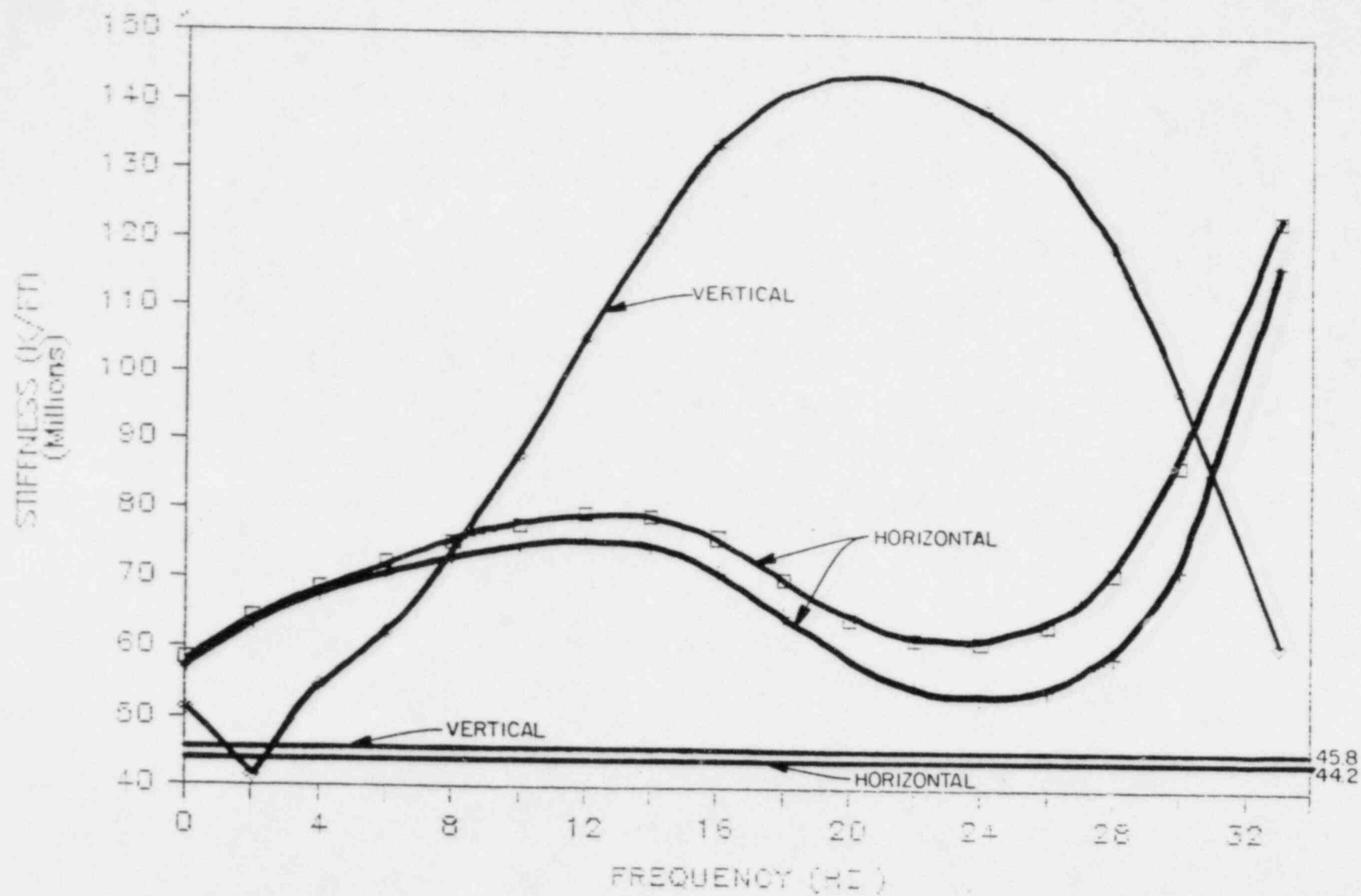


LAYERED SYSTEM ANALYSIS

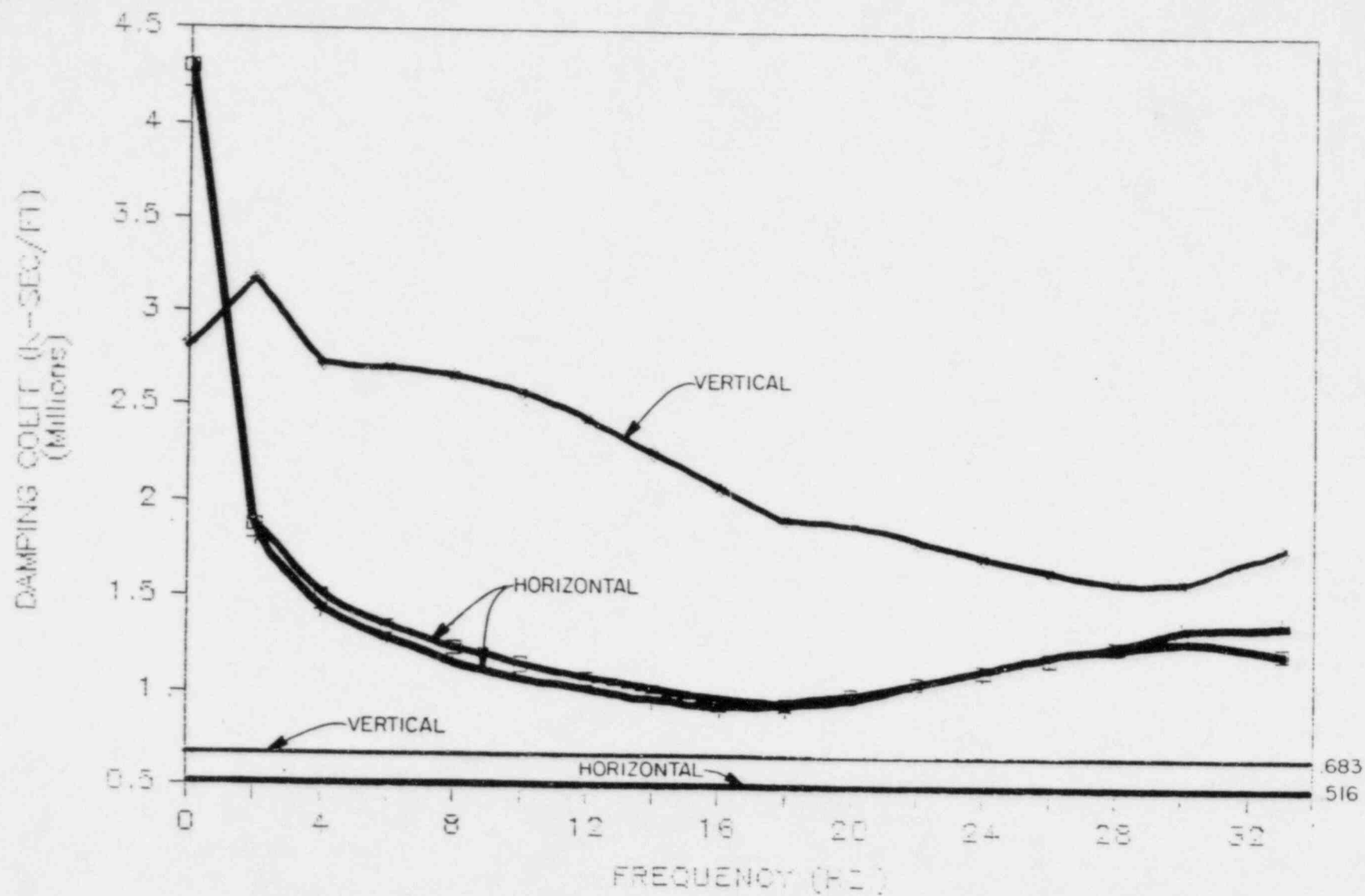
(FREQUENCY DEPENDENT)



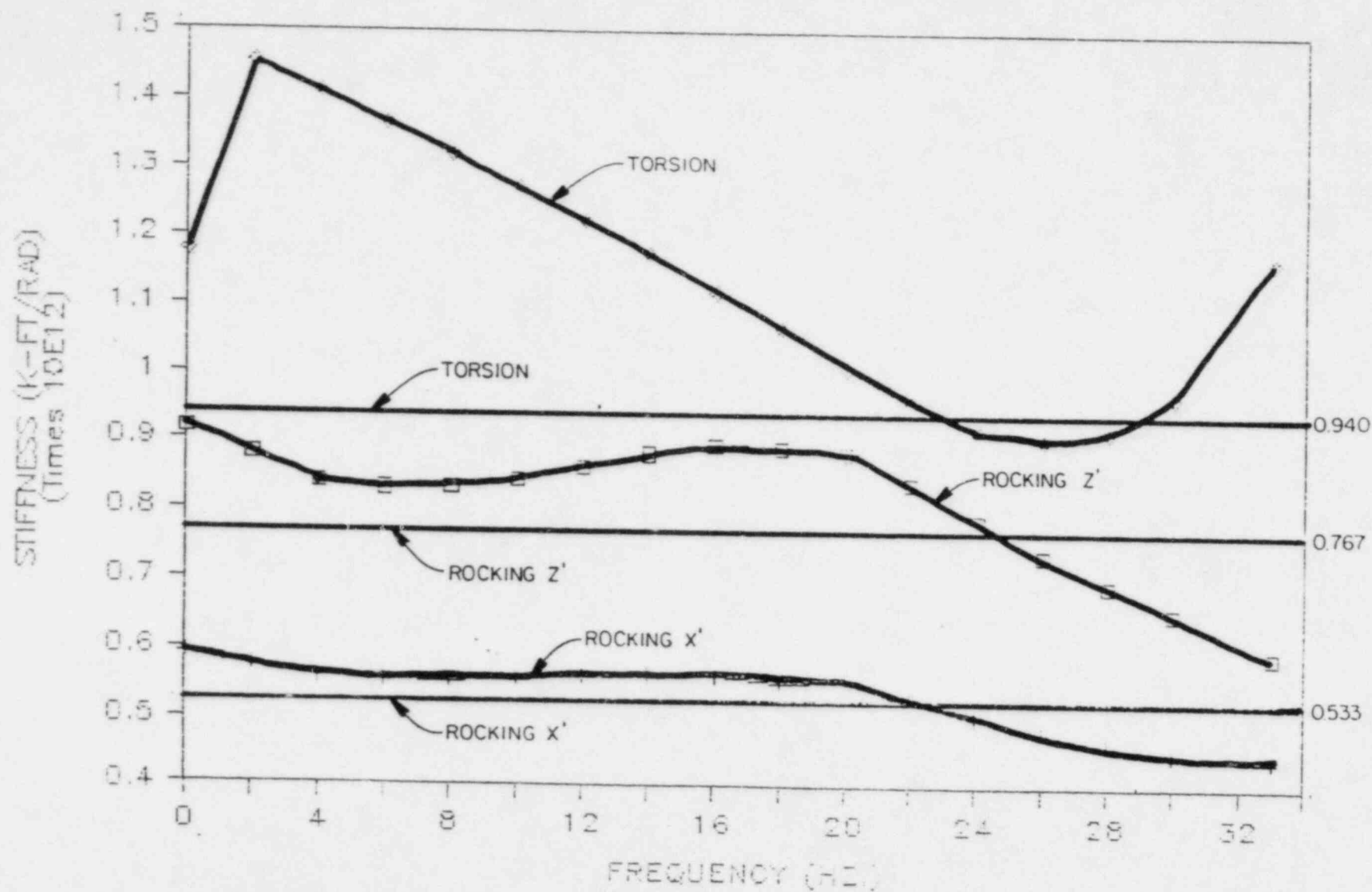
AUX/ELEC. KX, KY & KZ



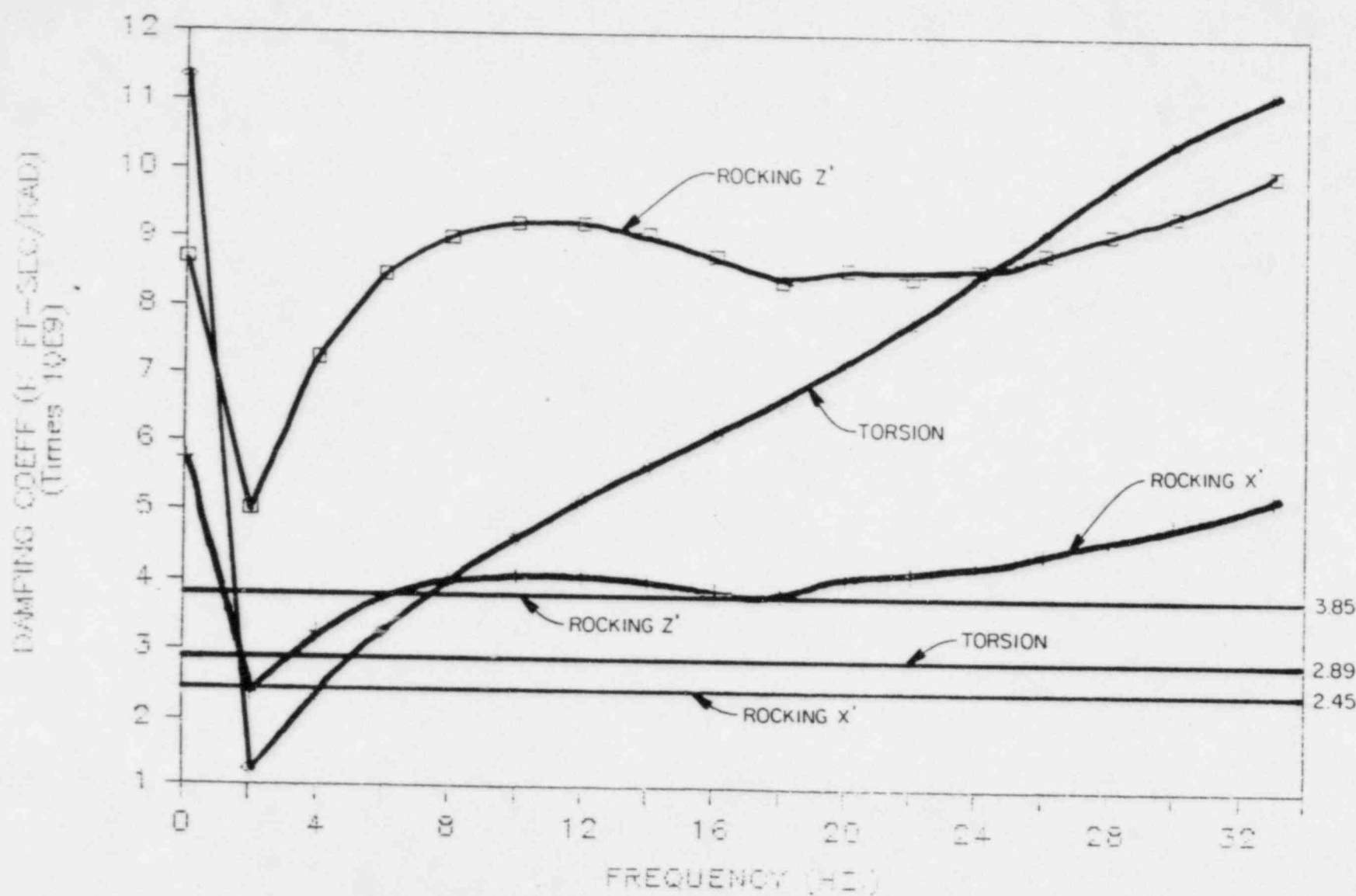
AUX/ELEC. CX, CY & CZ



AUX/ELEC. K_{RX} , K_{RY} & K_{RZ}



AU/ELEC. CRX, CRY & CRZ



MAJOR STEPS
FOR
RSI RE-ANALYSIS

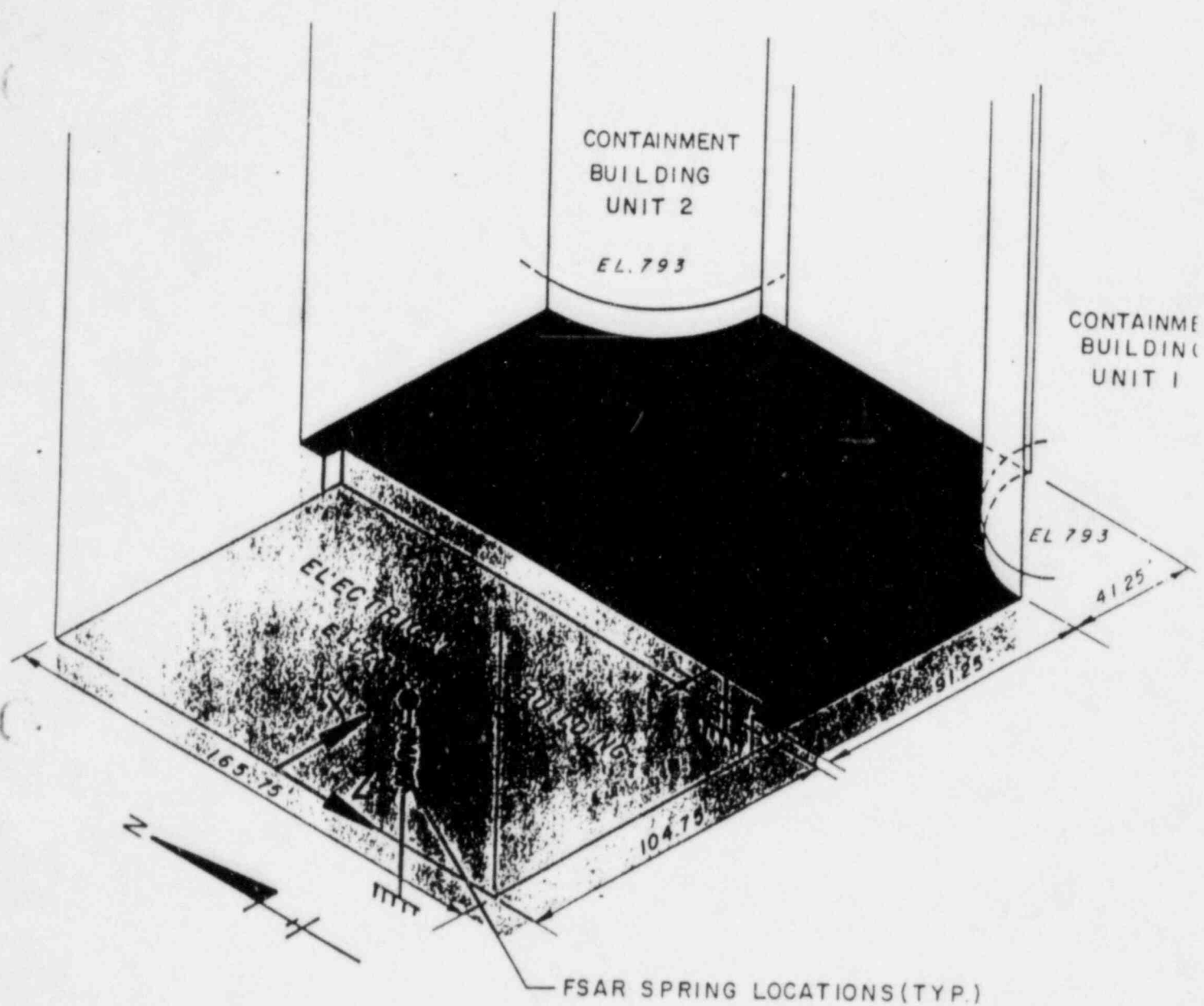
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EMBEDMENT COEFFICIENTS
AUXILIARY/ELECTRICAL BUILDING

<u>MODE</u>	$CF = K_{EMB}/K_{NON-EMB}$				$C_{EMB}/C_{NON-EMB}$
	CHRISTIANO ET AL. (1974)	NOVAK ET AL. (1973)	GAZETAS (1982)	BEST ESTIMATE	
VERT.	1.10	1.09	1.09	1.09	1.21
HORZ.	1.20	1.15	1.11	1.16	1.54
ROCKING (Z)	1.13	1.10	1.20	1.15	1.49
ROCKING (X)	1.15	1.12	1.24	1.17	1.56
TORSION	1.25	1.26	1.30	1.27	1.92

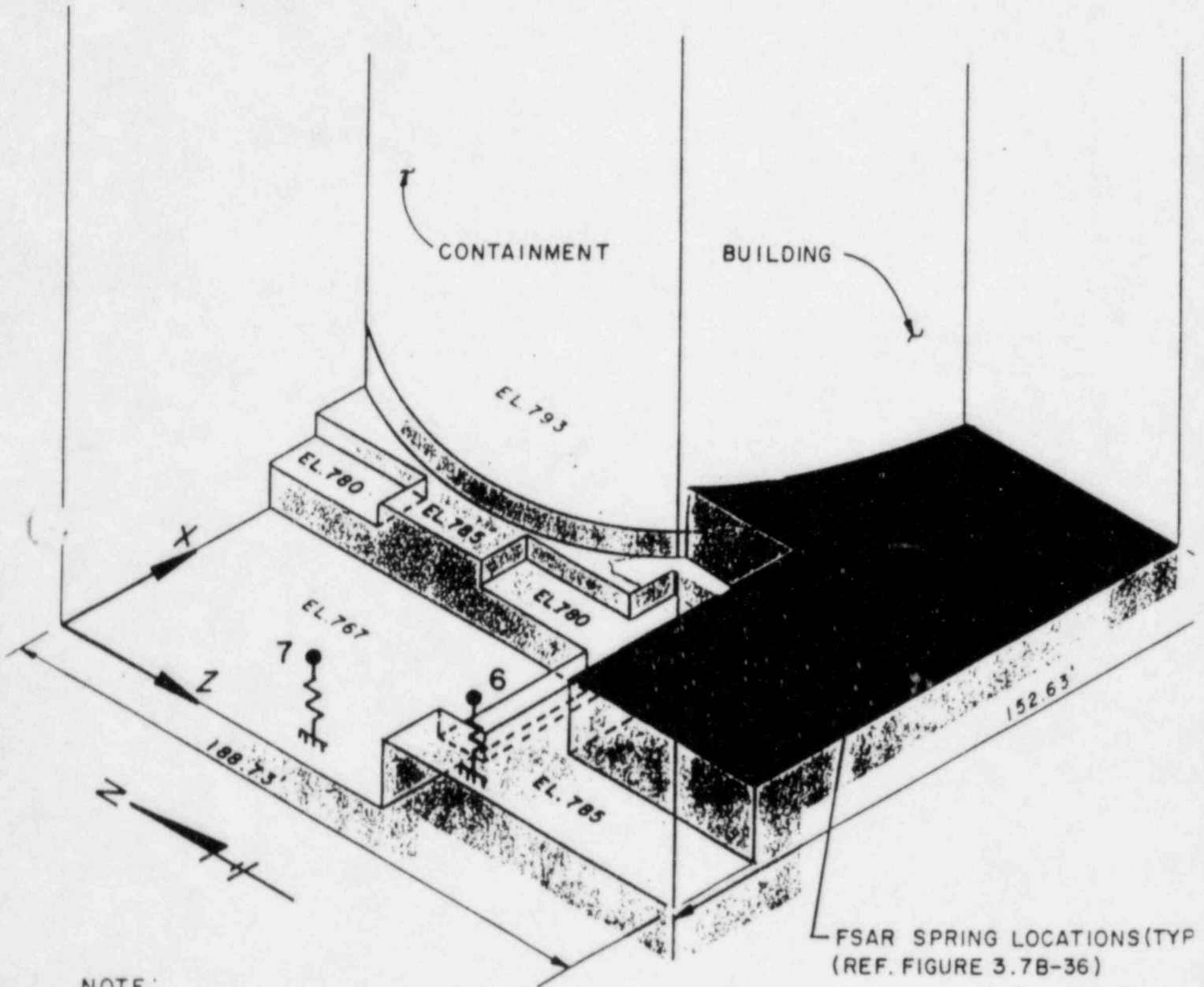
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RSI RE-ANALYSIS

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AUXILIARY / ELECTRICAL BUILDING

SPRING NODE	X	Y	Z
5	92.22	806.5	149.62
6	53.93	785.0	90.71
7	30.50	767.5	47.62



NOTE:

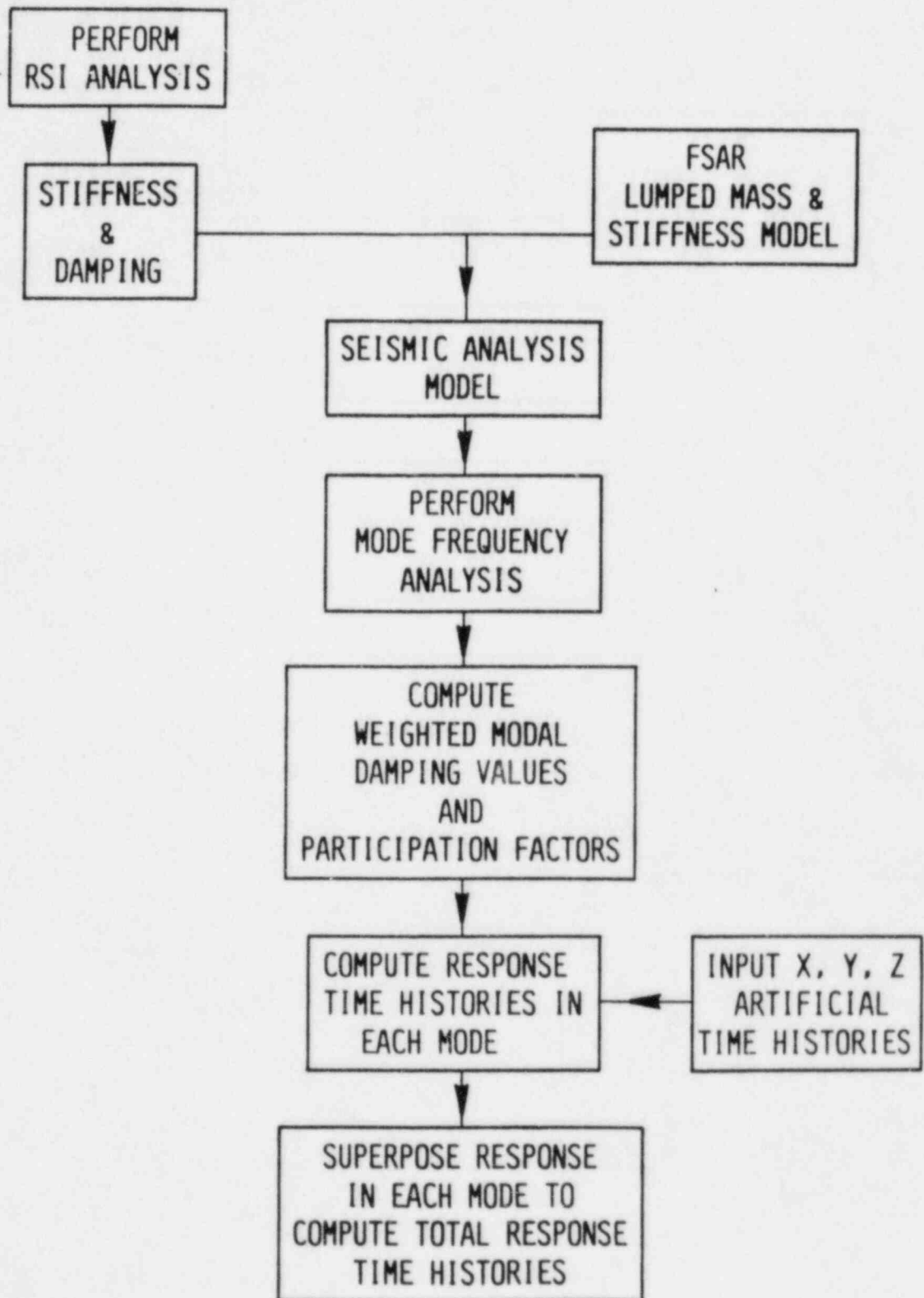
ELEVATIONS SHOWN ARE APPROXIMATE AND REPRESENT BOTTOM OF MAT.

SAFEGUARDS BUILDING FOUNDATION

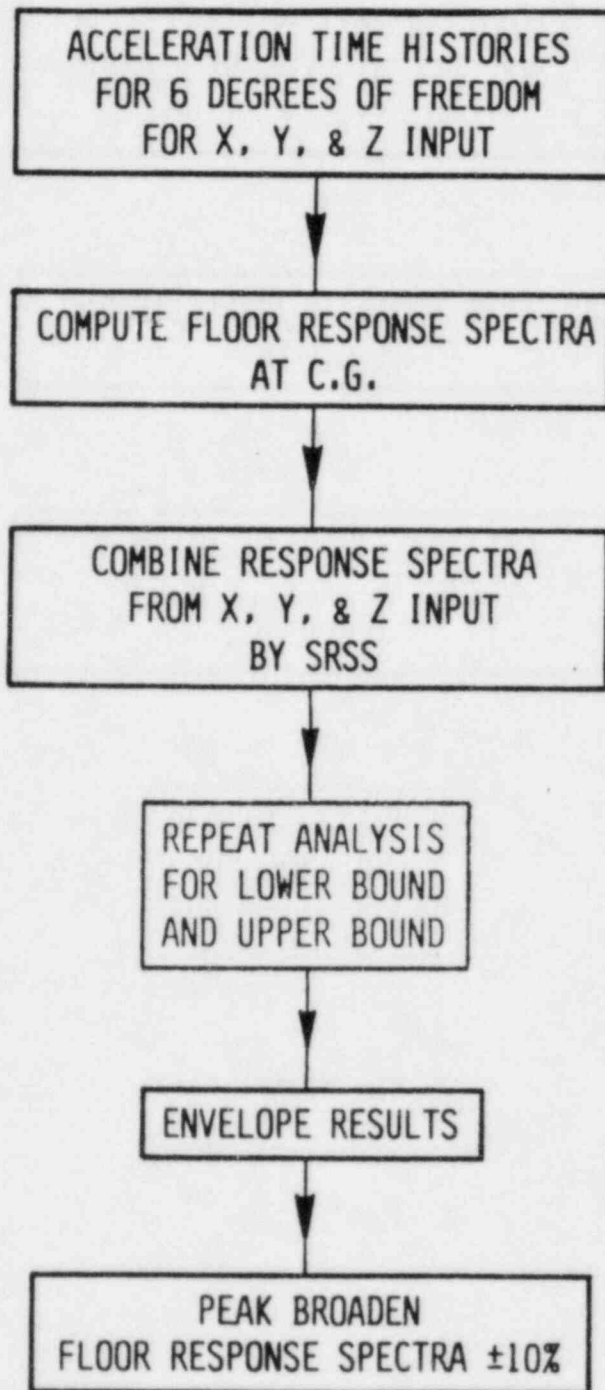
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RSI RE-ANALYSIS

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MODAL SUPERPOSITION ANALYSIS



OUTPUT



TREATMENT OF MODAL DAMPING

FSAR

$$D_i = \frac{\sum_j E_{ij} D_j}{\sum_j E_{ij}}$$

REF.: WHITMAN, 1969

RE-ANALYSIS

$$D_i = \frac{\sum_j E_{ij} \left(\frac{\omega_i}{\omega_j} \beta_j + D_j \right)}{\sum_j E_{ij}}$$

REF.: ROESSET ET. A
1972

D_i = WEIGHTED DAMPING FOR MODE i

D_j = HYSTERETIC DAMPING FOR COMPONENT j

E_{ij} = MODAL ENERGY STORED IN COMPONENT j
IN MODE i

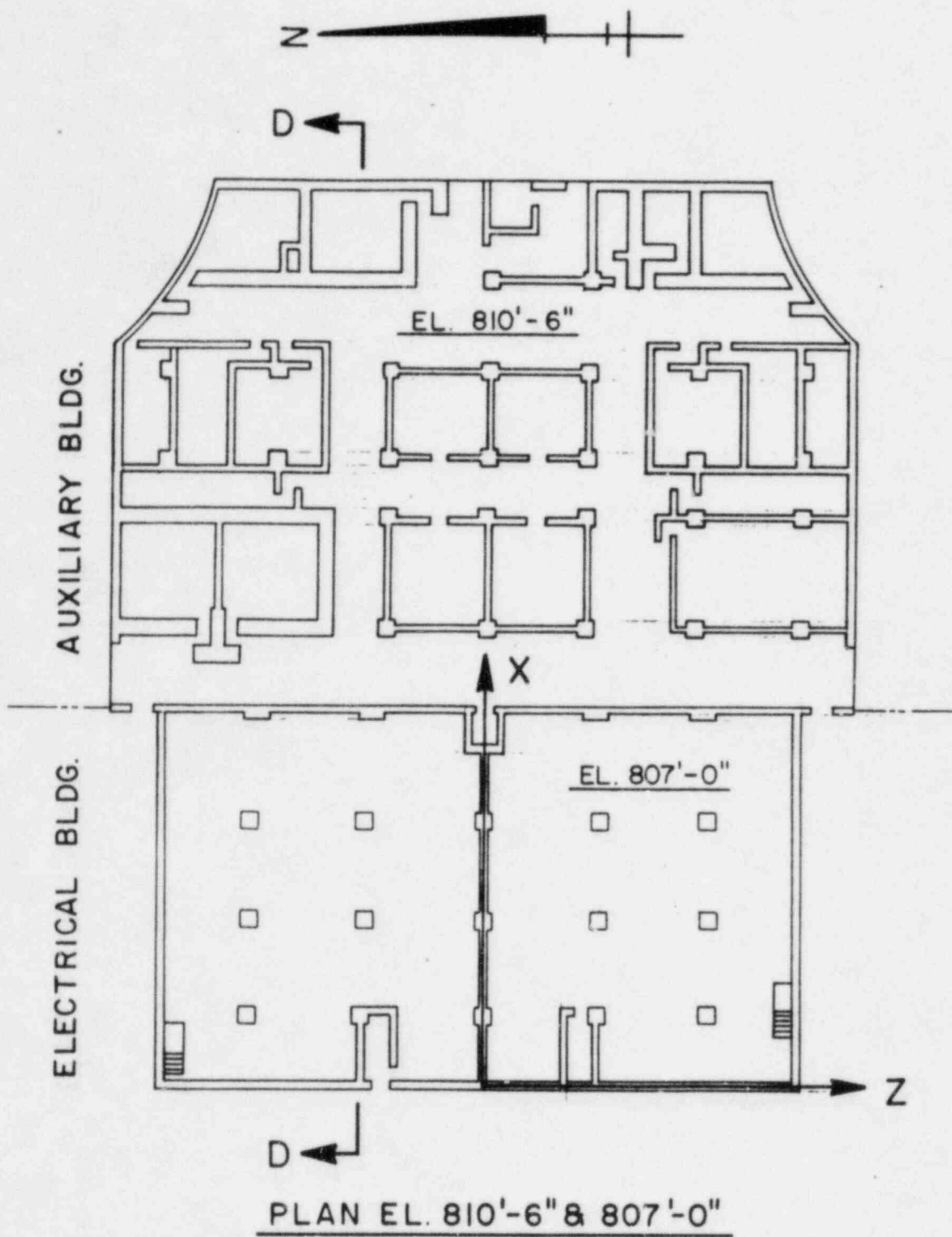
ω_i = FREQUENCY OF MODE i

ω_j = FUNDAMENTAL FREQUENCY OF RSI COMPONENT j

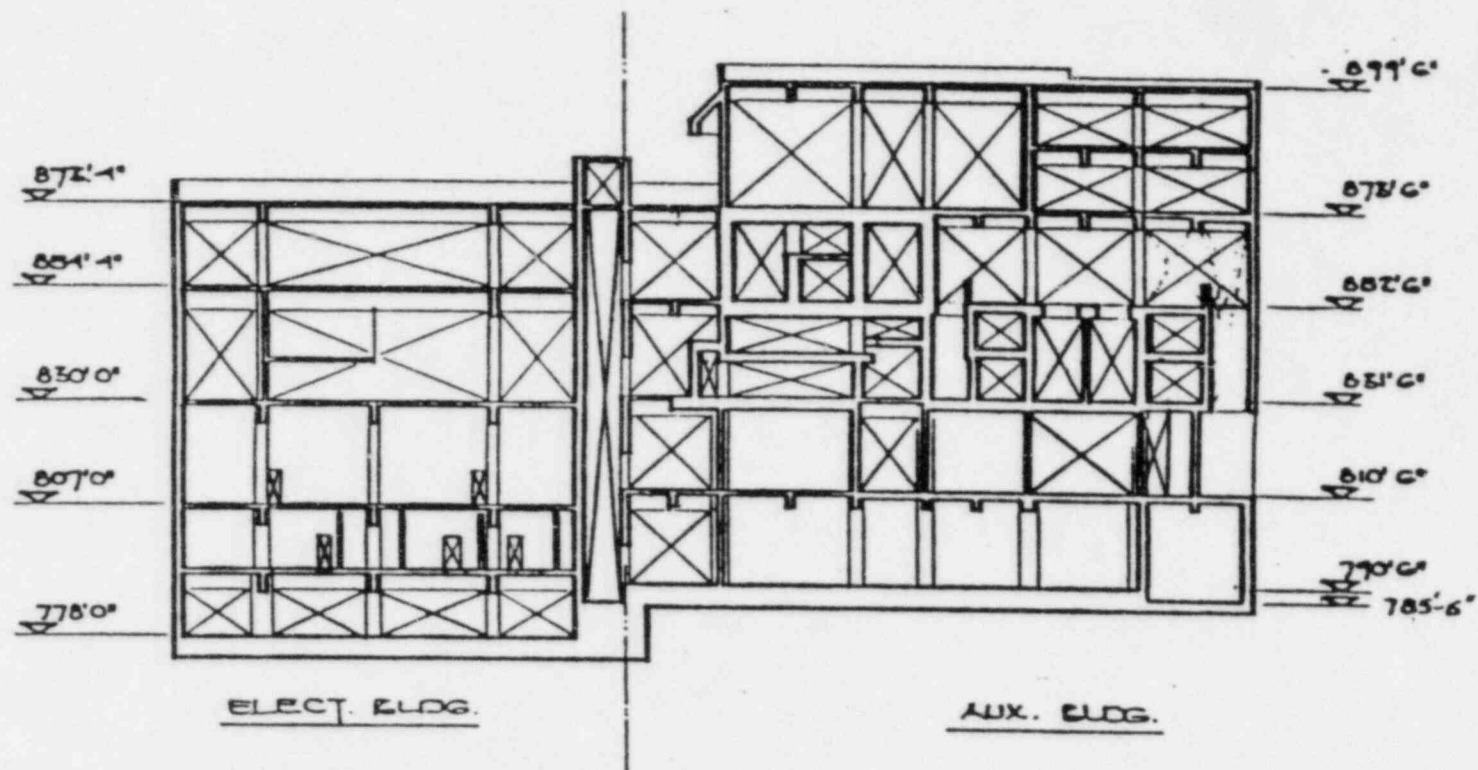
β_j = VISCOUS DAMPING FOR RSI COMPONENT j

MAJOR STEPS
FOR
RSI RE-ANALYSIS

<u>STEP</u>	<u>DESCRIPTION</u>
(1)	DEFINE RSI ANALYSIS PROFILE AND DYNAMIC ROCK PROPERTIES
(2)	DEFINE FOUNDATION GEOMETRY
(3)	OBTAIN STIFFNESS & DAMPING FOR 6 MODES (RIGID MATS ON ELASTIC LAYERED SYSTEM)
(4)	CORRECT FOR EMBEDMENT
(5)	DISTRIBUTE SPRINGS COMPATIBLE WITH STRUCTURAL MODEL
(6)	PERFORM MODAL SUPERPOSITION ANALYSIS WITH ATH <ul style="list-style-type: none">• 6 DOF• 3 DIRECTIONAL INPUT MOTION (SRSS)• MODAL DAMPING• VARY ROCK PROPERTIES AND EMBEDMENT EFFECTS• PEAK BROADEN
(7)	COMPARE "OLD" AND "NEW" RSI PARAMETERS AND FLOOR RESPONSE SPECTRA

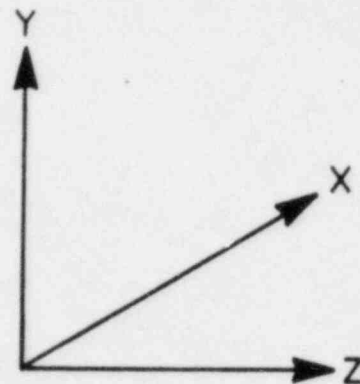


AUXILIARY / ELECTRICAL BUILDING

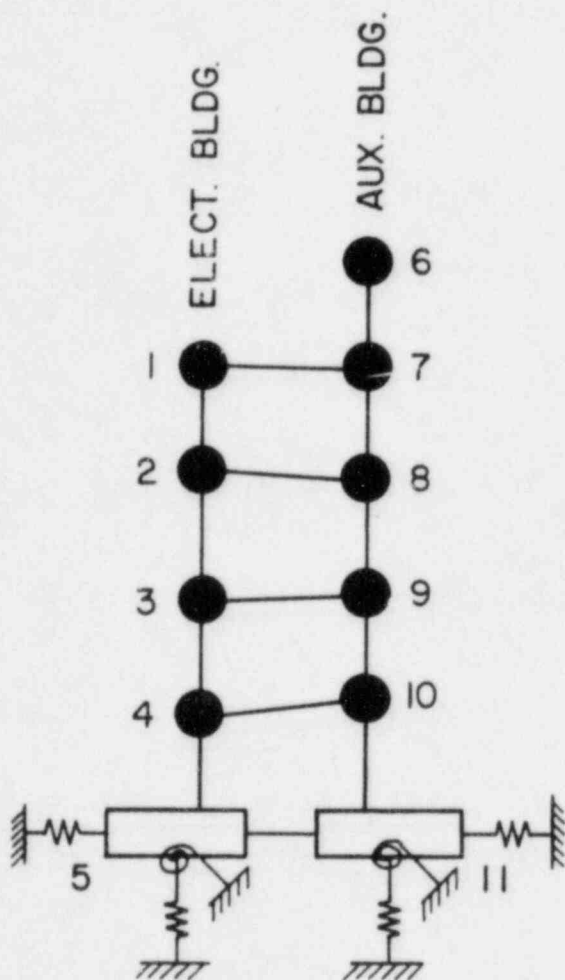


SECTION D-D

AUXILIARY / ELECTRICAL BUILDING



COORDINATE SYSTEM



SEISMIC MODEL

AUXILIARY / ELECTRICAL BUILDING

AUXILIARY/ELECTRICAL BUILDING
FOUNDATION SPRING CONSTANTS
RSI RE-ANALYSIS

<u>MODE</u>	<u>LOWER BOUND</u>	<u>BEST ESTIMATE</u>	<u>UPPER BOUND</u>
VERTICAL X 10^8 KIP/FT.	.35	.46	0.60
HORIZONTAL X 10^8 KIP/FT.	.32	.44	0.59
ROCKING ABOUT X AXIS X 10^{12} KIP-FT/RAD.	.38	.52	0.72
ROCKING ABOUT Z AXIS X 10^{12} KIP-FT/RAD.	.57	.77	1.04
TORSION ABOUT Y AXIS X 10^{12} KIP-FT/RAD.	.71	.94	1.24

1. ALL VALUES ACCOUNT FOR LAYERING AND EMBEDMENT EFFECTS.

COMPARISON
FSAR VERSUS RSI RE-ANALYSIS
AUXILIARY BUILDING
FOUNDATION SPRING CONSTANTS

<u>MODE</u>	<u>BEST ESTIMATE FSAR</u>	<u>BEST ESTIMATE RECOMMENDED</u>
VERTICAL X 10^8 KIP/FT.	.49	.26
HORIZONTAL ALONG X AXIS X 10^8 KIP/FT.	.49	.14
HORIZONTAL ALONG Z AXIS X 10^8 KIP-FT	.47	.14
ROCKING ABOUT X AXIS X 10^{12} KIP-FT/RAD.	.15	.30
ROCKING ABOUT Z AXIS X 10^{12} KIP-FT/RAD.	.08	.25
TORSION ABOUT Y AXIS X 10^{12} KIP-FT/RAD	.21	.21

COMPARISON
FSAR VERSUS RSI RE-ANALYSIS
ELECTRICAL BUILDING
FOUNDATION SPRING CONSTANTS

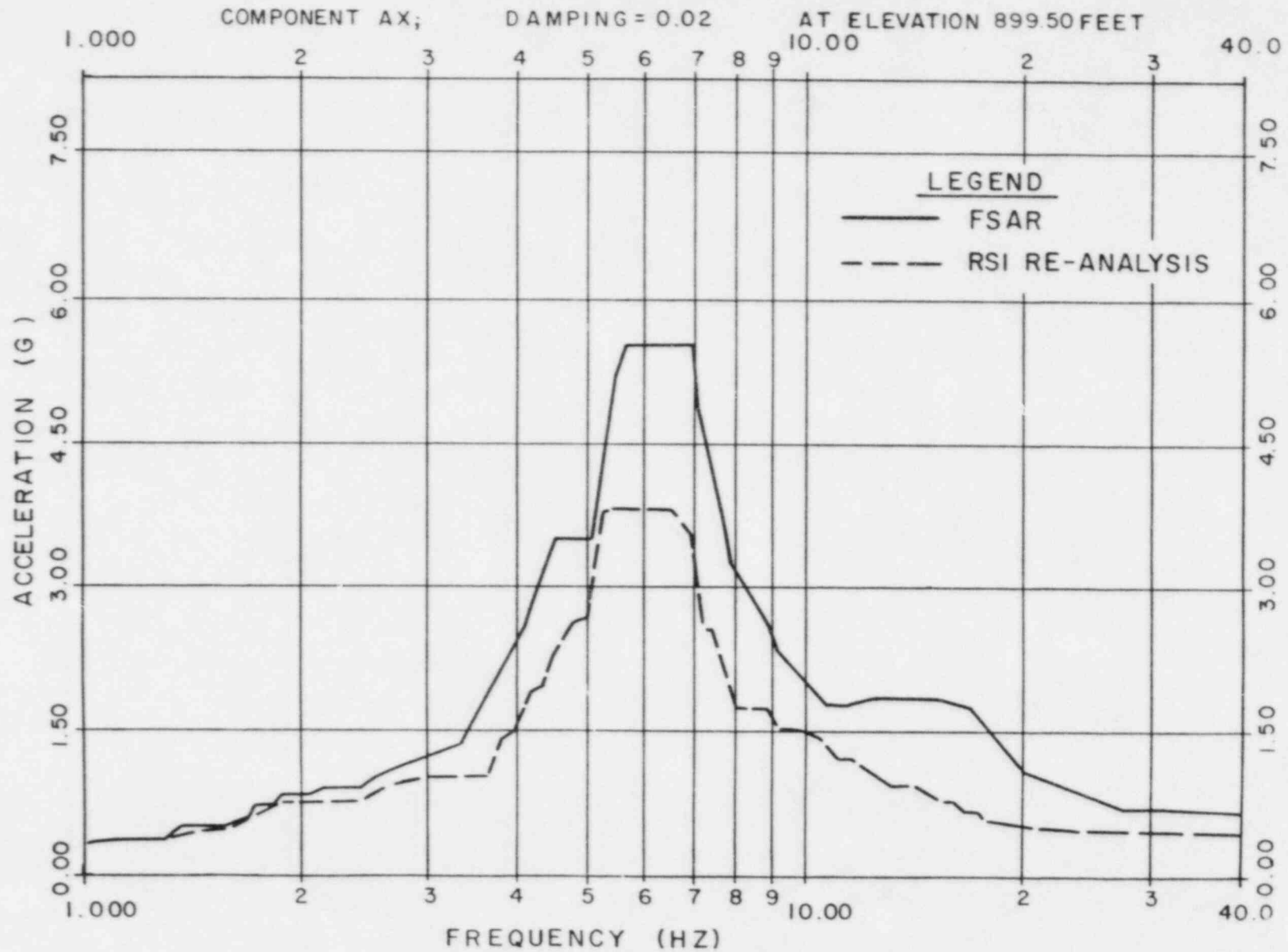
<u>MODE</u>	BEST ESTIMATE <u>FSAR</u>	BEST ESTIMATE <u>RECOMMENDED</u>
VERTICAL X 10^8 KIP/FT.	.39	.20
HORIZONTAL ALONG X AXIS X 10^8 KIP/FT.	.48	.30
HORIZONTAL ALONG Z AXIS X 10^8 KIP-FT	.50	.30
ROCKING ABOUT X AXIS X 10^{12} KIP-FT/RAD.	.09	.22
ROCKING ABOUT Z AXIS X 10^{12} KIP-FT/RAD.	.03	.36
TORSION ABOUT Y AXIS X 10^{12} KIP-FT/RAD	.12	.53

AUXILIARY/ELECTRICAL BUILDING
FOUNDATION DAMPING VALUES
RS1 RE-ANALYSIS

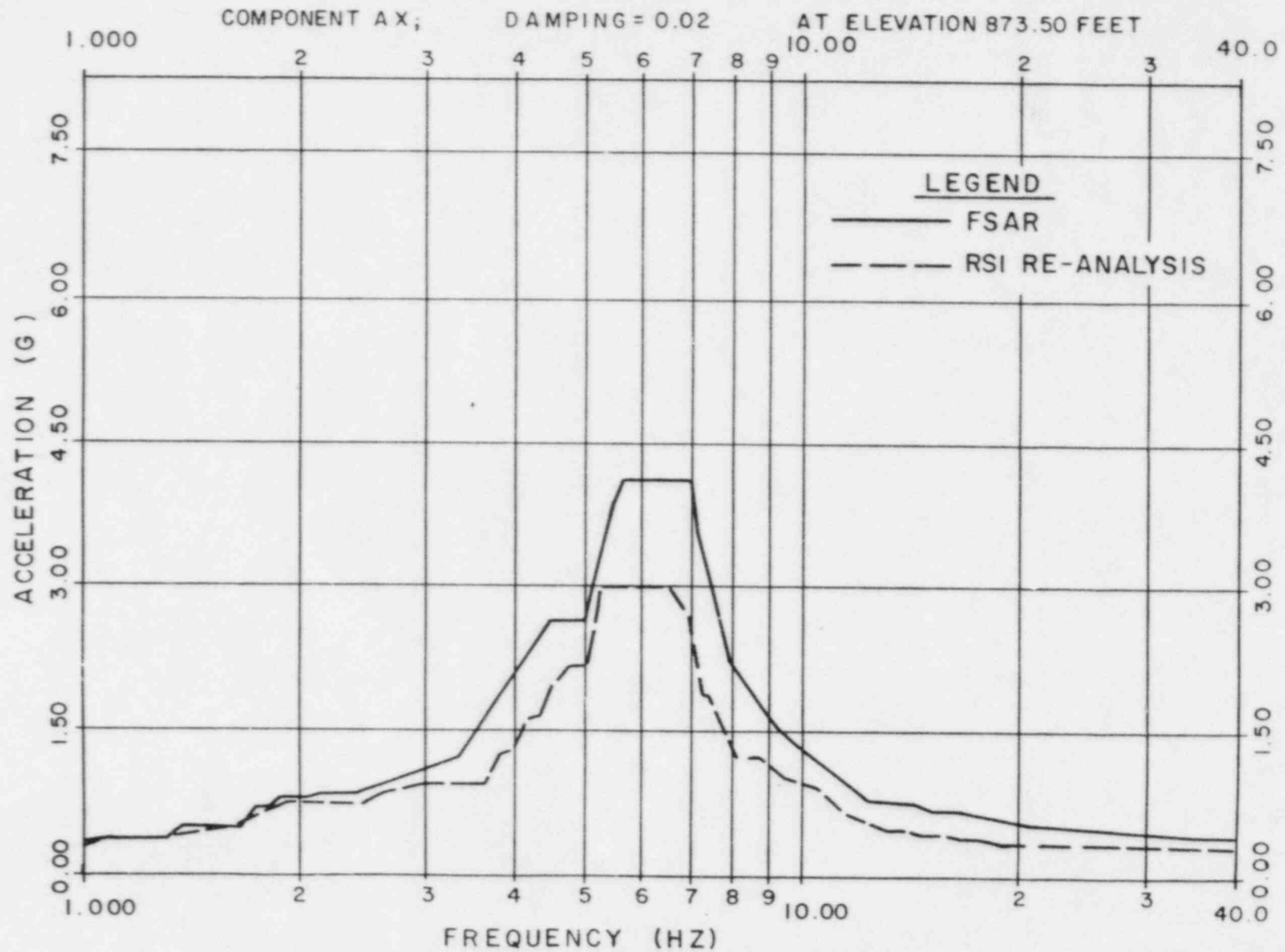
<u>MODE</u>	GEOMETRIC	MATERIAL
	<u>DAMPING (VISCOUS)</u>	<u>DAMPING (HYSTERETIC)</u>
	<u>%</u>	<u>%</u>
VERTICAL	65	2
HORIZONTAL	50	2
ROCKING ABOUT X	26	2
ROCKING ABOUT Z	31	2
TORSION	22	2

-
1. ALL VALUES ACCOUNT FOR LAYERING AND EMBEDMENT EFFECTS.
 2. GEOMETRIC DAMPING VALUES DEFINED AT RIGID-BODY INTERACTION FREQUENCIES.

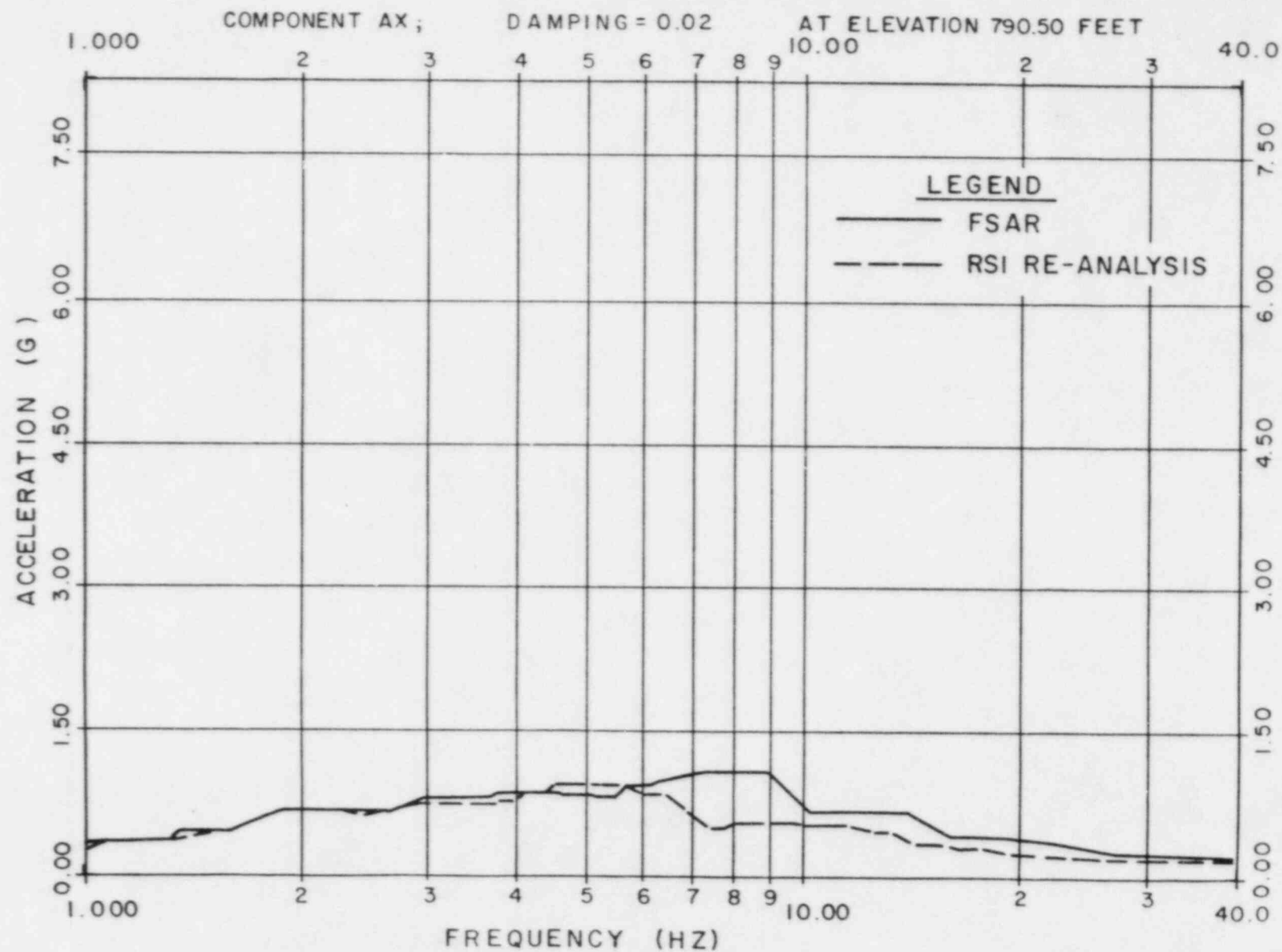
AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
FSAR vs RSI RE-ANALYSIS



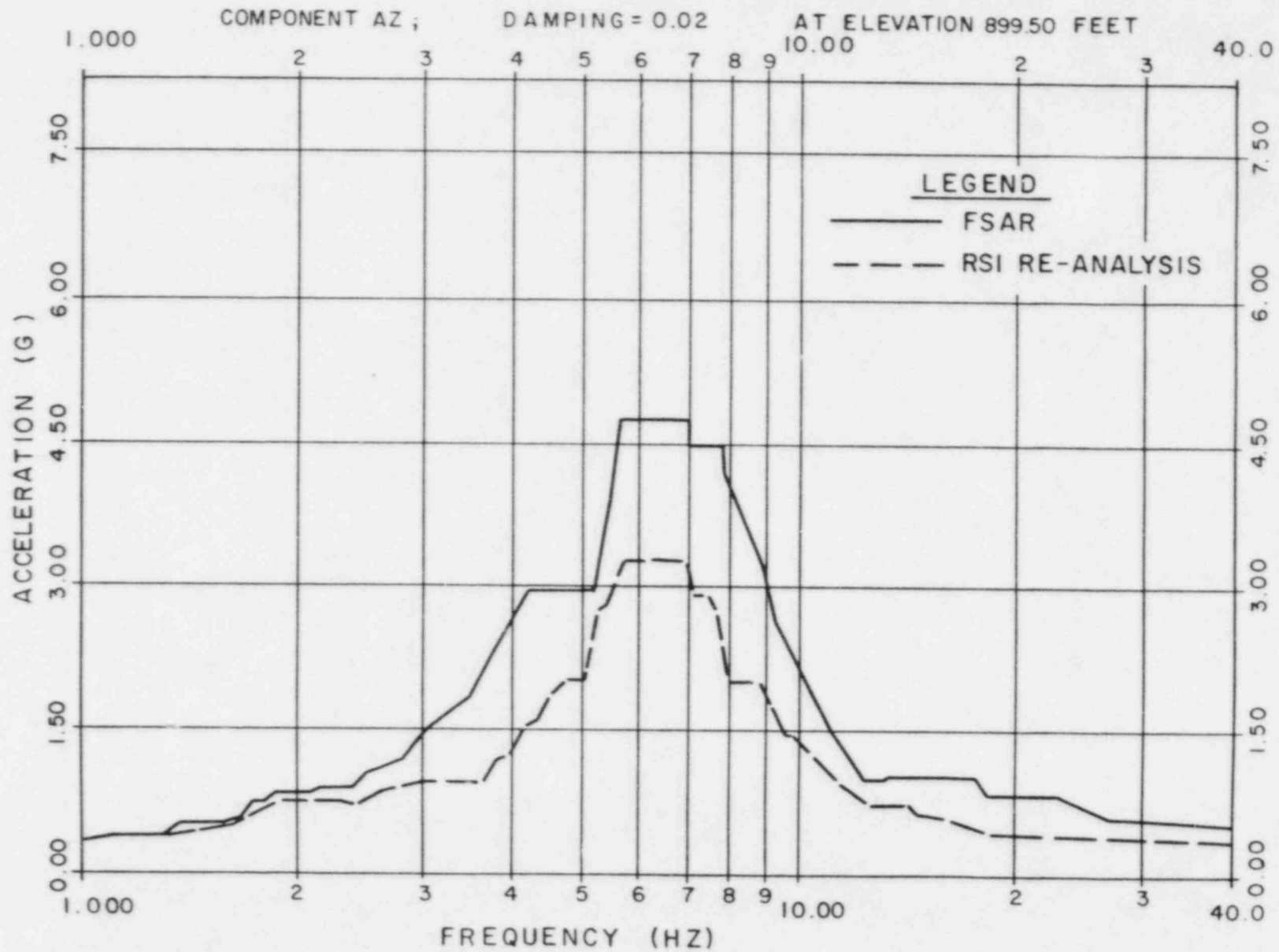
AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
FSAR vs RSI RE-ANALYSIS



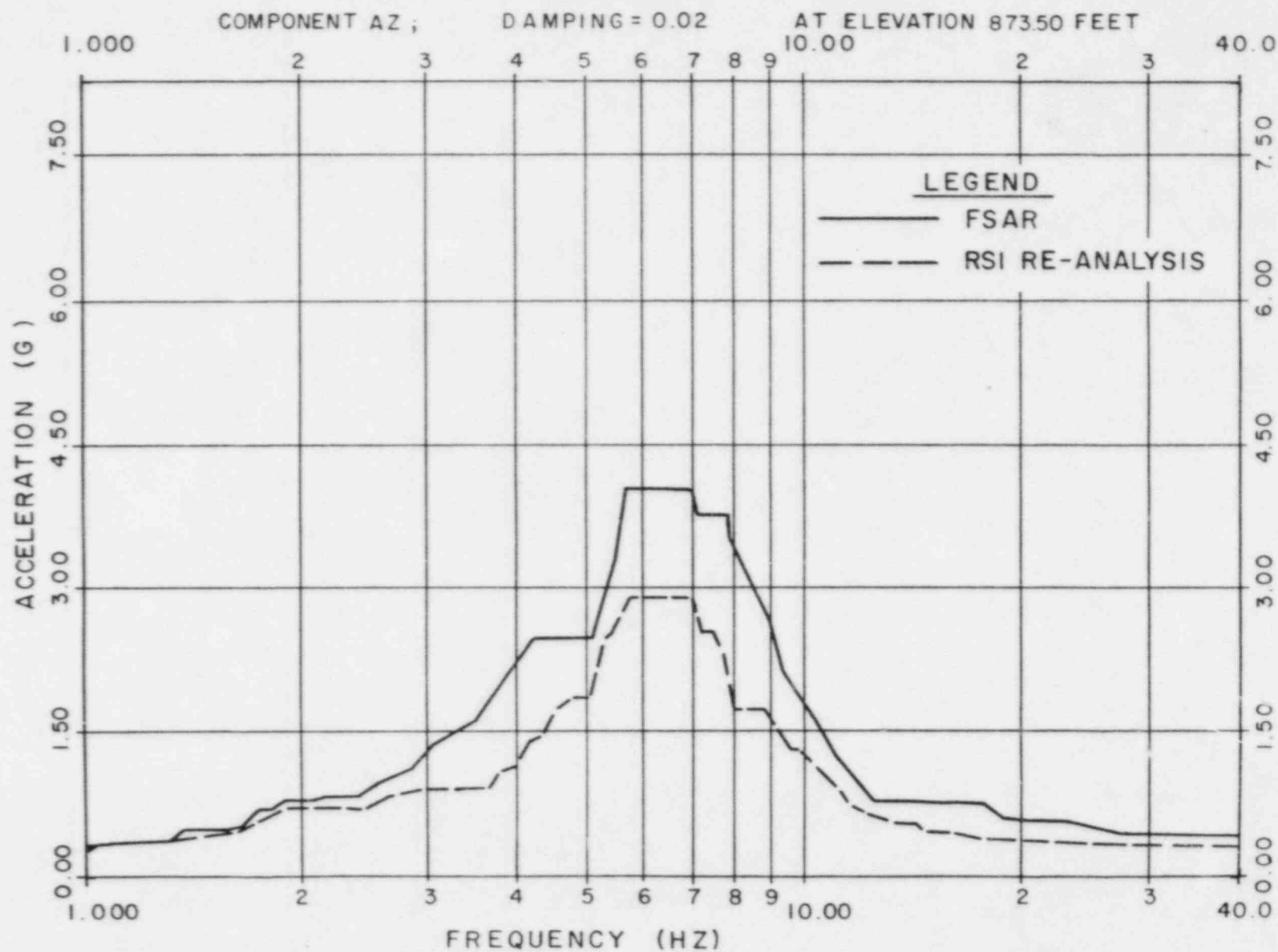
AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
FSAR vs RSI RE-ANALYSIS



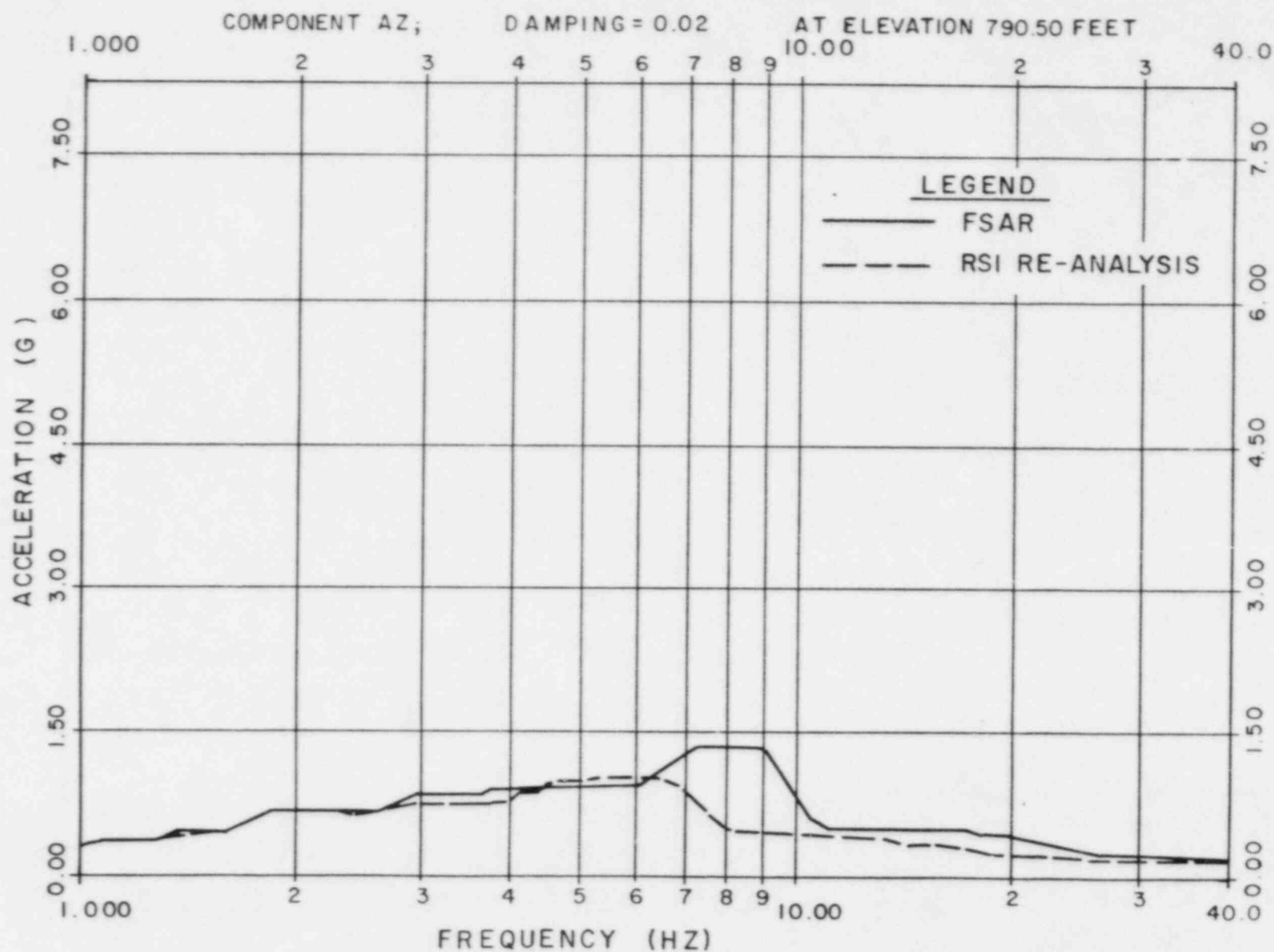
AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
FSAR vs RSI RE-ANALYSIS



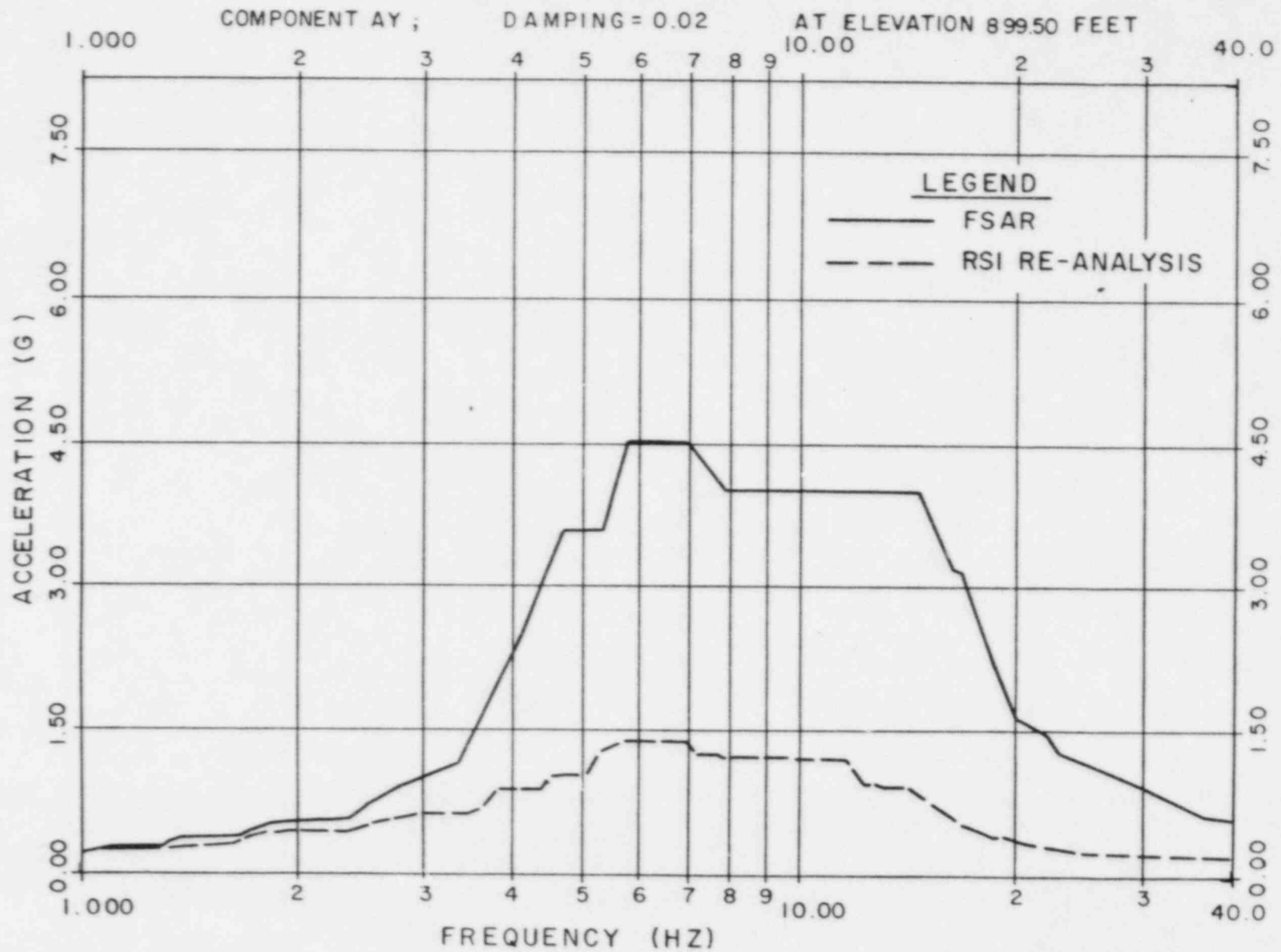
AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
FSAR vs RSI RE-ANALYSIS



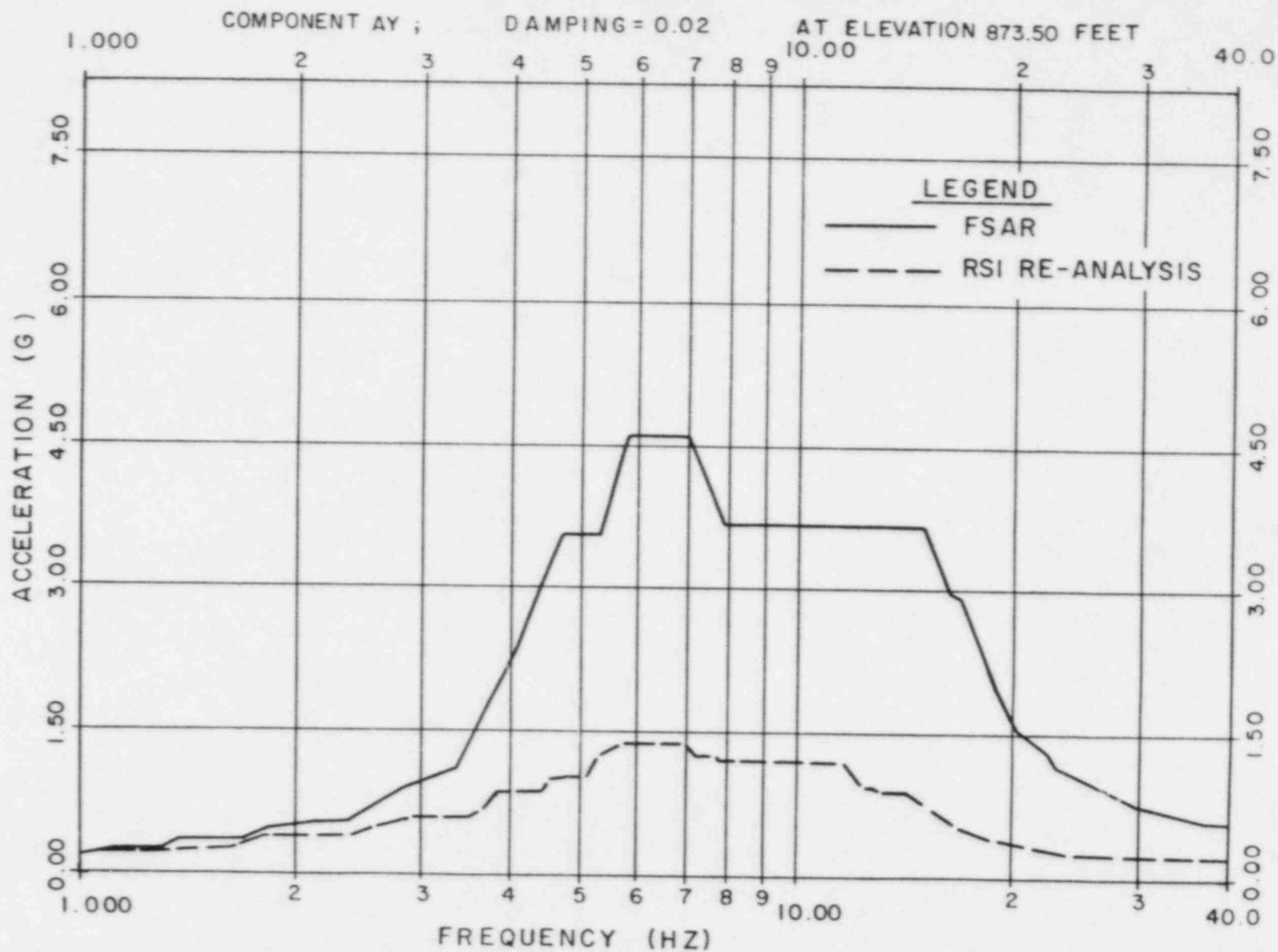
AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
FSAR vs RSI RE-ANALYSIS



AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
FSAR vs RSI RE-ANALYSIS



AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
FSAR vs RSI RE-ANALYSIS



AUXILIARY BUILDING
FLOOR RESPONSE SPECTRA
FSAR vs RSI RE-ANALYSIS

