more appropriate approach. An example of our concern is shown in Tables I and II for a problem (110) taken from ITR #17 where the mode of presentation shows significantly different results. Their response was that their approach was presented to the Staff some time ago and that the staff should have objected to it then. However, they agreed to use the form which we suggested. They also stated that large bore supports were being addressed separately in a different ITR so that the presentation of the results was not in itself of immediate significance. One of the purposes of these ITRs was to determine sources of significant differences between RCLA and PGE stress and support results and not specifically to determine if they satisfy the safety criteria.

For equipment nozzles the same remarks apply. RLCA intends to perform a separate verification of the safety of these nozzles.

Future corrective action on nozzles and supports is also described in more detail in ITR #8.

3. In problem 110 no spectra were available for the analyzed piping where they are attached to the reactor coolant loop. Apparently PGE used the RCL motions to determine the seismic stresses. RLCA used the building spectra in addition to the anchor motion to calculate the pipe stresses and support loads. In this case these exceeded by a considerable amount the allowable stress and the design support loads. Although RLCA issued a type A error report we discussed this to determine the procedure being used by PGE for reanalysis. RLCA stated that they had not received the PGE results and therefore reserved comment then. The same issue of presentation of results was also discussed (ref. item 2 above).

4. Other topics which were also discussed:

a. Interpretation of response spectra curves at various elevations.
b. No EOI's associated with differences in spectra were specifically issued. We questioned this. They stated that these were usually combined with other EOI's on the same problem.
c. The methods for calculating the maximum acceleration (the same as that used for calculating the forces).
d. Boundary support condition used in the analysis of the RHR pump in problem 103. The question raised was whether pump lift off can occur. They stated that the weight of the pump is sufficient to keep it from lifting. We examined the calculation and it seems to be thorough.
e. In problem 104 the natural frequency of the heat exchangers was determined as 9 Hz yet PGE assumed that it was rigid. RCLA, even though they disagreed with the assumption, also assumed it to be rigid. The reason for this was that they were aware that there was a problem with the heat exchangers, but to be able to compare with

the PGE results they assumed the same condition as PGE, otherwise they could not have compared results. These heat exchangers are being verified separately.

f. Criteria used for spacing the pipe masses around a support was stated as being the same as for the rest of the pipe. Support masses were not included in the models.

g. In problem 113 and 115 there were five separate analyses performed to represent five models of the steam generator bumper supports. The results presented are an envelope of all five analyses.

Mark Hartzman

Mark Hartzman
Mechanical Engineering Branch
Division of Engineering

cc: R. Vollmer
T. Novak
D. Eisenhut
J. Knight
F. Cherny
P. T. Kuo
H. Polk
P. Bezler, PNL
M. Reich, PNL
H. Schierling
F. Schauer
E. Sullivan

List of Attendees

Ed Denninson	RLCA
R. Cloud	RLCA
C. Browne	RLCA
Rob Foti	TES
Albert Leung	TES
S. Chim	TES
Peter Mason	Bechtel
Mike Tressler	PGE
Larry Shipley	Bechtel

TABLE I

RLCA Node	PGandE Node	SEISMIC STRESS (psi) Verification Analysis ^{A}	SEISMIC STRESS (psi) Design Analysis	Deviation ^{D} (Percentage)
615	460	52,903^{B}	3,156^{B}	94 +1576% *
620	462	48,492^{B}	2,947^{B}	94
625	463	43,660^{B}	2,589^{B}	94
395	83	43,488^{B}	9,896^{C}	77
630	464	31,839^{B}	2,057^{B}	94
400	385	36,000^{C}	9,160^{C}	75
495	325	38,407^{B}	27,575^{B}	28
500	330	38,413^{B}	27,733^{B}	28 -39%
410	385	30,356^{C}	9,160^{C}	70
455	397	35,422^{C}	11,864^{C}	67
450	395	35,297^{C}	10,328^{C}	71
425	386	34,244^{B}	12,560^{C}	63
315	104	24,112^{B}	1,632^{C}	93
415	386	25,937^{B}	12,560^{C}	52
320	107	23,393^{B}	1,538^{C}	93
755	439	29,743^{B}	10,362^{C}	65
760	440	30,998^{B}	10,196^{C}	67
460	398	28,939^{B}	12,833^{C}	56
640	465	18,493^{B}	833^{B}	95 - 2120%

^{A}Seismic anchor movements included.

^{B}Due to ZY seismic

^{C}Due to XY seismic

^{D}Deviation = (Verification-Design)/Verification x 100. Values greater than 15% exceed acceptance criteria.

* Percentage values calculated from (Verification - Design)/ Design x 100.

Table 3-3

Comparison of Stresses

Verification Analysis/Design Analysis

Piping Sample 110

TABLE II

Support Number	Load Direction[A]	Enveloped Seismic Loads		Deviation[C] (Percentage)
		Verification Analysis	Design Analysis	
10-49SL	F_Y	1,590	1,451	9
46-12R	F_X	523	451	14
	F_Z	721	1,030	43 −30%
46-7R	$F_{H\perp}$[B]	312	304	3
11-10SL	F_{axial}	510	335	34
11-11SL	F_Y	1,707	164	90 +941%
46-9V	F_X	130	192	48
10-14SL	F_Z	520	530	2
10-78SL	F_X	162	287	77
46-10V	F_X	268	234	13
	F_Z Fy	1,029	728	29 +41.3%
10-1SL	F_X	384	--	--
10-2SL	F_Z	765	--	--
46-11R	F_Y	637	179	72 +256%
10-80SL	F_Z	585	1,147	96 −49%
10-79SL	F_X	299	537	80

[A] Where F = Support force measured in pounds

[B] ⊥Indicates that load direction is perpendicular to pipe
HIndicates horizontal plane.

[C] Deviation = (Verification-Design)/Verification X 100.
Values greater than 15% exceed acceptance criteria.

[illegible] 47% [illegible]

Table 3-4
Comparison of Support Loads
Verification Analysis/Design Analysis
Piping Sample 110

ORIGINAL

OFFICIAL TRANSCRIPT PROCEEDINGS BEFORE

NUCLEAR REGULATORY COMMISSION

DKT/CASE NO. 50-275

TITLE PACIFIC GAS & ELECTRIC CO. (DIABLO CANYON UNIT 1 (DESIGN VERIFICATION)

PLACE BETHESDA, MARYLAND

DATE FEBRUARY 15, 1983

PAGES 1 THRU 47

ALDERSON REPORTING

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WASHINGTON, D.C. 20001

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

- - - - - - - - - - - - - - - - x
In the Matter of x
PACIFIC GAS & ELECTRIC CO. x Docket No. 50-275
[Diablo Canyon Unit 1 x
Design Verification] x
- - - - - - - - - - - - - - - - x

Room P-110
7290 Norfolk Avenue
Bethesda, Maryland
Tuesday, February 15, 1983

A conference in the above-entitled matter was held, pursuant to notice, at 10:05 a.m., when were present:

H. SCHIERLING, U.S. NRC
J. KNIGHT, U.S. NRC
M. REICH, Brookhaven National Lab
C. MILLER, Brookhaven National Lab
A. J. PHILIPPACOPOULOS, BNL
F. SCHAUER, DE/CSE
M. J. HOLLEY, JR., Teledyne/HH&B
J. M. BIGGS, TES/ HH&B
C. E. MRYGLOT, TES
VINCE STEPHENS, Robert Cloud Assoc.
R. L. CLOUD, Robert Cloud Assoc.
R. D. CIATTO, Teledyne
LAWRENCE CHANDLER, NRC/OELD
BIMAL SARKAR, Diablo Canyon Project
KEN BUCHERT, Bechtel
JOHN HOCH, Diablo Canyon Project
BRUCE NORTON, Norton, Burke, Berry & French
GEORGE LEAR, SGEB, NRC
HAROLD POLK, SGEB, NRR
P.T. KUO, SGEB, NRR
RICHARD F. LOCKE, PG&E
F. C. CHERRY, NRC/NRR/MEB
R. BOSNAK, NRC/MEB
M. HARTZMAN, NRC/DE/MEB
G. PRUETT, PG&E
S. DURBIN, State of California, A.G.

P R O C E E D I N G S

(10:05 a.m.)

MR. KNIGHT: Gentlemen, let's see if we can get started. My apologies for the delay.

As I am sure you who are in this room are aware, the Staff had asked Brookhaven to do some I guess what one might call "scoping analysis" for us as part of our review of the IDVP ongoing at Diablo Canyon. One main element of this most recent work has been a look at the horizontal response of the annulus steel in the containment building.

Brookhaven has now essentially completed that work. We had the benefit of a brief review with them a couple of weeks ago shortly before they had completed it, and it occurred to us that it would be timely to have everybody who is a party to this review made aware of the outcome of their work to date.

As of this time -- excuse me for a moment. You are also going to give us a brief status on the other two efforts, aren't you?

MR. REICH: Very briefly.

MR. KNIGHT: Okay. Do you want to do that later, or now?

MR. REICH: At the end -- or I can do it right now.

MR. KNIGHT: Why don't we do it first. I am going to ask Morris Reich to run down each of the three tasks that we had asked them to perform for us. The majority of the day will be spent talking about their results as far as the horizontal response of the annulus steel goes; but he will give us a brief status report on the other efforts.

As usual, since we have a recorder here today, when you speak would you please give your name. I would like to suggest that, as always -- and this is sometimes futile -- but I would like to suggest that we let the speaker pretty well finish his presentation before we ask questions. But certainly if there is a burning question and you feel a point needs to be made while the slide is up, please feel free to ask the question.

Are there any other administrative matters?

MR. SCHIERLING: Since we are making a transcript, please only one person talk at a time, because otherwise we will have a transcript which will not serve its purpose. I will send around an attendance list, and I would ask everybody to please sign in. I think present today we have the Staff; we have Brookhaven; we have Teledyne and its consultants as the IDVP manager; and representatives from PG&E are here.

Are there any other parties in the room

directly interested in the proceeding, or not? If so, please identify yourself.

[No response.]

MR. SCHIERLING: That is all I have, Jim.

MR. KNIGHT: Fine. Does anybody from PG&E or Teledyne have anything to say?

[No response.]

MR. KNIGHT: Okay, Morris.

[Slide.]

MR. REICH: I will start by reviewing the horizontal seismic analysis that we are going to talk about today.

Can everybody see this? I will go over the task outline, and I will have Professor Miller discuss all the work today that we carried out. We have completed this portion of the work. We have a horizontal floor spectrum. We have envelope spectra which we are going to --

MR. SCHIERLING: Morris, just one moment.

We have made copies of the slides that Brookhaven will be using. There might not be enough, but I will put them on the table. So please do not take any more than is absolutely necessary.

MR. CLOUD: Morris, it might be helpful if you could speak from the screen instead of the slide. Thank you.

MR. REICH: Let me continue what I was saying. Essentially today's meeting concerns itself with the horizontal seismic analysis which we have completed, and I think we have completed it according to schedule.

We were requested essentially to independently develop a horizontal floor response spectra for the containment annulus structure. For us, this involved the following tasks:

First, we carried out preliminary studies to identify significant flexibilities. The reason for this is as follows: We were told that there is going to be a deadline for this, and we should have this ready by at least the middle of February. And since no prints were available at the time when we were told to start the study, we took advantage of the prints which were available to us from the study that we made of the vertical spectra.

Essentially there was a lot of information in some of that. We were able to use that to start our preliminary studies to identify significant areas of flexibilities so that we could judge, a priori, where to concentrate our studies.

The prints came in to us on the 14th of

December, and we immediately set out to develop a detailed finite element model based on those prints. The results we are going to talk about today are up to about the 10th of January. So far as we know, that applies to the prints that we have up to the 10th of January.

Once we developed a very detailed finite element model -- and we are going to show this model here fairly shortly -- then we set out to calculate the mode shapes and frequencies. Then once we were finished with that, we carried out a time history analysis.

We determined the floor response spectra. Essentially what we have is, for each component or for each direction of input we would get two responses. We combined those by using SRSS. Then finally we have an envelope spectra for X and an envelope spectra for Y for each floor. That is essentially the task that we have carried out.

Then we notified the NRC about a week-and-a-half ago that we had completed this work and that we were ready to either have a meeting on it, or write a report on it. This is the final result.

Coming back to the other tasks that Jim asked me to comment on, as you know we are doing piping analysis. We are quite a way into that already. There are five people working on that. It is not a simple task, because the piping data is contained in hundreds of sheets. We are hunting through that data, and we have some questions which we are not completely resolved on yet. We will get back to you very shortly on that.

At the moment we have already made some preliminary runs, and some preliminary computer graphics' printout of how we see the system. We are comparing that to see how the system looks. I think it was about a week ago that we received a larger print from PG&E where we can at least compare the graphics which we have printed out versus that one. So that is going along very nicely.

As soon as we are in a position to feel that we have results, we will get in touch with you right away similar to what we are doing right now.

We have several unresolved questions on the buried oil tank which we were told we are going to receive information on fairly shortly, and maybe even today. We are waiting for that information because it impacts on how we are going to do the analysis. But we are set up. In a sense, we have done some of that work. That one needs a substantial amount of work yet, maybe another two weeks of work; but that is also quite a bit along.

At this point I will call on Professor Miller and have him go into the results of the horizontal spectra.

[Slide.]

MR. MILLER: As Morris indicated, the model that was developed I guess grew out of two things. One was certainly the model that we had used for the vertical analysis and reported in NUREG/CR-2834. We had also performed some preliminary kinds of studies to point out which were the significant flexibilities of the annular region when considering horizontal kinds of motion. So the model we ended up with is a result of a combination of both of those, identifying what the significant flexibilities were and then going back to use as much as we could of the vertical model.

I think also the model, the parameters used in the model and the properties of the structure are the properties as of the material that we had received through about January 10th. The changes that were made, as I said we started with the model that we had reported in NUREG/CR-2834. The vertical analysis, that model basically contained each of the four foors -- the steel on each of the four floors, the concrete on the fourth floor; it contained the columns; the floors were fixed at the crane wall. The crane wall was taken to be rigid in the vertical direction.

First of all, none of the bracing members were included in that original model. These are horizontal bracing members running in each of the floors. Those members were all added because they clearly made a difference to the horizontal response. They were treated as truss kind of members, bracing members.

The crane wall in the horizontal direction, based on some preliminary kind of numbers were no longer really being considered as rigid, so the crane wall was added as a series of finite element kind of elements to the vertical model.

There are two major internal structures to the crane wall that we believe effect its horizontal response. Those are the two pool walls that surround the reactor; but basically what they do is they stiffen the cylindrical shell that is the crane wall, so those walls are added.

At the 140-foot level there is essentially a solid floor that stands internal to the crane wall. If not solid, it is certainly rigid, based on any kind of movement you want to make. So there was a solid floor that was added inside the crane wall at the 140-foot level.

There is a lot of mass internal to the crane wall that sits on the 140 level that was not included in the original model: the steam generators, the pressurizers, the concrete shields surrounding the generators, the overhead crane and things like that. All of those masses were added at the 140 level.

Before we leave this, the degrees of freedom that were retained in the model, both horizontal displacements were retained, and the rotation of the outer vertical axis was retained.

Preliminary analysis indicated that bending of the overall structure was really associated with a much higher frequency mode than we are interested in, so the vertical displacements were restrained and the rotations about a horizontal axis were restrained. There was one exception.

The rotations about the horizontal axis nodes that were on the crane wall were released, so they could rotate. So those are the degrees of freedom that were included in the model. Basically the horizontal displacement, the one rotation about the vertical axies, and the two rotations about the horizontal axies for those nodes that were located in the crane wall were included.

[Slide.]

To show you what the model is, the overall picture is broken down into six parts. There is a plan view of each of the floors. There is an isometric of the crane wall. And then there is an isometric of the pool wall. This is the floor plan for level 1. These are the bracing members I am talking about that were added going from the vertical model to the horizontal model.

This (indicating) is the projection of the crane wall on the first floor. This is the start of those pool walls. Eventually as you move up the structure, these will run entirely across the interior of the crane wall, and basically stiffen the crane wall at those two locations.

MR. SCHIERLING: Chuck, could you always indicate at what elevation we are talking about?

MR. MILLER: This is floor one, and it is elevation like 101.

MR. REICH: "F-1" is "Floor 1."

MR. SCHIERLING: At 101; right?

MR. MILLER: 101; right.

[Slide.]

This is Floor 2, elevation 106. And again the pool wall still only goes over to the beginning of the reactor cavity itself. All the bracing members are added to the vertical model as with Floor 1.

[Slide.]

Floor 3 is at elevation 117. Again, these are the bracing members that were added. This (indicating) represents the crane wall going around the inside of the annulus steel. This (indicating) is the pool wall. It now goes completely across the structure.

[Slide.]

At the upper level, the 140 level -- now this is the operating floor -- this (indicating) is the annular region, these outside three bands. This represents the concrete part of the steel framing, more concrete, and so on. This is the location of those pool walls. This is filled in with finite elements which basically are rigid. The SAFIRE code, it is difficult to couple degrees of freedom and allow some kind of overall rigid body rotation. So rather than doing that, we actually put in elements to model the floor, even though the in-plane rigidity is much more than one would really need to consider.

[Slide.]

This is an isometric now of the crane wall indicating the kind of elements that were used. This is the base of the crane wall, so the model was fixed at this location. This is the first floor, elevation 100. This is the second floor, elevation 106. This is elevation 117. This is elevation 140, corresponding to the fourth floor. These nodes were just put in to get some kind of reasonable model of the crane wall. So there is no floor at this level; otherwise, there is a floor at every level, plus the base of the crane wall where the model was fixed.

[Slide.]

Okay. These are the pool walls, again surrounding the reactor. These were about 20 feet apart. This is the base of the crane wall over here (indicating), and the base of the crane wall over there. This is again the first floor, elevation 100; 106, second floor; the third floor, 117; and the 140 level.

These walls were fixed at all of these interior nodes, at the base of the interior nodes. So the four positions were along the bottom of the crane wall and along the bottom of these pool walls.

The primary function of these pool walls by the way -- they are stiff so far as any bending displacements are concerned -- so the primary function really is to couple this displacement on the crane wall with this displacement over here, and they are like 4-1/2 foot thick walls.

[Slide.]

Okay. Having added the model, the modal solution was carried out. As you undoubtedly know, we have been using the SAFIRE computer program at BNL, and continue to use that. We went out to have solutions up to 40 modes. They are all plotted. There are 3 kinds of modes that show up, if you look at them. There are relatively few extremely local modes corresponding to a single-member bending. In this respect, the horizontal model is performing very differently than the vertical model. Almost everything in the vertical model was individual beam modes. There were only two cases where we have a very localized kind of mode.

Most of the modes -- in fact, of these 40, 34 of them are Type 2, which is a torsion, a twisting of the horizontal steel about the crane wall. The crane wall remains fixed. The third type is the overall shear deformation or a beam, a shear beam kind of deformation of the crane wall, and of course the whole structure following along with it.

[Slide.]

The 40 frequencies go from the small, like 1 of 28. The first two really correspond to the overhead crane. The overhead crane weighs like 600 kips, and we made a frequency number for the crane which indicated it is like a cycle a second, and so we put a single mass to represent the mass of the overhead crane, connected it to the 140-foot fall of the beam, and had this kind of a frequency. It is really unimportant. We ran a problem once without these in and you don't really get any different results. So these first two modes, really insofar as anything we are talking about, do not really affect anything.

The 2-1/2 cycle/second mode is one of the local modes we are talking about. That is at the third floor, the 117 floor level. The 9.7 cycle mode is another local mode at the second floor level. The overall beam bending, shear beam bending modes, there are two of them that show up in this conglomerate of modes.

The first one corresponds to the bending about the weak axis. The weak axis really goes along with the orientation of these pool walls that stiffen the cylindrical shells. This would correspond to a deformation across those pool walls. That is the first beam bending kind of mode. The 15th mode on 18 cycles corresponds to bending about the other axis, the strong axis of the structure.

All of the other modes that show up in here are of this torsional kind of variety.

[Slide.]

I would just like to show a couple of modes to give some feel for what I am talking about. This is the mode at 2-1/2 cycles a second. So all that really happens is this one member here, the model has a node at this point. There is no bracing member going out that point, so it is a local mode.

In the mode plots that we have, by the way, the dashed lines correspond to the undeformed shapes; the solid lines correspond to the formed shapes, so that is an extremely local effect and the only place it takes place.

[Slide.]

This is the seventh mode which corresponds to the overall beam bending of the shear wall. But this kind of deformation is the kind of deformation I talked about when I was talking about torsional deformation. So this is at the first floor level. What really happens is this section of steel started out in this location (indicating), and basically it is its flexibility, or really its shear deformation in this annular steel section that causes a motion that looks like a torsion of the whole steel frame. And this follows all the way around the structure.

[Slide.]

For that same mode, going up the structure the same kind of thing happens at all the floors. So these are not local modes; they are modes that carry a force as you go over the whole structure, again, because you see at the second floor there is an overall torsion of the steel.

[Slide.]

You get the prettiest picture on the third floor because everything is nice and symmetrical, because basically the outer section is all rotated in a counter-clockwise direction of the vertical axis.

[Slide.]

This is the kind of deformation that goes along with the overall beam bending. Now this is looking at the 140-foot level. This is the 7th mode which corresponds to deformation about the weak axis, this axis here (indicating), because the pool wall is running in this direction. So this is a mode that is like around 13 cycles a second, and everything pretty much shifts over like so (indicating).

For these modes, though, you also see superimposed on the lower floors the same kind of torsion or shear deformation in the steel.

[Slide.]

This is cut off in the picture, but this is the isometric of the crane wall for that same mode indicating that as you go up the structure you basically have general shearing kind of deformation of the structure like you would expect with the cantilever beam kind of movement.

[Slide.]

There are a lot of the torsional modes that, while certainly not local in the sense that that first picture was local, are localized over a segment of the steel. So you do see deformation pretty much all over, but you certainly see much larger deformations in restricted parts of the steel.

[Slide.]

Having the modes, the time history solution is carried out again using the SAFIRE program and the Newmark 7.5 Hosgri record was used as input. It was used as input in both the east-west and north-south directions. So there were two runs made, one on the east-west, and one on the north-south. Structural damping was taken at 7 percent.

[Slide.]

When we had the response for each of the nodes, for the east-west response we had displacements in both the east-west and the north-south direction. So for each node on the floor, the response spectra were generated using the 2 percent equipment damping, and they were generated, as I said, and the X in our notation is east-west, and the Z is the north-south. So when you put an east-west motion in, you get an east-west motion out at each node, but you also get a north-south motion at each node, especially because of this torsional effect on the steel, the shear deformation of the steel. In other words, if the steel sits off to one side and it wants to move straight up, it actually rotates.

So what was generated was four sets of spectra. This would be the spectra in the X direction or the X input; the spectra in the X direction due to the Z input; the spectra in the Z direction due to the X input; and the spectra in the Z direction due to the Z input.

The kind of combinations that we will show you now -- we will show you some peaks first, but then we will show you some combinations.

[Slide.]

The kind of combinations that were done was at a single node the X will combine with the X spectra due to X input; X spectra due to the Z input; or combined in our SRSS kind of computation, and then peaks were calculated.

[Slide.]

Just to give you some feel for what is going on in the structure, this is a plot of the peak accelerations on a spectra which pretty much occur either at 13 or 18 cycles a second for input in the east-west or in the X direction. What is shown on the picture are the peak spectral value, the peak acceleration in the X direction; and this (indicating) is the peak acceleration in the Z direction for input in the X direction.

[Slide.]

The first thing that sort of shows up is that the peaks on the crane wall are a lot smaller than the peaks are out any place in the annular steel, indicating that the flexibility of the steel is indeed important if you want to get spectra that apply in the annular steel.

The other thing that shows up is, there are many places now where we put the input in the X direction. Here we had 7.3g's in the X direction and 3.4 in the Z direction. But there are places like over here (indicating) where you get 6.3 in the X direction and 10.2 over there in the Z direction.

So because of this rotation, there is a strong shift. There is a strong coupling between the X and the Z input. So it is undoubtedly due to the fact that when you shake this in this (indicating) direction, this steel wants to rotate around. So as it rotates around, it is at this point that the rotate has to move up. So for exciting the structure in this direction, you are going to get a larger response in that particular direction.

At this point over here (indicating), this wants to rotate; and since this is almost on this kind of an axis, you are going to get a big component in that direction. That shows up many places, and it all can be explained by that kind of a rotation.

There is a peak which will show up when we show the final results. This is a hanger that really -- this is tied. This is the first floor at the 101 level. This point is tied through a hanger to the second floor and to the third floor. There are very large spectral peaks that show up in this region as we go up. You will see that.

[Slide.]

This is the same floor, now, floor 1, with the input in the north-south or in the Z direction. So again we see the same kind of things where, if you excite it in a north-south direction, you sometimes see big accelerations in the east-west direction. Exactly the same thing happens. This is big over here (indicating) because the member is almost vertical so, if it is to rotate it is going to have to move in the east-west direction; whereas over here (indicating), when you excite in this direction (indicating), the rotation is primarily an up-and-down kind of component. So you see a relatively contribution in the Z direction. So once again, this shows the second floor; and you see the same thing on the third floor. There is a strong coupling between the two.

You do not see this on the fourth floor. The fourth floor is rigid. Most of this torsional twisting kind of motion takes place at the first three floors. So pretty much if you look at the spectral values from all the points on the floor, they are very much the same. So if you put in an X input you get like 5g's in the X direction and only one in the Z direction; if you put in the north-south, the Z input, you get like 1g in the X direction and 7.5g's in the X direction. So that behavior applies to the first three floors, not to the fourth floor.

[Slide.]

Now these are the final results. These are the envelope spectra. So what these represent now are the solid lines are the north-south motion. That is due to input in both the east-west and the north-south direction.

The way this one was calculated, this corresponds to floor 1. So at floor 1, the north-south spectra at each node was calculated for a north-south input and for an east-west input. They were SRSS at each node; and then the peak value of all the values on the floor were kicked off and plotted for a particular frequency.

So the solid line represents the north-south for basically the motion about the weak axis, if you will, the direction spectra. The dashed line represents the east-west for the X direction kind of spectra.

The magnitudes which you probably cannot see, this is 36g's. This peak corresponds to that local hanger-pattern response I talked about before. It is the hanger at that one level that controls through several floors, but it is at that particular floor.

[Slide.]

At floor 2, the same thing shows up. This is 12 (indicating); this is 18 (indicating). It is not as severe. This again is the north-south spectra, envelope spectra. The dashed line is the east-west envelope spectra. This is that 9-cycle mode that corresponds to a local mode, a single member being excited; so that was not of interest. This peak really could be neglected if you wanted. This corresponds to primarily that other kind of motion. A large number of the peaks are down in the 7 or 8g kind of range.

MR. CLOUD: Excuse me. Could you clarify the scale?

MR. REICH: Which scale? Each one has its own scale. You have to be careful.

MR. MILLER: These are automatically plotted to fill the page, so these (indicating) are g's; this is 0, 6, 12, 18.

MR. REICH: And the bottom is frequency.

MR. MILLER: The bottom is frequency. So all of these peaks will be out here around 13 to 18.

MR. CIATTO: Chuck, is the multiplier --

MR. MILLER: 10 to the zero.

MR. CIATTO: It's 10 to the zero.

MR. MILLER: For this case, but this is really 6g's, 12g's, and 18g's.

MR. CIATTO: Okay. That's "g's," it's not g point five.

MR. MILLER: No, no. It's g's. So this in fact is 6g's, this is 12g's, and that's 18g's.

MR. REICH: On the other one, by the way, they change automatically, because the thing takes it own scale. So you have to be careful.

MR. MILLER: Again, it is 10 to the zero over here. So this is 6, 12, 18, 36, 42. So your multiples are 6 as you go out.

[Slide.]

The third floor, it is straightening out. It's again a 6, 12, 18 kind of scale. This spike down here at 2-1/2 cycles, or somewhere, wherever that happens to fall, is again that very local mode that is a single member on the third floor. So if one was interested in something there, this peak could really be neglected. The other peaks pretty much follow the same kind of behavior as they did for the first two floors. They are a little more tied together because the floors are a little more tied together.

[Slide.]

Okay. On the fourth floor, this is a 10^{-1}. So this is 2.4, 4.8, and 7.2g's. So the peak is more now like 7 to 8g's on the fourth floor. Again, this corresponds to the 13 cycles which goes to bending about the weak axis. This corresponds to 18, which is bending about the weak axis. There is not much else that really shows up on this fourth floor other than these major spikes. This 9 cycle thing is one of the torsional modes that doesn't really make a significant contribution.

Those are really the results that we have.

MR. CIATTO: Ray Ciatto of Teledyne. Chuck, just to confirm the degrees of freedom, you mentioned all the vertical degrees of restraint. Is that right?

MR. MILLER: Right.

MR. CIATTO: You do have rotation about horizontal axes, and that is at the crane wall only?

MR. MILLER: At the crane wall only; right.

MR. CIATTO: Okay. And everything else is clamped? Is that right?

MR. MILLER: Rotation about a vertical axis.

MR. CIATTO: Rotation about a vertical axis, too. Okay. And dynamic degrees of freedom?

MR. MILLER: No reduction.

MR. CIATTO: Okay. Correspond to all the node points?

MR. MILLER: All the node points; all the degrees of freedom that were retained, yes.

MR. CIATTO: Thank you.

MR. BUCHERT: Ken Buchert of Bechtel. Chuck, following on with that, could you tell me how you modeled the joints, particularly the joints between the annulus steel and the crane wall and structural member to structural member in the annular steel?

MR. MILLER: The joint connections were the same, with half a dozen exceptions, as were used in the vertical model.

MR. BUCHERT: I'm sorry. I'm not familiar with that.

MR. MILLER: Okay. The first two floors, the beam and girder-to-column connections were rigid moment connections.

MR. BUCHERT: How about axial stiffness?

MR. MILLER: What do you mean, "axial stiffness"?

MR. BUCHERT: The crane walls pushing the annular steel in the horizontal direction.

MR. MILLER: Well, the flexibility of the crane wall is included in the model.

MR. BUCHERT: No. How about the connection between the --

MR. MILLER: The connection between the crane wall to the annular steel throughout was treated as a shear connection. You transmit shear and axial load, but no moment.

MR. BUCHERT: Infinitely rigid?

MR. MILLER: No. Wait. The shear connection was infinitely rigid between the crane wall and the adjacent piece of steel.

MR. BUCHERT: In shear; how about axial?

MR. MILLER: In axial, also.

MR. BUCHERT: Even though I had a, say, steel-to-steel, and in some cases I had an AISC typical connection, you took that as infinitely rigid in the axial direction?

MR. MILLER: For transmitting P over A stresses, yes. For moment, there was no moment fixity between the two.

MR. BUCHERT: I don't want to hog this, but one more. In set 5 I assume you have a linear analysis.

MR. MILLER: A linear analysis.

MR. BUCHERT: And what g value of the concrete did you use?

MR. MILLER: The elastic volumes of the concrete was a number that we got at the December 21st meeting at Brookhaven.

MR. REICH: It was given to us by Battelle.

MR. MILLER: I believe it was around 4,600 ksi, something slightly less than that.

MR. REICH: Hold it.

MR. BUCHERT: That's E?

MR. MILLER: It is Young's modulus.

MR. BIGGS: But no reduction?

MR. MILLER: With no reduction.

MR. REICH: One correction on that. All the property values were given to us at a meeting that was held at Brookhaven on December 21st, and the participants there were ourselves, the NRC, PG&E, and Bechtel, and one member from Teledyne.

MR. BIGGS: Mel Biggs, HH&B.

Would it be possible for you to go back to these mode shapes and identify which modes they are?

MR. MILLER: Yes.

MR. BIGGS: You gave us the first couple of ones, but then you stopped.

MR. MILLER: Just put the pictures on.

MR. SCHIERLING: Which ones do you want, Mel?

MR. BIGGS: The ones that were shown on the slide.

[Slide.]

MR. MILLER: This one is easy. That is a 2-1/2 cycle mode. That is mode number three.

MR. BIGGS: Mode number three.

[Slide.]

MR. MILLER: The first of the mode shapes in the handout corresponds to mode three.

[Slide.]

There are a series of pictures that go along with the pictures of the fourth floor and the crane wall. That corresponds to mode seven, which is the first beam bending mode.

MR. BIGGS: Mode seven?

MR. MILLER: Right.

[Slide.]

Now the others, this is the fourth mode, and there is a picture of the first three floors. I guess that is not a good way to do it.

MR. BIGGS: Those are all mode four?

MR. MILLER: They are all mode four, right, to indicate that this is what I will call a torsional mode to indicate the significance of this kind of a mode. It is also to indicate that fact that it is not local, but in fact the first three floors really are tied together.

That is the second floor for that particular mode, and this is the third floor for that particular mode. If you look at the fourth floor for that mode, you will find no deformation at all. That indicates that this twisting takes place between the top floor and the foundation. It is basically the fact that these floors are relatively flexible, and there is not really much to hold them from twisting. But the columns are held at the top and at the bottom.

[Slide.]

This is one of the other torsional modes. The reason we pulled this out was to indicate that some of the torsional modes do exhibit a more local kind of behavior than others. By "local" we mean over maybe a 90-degree segment of the structure, and there certainly is excitation around the whole shape. We can find out which mode this is.

Since we had to plot each mode, it takes six plots. So 40 modes correspond to 240 pictures. That is a lot of data.

MR. BIGGS: One more question. Let me make sure I understand your combination of direction and mode.

MR. MILLER: The way the spectra were generated, at each node we had, first of all, if we put input in what was our Z direction, we would get out of that then a motion in the Z direction and a motion in the X direction for that particular node. So this gave us a spectra which was in the Z direction due to a Z input; and this gave us a spectra which was in the X direction due to a Z input.

Then we also ran the problem with an X input and for the same node again got Z output and X output. This now gave us spectra in the Z direction due to the X input, and this gave us spectra in the X direction due to the X input.

Okay. Then to get the Z spectra, what we did is we took this number and this number, and went the square root of S [writing on the chalkboard], let's call this the super Z, I have an Szz Z squared, plus Szx X squared, the square root of that. That then we call the Z combined spectra at this point, and what is plotted is the envelope.

So what this gave us then was the node I. We got a Z acceleration spectra of something like this for frequencies, and went through all the nodes on the floor, and this particular frequency looked at what that value was and picked the peak that occurred on the floor. That is what is shown in those last four figures. And then of course we did the same thing in the other direction to get the X spectra.

So this would be the solid lines on those floors, and then the dashed lines would be just interchanging the Xs and Zs.

The pages before that were the peaks applied. All I really did was for each node, for each of the directions I went through and plotted, picked off the peak in this spectra (indicating), and the peak in that spectra (indicating).

MR. BUCHERT: Could you again give me the dates of the drawings that you used in this analysis, and when you got them, approximately?

MR. MILLER: Okay. The analysis was based on the drawings as listed in the vertical NUREG, whatever that number was, as modified. Those were used. There were concrete drawings that were obtained based upon a visit to Bechtel that we received sometime early in December.

MR. REICH: December 14th.

MR. MILLER: December 14th we received the drawings for the crane wall, the pool wall, the things like that. We also received sketches indicating modifications to the annular steel. Those we received also in that period of time. They were further explained at the December 21st meeting at Brookhaven and we received a submittal where the changes were marked up on those drawings. We received that January 10th. Those were included in the analysis.

MR. BUCHERT: Thank you.

MR. MILLER: We also had at that time drawings indicating vertical columns that were added to the annular steel for the vertical analysis considerations. Since we were restraining the vertical response of the model in any event, these vertical columns were not included in here. It didn't seem like they would really make any change that would affect it.

So basically the model contains the information we considered important that we received up through January 10th.

MR. CIATTO: Chuck, you mentioned the crane wall-to-girder connection to shear connections. Is the crane wall-to-floor slab elevation 140, is that also a shear connection?

MR. MILLER: That is really not an issue now, because the rotations about the horizontal axis really aren't --

MR. CIATTO: But I thought that at the crane wall the horizontal rotations about the horizontal axis was released. But that is only for the girder-to-crane wall connection?

MR. MILLER: Right.

MR. CIATTO: Okay. So we have fixity against rotation at elevation 140 around the crane wall?

MR. MILLER: Right. That will displace as a horizontal plane in any event. No matter what you do, that is not going to do any differently.

MR. KNIGHT: I am going to suggest that we take about a 10-minute break. If any other questions pop into people's minds, it may be a 15-minute break for short discussions.

Thank you.

[Recess.]

MR. KNIGHT: May we get started again, please?

In a moment, if there are other questions or further discussion, we are certainly here to continue for as long as it is useful. I believe there is something I would like to say about how the Staff is going to use this information and where we will proceed from here.

Basically in this particular review, I see our role as something of an oversight to the IDVP. Our purpose in asking Brookhaven to do this work was to give us sufficient information to characterize the nature of the structure or the nature of its responses and not to press on to duplicate or triplicate or quadruplicate, whatever turns out to be, the number of other people who are also at various levels of detail carrying out all of the work necessary for design and confirmation of that design.

So essentially the work you have seen today represents completion of the task as far as the Staff and Brookhaven has done. We view it as a piece of information certainly subject to further scrutiny, and certainly subject to response to questions from any of the other parties who may wish to make use of that information.

Obviously it is an element, and perhaps I should say a key element, in the information that the Staff has available to it is to perform our oversight and to make judgments as to whether or not what we see proceeding in the confirmation or IDVP process is something we would support.

Similarly, in the other effort we have asked Brookhaven to do for us, we will carry it to the point where it satisfies our needs. That, by and large, will be at about the same level where we have a good feel for what the process is, whether it is the general character of the structure or some other feature. But we will not be, so far as I see it at the moment at least, going forward and generating spectra at 60 locations on every floor or something like this. I think we have served our purpose. I think we have used the Taxpayers' money to its best advantage, and we are going to stop there.

I just wanted to give you that insight as to what we are doing. Hans had mentioned that some of the parties here had suggested that they may well have, when they have attempted to digest some of this information and to think about it, may well have questions. It seems to us that the most efficient way to move this information, to answer the questions and to still have a fairly well documented record, is to use the conference call. That is only a suggestion.

I am looking down the table to counsel and, subject to his objection, that would seem to be one of the better ways to do it. As I say, I would like to try to keep in perspective that Brookhaven is here as a consultant to the Staff, so I would want the Staff involved in any conference calls.

MR. CHANDLER: Jim, the only thing I would add to that is that we have previously expressed our view on the way communications ought to be conducted, including the use of phone calls, and recognize it as an appropriate mechanism for transmitting information.

To the extent that any particularly elaborate or substantive kinds of discussions go on, I would expect that the parties would adhere to the practice that we have been using throughout and document those kinds of more elaborate and formal transmittals of information.

MR. KNIGHT: Yes, sir?

MR. CLOUD: Jim, one thing that we would very much appreciate is if we could get a list of drawing numbers with dates and revisions, and sketches or sketch numbers with dates and revisions upon which this work was based.

MR. KNIGHT: Done. I think we should be able to provide that.

MR. SCHIERLING: Along that line, Jim, though, I think there very well might be a need for another meeting like this one today, if there are a sufficient number of questions. Rather than having a conference call, we might as well have another meeting and discuss those questions. It depends upon the feedback that we get from the different parties.

MR. BIGGS: When will there be a written report?

MR. KNIGHT: Well, I sigh somewhat deeply. Eventually we would ask Brookhaven to probably put together all of the three tasks they are now doing for us in a summary report.

Being somewhat parochial, from the Staff's point of view the most efficient use of time right now is for us to get on with the other tasks to give us the background information, which we will try to make available to everybody as expeditiously as possible, and not use the somewhat limited resources there to go through the formal mechanism of cranking out reports.

I guess I would entertain discussion, to the extent you feel it is appropriate, as to whether or not that kind of approach is really too "inhibiting," if you will, for the IDVP and others. If it were in some way, then I guess we would have to second-think that. But our immediate plan had been to put off producing a polished version of this information until probably sometime, I don't know, in the April type of time frame.

I guess our view has been that what appeared in the written report would not, although there would certainly be a fair amount more of the trim-out or polish, but that there would not be a great deal more substantive information.

MR. BIGGS: I understand your reasoning, but some of us are a little slow. It is difficult to fully understand a piece of work like this from a verbal presentation.

MR. SCHIERLING: Mel, that was one of the reasons why we had a transcript taken.

MR. CLOUD: One other brief technical question. I think you addressed this in your presentation, but just for confirmation: I believe you said that the overall model was taken as a fixed-base model and the ground time histories were input to the base of the containment? Is that correct?

MR. MILLER: Correct. Basically the crane wall and the pool walls formed the boundary.

MR. CLOUD: And the shield wall was not included?

MR. MILLER: The shield wall was not included in the model.

MR. KNIGHT: I was just sitting here discussing with Dr. Reich the likelihood that we could improve substantially, at least so far as our present level of effort goes, the production of a written report. I guess I will have to retrench our basic plan that we would, in all likelihood, proceed to accomplish the technical, if you will, and analytical portion of the two efforts. We would do all we can to respond to questions. Certainly there are specific elements of information which we can produce in some form, and we will certainly bend over backwards in whatever direction necessary to try to deliver that information.

I think it is safe to say, and I stand to be corrected, that if any of the parties should feel it useful or worthwhile to visit Brookhaven to discuss the matter with the staff there, we would be happy to do that.

MR. BIGGS: May I ask a couple of technical questions?

MR. KNIGHT: Please do.

MR. BIGGS: Can you make any general comment as to the effect of the crane wall flexibility on the floor response spectra?

MR. MILLER: Well, certainly the peaks in the spectra will show up at that 13-18 cycle kind of number. They correspond to the first two modes of the crane wall, one in the weak direction and one in the strong direction. So I would think that that kind of flexibility is important in the crane wall.

MR. BIGGS: I was looking at these torsional modes. They are spotty here. It appears that the crane wall is hardly moving at all in these modes, which would imply that at least in this mode the crane wall was not very important. I do not know whether this is an important mode or not.

MR. MILLER: The mode seven, which is shown -- there were some pictures in there -- there the crane wall motion is evident, but still not nearly to the extent that the local superimposed kind of torsion is even more important. I think if you look at the spectra and the peaks and you see the peak g's on the crane wall, the numbers like 1g, and the peak g's our from the crane wall, numbers like 7 and 8 g's on an average, you have to conclude that the flexibilities in the annular steel is more important than the flexibilities in the crane wall.

MR. POLK: That is so.

MR. MILLER: I would imagine that if you did that problem and assumed the crane wall rigid, you probably would not have seen a whole lot of difference.

MR. POLK: Yes.

MR. BIGGS: Another question. These floor response spectra are all envelopes?

MR. MILLER: They are all envelopes; right.

MR. BIGGS: For each floor?

MR. MILLER: Yes.

MR. BIGGS: Can you make a comment on the general response in the whole area, and how much these envelopes are affected by very local response?

[Slide.]

MR. MILLER: Yes. I think if you -- pretty much on the floors, this is the first floor. The peaks on the second floor are a little bit higher; and the third floor is probably much the same. There are peaks that are associated again with the local kind of phenomenon around this annular which tend to be -- this is 10 in one direction, 11 in the other direction. When you put the input in the vertical direction, the north-south direction, the peaks go up to like 30. So there are very high peaks certainly associated with the restricted area around here. This carries through all the floors, but it is in that region.

If you look over the rest of it, the peaks are probably more like -- there are peaks of 8 here (indicating). It depends on what you want to call an "average," but probably something like around certainly 4 to 8 or so would be a reasonable kind of number. There are many that are over 4. Most of them are over 4. There are lots over 6 and 7. So I would say the 30g kind of numbers are local and asymuth but do exist over all the floors.

If you look for more numbers than exist, although lots them -- the angles may be something like 6 or 7g's is a more reasonable kind of average number. These, by the way, if you look at frequencies that go along with these, all these frequencies are at either 13 or 18, in that region. So where they occur on this spectra would be the same if you elminate the one down here, that peak probably drops down to something like 8 or 9.

MR. BIGGS: Thank you.

MR. KNIGHT: Are there any other questions?

MR. CIATTO: Would Brookhaven be following through on a piping analysis from both of these spectra?

MR. KNIGHT: That is something that affects Brookhaven that we are going to discuss later today. I think it is very likely that we will look at it. Our goal here again is to get background information for us, for the Staff, so that when we go and do an overview we will perhaps have our perceptions sharpened a little bit as to what we are to be looking for and not, as I said, to duplicate what has been done in other people's work.

In that spirit, I believe we will be searching for the same level of cutoff on the other efforts. In other words, to have enough to make us a little smarter, to make us a little brighter as to what the nature of the problem is, and to do some of the response analysis but not try to crank it through to get some kind of ultimate number.

MR. CLOUD: But is it true, however, that I believe that in the building there obviously have to be additional modifications over and above what are considered in the model upon which these results are based, if I understand correctly, so that -- and the reason I raise the issue is because if piping analyses were to be done, it would be advantageous I believe to weigh the effect of those modifications which would be considered.

MR. KNIGHT: We understand that certainly one of the caveats in our proceeding with the information that PG&E had available for us was that they were still looking at the project. There are still looking at this area and are still considering it, and there may well be modifications from when we more or less cut it off that generally were not reflected. So that to my way of thinking is all the more reason for the Staff to not try to charge ahead and try to come out with some set of piping numbers that would probably have very little relevancy.

MR. CLOUD: Yes. Because certainly from the point of view of the IDVP we have changed our approach to attempt to avoid any confirmation of work that we know is to be changed or which is not final. So to the extent that Brookhaven is doing confirmatory studies, in order for that to be of assistance both to you and to us, it would be better if it were to be done on the final configuration.

MR. KNIGHT: Yes. I agree. I see all of this occurring on several different levels of again the work Brookhaven is doing for the Staff -- I guess it is the other way around. At the first level we are at a characterization of effort for us. Certainly the IDVP has been doing what someone might call "independent verification on a sampling basis." Of course the project has the responsibility for the whole ball of wax, the final design and the execution of it.

So we are going to try very hard to keep the effort we expand, if you will, and the amount of the Taxpayers' dollars we put into it at a level that is appropriate.

MR. CLOUD: I understand.

MR. SCHIERLING: Along that line, if I recall at the meeting we had in Brookhaven in December PG&E indicated that modications were being made, and not necessarily are those modifications currently reflected as the input into the Brookhaven analysis. Of course that would have to be --

MR. CLOUD: That is the reason I asked for a list of drawing numbers.

MR. SCHIERLING: Right.

MR. CIATTO: Incidentally, Hans, do you need a formal request for information on the list that Bob alluded to?

MR. SCHIERLING: No, I don't think so.

MR. REICH: There is one item I would like to bring up. There was a request for information from Teledyne to us, 150, 151, and 152, and we have complied with those. We have sent thoe out to Teledyne.

While I am on the topic, I would like to mention, as I mentioned to Jim, this staff is always ready and willing to answer questions. The senior staff is here. Dr. Miller is here, and Dr. Philippacopoulos is here. That was in the framework I mentioned over here.

MR. KNIGHT: I think we are on the verge of setting an all-time record for a meeting like this.

[Laughter.]

MR. KNIGHT: If there are no further questions, thank you, gentlemen.

[Whereupon, at 11:40 a.m., the meeting was adjourned.]

NUCLEAR REGULATORY COMMISSION

This is to certify that the attached proceedings before the

NUCLEAR REGULATORY COMMISSION

in the matter of: PACIFIC GAS & ELECTRIC CO. (Diablo Canyon Unit 1 Design Verification)

Date of Proceeding: February 15, 1983

Docket Number: 50-275

Place of Proceeding: Bethesda, Maryland

were held as herein appears, and that this is the original transcript thereof for the file of the Commission.

Jane N. Beach

Official Reporter (Typed)

Jane N. Beach

Official Reporter (Signature)

BNL DIABLO CANYON CONTAINMENT ANNULUS STRUCTURE
HORIZONTAL SEISMIC ANALYSIS

TASK OUTLINE

REQUESTED TO INDEPENDENTLY DEVELOP HORIZONTAL FLOOR RESPONSE SPECTRA FOR UNIT 1 CONTAINMENT ANNULUS STRUCTURE.

- PRELIMINARY STUDIES TO IDENTIFY SIGNIFICANT FLEXIBILITIES
- DEVELOP DETAILED FINITE ELEMENT MODEL
- CALCULATE MODE SHAPES AND FREQUENCIES
- CARRY OUT TIME HISTORY ANALYSIS
- DETERMINE FLOOR RESPONSE SPECTRA
- OBTAIN ENVELOPE SPECTRA FOR EACH FLOOR

Morris T1

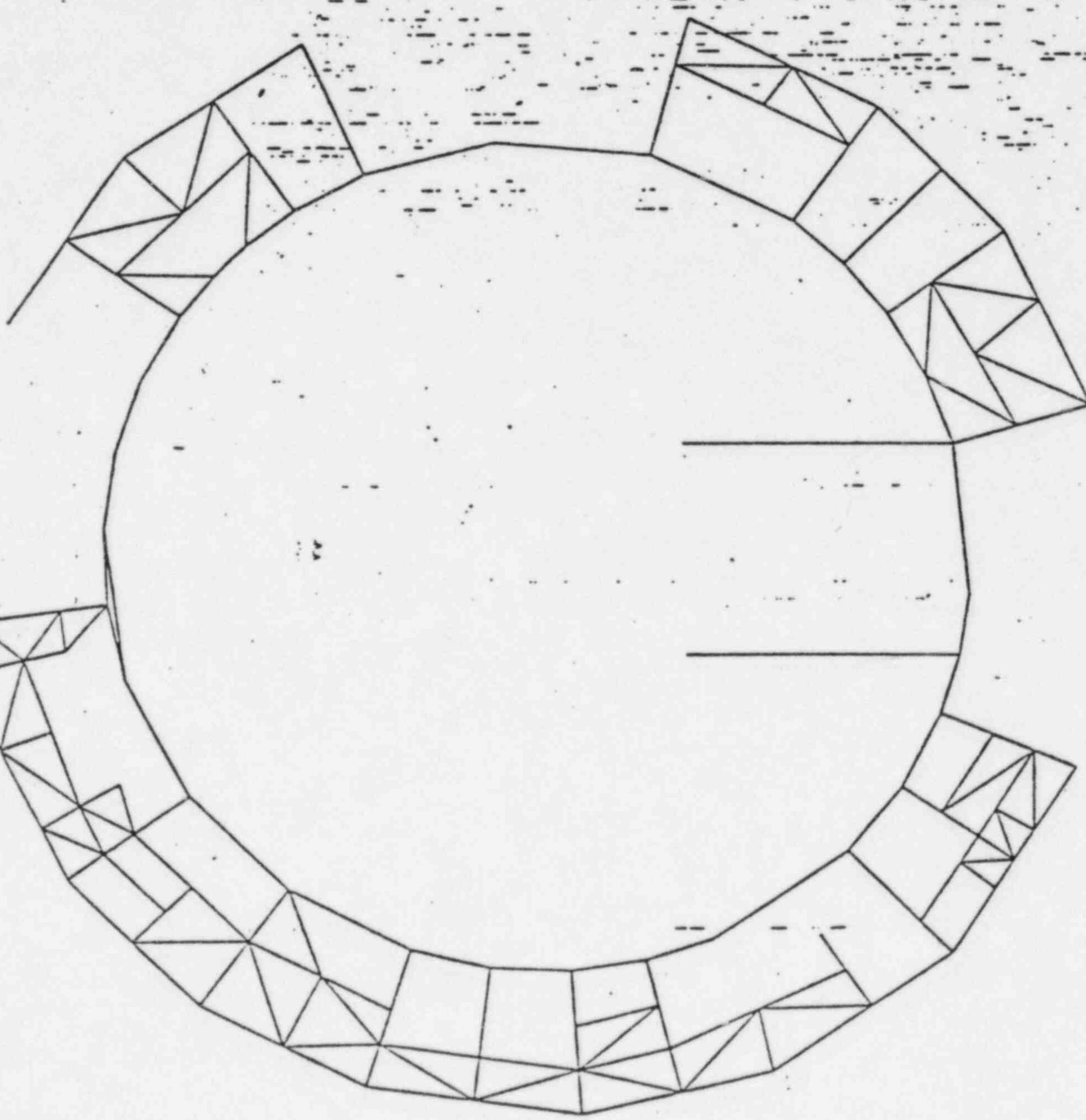
DEVELOPMENT OF MODEL

IN VIEW OF RESULTS OF PRELIMINARY STUDIES, THE MODEL CONSTRUCTED FOR THE VERTICAL ANALYSIS (NUREG/CR-2834) WAS MODIFIED AS FOLLOWS:

- ALL BRACING MEMBERS ADDED TO FLOORS
- CRANE WALL ADDED (3 FT. CYLINDER FROM 91 FT. TO 140 FT.)
- TWO POOL WALLS ADDED ACROSS CRANE WALL
- SOLID FLOOR ADDED INSIDE CRANE WALL AT ELEV. 140 FT.
- MASS (TRANSLATION AND ROTATION) OF STEAM GENERATORS SURROUNDING CONCRETE, AND PRESSURIZER ADDED AT ELEV. 140 FT.

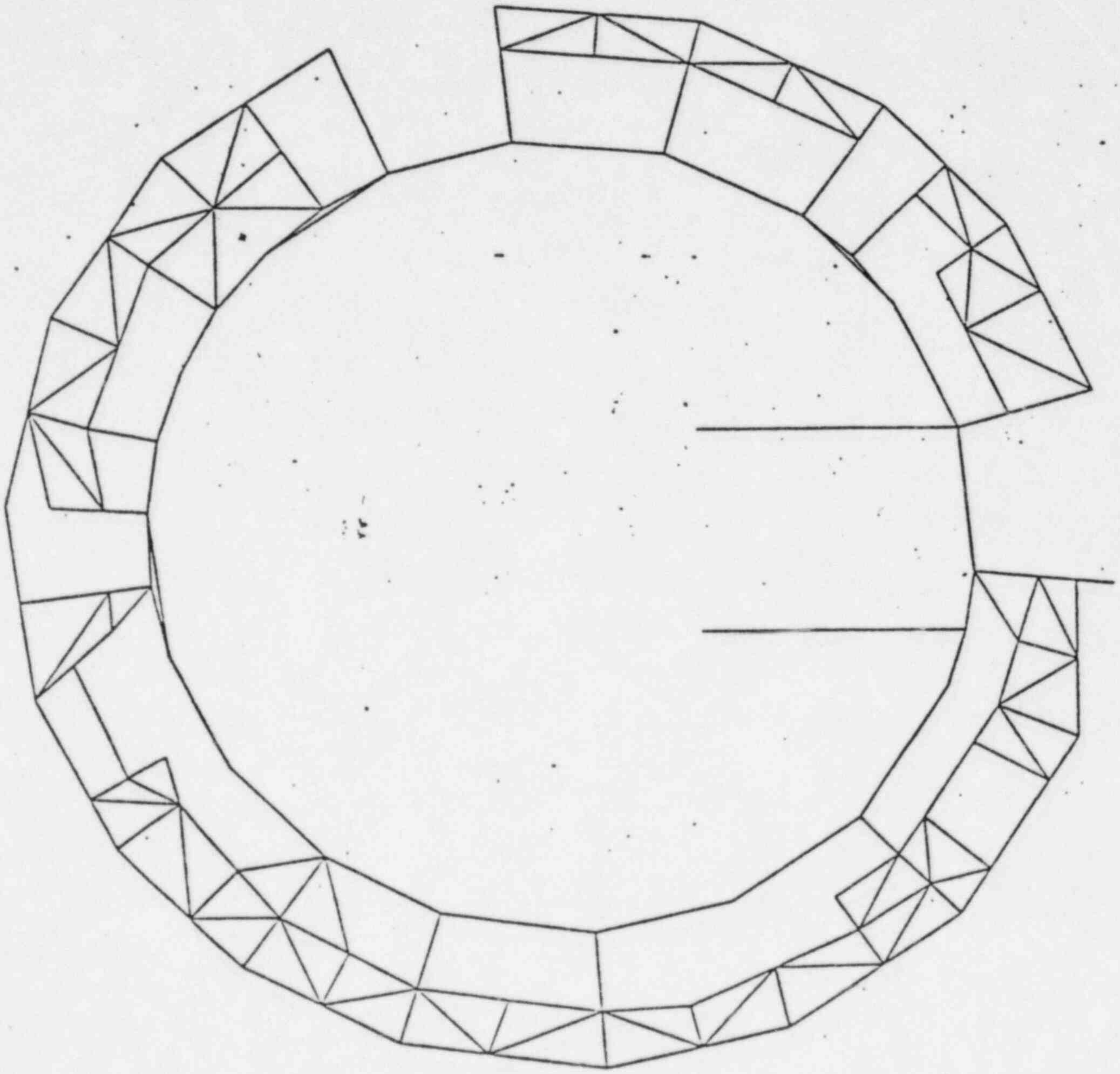
Miller

FLOOR #1 ELEV. 101



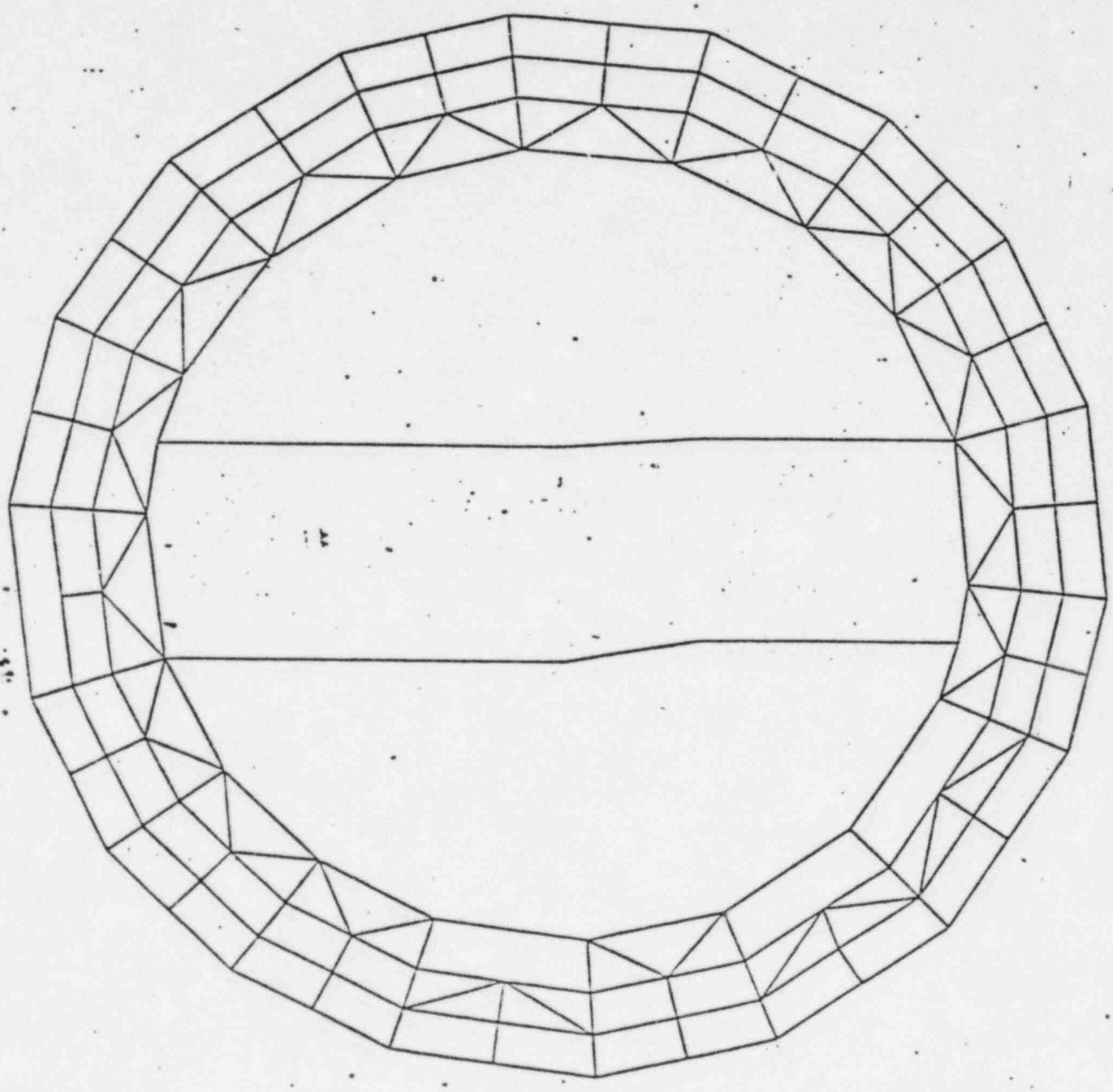
F1

FLOOR # 2 ELEV 106'



F2

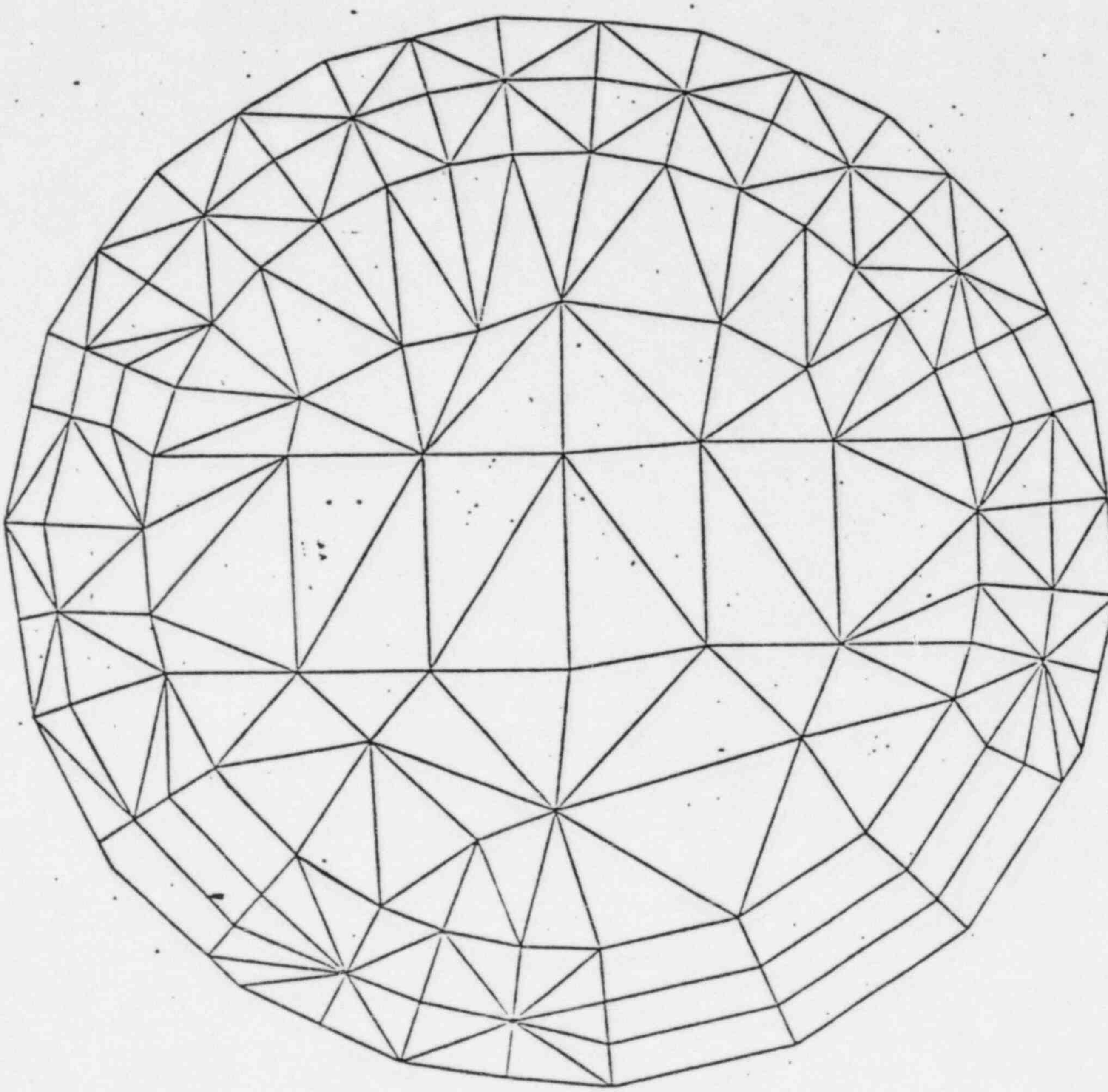
FLOOR # 3 ELEV 117'



BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

F3

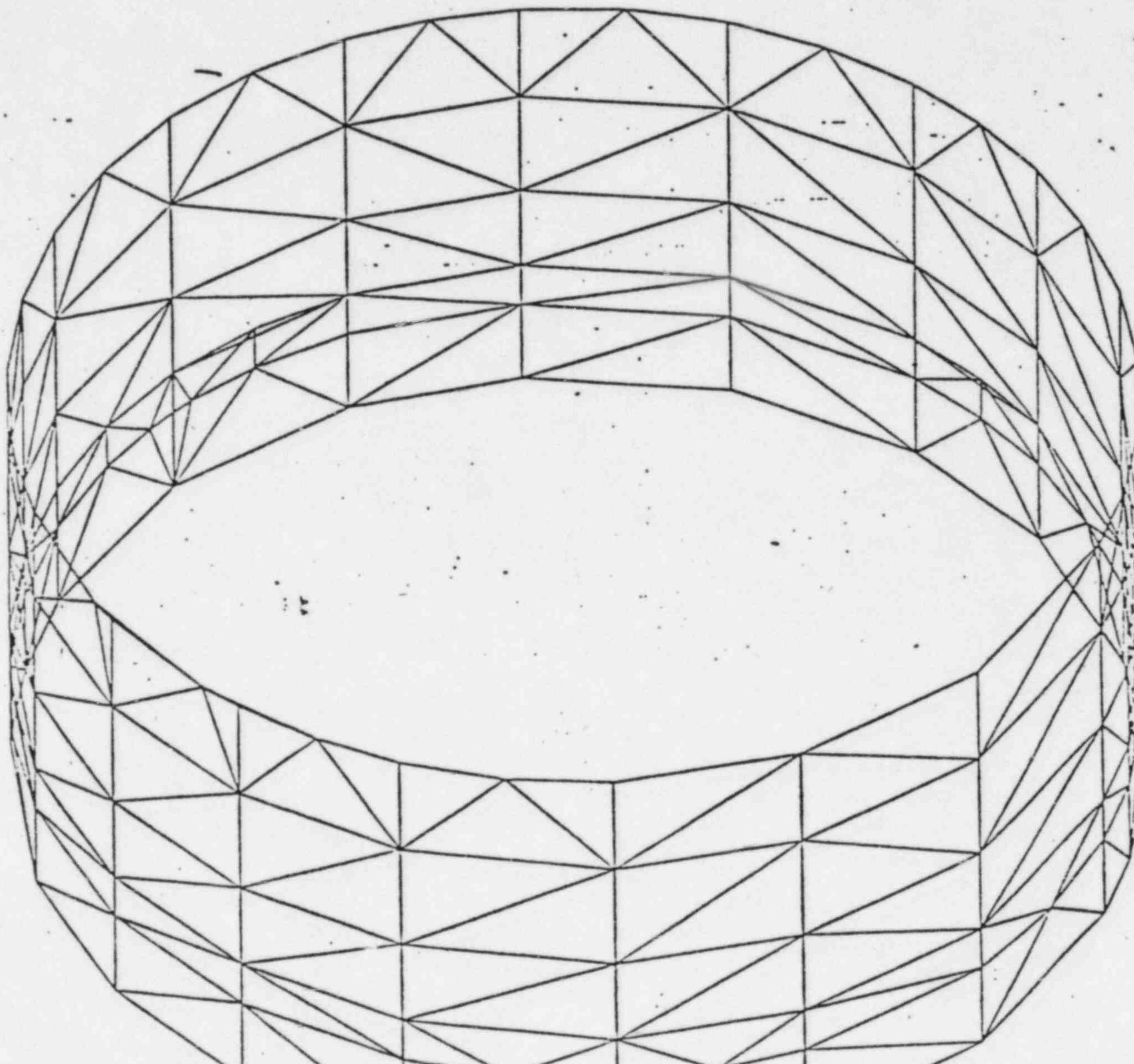
FLOOR # 4 ELEV : 140'



BROOKHAVEN NATIONAL LABORATORY bnl
ASSOCIATED UNIVERSITIES, INC.

F4

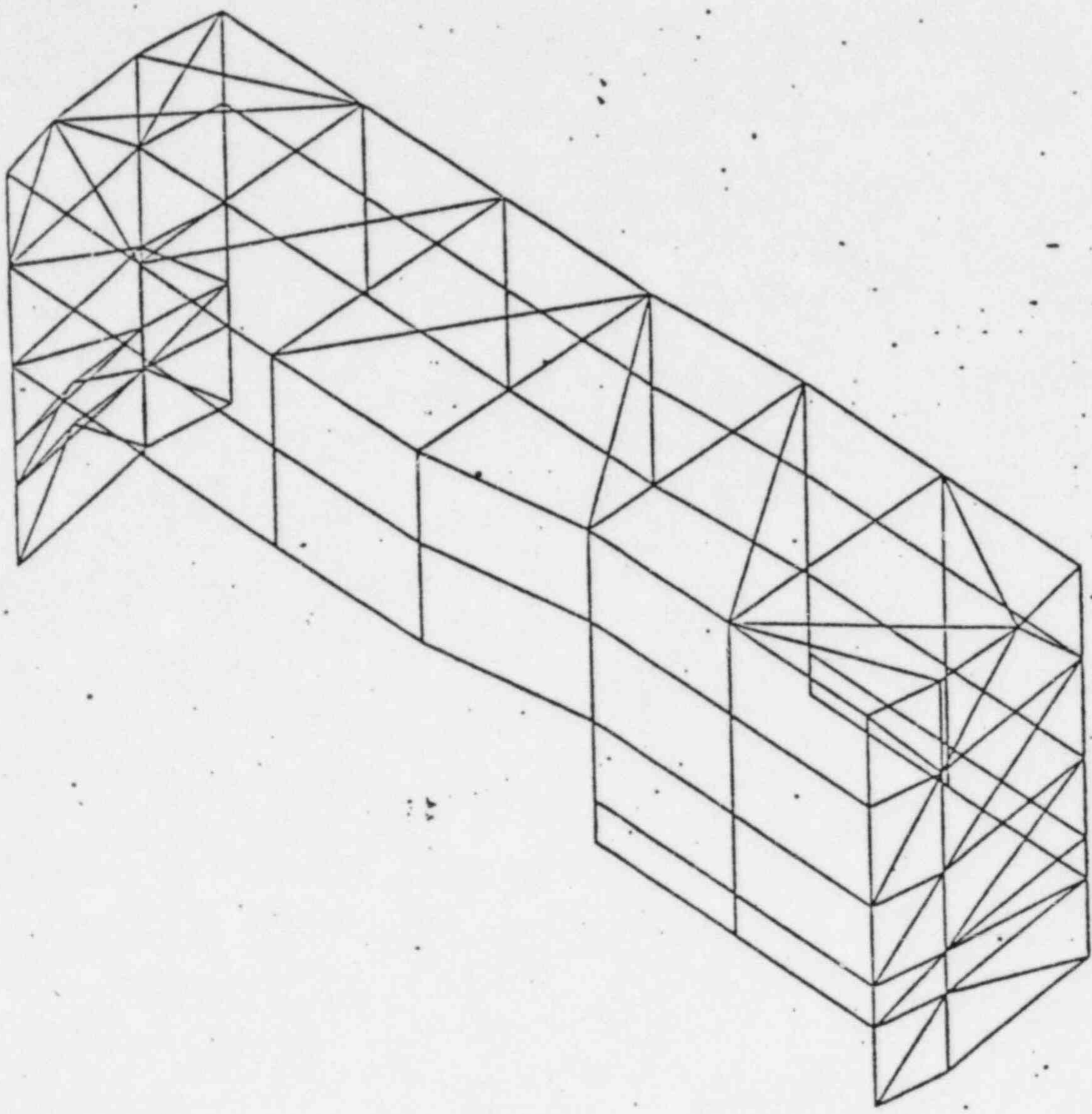
CRANE WALL



BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

C.W.

Pool Walls



P.W.

MODAL SOLUTION

- 40 MODES FOUND USING SAPV COMPUTER PROGRAM AT BNL.
- MODES ARE OF THREE TYPES:

  (1) LOCAL

  (2) TORSION OF ANNULAR STEEL

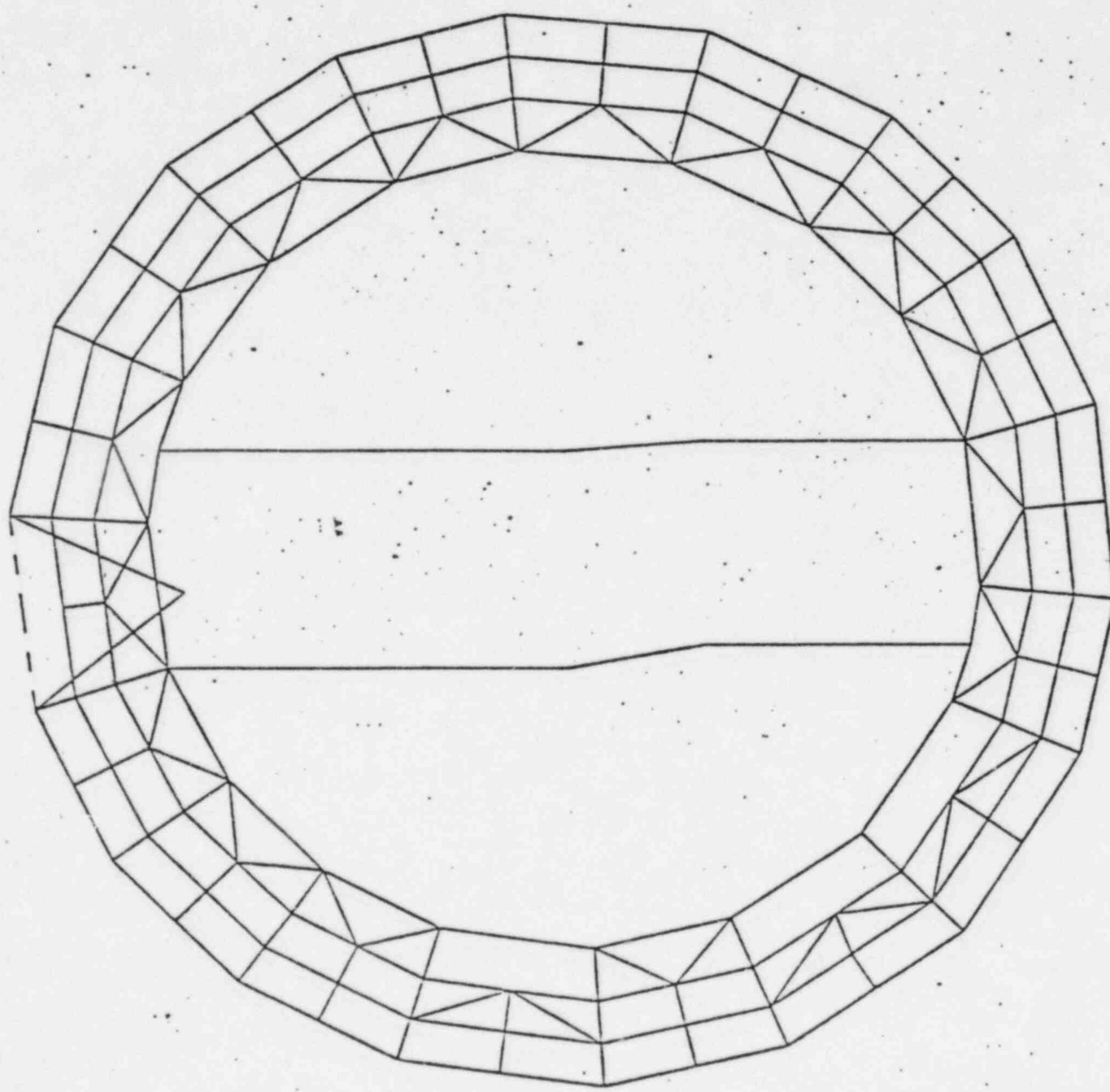
  (3) SHEAR DEFORMATIONS OF CRANE WALL

DIABLO CANYON CONTAINMENT ANNULUS STRUCTURE

HORIZONTAL SEISMIC ANALYSIS

MODE NO.	FREQUENCY	MODE NO.	FREQUENCY
1	.89	21	20.81
2	.89	22	20.99
3	2.56	23	21.64
4	7.26	24	22.61
5	9.72	25	22.74
6	11.22	26	23.32
7	13.08	27	23.40
8	13.56	28	23.51
9	13.64	29	23.67
10	14.02	30	24.03
11	14.03	31	24.30
12	14.30	32	25.03
13	15.24	33	25.41
14	17.42	34	25.49
15	18.26	35	25.95
16	18.79	36	26.37
17	19.61	37	26.60
18	20.00	38	26.86
19	20.21	39	27.26
20	20.77	40	27.65

MODE #3 - FLR #3



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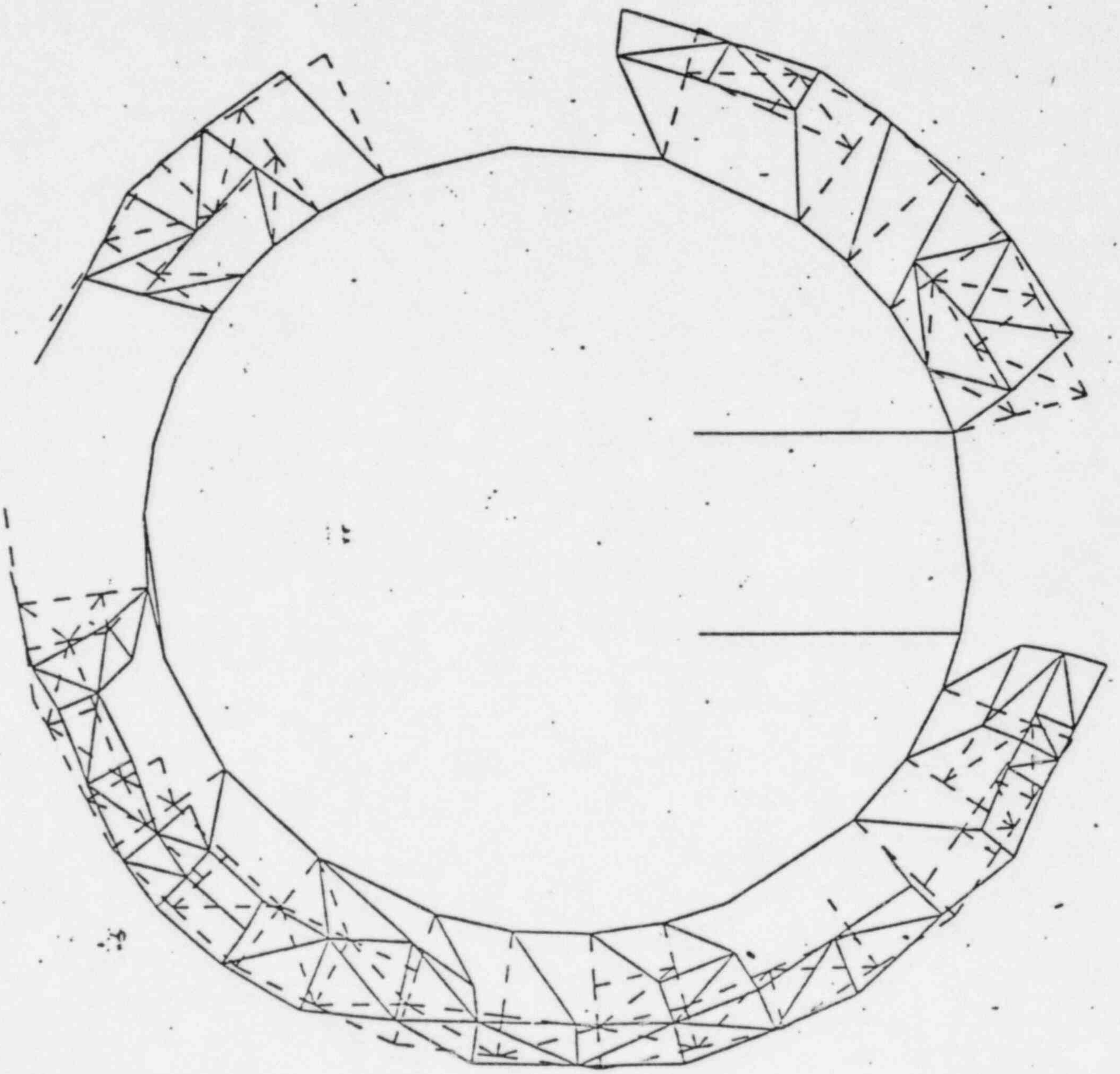
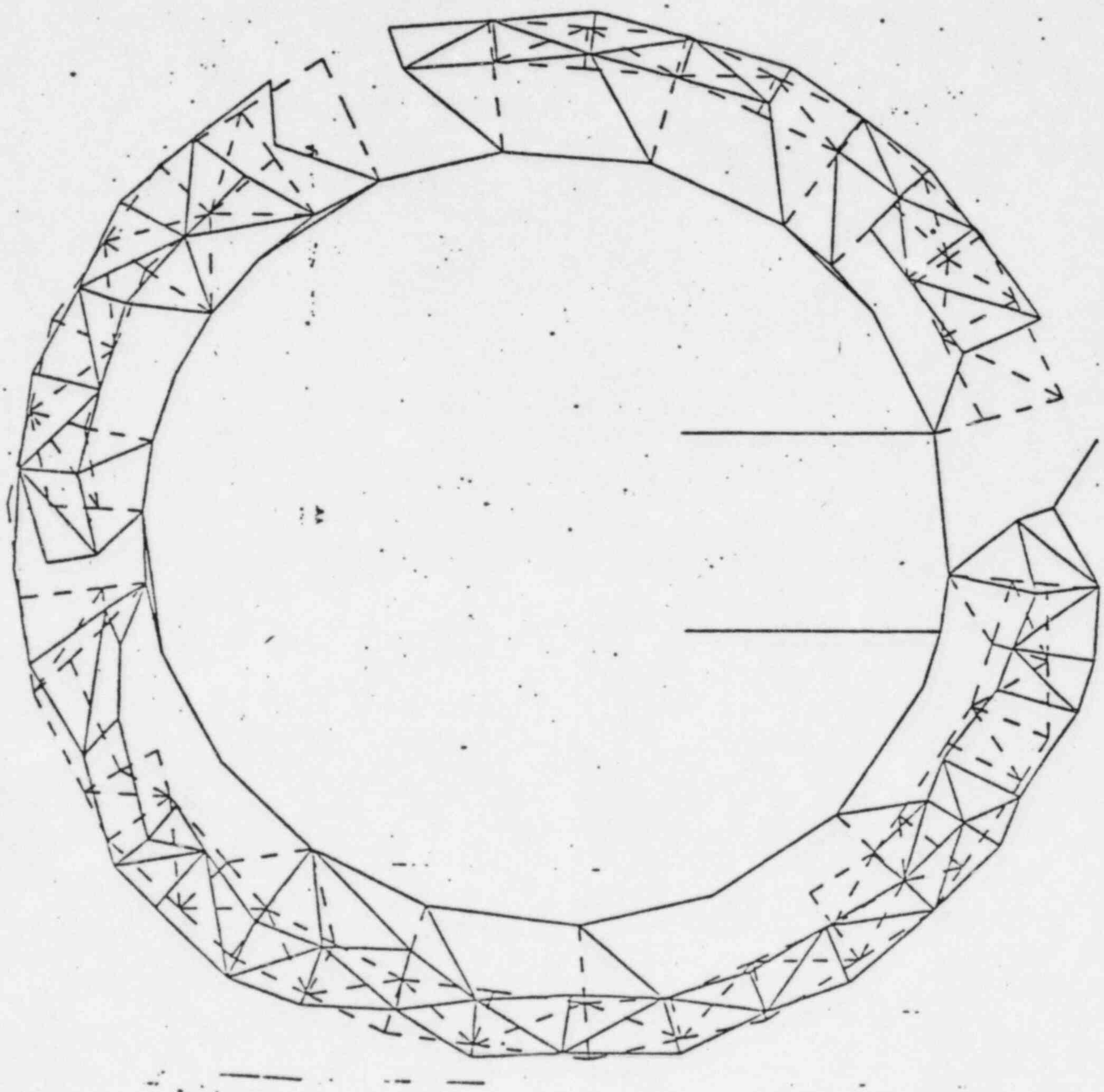
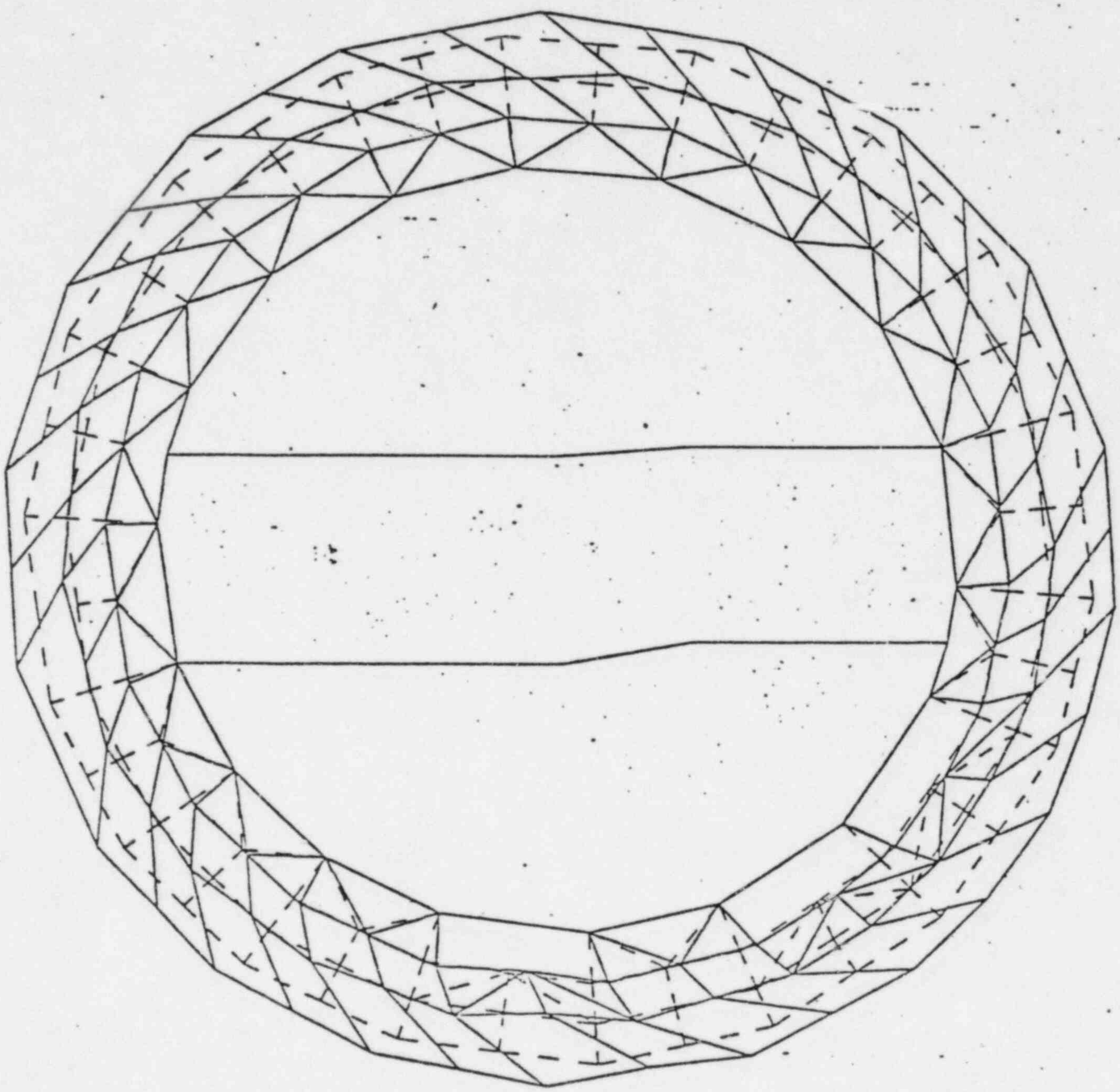
MODE : #4 - FLR #1



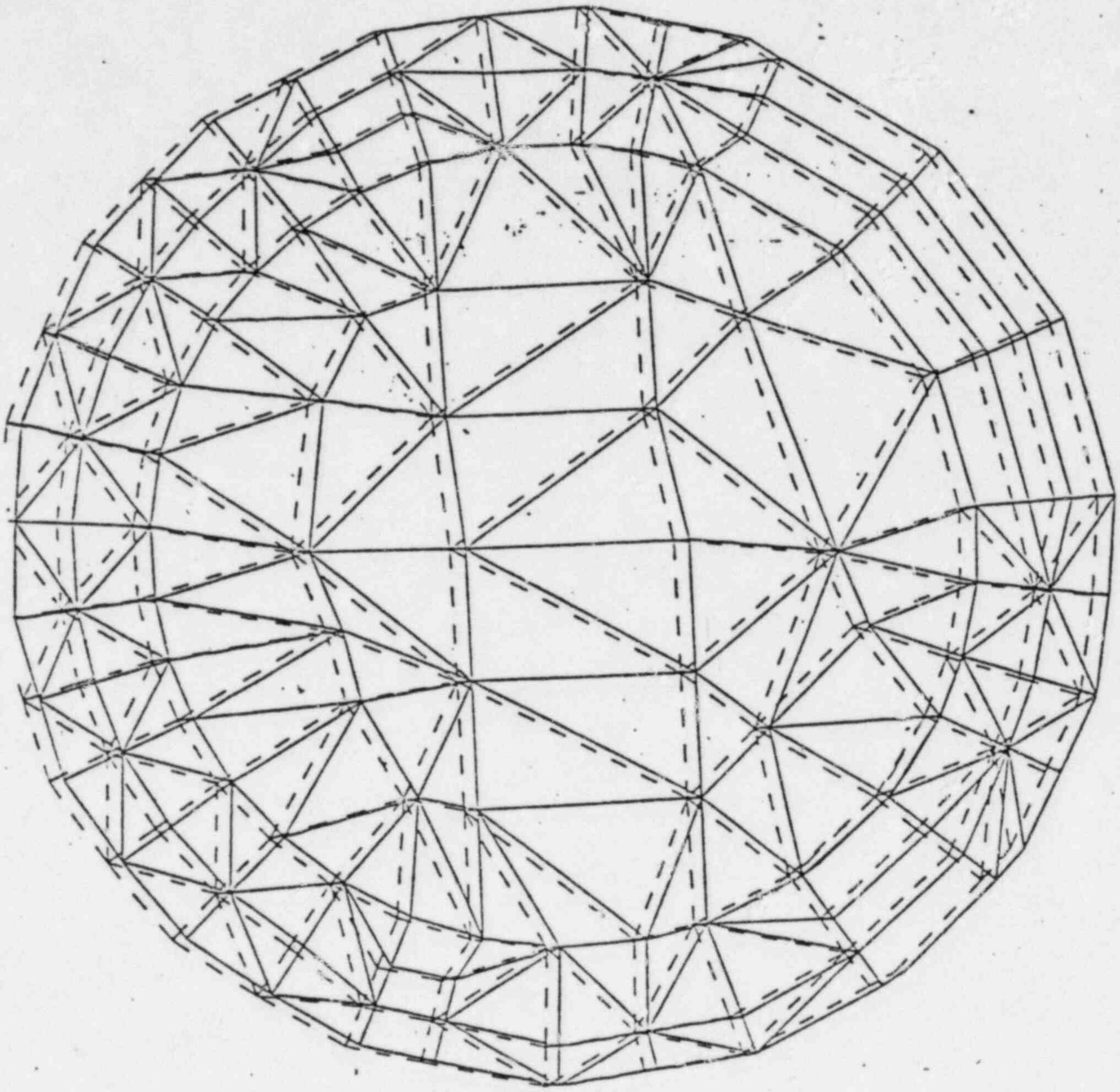
MODE #4 - FLR #2



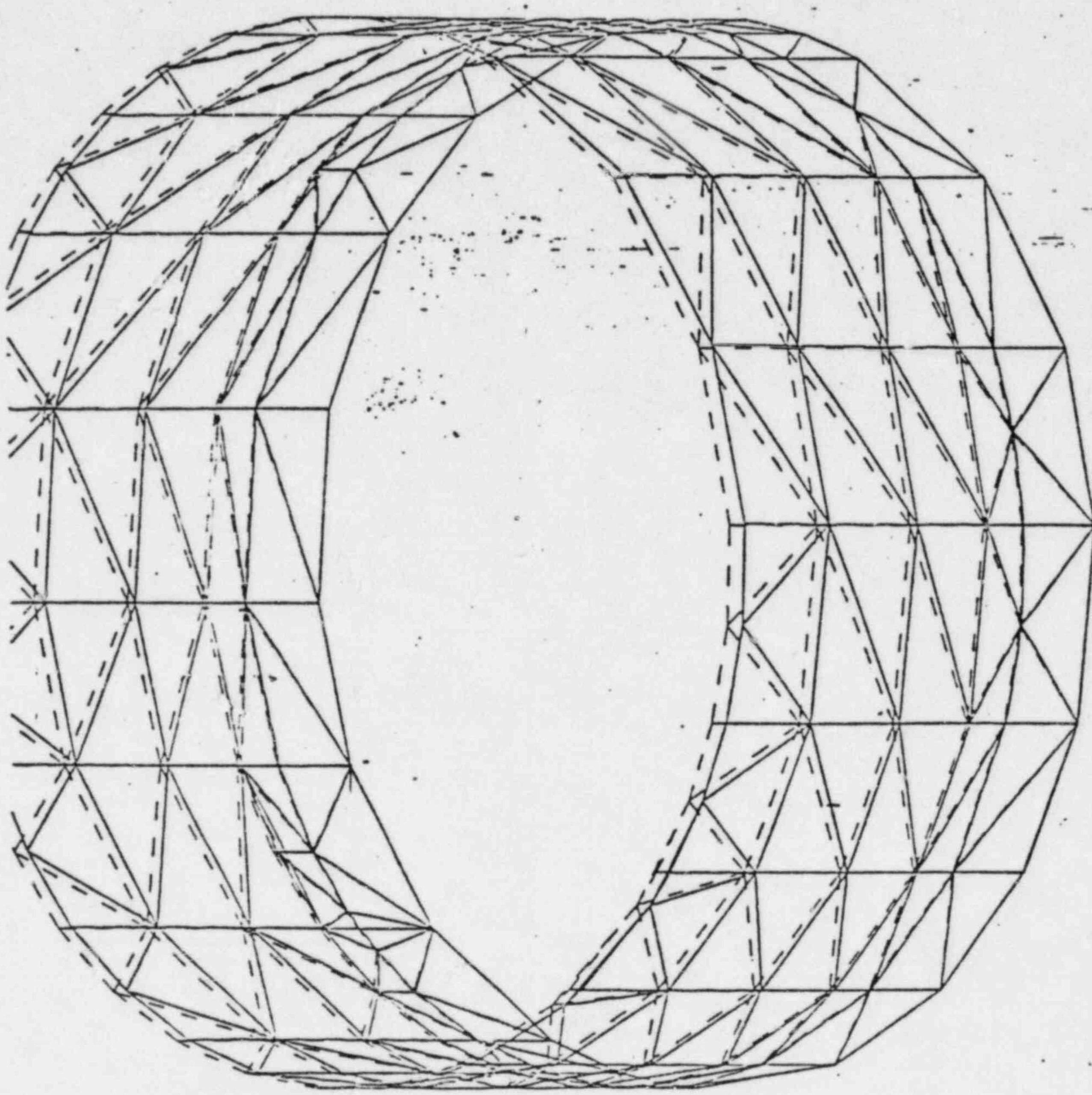
Mode #4 - FLR #3



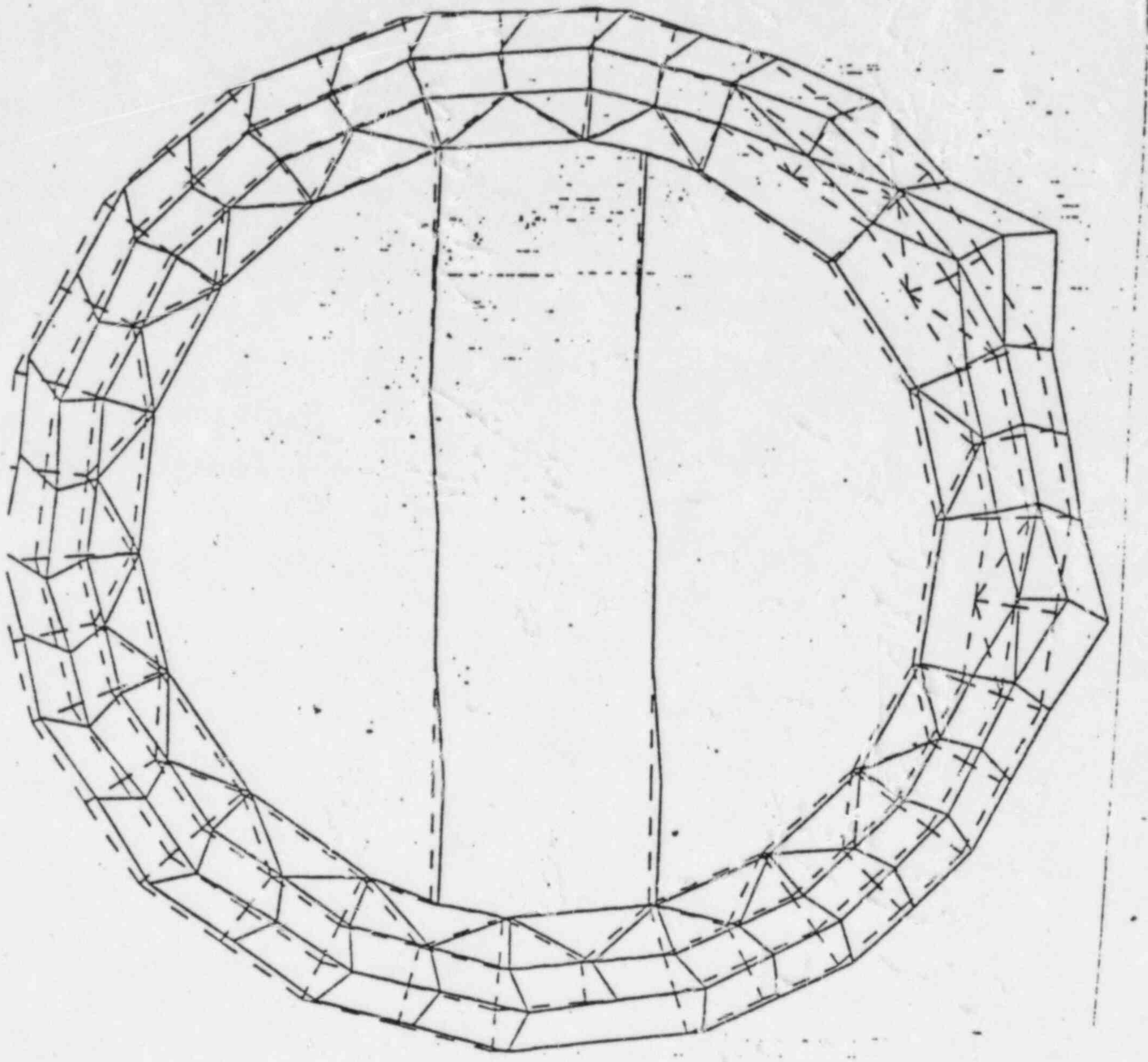
Mode #7 Flc #4



MODE #7 : CRANE WALL



MODE #7 : FLR #3



TIME HISTORY SOLUTION

- NEWMARK 7.5M HOSGRI RECORD USED AS INPUT IN BOTH E-W AND N-S DIRECTIONS
- STRUCTURAL DAMPING TAKEN AS 7%

FLOOR RESPONSE SPECTRA

- EQUIPMENT DAMPING 2%
- FOR EACH INPUT (X & Z DIRECTIONS) GENERATED X & Z SPECTRA

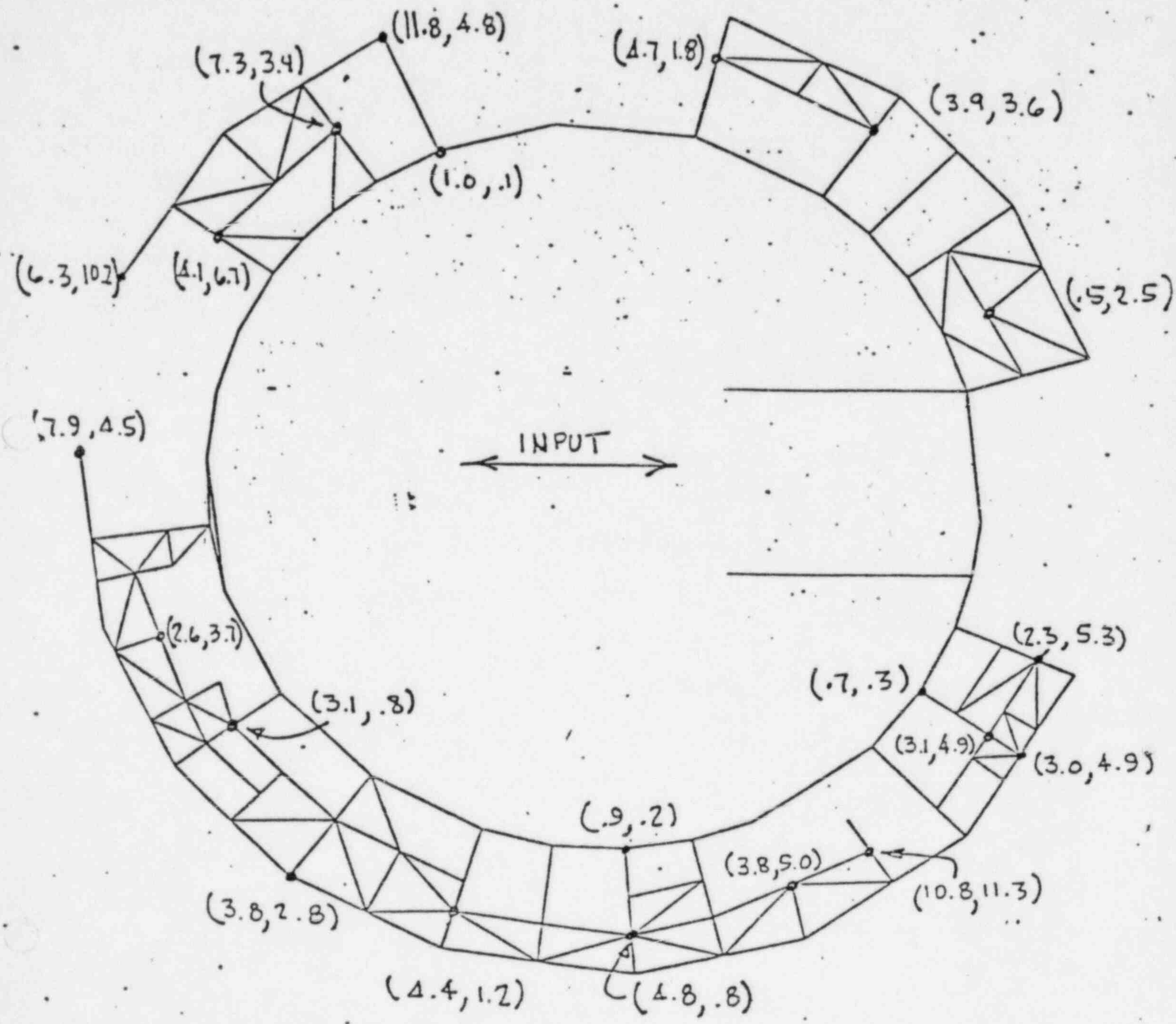
  S_{XX}; S_{XZ}; S_{ZX}; S_{ZZ}

- CONTRIBUTIONS FROM BOTH DIRECTIONS WERE CONBINED ACCORDING TO SRSS

PEAK ACCELERATION (G

(x, z)

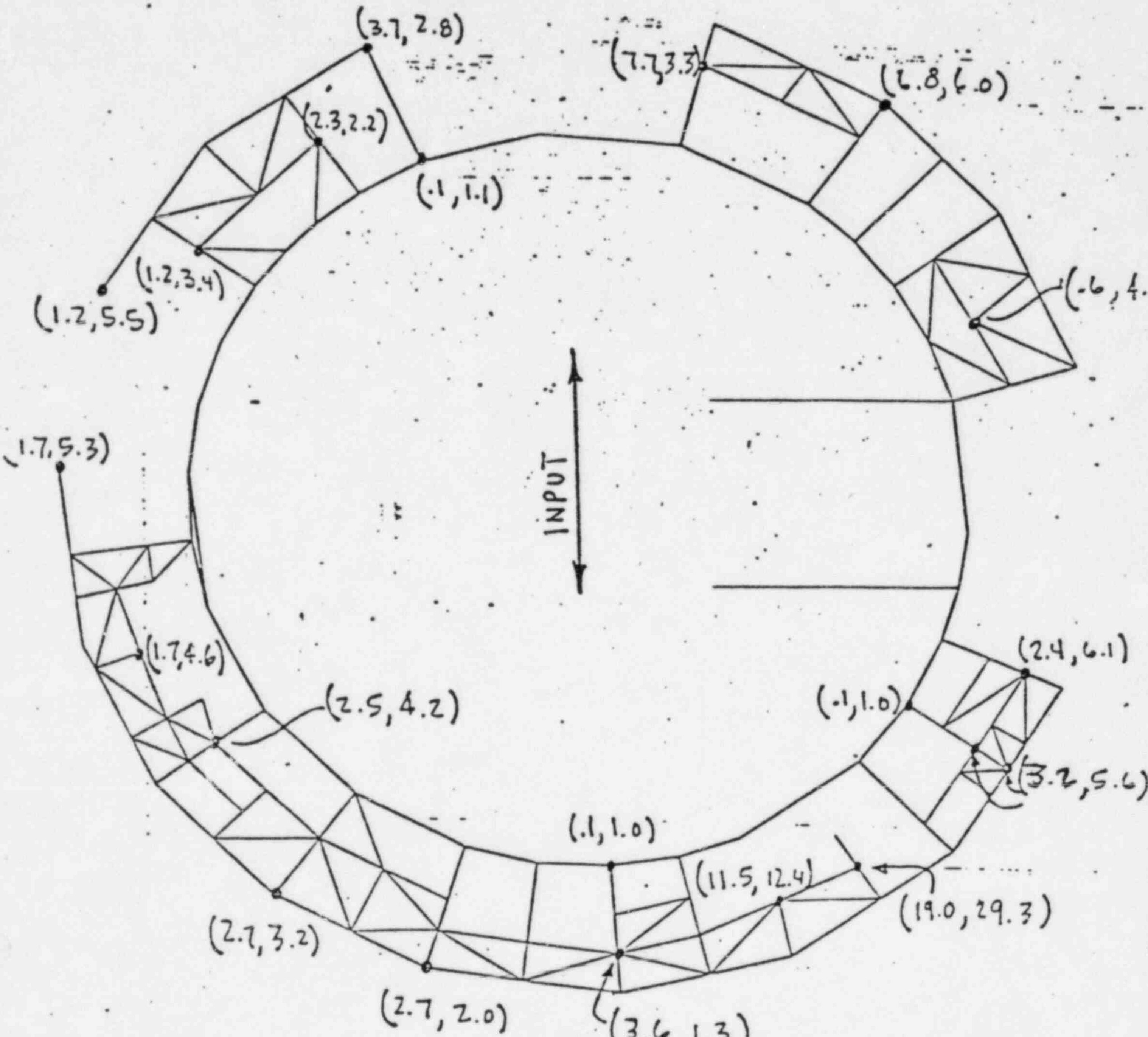
FLOOR #1



FLOOR #1

PEAK ACCELERATIONS (G'

(X, Z)



PEAK ACCELERATIONS

FLOOR #4

X INPUT (5.0, 1.1)

Z INPUT (1.0, 7.5)